Integrated Corridor Management

Integrated Corridor Management Concept Development and Foundational Research

Technical Memorandum

Task 2.3 — ICMS Concept of Operations for a Generic Corridor

April 18, 2006

Prepared for:
United States Department of Transportation
ITS Joint Program Office
FHWA
FTA

FHWA-JPO-06-032
EDL #14281

Technical Report Documentation Page

1. Report No. FHWA-JPO-06-032	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ICMS Concept of Operations for a Generic Corridor		5. Report Date April 18, 2006 6. Performing Organization Code JPO
7. Author(s) L. Neudorff, J. Harding, and L. Englisher		8. Performing Organization Report No. FHWA-JPO-06-032
9. Performing Organization Name and Address Siemens ITS, Suite 1900, 2 Penn Plaza, New York, NY 10121 Science Applications International Corporation, 1710 SAIC Dr. McLean, VA 22102 Transystems, One Cabot Road, Medford, Massachusetts 02155		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFH 61-C-01-00180 task order 2.3
12. Sponsoring Agency Name and Address United States Department of Transportation ITS Joint Program Office, HVH-1 400 7th Street SW Washington, DC 20590		13. Type of Report and Period Covered Tech Memo 14. Sponsoring Agency Code FHWA
15. Supplementary Notes FHWA Task Manager (COTR), John Harding		

16. Abstract

This Generic Concept of Operations for Integrated Corridor Management (ICM) has been developed as part of Phase 1 (Foundational Research) for the Federal Highway Administration and the Federal Transit Administration (FHWA/ FTA) Integrated Corridor Management Initiative. The basic premise behind the ICM initiative is that independent, individual network-based transportation management systems, and their cross – network linkages, can be operated in a more coordinated and integrated manner, thereby increasing overall corridor throughput and enhancing the mobility of the corridor users.

This document is intended as a high-level Concept of Operations (Con Ops) for a "generic" 15-mile corridor (Figure 1) consisting of freeway, arterial, bus and rail networks, and serving a central business district. The purpose of this (and any) Concept of Operations) is to answer the questions of who, what, when, where, why and how for the application of an Integrated Corridor Management System (ICMS) within the corridor. Given that an ICMS is a "system of systems", involving multiple agencies and stakeholders, it is also essential that the Con Ops define the roles and responsibilities of these participating agencies and other involved entities.

The generic Concept of Operations should be viewed as an example of an ICM Con Ops that can be used by agency and network owners as the basis for developing their own corridor-specific and real-world Concept of Operations. It is emphasized that this generic document is intended as guidance – not as a "template". Moreover, the generic corridor itself should not be construed as the optimum configuration for implementing ICM. It is only a tool to facilitate the development of this Con Ops example.
The generic ICM Concept of Operations identifies important areas, features and issues that must be addressed in any site-specific Concept of Operations for integrated corridor management. Moreover, the process of developing a Concept of Operations – the involvement of all appropriate stakeholders and their continuing interaction to develop an ICM vision, identify goals and objectives, determine corridor needs, specify approaches and strategies, and resolve the various integration issues – is probably more important that the actual document itself.

17. Key Words Integrated Corridor Management, Concept of Operations, ITS, Technology, Operational Characteristics, Operational Scenarios		18. Distribution Statement No restrictions	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 100	22. Price NA

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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PREFACE

Introduction And Background

This *Generic Concept of Operations for Integrated Corridor Management (ICM)* has been developed as part of Phase 1 (Foundational Research) for the Federal Highway Administration and the Federal Transit Administration (FHWA/FTA) Integrated Corridor Management Initiative. The basic premise behind the ICM initiative is that independent, individual network-based transportation management systems, and their cross-network linkages, can be operated in a more coordinated and integrated manner, thereby increasing overall corridor throughput and enhancing the mobility of the corridor users.

This document is intended as a high-level Concept of Operations (Con Ops) for a “generic” 15-mile corridor (Figure 1) consisting of freeway, arterial, bus and rail networks, and serving a central business district. The purpose of this (and any) Concept of Operations) is to answer the questions of who, what, when, where, why and how for the application of an Integrated Corridor Management System (ICMS) within the corridor. Given that an ICMS is a “system of systems,” involving multiple agencies and stakeholders, it is also essential that the Con Ops define the roles and responsibilities of these participating agencies and other involved entities.

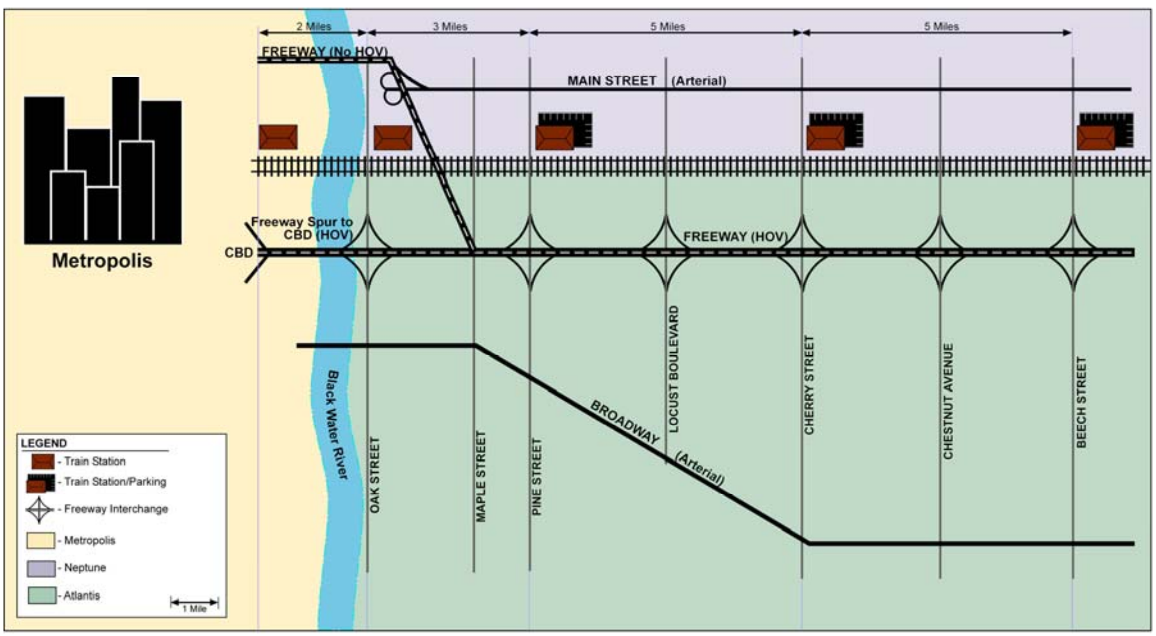

Figure 1. Schematic of Generic Corridor

The generic Concept of Operations should be viewed as an example of an ICM Con Ops that can be used by agency and network owners as the basis for developing their own corridor-specific and real-world Concept of Operations. It is emphasized that this generic document is intended as guidance, not as a “template.” Moreover, the generic corridor itself should not be construed as the optimum configuration for implementing ICM. It is only a tool to facilitate the development of this Con Ops example.

The generic ICM Concept of Operations identifies important areas, features and issues that must be addressed in any site-specific Concept of Operations for integrated corridor management. Moreover, the process of developing a Concept of Operations — the involvement of all appropriate stakeholders and their continuing interaction to develop an ICM vision, identify goals and objectives, determine corridor needs, specify approaches and strategies, and resolve the various integration issues — is probably more important that the actual document itself.

ICM Implementation Guidance

The development of a Concept of Operations is an important step in the overall process to plan and implement integrated corridor management. This process is documented in a companion ICM document entitled "*ICM Implementation Guidance.*" The Implementation Guidance document identifies and discusses the process steps needed to support the development, implementation, and operation of an ICM system. It is intended as a guide for transportation professionals who will be involved in some stage of the life-cycle for an Integrated Corridor Management System (ICMS).

The ICM Implementation Guidance is based on the principles of "systems engineering," a formal process by which quality is continuously promoted. The systems engineering process is often shown as a "V" (Figure 2) as a way of relating the different stages in the system life cycle to one another.

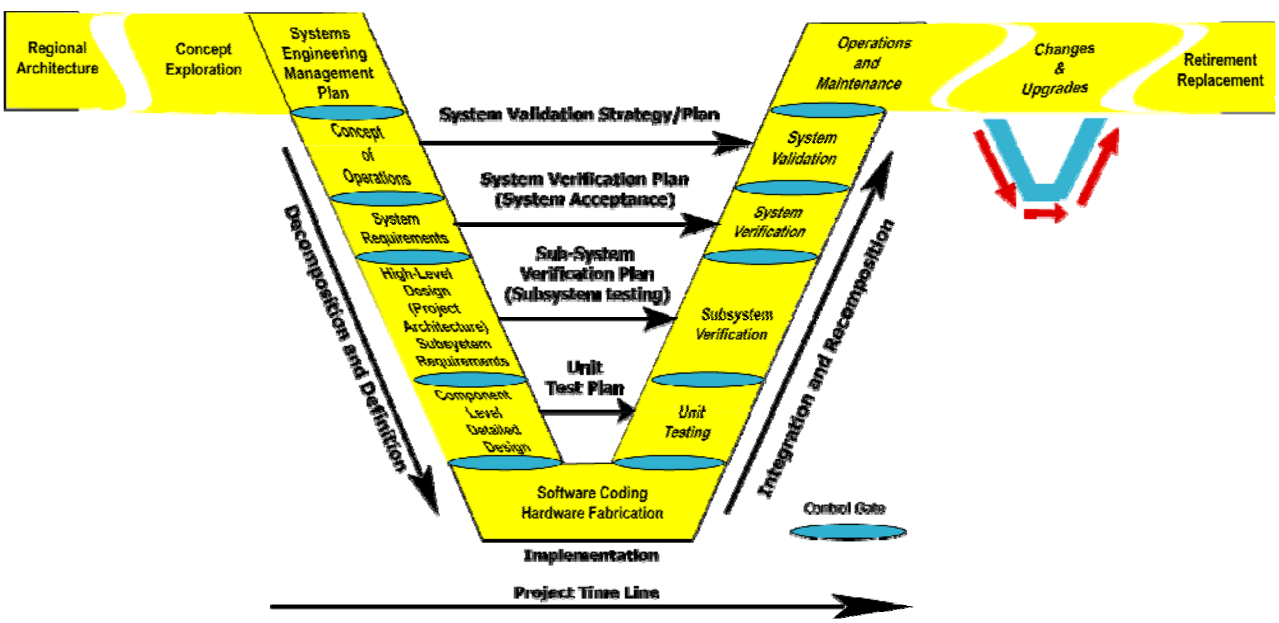

Figure 2. "V" Diagram

As shown in the diagram, the Concept of Operations is a relatively early activity in the overall process. Specific steps and activities that occur prior to or during the development of the Concept of Operations, all of which provide input to the Con Ops Document itself, are summarized below:

CONCEPT EXPLORATION

Functions:

- Identify Need for Corridor Management
- Establish Corridor Stakeholder Group
- Identify Potential Corridors and Initial Boundaries

Result: Stakeholders, Potential Corridor & Boundaries

SYSTEM CONCEPTION

Functions: Needs Analysis and ICM System Concept, including:

- Inventory Existing Systems /Data Collection
- Identify Current Corridor Conditions, Problems, and Needs
- Establish Corridor Vision and Goals
- Identify Potential ICM Approaches and Strategies
- Refine Corridor Boundaries
- Create Performance Measures and Metrics
- Define Proposed Changes
- Develop a System Concept
    - Align with the Regional ITS Architecture
    - Identify Operational Scenarios
    - Identify Implementation Issues (Operational, Technical, and Institutional)

Result: Concept of Operations

Concept Of Operations

As discussed in the ICM Implementation Guidance, the Concept of Operations is a formal document that provides a user-oriented view of integrated corridor management, the ICM approaches and strategies, and the associated operations. It is developed to help communicate this view to the stakeholders and to solicit their feedback. The Concept of Operations documents the results and findings from the “Concept Exploration” and “System Conception” stages, laying out the ICM concept, explaining how things are expected to work once it is in operation, and identifying the responsibilities of the various stakeholders for making this happen. The Concept of Operations documents answers to the following questions:

- What – the known elements and the high-level capabilities of the system.
- Where – the geographical and physical extents of the system.
- When – the time-sequence of activities that will be performed.
- How – resources needed to design, build, operate, and maintain the system.
- Who – the stakeholders involved with the system, and their respective responsibilities.

- Why – justification for the system, identifying what the corridor currently lacks, and what the system will provide.

The Concept of Operations does not delve into technology or detailed requirements of the ICMS; but it does address the operational scenarios and objectives, information needs, and overall functionality. The Concept of Operations must also address the "institutional" environment in which integrated corridor management must be deployed, operated, and maintained. Paraphrasing the "IEEE Guide for Concept of Operations" document and the FHWA document "Developing and Using a Concept of Operations in Transportation Management Systems," a Concept of Operations provides several benefits, including:

- Providing a means for engaging ICM stakeholders and soliciting their input as to their respective desires, visions, and expectations (without requiring them to provide quantified, testable specifications), as well as their thoughts and concerns on possible solution strategies.
- Providing a means of describing stakeholders' operational needs for ICM, without bogging down in detailed technical issues.
- Identifying the institutional, technical and operational environment in which ICM will function.
- Formulating and documenting high-level definitions and descriptions of integrated corridor management system and any changes to the associated network systems.

Definitions

Definitions are important as they provide the basis for a common understanding, thereby facilitating communication and discussion among ICM stakeholders.

Integrated Corridor Management

Integrated corridor management consists of the operational coordination of multiple transportation networks and cross-network connections comprising a corridor, and the coordination of institutions responsible for corridor mobility. The goal of ICM is to improve mobility, safety, and other transportation objectives for travelers and goods. ICM may encompass several activities, for example:

- Cooperative and integrated policy among stakeholders.
- Concept of operations for corridor management.
- Communications among network operators and stakeholders.
- Improving the efficiency of cross-network junctions and interfaces.
- Mobility opportunities, including shifts to alternate routes and modes.
- Real-time traffic and transit monitoring.
- Real-time information distribution (including alternate networks).
- Congestion management (recurring and non-recurring).
- Incident management.
- Travel demand management.
- Public awareness programs.
- Transportation pricing and payment.

Integrated Corridor Management may result in the deployment of an actual transportation management system (ICMS) connecting the individual network-based transportation management systems (complete with ICMS central hardware and servers, data base, decision support software, joint sharing of command and control activities, etc.); or integrated corridor management may just be a set of operational procedures, agreed to by the network owners, with appropriate linkages between their respective systems. Regardless of the type of "system" deployed, the process steps and associated activities identified herein are directly applicable.

Corridor

From the perspective of the ICM initiative, a "*corridor*" has been defined as a largely linear geographic band defined by existing and forecasted travel patterns involving both people and goods. The corridor serves a particular travel market or markets that are affected by similar transportation needs and mobility issues. The corridor includes various networks (e.g., limited access facility, surface arterial(s), transit, bicycle, pedestrian pathway, waterway) that provide similar or complementary transportation functions. Additionally, the corridor includes cross-network connections that permit the individual networks to be readily accessible from each other. The term "*network*" is used in the corridor definition to denote a specific combination of facility type and mode.

Integration

The definition of ICM includes the term "coordination" multiple times. Such coordination, and the associated network interconnection and cross network management, requires "**integration,**" a term defined in the dictionary as "making into a whole by bringing all parts together." In the context of ICM, integration is a bridging function between the various networks that make up a corridor, and involves processes and activities that facilitate a more seamless operation. In order to implement ICM, the transportation networks within a corridor (and their respective ITS systems) need to be "integrated" in several different ways, specifically:

- **Operational integration** may be viewed as the implementation of 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, and facilitate management of the total capacity and demand of the corridor.
- **Institutional integration** involves the coordination and collaboration between various agencies and jurisdictions (network owners) in support of ICM, including the distribution of specific operational responsibilities and the sharing of control functions in a manner that transcends institutional boundaries.
- **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, and by which the impacts of operational decisions can be immediately viewed and evaluated by the affected agencies.

These various aspects of integration must be addressed within the ICMS Concept of Operations to varying degrees of detail, with most of the emphasis being on operational and institutional integration, and less on technical integration. It is also noted that the various issues associated with operational, institutional and technical integration are closely related and interdependent.

Document Layout and Use

As noted at the beginning of this Preface, the following document is intended as a high–level Concept of Operations (Con Ops) for a generic corridor, providing an example of an ICMS Con Ops that can be used by agency and network owners as the basis for developing their corridor-specific and real-world Concept of Operations. The layout and content is loosely based on the document "Developing and Using a Concept of Operations in Transportation Management Systems"[1] as developed for the FHWA Pooled Fund Study (and hereinafter referred to as "PFS Reference"). That document, along with its primary reference, the ANSI/AIAA Concept of Operations Standard, recommends a significant amount of repetition in a Concept of Operations. This generic Concept of Operations has been developed to minimize such repetition, thereby keeping the document relatively brief and easier to use as a guide that focuses more on content rather than form.

Each chapter follows the same basic format: a brief **Overview** describing the purpose of the chapter (i.e., what it is supposed to accomplish). Each section within a chapter begins with a brief **Guidance** box identifying the purpose of the section; followed by Con Ops text for the generic corridor.

As previously noted, the generic corridor should be viewed as a tool to facilitate the development of this Con Ops example. Moreover, the generic corridor and the associated Concept of Operations does not attempt to be all-inclusive with respect to the types of networks that might be included within a corridor, the ICM stakeholders, and the operational approaches and strategies to be deployed. Additionally, much of the information made regarding "existing" conditions within the generic corridor (e.g., traffic flow and transit usage, technologies deployed within the individual network systems, proposed functionality of a regional architecture, etc.) has been fabricated, based on the experience and realities of the Project Team's collective experience, thereby providing a basis for describing the ICM operational concepts herein. The Con Ops for a real corridor will likely have more information.

The actual situation for most real-world corridors will undoubtedly be different from this generic corridor in terms of network types and other corridor characteristics, stakeholders, institutional and technical environment and the ICM concept and operational capabilities as discussed herein. Accordingly, the information within each chapter of this generic Con Ops should be utilized to tailor a site-specific ICM Concept of Operations to meet any and all unique corridor conditions. Finally, it is again emphasized that the document format and description of ICM elements provided herein exist as a guideline of things to include in a corridor-specific Con Ops. Just as this generic Con Ops does not follow verbatim the Con Ops layout identified in the PFS reference, it is not necessary for the user to perfectly match the structure of this generic document.

[1] *Developing and Using a Concept of Operations in Transportation Management System*, FHWA TMC Pooled-Fund Study (http://tmcpfs.ops.fhwa.dot.gov/cfprojects/new_detail.cfm?id=38&new=0.

1 Scope and Summary

Overview – The Scope and Summary Chapter has the dual role of introducing to the reader both the document and to the ICM system. In essence, it serves as an executive summary for the Concept of Operations document. Many readers may not get any further than the initial Scope Chapter. Accordingly, a reader should be able to walk away from reading the scope with a high-level understanding of the ICM system and its mission; as well as what to expect in the remainder of the document should they decide to continue on.

1.1 Introduction and Document Contents

This is the "Concept of Operations" for an Integrated Corridor Management System (ICMS) to be deployed along the Generic Corridor located within the Cities of Neptune and Atlantis, and serving the Metropolis Central Business District as well as the suburban and commercial areas beyond the aforementioned cities. This document provides a user-oriented view of the system concept. It does not delve into technology or technical details. Rather, it focuses on the corridor's needs and problems, goals and objectives, the proposed operational approaches and strategies for attaining these goals, the institutional framework in which the ICMS will operate, and the associated operational, technical, and institutional issues that must be addressed. It has been developed to help communicate this view to the corridor stakeholders (i.e., any person or group with a direct interest in the integrated operation of the Generic Corridor and the associated networks[2] and cross-network linkages) and to solicit their feedback. In essence, the Concept of Operations lays out the ICMS concept, explains how things are expected to work once it's in operation, and identifies the responsibilities of the various stakeholders for making this happen.

The Concept of Operations consists of several chapters and sections as summarized in Table 1-1.

Table 1-1. Layout – ICMS Concept of Operations

1.	**Scope and Summary**	
		Introduction and Document Comments
		ICM Corridor Boundaries and Travel Characteristics
		Corridor Stakeholders and Users
		Need for Integrated Corridor Management (ICM)
		ICM Vision, Goals and Objectives
2.	**References**	

[2] The term "network" is used to denote a specific combination of transportation facility and mode.

Table 1-1. Layout – ICMS Concept of Operations (continued)

3.	**System Overview and Operational Description**	
		Corridor Boundaries and Networks Corridor Stakeholders Operational Conditions of the Generic Corridor and Included Networks Existing Network-based Transportation Management/ ITS Assets Proposed Near-Term Network Improvements Current Network – Based Institutional Characteristics Regional ITS Architecture Review Individual Network and Corridor Problems, Issues, and Needs Potential for ICM in the Generic Corridor Generic Corridor Vision
4.	**ICM System Operational Concept**	
		Corridor Goals and Objectives Application of ICM Approaches and Strategies ICM Concept Asset Requirements and Needs Comparison of ICM Asset Requirements with Current/Proposed Assets Generic Corridor Concept Operational Description Alignment with Regional ITS Architecture Implementation Issues Generic Corridor ICM Concept Institutional Framework Performance Measures and Targets
5.	**ICM Operational Scenarios**	

		Daily Operational Scenario
		Scheduled Event Scenario
		Incident Scenarios
		    Minor Traffic Incident
		    Major Traffic Incident
		    Minor Transit Incident
		    Major Transit Incident
		Major Planned Special Event Scenario
		Evacuation Scenario

1.2 ICM Corridor Boundaries, Networks and Stakeholders

The Generic Corridor is a largely linear band, approximately 15 miles in length, consisting of a freeway, adjacent arterials, and a parallel rail system as shown in Figure 1-1. The generic corridor is primarily a commuter corridor utilized for travel between the central business district of employment (in Metropolis) and commercial areas and suburban residential areas. At one end of the corridor is the Black Water River, which is the jurisdictional boundary for Metropolis. On the other side of the river, the Generic Corridor is divided between two cities – the City of Neptune is to the north of the rail line, and the City of Atlantis is to the south of the rail line. The Black Water River is crossed by four bridges – one for the freeway, one each for the freeway spur and the Broadway arterial (both of which empty into the central business district), and a railway bridge for the regional rail service.

The corridor is part of the Black Water River Metropolitan Planning Organization (BWRMPO) region and also part of an inter-regional multi-state corridor that is designated as an evacuation route. The networks comprising the generic corridor and their respective characteristics are summarized below:

- **Freeway Network** (including a spur into the CBD), operated by the State DOT — three travel lanes in each direction, with one of the lanes designated as HOV-3 during the peak hours (and open to all traffic during non-peak hours). The HOV lanes operate on the freeway spur; but not on the segment of the freeway that by passes the CBD.
- **Arterial Network** – Two arterial networks on opposite sides of freeway, with Main Street located in Neptune, and Broadway located in Atlantis, with each operated by their respective City Departments of Public Works/Transportation. Each arterial has two travel lanes in each direction, with no parking. Signalized intersections are spaced nominally at one-half mile intervals. Broadway links directly to a bridge crossing the Black Water River, entering the Metropolis CBD.
- **Regional Rail Network**, operated by the Regional Rail Agency — Two tracks (one in each direction), and 5 stations located within the corridor, with bus stops at each terminal and Park & Ride facilities at the three outer stations.
- **Bus Transit Network**, operated by the Generic Bus Authority — Local bus service operating on Main Street and Broadway, with bus stops every one-half mile (approximately), including the rail stations (except the Metropolis CBD Station) for the Main Street service. There is also an express bus service (originating outside the corridor) operating in the freeway HOV lanes, leaving the freeway and servicing the Beech Street and Cherry Street rail terminals within the Generic Corridor.

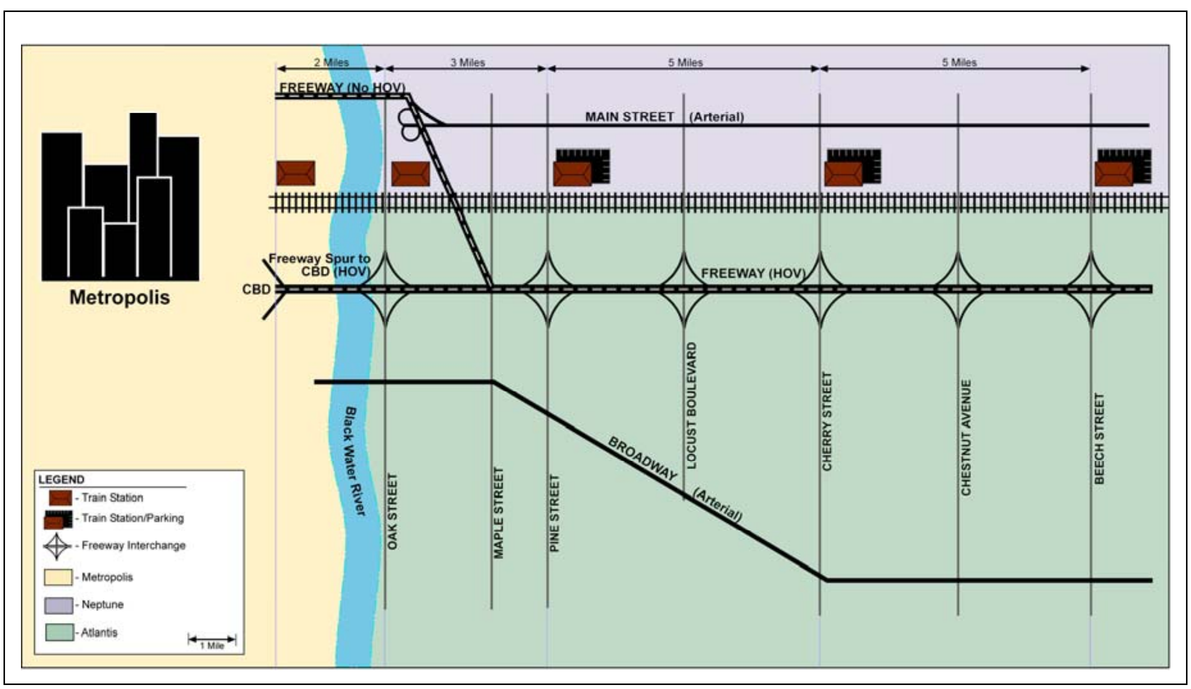

Figure 1-1. Map of the Generic Corridor

Those with operational and management responsibilities for the individual networks are shown graphically in Figure 1-2. The Generic Bus Authority operates on all of the roadway networks. Enforcement, security, and accident investigation on these networks are the responsibility of the state police (freeway), the Neptune Police, the Atlantis Police, and the Rail Agency Police. Ambulance services and HAZMAT clean-up are the responsibility of the local fire departments.

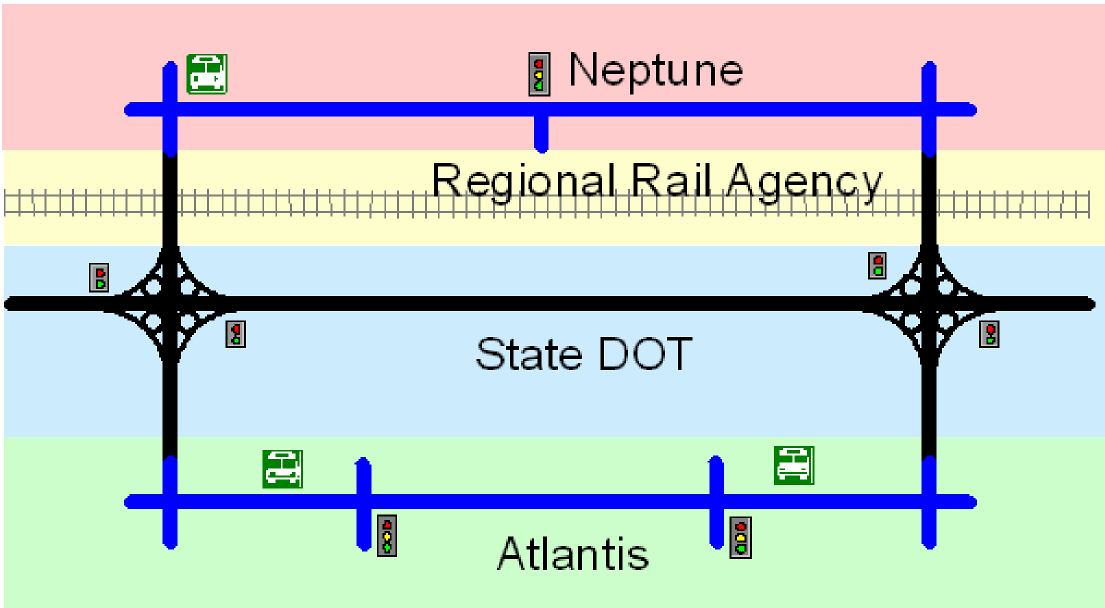

Figure 1-2. Operational Responsibility for Corridor Networks

The ICM stakeholders for the generic corridor are listed in Table 1-2, all of which were involved to some extent in the development of this Concept of Operations.

Table 1-2. Generic Corridor Stakeholders

• State department of transportation (DOT) • Neptune Department of Transportation • Atlantis Department of Public Works • Metropolis Department of Transportation • Regional Rail Agency • Generic Bus Authority • Black Water River MPO • State Police • Neptune Police • Atlantis Police • Rail Agency Police	• Fire Departments (include ambulance service and HAZMAT) • AAA (representing users of the roadway) • Visitors Bureau (representing tourists that use the corridor) • Strap Hangers Association (representing transit riders) • FHWA • FTA • DHS/FEMA • Courier fleets (e.g. US Postal Service, Federal Express, UPS) • Information Service Providers

1.3 Corridor Operating and Institutional Conditions

The Generic Corridor provides transportation for the movement of commuters, freight, recreational, and other traffic, with commuter traffic comprising 70 percent of the travel market during peak periods. Traffic congestion along the roadway-based networks is a growing problem in the Generic Corridor, particularly during the peak periods. For example:

- The regular freeway lanes operate with an average peak period speed of approximately 35 mph; although the freeway HOV lanes operate at an average peak period speed of 55 mph.
- The two arterial facilities, Main Street and Broadway, both operate at an average peak period speed of 25 mph.
- With respect to transit operations within the corridor, the roadway congestion problems have also degraded the operation of the buses – particularly on the arterials and surface streets – making it increasingly more difficult for buses to maintain their published schedule. Specifically, 30 percent of the buses operating along the two arterials run behind schedule during the peak period.
- The express buses, which operate primarily within the HOV lanes of the freeway, also experience delays when moving out of the HOV lanes to exit the freeway and traveling along the arterials to service the rail stations. The peak period express bus service runs behind schedule 15 percent of the time.
- The regional rail service has an excellent on-time performance record (better than 95 percent). The increasing roadway congestion has increased rail ridership to some extent; but it is still under-utilized in terms of its available passenger-carrying capacity, even during the peak travel periods. This is due, in part, to a relatively limited number of parking spaces at some of the rail stations.

The congestion problems have resulted in a number of serious mobility related issues, such as loss of personal and professional time, increased fuel consumption, environmental degradation, and traveler frustration. As congestion and delays have increased, actual throughput corridor-wide has actually declined.

Due to the high percentage of freeway incidents, including weather-related problems – which combined account for more than half of the freeway congestion – travel reliability along the freeway is very low. The average freeway travel time can fluctuate by as much as 100 percent on a day-to-day basis depending on the location and severity of the incident. Moreover, freeway incidents often result in a shift of trips from the freeway to the arterials, resulting in a 50 percent increase in arterial travel time, with a concomitant impact on the reliability of bus operations along the arterials.

The various transportation agencies and public safety agencies within the Generic Corridor have implemented a variety of policies, strategies, and Intelligent Transportation Systems (ITS) technologies to improve performance of their respective networks. For example:

- State DOT – a freeway management system incorporating roadway surveillance (detectors and CCTV); incident management procedures for detection and response, including freeway service patrols; Dynamic Message Signs (DMS) at selected locations along the freeway; and ramp metering. The State DOT also operates a website that provides real – time information on freeway operations.

- Neptune and Atlantis – traffic signal control systems along the length of Main Street and Broadway, providing coordinated signal operation on a time-of-day/day-of-week basis. No surveillance is provided along the arterials except for local actuation detectors on the approaches to the signalized intersections. There is also CCTV at the major intersections.
- The Regional Rail Agency and the Generic Bus Authority have each implemented transit management systems to improve service to their customers, including automated vehicle location (AVL) systems with schedule adherence capabilities. Both agencies also operate websites that provide real – time information on the operations of their respective transit networks.
- The police and fire departments utilize a computer – aided dispatch (CAD) system.

The current Transportation Improvement Plan (TIP) includes an array of improvements and enhancements to these ITS-based transportation management systems, such as a new road – weather information system and additional DMS and CCTV along the freeway, HOV by-pass capability at the metered freeway on-ramps, enhanced communications subsystem for the Atlantis and Neptune signal systems, and In-terminal/wayside DMS (e.g. next train/bus arrival) at all stations and bus stops. Additionally, the Generic Bus Authority and the Regional Rail Agency have entered into an inter-agency agreement for the development of a combined smart card payment system for both bus and train fares – an improvement that will eventually cover the region.

These agency–specific systems, strategies and technologies have provided benefits in the context of their individual networks. However, the institutional fabric within the Generic Corridor is multi-agency, multi-functional, and multi-modal; and the authority for transportation-related decision-making is dispersed among the different agencies. As such, the management and operations of the various networks in the Generic Corridor (and the supporting ITS-based systems) have tended to be "stovepiped," with minimal communications between the transportation networks and their operators except for major events and incidents. On a day-to-day operating basis, the corridor consists of independent networks and systems. For example:

- Traveler information is available, but it is relatively sparse and incomplete from a corridor perspective. Moreover, travelers must go to separate web sites to obtain pre-trip information.
- Another important source of corridor information is the Police and Fire Departments' Computer Aided Dispatch (CAD) System that supports emergency call taking and dispatch; although it is currently only accessible by the police and fire units.
- There are limited means by which route and modal shifts between networks can be readily accommodated, due to a lack of real – time information on the status/spare capacity of some of the networks and junctions (e.g., the arterial streets and the rail station park and ride lots), the inability to readily change the operating parameters of these networks (e.g., arterial signal timing, ramp metering rates), or some combination.

- There is no coordination between the arterial signal timing and bus operations, such as providing signal priority to those buses that are running behind schedule.
- This lack of coordination also exists between rail and bus schedules and their respective operations (e.g., “just-missed” bus-rail connections that increase a rider’s wait time and level of frustration).

That said, the current institutional environment does offer more opportunities than constraints in support of Integrated Corridor Management. For example, task forces have been established for the many special events held in Metropolis. These special event task forces address the impact of these events, looking at all aspects of venue management including transportation. Through the task force, a central command for transportation is established in advance that coordinates the planning, preparations, and event-day operations command. However, after each event, the task force – including the central command – is disbanded and all central command protocols are relinquished.

The generic corridor is also part of a broader Regional ITS Architecture, in which all the Generic Corridor Stakeholders participated. The BWRMPO took the lead in developing the Regional ITS Architecture, including the establishment of a “Regional ITS Architecture Committee.” This Committee maintains the architecture, and has the authority to establish sub-committees and coordinate the procurement of ITS projects. The Regional ITS Architecture promotes system integration (refer to Table 1-3), but given that none of the attributes have been deployed, it has had limited effect on coordinating regional transportation management and operational activities.

The coordination facilitated by the Regional ITS Architecture Committee and the special event centralized command model indicates that an institutional structure to support ICM could be established.

Table 1-3. Attributes of Regional ITS Architecture

• Real -time information sharing (data, video) between all agencies. • Clearinghouse of real-time information covering all critical routes and modes. This ATIS database integrates available information from agency-specific systems to provide a composite picture of the real-time status of the surface transportation network. • Regional coordination support between transportation agencies and public safety agencies during "major" incidents, construction activities and special events (i.e., those for which the impacts cross most of the agency boundaries). • A regional payment/financial clearinghouse, by which the same ETC tag/smart card can be used to pay transit fares, tolls and parking in the region. • It does not include inter-agency operations or control of system components.

1.4 Need and Potential for Integrated Corridor Management

The basic premise behind the proposed Integrated Corridor Management System (ICMS) is that the various networks that comprise the generic corridor, and their associated systems, can be operated in a more "integrated" manner though the use of currently available technologies. It is anticipated that by "linking" the adjacent networks into an ICMS – in essence, creating a "system of systems" – the benefits currently provided by the individual network-specific transportation management systems will be further enhanced.

By definition, "Integrated Corridor Management" focuses on the operational, institutional, and technical coordination of multiple transportation networks and cross-network connections comprising a corridor. ICM can encompass several activities which address the operational problems and needs previously identified. Moreover, the ICMS concept will address several of the corridor issues and needs identified by the stakeholders during interviews and a workshop, as summarized in Table 1-4.

Table 1-4. Major Corridor Issues and Needs (as Identified by Stakeholders)

• More of a "corridor-wide" and multi-modal view of ITS and operations • Improved coordination, communication (i.e., information sharing) and integration between all transportation stakeholders. This is done to some extent for special events; but needs to be expanded to cover day-to-day operations and minor incidents. • Information clearinghouse available to all transportation stakeholders (including emergency services, commercial vehicles, tourism, travelers etc.) with a single graphical representation and common geo-referencing. • More standardization and system interoperability within and between all stakeholders. Focus of standards should be on interoperability/integration. • Improved operational coordination of networks in the corridor, particularly at junctions, such as freeway ramps and connecting arterial signals, signalized intersections and bus operations, transfers between rail and bus) • Accurate models to simulate corridor operation under various scenarios • Joint use of resources and infrastructure (e.g., service patrols, DMS) leveraging equipment use between agencies. • Increased public outreach; educate about the benefits of ITS and operations.

Table 1-4. Major Corridor Issues and Needs (as Identified by Stakeholders) (continued)

• Travel information presented consistently throughout the region (seamless to the traveler), such as travel times.
• Increased transit usage within the corridor; this should also help alleviate roadway congestion
• Coordinated and efficient responses to incidents involving all agencies (transportation, police and fire), including integration of incident command structure and emergency procedures.
• Methods (performance measures) for screening, monitoring and evaluating corridor-based strategies and operations to determine whether deployments are successful, meet agency goals and are cost-effective.

1.5 ICM Vision, Goals and Objectives

The Generic Corridor stakeholders have established the following vision:

> *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.*

Using the vision statement as a starting point, and with due consideration of the Generic Corridor conditions, deficiencies and needs, the corridor stakeholders developed ICMS goals and objectives as summarized in Table 1-5.

Table 1-5. ICMS Goals & Objectives

• **Corridor Perspective** – A corridor perspective must be established among all the entities in the corridor. A single network's goals and objectives cannot take precedence over the other combined networks' goals and objectives. A corridor perspective will be established through institutional integration and the development of common performance measures. All entities will take on appropriate responsibilities and share levels of control. Associated objectives include an ICMS funding structure, ITS standards, and corridor-based performance monitoring.
• **Corridor Mobility and Reliability** – The transportation agencies within the corridor have done much to increase the mobility and reliability of their individual networks, and will continue to do so. The integrated corridor perspective builds on these network initiatives, managing delays on a corridor basis, utilizing any spare capacity within the corridor, and coordinating the junctions and interfaces between networks, thereby providing a multi-modal transportation system that adequately meets customer expectations for travel time predictability. Associated objectives include reducing overall trip and person travel time through the corridor, improving travel predictability, increasing transit ridership, and improving commercial vehicle operations through and around the corridor.

Table 1-5. ICMS Goals & Objectives (continued)

• **Corridor Traveler Information** – Travelers must be provided with a holistic view of the corridor and its operation through the delivery of timely, accurate and reliable multimodal information, which then allows travelers to make informed choices regarding departure time, mode and route of travel. Associated objectives include expanding the network coverage and types of information gathered on corridor conditions (e.g., arterials, weather, air quality), providing a complete ATIS database with traveler information presented in a consistent matter (including a single graphical display of the corridor and all networks), and expanding the coverage and availability of ATIS devices.
• **Corridor Event and Incident Management** – Provide a corridor-wide and integrated approach to the management of incidents, events, and emergencies that occur within the corridor or that otherwise impact the operation of the corridor, including planning, detection and verification, response and information sharing, such that the corridor returns back to “normal conditions” as quickly as possible. Associated objectives include improve pre-planning and provide a coordinated response for incidents, events, and emergencies that have corridor and regional implications (e.g., common command structure), and develop a comprehensive training program involving all corridor networks and public safety entities.

These corridor-wide goals and objectives are interrelated such that activities and strategies oriented towards attaining one of the goals will likely impact (usually in a complementary fashion, but not always) the attainment of other goals and objectives. They also recognize that the traveler’s (i.e., the customer’s) perspective is that there is only one surface transportation system; and that the public generally does not care which jurisdiction or agency is responsible for the road or transit network on which they are currently traveling. As taxpayers and fare/toll payers, they want and deserve a safe and reliable trip – one that provides a consistent level-of-service with minimal congestion, and is predictable in terms of travel time. They also deserve accurate and timely information so that they can make informed decisions before and during trips.

1.6 ICM Operational Approaches and Strategies

Several ICM strategies were identified by the corridor stakeholders based on their contribution to achieving the Generic Corridor goals and objectives. These strategies can be categorized by the following ICM approaches:

- **Information Sharing/Distribution**: Real-time information (data and video) will be shared all stakeholders and their respective systems, and combined into an information clearinghouse that can be viewed by all the stakeholders and form the basis for a corridor-based advanced traveler information system (ATIS) database that provides information to travelers pre-trip (e.g., via websites and 511). Information Service Providers (ISPs) and other value-added entities will also have access the corridor ATIS database. En-route traveler information devices (DMS, transit public announcement systems) will be used to describe current operational conditions on another network(s) within the corridor**.** These and other strategies within the “Information Sharing/Distribution” Approach will provide the informational foundation for ICM operations. This is the first step to the integration of the individual network systems. The focus on travelers is supported by the trip information services that will be implemented.
- **Improve the Operational Efficiency of Network Junctions and Interfaces**: Representative strategies include signal priority for the Generic Bus Authority

vehicles (e.g. extending green times to buses that are operating behind schedule) along Main Street and Broadway; transit hub connection protection (e.g., holding buses at rail stations while waiting for a regional rail service to arrive); multi-agency/multi-network incident response teams and service patrols; and coordinated operation between ramp meters and arterial traffic signals in close proximity. These “Improve Operational Efficiency” strategies address many of the corridor deficiencies that affect the efficiency of transit operations, and their implementation will reduce travel times and increase the reliability of the Generic Bus Authority operations, as well as enhancing the convenience of rail travel. The strategies use cross-network operations to improve each individual network’s performance by taking advantage of another network’s functions. This, in turn, builds a foundation for a corridor perspective as well as changing the focus to the traveler’s trip performance.

- **Accommodate/Promote Cross-Network Route and Modal Shifts**: In general, the ICMS will merely provide information (“inform”) to users via the information sharing strategies and accommodate any user-determined network shifts (e.g., modify arterial signal timing to accommodate traffic shifting from freeway, modify ramp metering rates and HOV by-pass policies to accommodate traffic and buses shifting from arterials to the freeway, modify transit priority parameters to accommodate more timely bus service on Main Street and Broadway). During major incidents and events, and if agreed to by all affected stakeholders, network shifts will be promoted (“instruct”) using the various ATIS devices. “Accommodating/promoting shifts” among networks makes efficient use of any spare capacity within the corridor to better manage congestion and facilitate reliability. Shifting trips among corridor networks, whether via “inform” of “instruct,” is the essence of a corridor perspective and supports a traveler focus by informing corridor users of all their transportation alternatives and the conditions on each.
- **Manage Capacity – Demand Relationship Within Corridor – “Real-Time”/Short Term**: The implementation of cross-network shifts assumes that spare capacity exists on the adjacent networks and the cross-network linkages and junctions (e.g. park and ride facilities). If not, it may be necessary either to temporally increase the capacity of these alternate networks and/or reduce the corridor demand. For example, coordinate scheduled maintenance and construction activities among the corridor networks such that the total corridor capacity (i.e., the sum of the individual network capacities) is not reduced below some minimum acceptable level as determined by the stakeholders; add transit capacity by adjusting headways and number of vehicles on the Regional Rail network and the Generic Bus Authority service; increase roadway capacity by opening the freeway HOV lanes/shoulders; modify HOV restrictions (increase minimum number, make bus only); modify transit fares to encourage ridership; modify parking fees; restrict/reroute commercial traffic; etc. The “Manage Capacity-Demand Relationship (short-term)” approach provides operational strategies that further enhance corridor mobility and reliability. As a general rule, these strategies will be deployed only during major incidents, events, and/or emergencies.
- **Manage Capacity – Demand Relationship Within Corridor – Long Term**: These strategies – such as low-cost infrastructure improvements to cross-network linkages and junctions, guidelines for work hours during

emergencies/special events, and other TDM activities – are considered “long term” in terms of the amount of time required for developing and deploying the strategies, and/or the time required for the desired results to accrue. This approach addresses the lack of adequate parking for the Regional Rail service and any other physical constraints that may limit integrated operations.

There is great potential to enhance current and near-term operations within the Generic Corridor by implementing the ICMS and the cross-network operational strategies summarized above. All of these enhancements would not be possible from an independent network operational perspective.

1.7 ICM Concept Operational Description

In the future, the Generic Corridor ICMS will provide, to the greatest extent possible, efficient and reliable travel throughout the Generic Corridor and the constituent networks, resulting in improved and consistent trip travel times. Using cross-network strategies, the Generic Corridor will capitalize on integrated network operations to manage the total capacity and demand of the system in relation to the changing corridor conditions.

The daily operation of the corridor will be similar to the transportation command center model that has been used for major special events; but will now be applied on a permanent basis for day-to-day operations. This will be accomplished via a virtual **Corridor Command Center (CCC)** operating among the corridor agencies. This virtual corridor command center will operate the ICMS as a “sub-regional” system managing the various networks and influencing trips that use the corridor. The virtual command center will consist of agency, network, and public safety **Agency/Service Operations Officers (ASOs).** The ASOs will be designated by their respective organizations and approved by a centralized decision-making body established for the Generic Corridor. Each agency/service officer will be in charge of a specific corridor network or service with respect to ICM operations and coordination. The ASOs, with approval of the central body, will also designate a **Chief Corridor Operations Officer (CCOO)** every three years. The chief operations officer responsibilities will consist of coordinating corridor operation on a daily basis and managing the response to any fluctuations in capacity and or demand.

All operations among corridor networks and agencies (e.g., activation of specific ICM strategies) will be coordinated by the corridor command center. The CCC will investigate and prepare corridor response plans for various scenarios that can be expected to occur within the Generic Corridor. The chief corridor operations officer will be responsible, with the other agency/service operations officers, for configuring the CCC with respect to its functions and staffing for all hours of operations. Staff will be assigned by the corridor stakeholders to support daily operations, develop response plans, analyze system deficiencies and needs, and general administration. Performance measurement and monitoring will also be the responsibility of the corridor command center. The agency/service operations officers, led by the chief corridor operations officer, will be accountable to a centralized decision-making body and make reports as the decision-making body designates.

Communications, systems, and system networks will be integrated to support the virtual corridor command center. Voice, data, video, information, and control will be provided to all agencies based on the adopted protocols and standards for the sharing of information and the distribution of responsibilities. The ICMS will support the virtual nature of the corridor command center by connecting the chief, agency/service operations officers, and other critical staff on a real-time basis via communications and other ITS technologies. The chief corridor operating officer, ASOs, and other CCC staff will monitor corridor travel conditions 24/7, and use the response plans, real-time information, and the implemented corridor strategies to address any conditions that present themselves. While all the ICMS operational strategies will be available for use, it is envisioned that only a subset of these strategies will be activated at any one time, depending on the operational conditions and events within the corridor.

The corridor command center will conduct desktop scenario sessions to prepare, train and refine response plans for incidents, special events, weather, and evacuations. All the agency/service operations officers and staff will know their respective roles and responsibilities and will be aided, when available, by response plans and ICMS decision support software. Moreover, agency operations officers will be able and authorized to improvise as situations may dictate.

Traveler information (on 511, websites, DMS, and through the media and ISPs) will be corridor-based, providing information on corridor trip alternatives complete with current and predicted conditions. Travelers will access or be given real-time corridor information so they can plan or alter their trips in response to current or predicted corridor conditions.

Each traveler will be able to make route and modal shifts between networks easily due to integrated corridor information, integrated fare/parking payment system, and coordinated operations between networks. Using one network or another will be dependent on the preferences of the traveler, and not the nuances of each network. Travelers will be able to educate themselves about the corridor so they can identify their optimal travel alternatives and obtain the necessary assets (e.g., smart card, available parking) to facilitate their use of corridor alternatives when conditions warrant.

1.8 Required Assets and ICMS Implementation Issues

As previously noted, the various transportation and public safety agencies within the Generic Corridor have implemented a variety of policies, strategies, and ITS technologies – that is, “assets” – to improve performance of their respective networks. Nevertheless, additional corridor assets are required to implement and support the operational strategies and for the ICMS to meet the corridor goals and objectives. The most significant of these proposed changes (from a field infrastructure and technical integration perspective) are summarized in Table 1-6. These and the other “missing” assets will be prioritized and accounted for when the high-level and detailed level component designs are developed as part of the systems engineering process.

Table 1-6. Summary of Significant Changes and Additions to the Generic Corridor

Organizational Entity	Summary of Changes and Additions
State DOT	• Additional surveillance (volumes, queues) on freeway off ramps • Additional inbound and outbound DMS on the freeway in advance of cross-network connections • Enhanced ramp metering software and communications with adjacent Atlantis signals

Table 1-6. Summary of Significant Changes and Additions to the Generic Corridor (continued)

Atlantis	• Surveillance along the entire length of Broadway and cross-network connectors, providing volumes and average speeds/travel times. • Additional CCTV along Broadway, including coverage of bus stops • Inbound and outbound DMS on Broadway at critical locations • Transit priority and emergency preemption devices and enhanced controller firmware at signalized intersections along Broadway • Enhanced controller software and communications with adjacent freeway ramp meters
Neptune	• Surveillance along the entire length of Main Street and cross-network connectors, providing volumes and average speeds/travel times. • Additional CCTV along Main Street, including coverage of bus stops • Inbound and outbound DMS on Main Street at critical locations • Transit priority and emergency preemption devices and enhanced controller firmware at signalized intersections along Main Street
Regional Rail Agency	• Additional spaces at Park & Ride Lots (Beech St. & Pine St. stations) • Surveillance of park & ride lots at the three stations for real-time monitoring of parking availability • Software to calculate parking availability (number of vacant spaces) • Automated passenger counting technology (i.e., determine availability seating on each train)
Generic Bus Authority	• On-board devices for signal transit priority, including connection to schedule adherence subsystem
Public Safety Agencies	• Enhancements to CAD software to identify “best” routes • Interface to CAD, including protection/security of sensitive information
Corridor Wide	• Corridor simulation model • Communications linkages between transportation management and emergency service centers (connect to existing subsystems) • ITS standards for center – to – center communications • Interfaces to existing systems, including “translators” as required • Servers for information processing and aggregation, video sharing and control • Decision support software for evaluating current/projected corridor conditions and selecting the most appropriate response plans

The ICM concept represents a significant paradigm shift for management and operations within the Generic Corridor – from the current lack of any coordinated operations between corridor networks and agencies, to a fully integrated and pro-active operational approach that focuses on a corridor perspective rather than a collection of individual (and relatively independent) networks. To make this happen, several implementation and integration issues must be resolved. Several of these implementation issues will involve choices that cannot be fully addressed and subsequently resolved until later stages of the systems engineering process (e.g., design, procurement, and implementation). Some of the key issues are summarized below:

- Several of the **technology** issues were identified previously in Table 1-6 (e.g., the need for additional surveillance capabilities, additional DMS). The technical details – such as the distribution and actual location of the devices, and their respective capabilities, will be addressed during the Requirements and Design stages of the ICMS project. Another major technology issue involves the adoption and implementation of ITS standards for the center – to – center (C2C) connections, and how these standards are integrated into the legacy systems within the corridor (e.g., potential use of "translators"). Video sharing represents another issue. The ICM concept for the Generic Corridor includes significant sharing of video between the corridor stakeholders and with the media/ISP's. The desire is to have "full – motion" video in this regard; although this will significantly increase the bandwidth requirements for the C2C communications subsystem.
- Several **operational** issues must be resolved prior to system implementation if the various ICMS strategies are going to be applied consistently and in a manner that improves overall corridor performance. A preliminary Operations Plan and Manual will be developed during system design. This plan will address several issues such as the procedures and protocols for identifying route/modal shifts when spare capacity exists on multiple networks, and also when sufficient spare capacity is not available within the corridor; policies for implementing demand/capacity management strategies; procedures and protocols for the shared use of resources and/or shared control of ITS devices (including resolution of multiple and conflicting) requests for the same device; potential safety concerns with the ICMS operational strategies; and disseminating traveler information in a consistent manner across networks. With respect to the latter issue, the common convention for operations-based measures and AITS displays will likely be comparable link travel times.
- Resolving the **institutional** issues is an on-going process of coordination and collaboration between corridor stakeholders. As previously discussed, the current institutional framework within the Generic Corridor is multi-agency, multi-functional, and multi-modal, with the authority for transportation-related decision-making is dispersed among several different agencies. A more formal institutional structure, with defined processes and documented policies as well as dedicated staff with the appropriate responsibility and authority to operate the Generic Corridor as an integrated system, will be necessary for the ICMS to be a success. A proposed institutional structure to support the implementation and on-going operation of the ICM concept is described next.

1.9 Generic Corridor ICM Concept Institutional Framework

The management and operations of the corridor and the ICMS will be a joint effort involving all the stakeholders. To effectively manage and operate the ICMS concept as described in this Concept of Operations document, the creation of a central corridor decision-making body is recommended. This body, designated as the **Generic Corridor Operations Panel (GCOP),** will consist of leadership level representatives from each of the stakeholders in the Generic Corridor. The GCOP will be the central decision-making body for the corridor, managing the distribution of responsibilities, the sharing of control, and related functions among the corridor agencies. The GCOP will be responsible for establishing the necessary inter-agency and service agreements, budget development, project initiation and selection, corridor operations policies and procedures, and overall administration.

To support the GCOP and other future corridor operations panels, it is recommended that the **Regional ITS Architecture Committee** be restructured, re-chartered, and renamed to reflect an expanded scope that includes the promotion and stewardship of corridor-based coordinated operations throughout the metropolitan region. The new committee will continue its duties in relation to the Regional ITS Architecture, but the duties will be expanded to promote coordinated operations within the various corridors that make up the region, as well as addressing any “inter-corridor” operational issues (i.e., be the coordinator of multiple corridor operation panels and ICM systems).

The **BWR Transportation Operations Council** will be the regional body to identify and investigate future coordinated operations opportunities, such as deploying Integrated Corridor Management systems in other corridors within the region. The BWRTOC will coordinate all operations request for funding (from the GCOP) and present requests to the main MPO committees for approvals. The BWRTOC will review corridor operating procedures, policies, and technical standards in order to ensure consistency, compatibility, and compliance with the Regional ITS Architecture.

The proposed institutional framework for the Generic Corridor ICMS as described above is shown in Figure 1-3.

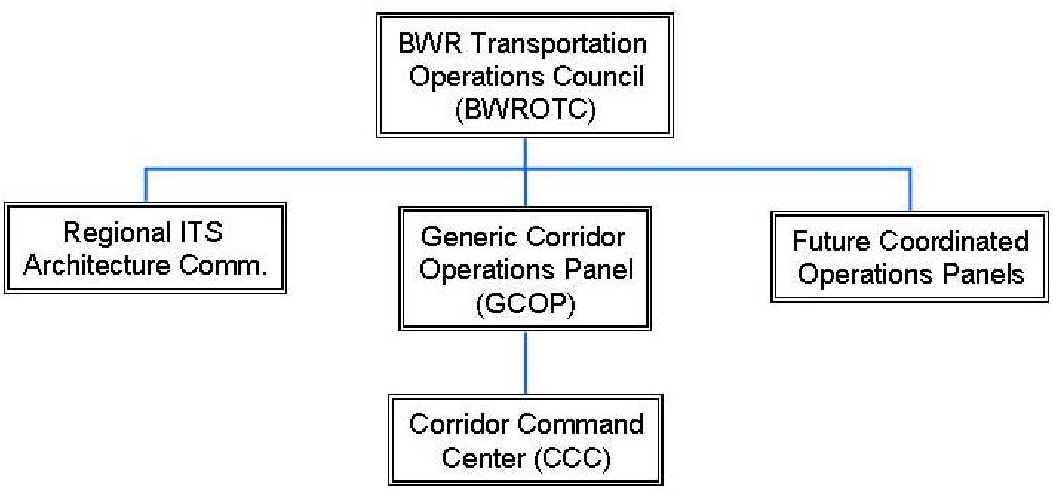

Figure 1-3. Institutional Framework of Generic Corridor ICMS

ICMS procurement/implementation approaches and funding, and the individual agency responsibilities in this regard, are still being discussed by the stakeholders. Each network and agency has existing procurement policies and practices. Each procurement policy and practice has to be identified and understood in order to establish a system procurement policy for the ICMS. The procurement policy may be a combination of policies or a policy that directs the use of the most appropriate agency practice for the item being procured. As the ICMS project moves from concept to the design stage, formal inter-agency agreements will be developed and executed describing this institutional framework and structure in detail, including each agency's responsibilities.

It is emphasized that this ICMS concept is consistent with the Regional ITS Architecture. There are no conflicts, per se; but the ICMS concept does include significantly more information sharing (including command and control functions) and integrated operational capabilities than provided by the Regional ITS Architecture. Moreover, the ICMS concept includes a virtual CCC, which is not addressed in the regional architecture.

Summarizing, as a result of the ICMS concept, the Generic Corridor will be an integrated transportation system, managed collectively and operated centrally (when circumstances dictate), to maximize its utility to corridor travelers. All corridor assets will be attuned to obtain the goals and objectives of the corridor, as well as the goals of each individual traveler as there preferences prescribe. The corridor users will recognize the Generic Corridor as a seamless transportation system that provides them with multiple viable alternatives that they can select based on their specific travel circumstances and needs.

2 REFERENCES

Overview – This Con Ops chapter serves as a guide to resources utilized in the development of the ICMS Concept of Operations document, as well as a source for additional information regarding the various agencies and their network-specific systems to be integrated into the ICMS, related guides and standards, and the ICM Initiative itself.

The following references were used in developing the Concept of Operations for the Generic Corridor:

References Specific to the Generic Corridor

- Business Planning/Strategic Planning Documents for the corridor agencies.
- Concept of Operations for related agency/facility-specific systems.
- Requirements of related systems.
- Studies identifying operational needs.
- Regional ITS Architecture documents.
- Planning studies/ Master Plans.
- Transportation Improvement Programs (TIP).
- Long Range Transportation Plans.

General References for Integrated Corridor Management

- ICM Implementation Guide and other Technical Memoranda available at http://www.itsa.org/icm.html.

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Security," Federal Highway Administration, FHWA-OP-03-008 (Washington, DC: 2002).

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- *TCRP Report 92: Strategies for Improved Traveler Information*, Multisystems, Inc., Transportation Research Board, 2003 .

3 Existing Corridor Scope and Operational Characteristics

Overview – This Chapter provides a general description of the subject corridor including corridor boundaries and the networks within the corridor, identification of corridor stakeholders, current conditions experienced by each corridor network, existing and planned corridor assets (including a review of the regional ITS architecture), the institutional framework, identification of individual network and corridor operational characteristics and deficiencies, an assessment of the potential for ICM, and a vision statement indicating how the corridor will operate in the future. The information in this chapter sets the stage for the Operational Concepts described in the subsequent chapters.

3.1 Corridor Boundaries and Networks

Guidance – The Concept Exploration and the System Conception activities (within the systems engineering process) include two levels of corridor boundaries delineation analyses. The initial corridor identification and boundary delineation identified during concept exploration is primarily conceptual and qualitative in nature, relying on local knowledge (and possibly a high-level review of any available data on travel patterns and markets), combined with engineering judgment, to ferret out the rough impact area of the corridor. This is followed by a more quantitative analysis conducted during system conception that takes into account current and forecasted travel patterns, the travel market or markets that are served by the proposed corridor (and their respective needs and issues), operational characteristics and typical scenarios/events within the corridor, availability of cross-network connections and spare capacity, other conditions and deficiencies, etc. The results of the system conception level corridor boundaries analysis is documented in the Concept of Operations.

The Generic Corridor is a largely linear band, approximately 15 miles in length, consisting of a freeway, adjacent arterials, and a parallel rail system as shown in Figure 3-1. The generic corridor is primarily a commuter corridor utilized for travel between the central business district of employment (in Metropolis) and commercial areas and suburban residential areas. At one end of the corridor is the Black Water River, which is the jurisdictional boundary for Metropolis. On the other side of the river, the Generic Corridor is divided between two cities: the City of Neptune is to the north of the rail line, and the City of Atlantis is to the south of the rail line. The Black Water River is crossed by four bridges: one for the freeway, one each for the freeway spur and the Broadway arterial (both of which empty into the central business district), and a railway bridge for the regional rail service.

The corridor is part of the Black Water River Metropolitan Planning Organization (BWRMPO) region and also part of an inter-regional multi-state corridor that is designated as an evacuation route. The networks comprising the generic corridor and their respective characteristics are summarized in Table 3-1.

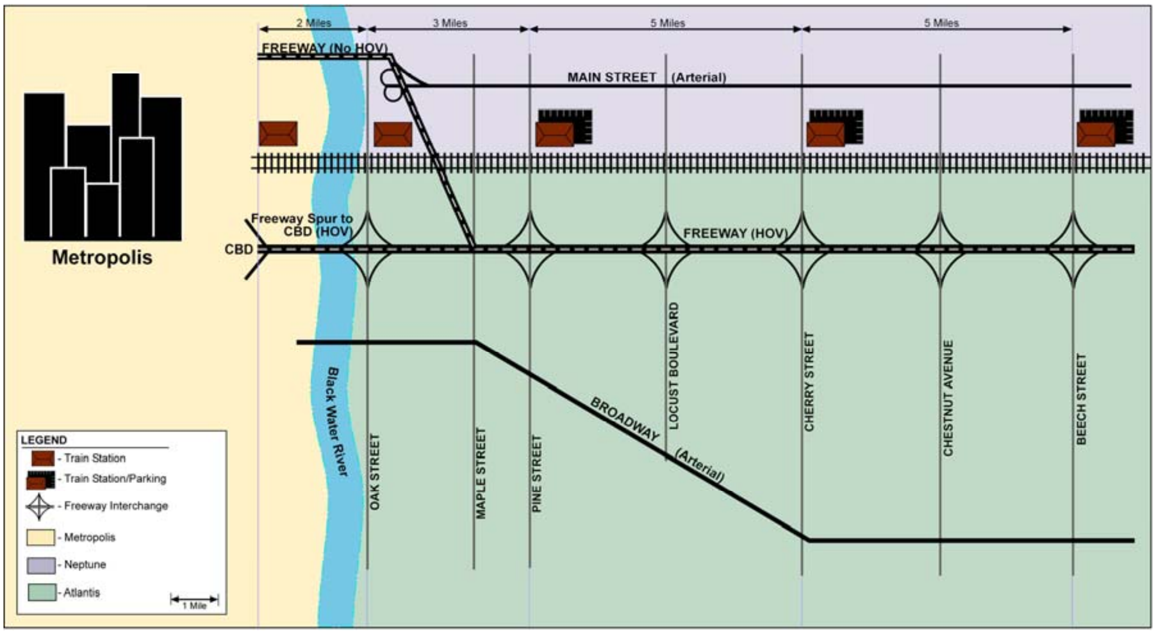

Figure 3-1. Map of the Generic Corridor

Table 3-1. Generic Corridor Network Characteristics

Network	Characteristics
Freeway Network	• Three travel lanes (total) in each direction • One HOV lane (left lane) used as HOV-2 during the peak hours; open to all traffic during non-peak periods. • Access to adjacent arterials (via off ramps and other surface streets) approximately every 2 to 3 miles • Emergency shoulder on left and right • Freeway Spur (with HOV lane) serving/emptying into the CBD • Freeway continues (without HOV) by-passing the CBD
Arterial Network	• Two arterial networks on opposite sides of freeway, with Main Street located in Neptune, and Broadway located in Atlantis. • Two travel lanes in each direction, with no parking • Access to the freeway, via on-ramps and surface streets, approximately every 2 to 3 miles. • Cross network connections (via other surface streets) to each other approximately every ½ mile (with signalized intersections) • Broadway links directly to a bridge crossing the Black Water River, entering the Metropolis CBD.

Network	Characteristics
Regional Rail Network	• Two tracks (one in each direction) • 5 stations located within the corridor, with bus stops at each terminal. Park & Ride facilities present at the three outer stations. • Commuter rail service, with peak period headways of 15 minutes (with longer trains), and off peak headways of 30 minutes.
Bus Transit Network	• Local bus service operating on Main Street and Broadway, with bus stops every ½ mile (approximately), including the rail stations (for the Main Street Service). Peak period headways are 15 minutes; and off-peak headways are 20 minutes. • Express bus service (originating outside the corridor) operating on the freeway, leaving the freeway and servicing the Beech Street and Cherry Street rail terminals within the generic corridor. Only peak-period service is provided, with headways of 15 minutes.
Black Water River Bridges	• Freeway Bridge – 3 lanes in each direction with HOV in the left lane. No shoulders. • Broadway Bridge – 2 lanes in each direction

3.2 Corridor Stakeholders

Guidance – A "*stakeholder*" is 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 number and types of corridor stakeholders will be dependant on the transportation networks included in the corridor and the proposed ICM concepts. 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 plan and develop an ICMS. The list of stakeholders needs to be reviewed at key points throughout the ICMS development process to determine if any needed stakeholders are missing. In completing this section of the Con Ops, all potential stakeholders, even ones not involved in the development of the document, should be identified. If there are stakeholders identified that are not part of the concept development, plans should be made to contact those stakeholders to enlist their review of the document and participation in subsequent activities.

The ICM stakeholders for the generic corridor are listed in Table 3-2, all of which were involved to some extent in the development of this Concept of Operations. Those with operational and management responsibilities for the individual networks are shown graphically in Figure 3-2.

Table 3-2. Generic Corridor Stakeholders

• State Department of Transportation (DOT) • Neptune Department of Transportation • Atlantis Department of Public Works • Metropolis Department of	• Fire Departments (include ambulance service and HAZMAT) • AAA (representing users of the roadway) • Visitors Bureau (representing tourists that use the corridor)

Transportation • Regional Rail Agency • Generic Bus Authority • Black Water River MPO • State Police • Neptune Police • Atlantis Police • Rail Agency Police	• Strap Hangers Association (representing transit riders) • FHWA/FTA • DHS/FEMA • Courier fleets (e.g. US Postal Service, Federal Express, UPS) • Information Service Providers

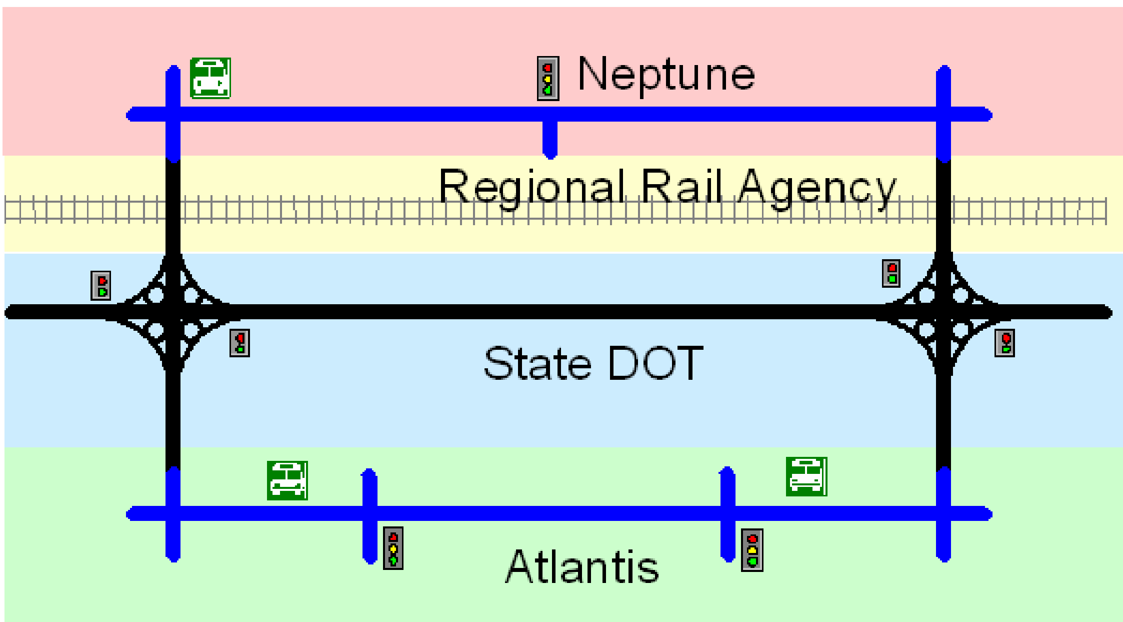

Figure 3-2. Operational Responsibility for Corridor Networks

Other agencies with operational responsibilities (not shown in Figure 3-2) include the following:

- Generic Bus Authority – operating on all arterials and freeways, servicing the Rail park and ride facilities.
- State Police – Enforcement, security, and accident investigation on the freeway.
- Neptune Police – Enforcement, security, and accident investigation on the Neptune arterials (including Main Street) and other local streets (e.g., cross-connections).
- Atlantis Police – Enforcement, security, and accident investigation on the on the Atlantis arterials (including Broadway) and other local streets (e.g., cross-connections).

- Rail Agency Police – Enforcement, security, and accident investigation on the regional rail network and stations.
- Fire Departments – ambulance services and HAZMAT for all networks.

3.3 Operational Conditions of the Generic Corridor and Included Networks

Background – This section focuses on the operational characteristics of the corridor and the associated networks. Corridor attributes to be addressed in this section include the major traffic generators, primary travel markets served by the corridor, corridor demand and usage, and the types and frequency of events that impact network and corridor operations.

The Generic Corridor provides transportation for the movement of commuters, freight, recreational, and other traffic, as summarized in Table 3-3:

Table 3-3. Breakdown of Transportation System Users during Peak and Off-Peak Hours (Percent)

Period	Commuter	Commercial	Recreation	Other
Peak	70	15	5	10
Off- Peak	30	30	15	25

The significant level of commuter traffic results in significant peaking characteristics within the corridor for both roadways and transit as shown in Figures 3-3 and 3-4.

The travel market within the Generic Corridor consists of the following trip types:

- Users with trips originating either in the corridor with a destination outside the corridor or outside the corridor with destinations within the corridor.
  - Commuters traveling to/from the Metropolis central business district. The modal split between roadway and transit in this regard is approximately 70/30 during the peak periods and 80/20 in the off-peak periods.
  - Commercial vehicles to and from the central business district.
- Users traveling within the corridor on local trips (i.e. both origin and destination within the corridor) .
  - Trips to markets, schools, places of worship, etc. Approximately 85 percent of these trips are on the roadway networks, with 15 percent on the transit networks.
  - Courier/deliveries. Nearly all of these occur on the roadways.
- Traffic passing through the corridor (i.e. with neither origin or destination in the corridor) to access or pass through the central business district.
  - Long haul travelers .
  - Freight traffic and other commercial vehicles.

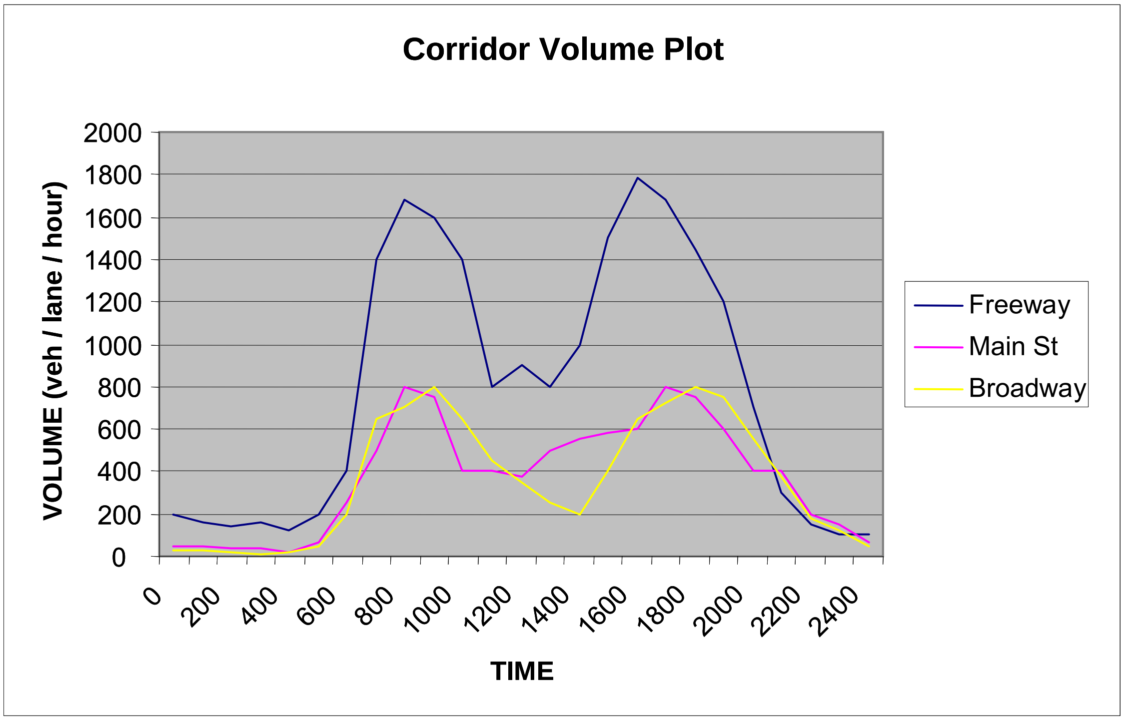

Figure 3-3. Roadway Use during Typical Work Day

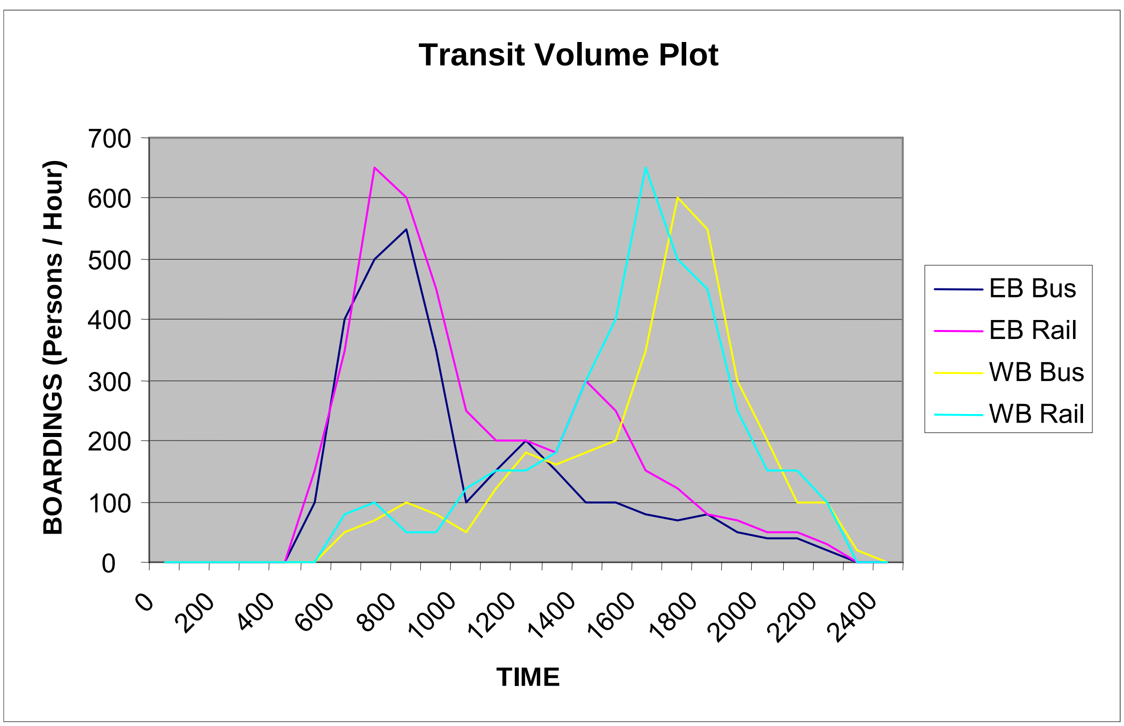

Figure 3-4. Transit Use during Typical Work Day

The split between these travel markets and trips are summarized in Table 3-4.

Table 3-4. Travel Market Trip Types in the Generic Corridor (Percent)

	Local	Origin or Destination	Through
Peak Period	60	30	10
Off- Peak Period	40	40	20

Traffic congestion along the roadway-based networks is a growing problem in the Generic Corridor, particularly during the peak periods. The congestion problems have resulted in a number of serious issues, such as loss of personal and professional time, increased fuel consumption, increased accident rates, environmental degradation, and traveler frustration. As congestion and delays have increased, actual throughput corridor-wide has actually declined.

On average, the regular freeway lanes experience Level-Of-Service (LOS) D during the peak periods, with an average peak period speed of approximately 35 mph. The freeway HOV lanes operate at a LOS of C with an average peak period speed of 55 mph. The two arterial facilities, Main Street and Broadway, both operate at a LOS of D with an average peak period speed of 25 mph.

Recent studies of the freeway operations indicate that congested conditions (i.e., average speeds of less than 40 miles per hour) typically exist during four hours of every workday: two during the AM peak, and two during the PM peak. The cause of this freeway congestion can be attributed to the following factors:

- Bottlenecks/Demand (Recurring) – 35 percent.
- Incidents – 35 percent.
- Weather – 20 percent.
- Special Events – 10 percent.

Arterials studies indicate that during the peak periods, approximately half of the drivers experience a “loaded cycle (i.e., having to wait at the signal for more than one green phase on the major approach) at 25 percent of the signalized intersections.

With respect to transit operations within the corridor, the roadway congestion problems noted above have also degraded the operation of the buses – particularly on the arterials and surface streets – making it increasingly more difficult for buses to maintain their published schedule. Specifically, 30 percent of the buses operating along the two arterials run behind schedule during the peak period (with 15 percent running behind schedule during the off peak periods). The express buses, which operate primarily within the HOV lanes of the freeway, also experience delays when moving out of the HOV lanes to exit the freeway and traveling along the arterials to service the rail stations. The peak period express bus service runs behind schedule 15 percent of the time.

The regional rail service has an excellent on-time performance record (better than 95 %). The increasing roadway congestion has increased rail ridership to some extent; but it is still under-utilized in terms of its available passenger-carrying capacity, even during the peak travel periods. This is due, in part, to a relatively limited number of parking spaces at some of the rail stations, where the lots can fill up quickly during the AM Peak, and remain full until the PM Peak.

The average peak period travel times for the various networks for trips traveling the length of the corridor are provided in Table 3-5.

Table 3-5. Average Peak Period Travel Times; Corridor Length Trips

Corridor Networks	Average Peak Period Travel Time per Person (minutes)
Freeway – Regular lanes	26
Freeway – HOV	16
Main Street	36
Broadway	36
Bus (Local)	40
Bus (Express)	24
Rail	20

Due to the high percentage of freeway incidents, freeway and subsequently arterial reliability are low. The average freeway travel time of 26 minutes can fluctuate by more than 100 percent depending on the location and severity of the incident. Moreover, freeway incidents often result in a shift of trips from the freeway to the arterials, resulting in a 50 percent increase in arterial travel time, with a concomitant impact on the reliability of bus operations along the arterials.

The operation of regional rail network is very reliable (with, as noted above, an on-time performance record of better than 95 percent). The primary operational concern in this regard is occasional flooding of a section of track, particularly after heavy rains, which necessitates the deployment of a "bus bridge" around the service outage.

Based on historical data, the corridor has been experiencing on average an annual growth in demand of 2 percent spread over the corridor networks. Due to recent economic factors, such as the rise in gasoline prices, the spread has been shifting a little to rail. However it is expected that overtime if gasoline prices lower, some of the shift to rail will return to the freeway and arterials.

3.4 Existing Network-based Transportation Management/ITS Assets

Guidance – This section essentially inventories the existing network-specific transportation management and ITS-based assets. The section should identify each asset and provide a brief description that explains the attributes of each asset.

The various transportation agencies that operate networks within the Generic Corridor have implemented a variety of policies, strategies, and technologies to improve performance of their respective networks. The assets that support each network's operations and their attributes are summarized in Table 3-6, and illustrated in Figure 3-5.

Table 3-6. Network Transportation Management Assets

Network	Assets
Freeway Traffic Management System	• Traffic Management Center (TMC) at State DOT Regional Office – Staffed 24/7 • Surveillance: detector stations – measuring volume, occupancy, and speed per lane – every mile or 2 (+/-), plus detectors at the on-ramps (part of a ramp metering system), but not on off ramps • CCTV surveillance 85 percent coverage • DMS: a few, but not in advance of every cross-network junction. NTCIP[1] protocols used for DMS communications • Ramp Metering: all ramps, operated TOD/DOW[2] and TRSP[3] basis. No HOV by-pass. • Roving service patrols • State DOT Freeway conditions website

Arterial Traffic Management Systems	• Separate traffic signal systems for each City (Metropolis, Neptune, and Atlantis)
	• Traffic Control Centers (TCC) at the DOT/DPW offices of Metropolis, Neptune and Atlantis
	• Centralized traffic signal systems
	    o Upload/download capability for signal timing and plan parameters
	    o Function primarily on TOD/DOW basis
	• Surveillance: only detection at signalized intersections for local actuation
	• CCTV surveillance: at some major intersections
	• Emergency Vehicle Pre-emption at some intersections near fire stations
	• Dynamic Message Signs (DMS) – none
	• Transit priority – none

Bus Transit Management System	• TMC at the Bus Maintenance Facility • AVL system on all buses with schedule adherence capability at central dispatch • Bus schedule/conditions website
Rail Transit Management System	• TMC at Regional Rail Agency Headquarters • Vehicle location system with schedule adherence notification capability from rail TMC • Regional Rail schedule/conditions website • Park & Ride Lots – no automated surveillance of available spaces. When full, operator posts a "full" sign at the entrance.
Police and Fire Departments	• Radio Communication Systems • Computer Aided Dispatch (CAD) Systems

[1] NTCIP = National Transportation Communications for ITS Protocols
[2] TOD/DOW = time of day/ day of week
[3] TRSP = Traffic responsive

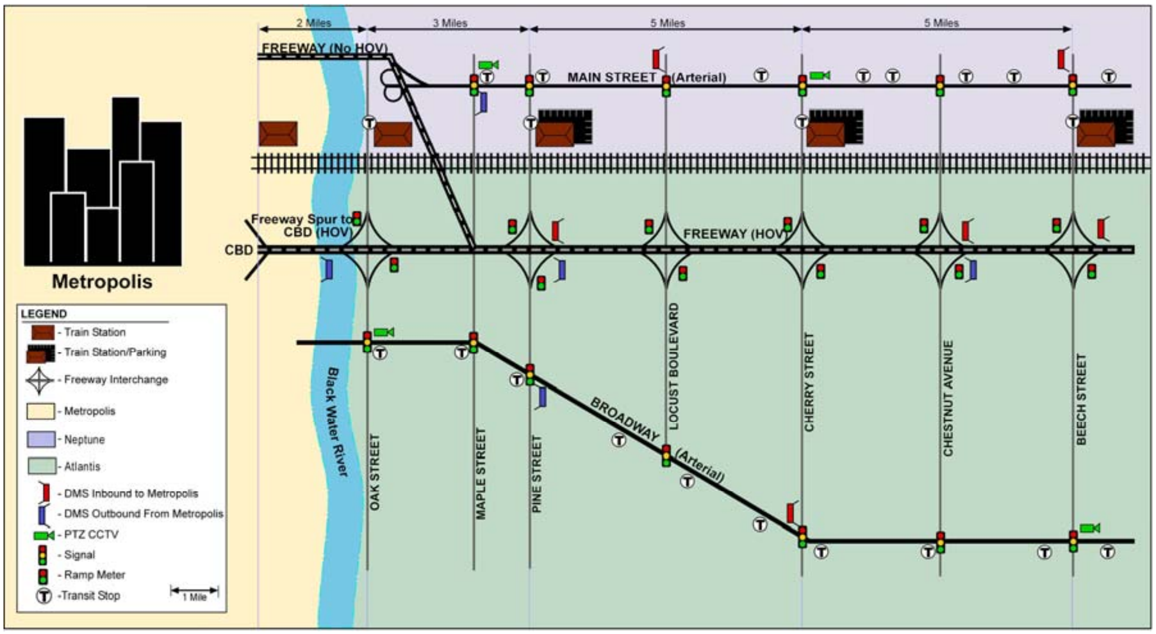

Figure 3-5. Existing Network-Based ITS Assets

3.5 Proposed Near-Term Network Improvements

Guidance – This section captures any transportation management and ITS improvements that are likely to be implemented on networks within the corridor in the next few years. These improvements may factor into the development of an ICMS. Each improvement should be identified including any significant assets that are elements of the improvement.

The current Transportation Improvement Plan (TIP) identifies an array of improvements for the region. Those improvements located within the corridor are listed below, and need to be accounted for in any subsequent requirements analysis and ICMS design. The improvements are categorized by network and responsible agency.

- Freeway – State DOT
  - Upgrades to the freeway management system surveillance capabilities that include more detectors and full – coverage CCTV.
  - Revised and upgraded incident management procedures for automated detection and response (including expanded freeway service patrols).
  - Dynamic Message Signs (DMS) at additional locations along the freeway.
  - Ramp metering enhancements to include HOV by-pass at selected locations.
  - Road – Weather Information System (RWIS) along the freeway.
- Arterials – Neptune DOT and Atlantis DPW
  - Retro-fit of the communications network (twisted – pair to fiber optics) for the traffic signal control systems.
  - Upgrades to central software and controllers incorporating NTCIP.

(Note: Retro-fit of communications and software upgrades are referred to as arterial system or arterial signal system upgrades in subsequent sections of the Con Ops).

- Rail – Regional Rail Agency
    - o In-terminal/wayside DMS (e.g. next train arrival) at all stations and platforms.
    - o Improved PA systems for in-vehicle annunciation and in-terminal announcements.
    - o Smart card system on the buses and at the train stations for transit fares. (Joint bus/rail transit improvement that will eventually cover region).
- Bus – Generic Bus Authority
    - o In-terminal/wayside DMS (e.g. next bus arrival/Route #) at each bus stop.
    - o Improved PA systems for in-vehicle annunciation and in-terminal announcements.
    - o Smart card system on the buses and at the train stations for transit fares. (Joint bus/rail transit improvement that will eventually cover region).

3.6 Current Network-Based Institutional Characteristics

Guidance – This section describes the current institutional environment of the corridor, taking into account each network, the region, and any other institutions that will affect the integration of the corridor. Any mechanisms that have been established to enhance coordination (e.g., inter-agency relationships and agreements, information sharing, joint operational procedurals), be they at the regional or corridor levels, should be addressed. The section should also identify any institutional constraints that would affect integrated corridor management.

This institutional fabric within the Generic Corridor is multi-agency, multi-functional, and multi-modal. Moreover, the authority for transportation-related decision-making is dispersed among several different agencies, including the State DOT, Neptune, Atlantis, the Regional Rail Agency, the Generic Bus Authority, Metropolis, as well as the various enforcement agencies and fire departments. Additionally, agencies of the US Government (e.g., FHWA, FTA, DHS) and their rules and regulation also impact the operation of the corridor. The management and operations of the various networks in the Generic Corridor (and the supporting ITS-based systems) have tended to be "stovepiped," with minimal communications between the transportation networks and their operators except for major events and incidents. As such, on a day-to-day operating basis, the corridor consists of independent networks and systems.

From a regional perspective, the Black Water River Metropolitan Planning Organization (BWRMPO) manages the development of the Transportation Long-Range Plan and the Transportation Improvement Plan (TIP). At a regional level, all the stakeholders that have been identified as Generic Corridor stakeholders take part in the identification and selection of metropolitan transportation planning region improvement projects. The BWRMPO structure includes a Board of Directors and the following two main committees:

- Elected Officials Committee: includes elected officials from all the jurisdictions in the region.

- Technical Officials Committee: includes technical officials from the various organizations that are part of the transportation planning process and have a stake in the selection of regional projects.

An executive director manages the BWRMPO. The executive director reports to and is appointed by the Board of Directors. The executive director manages a staff of 60.

The BWRMPO took the lead in establishing the Regional ITS Architecture (discussed in a subsequent section herein). As part of this process, the BWRMPO established a "Regional ITS Architecture Committee." This Committee, which reports to the two main committees, was given the authority to establish sub-committees and manage the procurement of technical support. The Regional ITS Architecture Committee maintains the architecture and technically supports the coordination of ITS projects. The Regional ITS Architecture promotes system integration, but has had limited effect on coordinating regional transportation management and operational activities. The Regional Architecture Committee is comprised of Transportation Management/ITS representatives from each of the regional networks and chaired by the BWRMPO Operations/ITS Director.

To facilitate the pending implementation of a Smart Card transit fare system, the Regional Rail Agency and the Generic Bus Authority have entered into an interagency agreement that creates a new unit in the Rail Agency to development, implement, and operate the Smart Card system. The unit will report to a three-person committee composed of a rail agency representative, a bus authority representative, and the BWRMPO Transit Initiatives Director. The three-person committee will primarily make design and operations decisions. Decisions that cannot be reached by the three-person committee are to be presented to the BWRMPO Board of Directors for action. The Smart Card System will be jointly funded based on a proportion of each entities smart card revenue generation. The Smart Card unit, on behalf of both agencies, will pursue any federal funds that are available for design and implementation of the system.

The State DOT is taking the lead in addressing regional incident management procedures for major incidents and related emergencies. A major part of this project is to coordinate incident and emergency management procedures with the adjacent jurisdictions transportation, public safety entities, and the Department of Homeland Security as required. To date no coordinating body has been established.

There have been a number of special major events in Metropolis over the past few years, each requiring special transportation management measures at both the regional and corridor level. For each of these events, the Mayor of Metropolis has requested from the other jurisdictions the formation of a special event task force to address the impact of these events. The task force looks at all aspects of venue management including transportation. Through the task force, a central command for transportation is established in advance that coordinates the planning, preparations, and event-day operations command. The task force identifies and implements special transportation operational strategies for the event to facilitate the access and egress of attendees and maintenance of existing travel. After each event, however, the task force, including the central command, is disbanded and all central command protocols are relinquished.

To facilitate the initial exploration and subsequent development of an ICM concept to the Generic Corridor, the State DOT, in coordination with the BWRMPO, established a Generic Corridor ICM Study Task Force. The ICM Task Force is responsible for determining the feasibility of developing and deploying such an ICM system, including identifying the associated operational, technical, and institutional issues. The development of this Concept of Operations and subsequent ICM system requirement is part of this responsibility. All the stakeholders identified in previous Table 3-2 are participating in the study in some capacity.

The current institutional environment seems to offer more opportunities than constraints in support of ICM. The coordination facilitated by the Regional ITS Architecture Committee and the special event centralized command model indicates that an institutional structure to support ICM could be established. Some specific issues that will have to be addressed in establishing an ICM institutional structure is the participation of the public safety entities in the corridor, the evolution of the Generic Corridor ICM Study Task Force, and the decision-making structure that includes how the Generic Corridor with ICM will be collectively managed and funded, and what will be the ultimate corridor decision-making body.

3.7 Regional ITS Architecture Review

Guidance – Integrated corridor management builds upon regional management. An ICMS may be considered a "sub-regional architecture" in this regard. The development of an Integrated Corridor Management System (and the ICMS architecture) should therefore be compatible and consistent with the regional ITS architecture, and this requires an understanding of the various attributes that comprise the regional architecture and the associated management functions. This section presents a review of the regional architecture in which the Integrated Corridor Management System will function, including the current state of the architecture and how changes to the Architecture are currently handled.

The generic corridor is part of a broader regional ITS architecture (refer to Figure 3-6), in which all the generic corridor stakeholders participated. The proposed functionality of the regional architecture includes the following:

- Real-time information sharing (data, video) between all agencies within the region. It is noted that the Regional ITS Architecture recommends the use of "ITS Standards as adopted by US DOT" for this purpose; but no additional details are provided.
- Clearinghouse of real-time information covering all critical routes and modes. This regional ATIS database integrates available information from agency-specific systems and TMCs/TCCs to provide a composite picture of the real-time status of the surface transportation network. The information is made available to all the region's agencies/TMCs/TCCs, other operating entities, and private traffic reporting entities.
- Regional coordination support between TMCs/TCCs, transportation agencies, and public safety agencies during "major" incidents, construction activities and special events (i.e., those for which the impacts cross most of the agency boundaries).
- A regional payment/financial clearinghouse, by which the same ETC tag/smart card can be used to pay transit fares, tolls and parking in the region.

The Regional ITS Architecture does not include inter-agency operations nor control of system components.

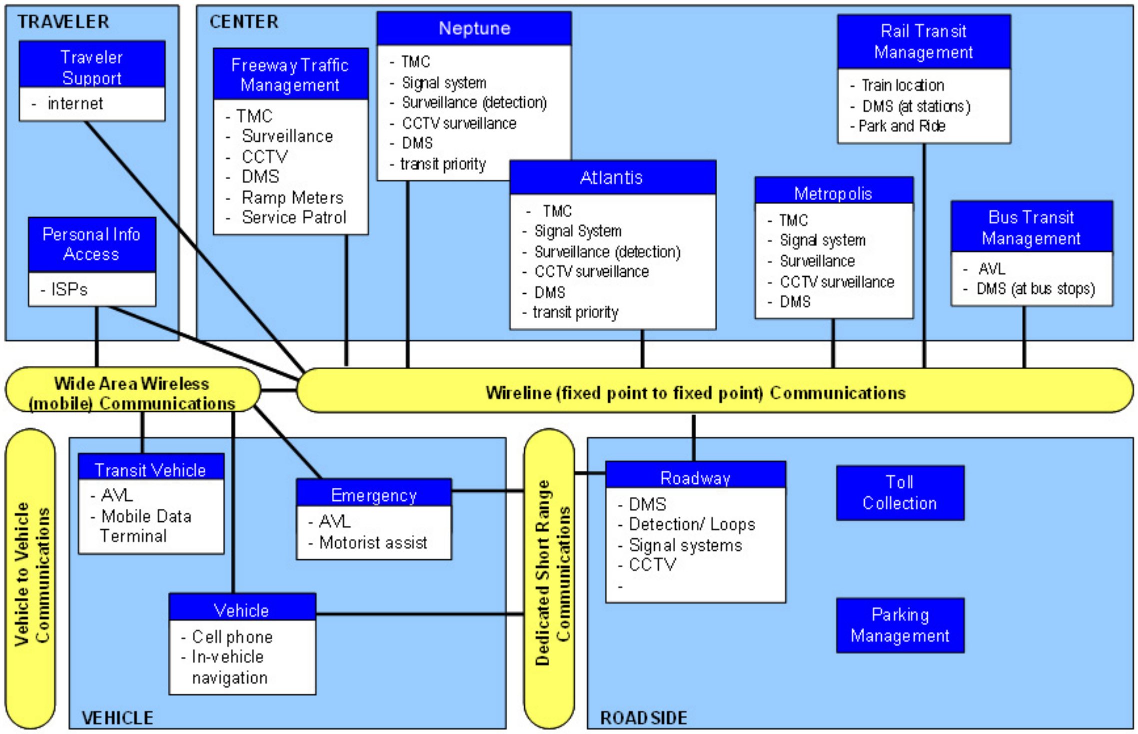

Figure 3-6. Regional ITS Architecture

Most of the proposed functionality has not yet been implemented. The aforementioned Regional Rail Authority/Generic Bus Authority Smart Card initiative will use the architecture in development of the smart cart system design so the system can be integrated with any expansion of the system to ETC tags for future tolls and parking payments.

The Metropolitan Planning Organization's Region ITS Architecture Committee maintains the Regional ITS architecture and provides technical support and review of ITS projects for their conformance to the regional architecture. For example:

- With Neptune and Atlantis both planning to upgrade their respective arterial signal systems, the Regional ITS Architecture Committee is taking an active role to make sure each system conforms to the Regional ITS Architecture and supports cross system communications and data/information transfers utilizing ITS Standards.
- The Regional ITS Architecture Committee has reviewed the State DOT's plans for the upgrade to the freeway management system that includes the expanded CCTV coverage, additional DMS signs, and ramp meeting and has concluded the systems' designs conform to the ITS architecture.

The Regional ITS Architecture Committee has not yet dealt with the modification or expansion of the ITS architecture. The Committee charter states that changes or additions to the Regional ITS Architecture – as might be necessitated by the development of an ICMS within the Generic Corridor – must be presented to the Committee in writing. The Committee will consider the merits of the changes and conduct a feasibility analysis. If the changes are feasible, and the Committee agrees that the changes are necessary for interchangeability and interoperability between agencies and their systems, the Committee must present the recommended changes and their finding to the BWRMPO Technical and Elected Official Committees for approval.

3.8 Individual Network and Corridor Problems, Issues and Needs

Guidance – This section summarizes the problems, issues and needs of the individual networks and the corridor as a whole. Using the inventory information and other gathered data, coupled with stakeholder discussions, this section should address operational, technical, and, institutional deficiencies and constraints, thereby providing insight as to the types of problems being faced in the corridor.

Many of the operational deficiencies within the Generic Corridor have already been discussed in Section 3.3. Congestion – particularly during the peak periods – represents a major problem along most of the networks within the Generic Corridor. Specific examples include the following:

- Each roadway network within the corridor is running below an ideal LOS except for the freeway HOV lanes. On average, corridor-length trips along the freeway under free flow conditions take 16 minutes versus 26 minutes under congested conditions.
- Congestion caused by incidents and other unplanned events has lowered the reliability of corridor travel to unacceptable levels, with average freeway corridor travel times fluctuating as much as100 percent on a day-to-day basis. The State DOT has implemented an incident management program; but it is focused on the freeway, with minimal coordination with adjacent and intersecting arterials.
- Of the 5 independent networks within the Generic Corridor, 4 have expressed their frustration with the impact of incidents, especially major freeway incidents. The lack of coordination between the networks in the corridor contributes to each network's inability to mitigate the impact of incidents and maintain some respectable level of service.
- Arterial travel is compromised by the inability to actively change and coordinate signal timing plans in response to current and changing demand patterns or reductions in arterial capacity due to arterial incidents. Any response to events that increase arterial demand/reduce arterial capacity requires manual interaction. Incidents on the freeway can further exacerbate these problems when freeway travelers shift to the arterials and temporarily increase demand. As a result, approximately 50 percent of arterial travelers sit through a loaded cycle at a quarter of the signalized intersections. The proposed arterial system upgrades to each of the major arterials will improve the operations of each individual arterial, but it will not provide for any traffic – responsive or adaptive management of the system, nor will it integrate operations with each other or other networks.
- The poor arterial performance also affects bus operations, making it increasingly more difficult for buses to maintain their published schedules and headways (e.g., 30 percent of the buses operating along the two arterials run behind schedule during the peak period). Improved operations along the arterials will assist in increasing the schedule adherence of the buses. However, the lack of any real-time information on arterial conditions is a concern for the operation of

the future bus stop DMS network in that these signs may require significant manual intervention to keep riders properly informed about schedule delays.

- The express bus service is popular. However, due to the need to traverse the regular (and congested) freeway travel lanes to access the HOV lanes and the exits, and then travel along congested arterials to access rail stations, its operations do not meet traveler expectations.

The regional rail line is the most reliable of all the network alternatives and, on average, offers a shorter travel time (relative to the regular freeway lanes) to traverse the corridor. The rail is currently under utilized resulting in spare corridor operating capacity. The cause of this under utilization is mostly attributed to the lack of parking at or near stations; however, the lack of coordination between rail and bus schedules and their respective operations (e.g., “just-missed” bus-rail connections that increase a rider’s wait time and level of frustration) is probably another factor. Even though the Bus Authority and Rail Agency have entered into an inter-agency agreement for the development of the smart card payment system, the coordination of overall schedules and service has been a subject of contention since the express bus and regional rail have always been viewed as competitors for the same riders.

Travel on each of the corridor networks – except for the Freeway HOV and rail line – is expected to further degrade as demand increase over the next few years, resulting in even more congestion. Each network has identified improvements to address their respective individual conditions, determining what will be necessary to address the predicted future level of demand. All the improvements focus on monitoring and managing/operating each network more efficiently. However, due to limited space, air quality conformity issues, community issues, and funding, large-scale physical capacity improvements are not feasible. Each of the networks that are experiencing congested conditions during the peak periods have indicate that eventually they will not be able to tweak out any additional performance on a network level.

Traveler information is another issue. Currently, the State DOT, the Regional Rail Agency, and the Generic Bus Authority manage websites for disseminating traveler information (including CCTV video images in the case of the State DOT site). However, this information is limited to these agencies’ respective networks (i.e., freeway conditions, rail operations, bus operations).

Several corridor stakeholder workshops and interviews were conducted as part of the ICM Concept activity. Several additional corridor issues and needs were identified, as summarized in Table 3-7.

Table 3-7. Corridor Issues and Needs (as Identified by Stakeholders)

- More of a “corridor – wide” and multi-modal view of ITS and other operational improvements.
- Improved coordination, communication and integration among all transportation stakeholders. This is done to some extent for special events; but needs to be expanded to cover day-to-day operations and minor incidents.
- More inter-agency information sharing.
- Information clearinghouse available to all transportation stakeholders (including emergency services, commercial vehicles, tourism, travelers etc.) with a single graphical representation and common geo-referencing.
- Adequate data and video communications architecture and infrastructure, regional consistency and inter-agency connectivity.
- More standardization and system interoperability within and between all stakeholders. Focus of standards should be on interoperability/integration (data and video sharing perspective). At the same time, the standards need to be flexible so systems can use different types of data.
- Accurate, real-time information on the operation of all networks (e.g., currently limited surveillance along the arterial networks) .
- Improved operational coordination of networks in the corridor, particularly at junctions, such as freeway ramps and connecting arterial signals, signalized intersections and bus operations, transfers between rail and bus).
- Accurate models to simulate corridor operation under various scenarios.
- Joint use of resources and infrastructure (e.g., service patrols, DMS) leveraging equipment use between agencies.
- Increased public outreach; educate about the benefits of ITS and operations. Expectations will increase as more ITS solutions are deployed.
- Travel information presented consistently throughout the region (seamless to the traveler), such as travel times. Traveler information policies and standards are needed to cover phone, web, DMS and radio.
- Funding for corridor initiatives, including operations and maintenance; also defined public vs. private sector roles and funding sources.
- Increased transit usage within the corridor; this should also help alleviate roadway congestion.
- Coordinated and efficient responses to incidents involving all agencies (transportation, police and fire), including integration of incident command structure and emergency procedures.
- Improved first responders’ ability to provide timely and accurate information to TMCs; need better relationships between the two and communications capability.
- Address commercial vehicle operations within the corridor.
- Methods (performance measures) for screening, monitoring and evaluating corridor-based strategies and operations to determine whether deployments are successful, meet agency goals and are cost-effective.

3.9 Potential for ICM in the Generic Corridor

Guidance – This section discusses how the corridor deficiencies and needs can be addressed from a corridor perspective by applying corridor management and cross-network operational strategies. The result of this section should be an assessment of whether or not ICM strategies can address the operational deficiencies that are limiting corridor performance.

The Generic Corridor consists of 5 independent networks:

- Freeway (regular and HOV)
- Arterial – Main Street
- Arterial – Broadway
- Bus (local and express)
- Rail

Each of the corridor networks, except for the rail and HOV, are experiencing congested conditions and travelers are incurring increasing trip delays. This has a negative impact on overall corridor mobility, safety, and the region's economic competitiveness. In addition, unplanned events such as incidents on the freeway are eroding the reliability of the system such that travelers just expect being late to their destinations.

As defined,[3] "Integrated Corridor Management" focuses on the operational, institutional, and technical coordination of multiple transportation networks and cross-network connections comprising a corridor. Moreover, ICM can encompass several activities which address the problems and needs identified in the previous section (e.g., integrated policy among stakeholders, communications among network operators and stakeholders, improving the efficiency of cross-network junctions and interfaces, real-time traffic and transit monitoring, real-time information distribution, congestion management, incident management, public awareness programs, and transportation pricing and payment).

One of the deficiencies that needs to be addressed – and a specific attribute of the Regional ITS Architecture – involves the exchange and sharing of real-time data. With real-time data and video among the networks, each network could monitor the conditions of adjacent networks to anticipate when travelers may shift to their network and take appropriate actions. Moreover, real-time condition information would provide the foundation for corridor-wide traveler information.

Combining surveillance among networks, especially the full coverage CCTV being implemented on the freeway, could be used to obtain information on network junctions. The information from the CCTV can also be used to verify conditions and provide information to incident first responders so an appropriate response can be dispatched, as well as the selection and execution of appropriate corridor incident mitigation strategies.

Since both Neptune and Atlantis are enhancing their respective arterial signal systems in the corridor, a few corridor strategies could be readily introduced in conjunction with these upgrade projects. To address freeway/arterial congestion at the ramps and adjacent intersections, integrated operations of adjacent ramp meters and signalized

[3] Refer to ICM Initiative Website

intersections could be implemented. There is also potential to provide signal priority to arterial buses and express buses that are delayed by ramp and arterial congestion. Signal priority on the arterials would also increase the schedule adherence of buses and may be an alternative to parking at stations for those that would like to use the rail system. Adding arterial surveillance as part of these system enhancements is also a possibility.

Another need that is addressed in the Regional ITS Architecture is a regional payment/financial clearinghouse, by which the same ETC tag/smart card can be used to pay transit fares, tolls and parking. As previously noted, the Generic Bus Authority and the Regional Rail Agency have already commenced a joint Smart Card initiative. This agreement can be the basis for improved communications between the two transit agencies. Better communications – including real-time data – between the rail and bus services would provide the foundation necessary for connection protection, thereby reducing bus-rail trip times and increasing customer service.

Another potential element of ICM involves enhanced mobility opportunities, including shifts to alternate routes and modes. Currently, any shifts that do occur are based on traveler knowledge and past experience. Using integrated real-time information, the various networks working as a corridor could influence traveler network shifts; especially promoting, when appropriate, shifts to the rail network with its unused capacity. The one problem with influencing a shift to rail is the parking shortage. Parking notification could be used to direct travelers to available parking; or in some situations temporary parking may be instituted to handle the new demand.

Current and new DMS deployed among the networks could be operationally integrated and messages could be used to provide travelers condition information on all corridor networks so that each traveler can take appropriate action if one or more of the corridor's network's performance is compromised. More can be done with corridor trip travel times to influence traveler shifts, or staggering of the start of travel. For special events, the DMS could be used to direct event attendees to specific event corridor transportation services.

Clearly, there is great potential to enhance current and near-term operations by implementing selected ICM and cross-network strategies. All of these enhancements would not be possible from an independent network operational perspective. The potential strategies identified above indicate that further investigation and design concerning integrated corridor management is warranted.

3.10 Generic Corridor Vision

Guidance – This vision statement should portray future state of the corridor and its operation (via ICM) for a specific time horizon, providing a platform for establishing goals and objectives. The vision statement must also be simple, easy to read and accessible to a wide audience.

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.

4 ICM SYSTEM OPERATIONAL CONCEPT

Overview – This Chapter of the Con Ops describes the Integrated Corridor Management System (ICMS) operational concept for the subject corridor. The proposed ICMS concept explains how things are expected to work once the ICM program and system are in operation, and identifies the responsibilities of the various stakeholders for making this happen. Information to be included in this chapter include the ICM goals and objectives, the operational approaches and strategies to be implemented in response to the corridor problems and needs, proposed changes to the current technical, operational, and institutional situation within the corridor (in essence, de facto "requirements") providing a sense of the overall scope for the ICMS concept, alignment of the ICMS with the Regional ITS Architecture, and corridor performance measures and metrics. The system concept must also address the key system implementation issues including how they may be resolved. An initial mapping (i.e., traceability) of each selected ICM strategy to the goal(s) and the corresponding need(s) it addresses is also developed.

4.1 Corridor Goal and Objectives

Guidance – This section defines the corridor goals and objectives, which are formulated to address the current corridor conditions, deficiencies, and needs, and to help achieve the long-term vision.

The vision statement for the Generic Corridor includes such key terms and phrases as "seamless," "predictable," "conveniently shift," "readily access traveler information," and "improve corridor performance." Using the vision statement as a starting point, and with due consideration of the Generic Corridor conditions, deficiencies, and needs, the corridor stakeholders developed the goals and associated objectives described in Table 4-1. These goals and objectives are interrelated such that activities and strategies oriented towards attaining one of the goals will likely impact (usually in a complementary fashion, but not always) the attainment of other goals and objectives.

Table 4-1. Generic Corridor Goals and Objectives for ICMS

Goals	Objectives
Corridor Perspective – A corridor perspective must be established among all the entities in the corridor. A single network's goals and objectives cannot take precedence over the other combined networks' goals and objectives. A corridor perspective will be established through institutional integration and the development of common performance measures. All entities will take on appropriate responsibilities and share levels of control.	• Develop an organizational and communications model to enhance "corridor" collaboration. • Create a funding structure for ICMS deployment, improvements, operations, and maintenance. • Adopt ITS standards (e.g., sharing of data, video, operational control). • Create and implement a plan for public outreach regarding ICM. • Institute corridor-based performance monitoring.

Goals	Objectives
Corridor Mobility and Reliability[1] – The transportation agencies within the corridor have done much to increase the mobility and reliability of their individual networks, and will continue to do so. The integrated corridor perspective builds on these network initiatives, managing delays on a corridor basis, utilizing any spare capacity within the corridor, and coordinating the junctions and interfaces between networks, thereby providing a multi-modal transportation system that adequately meets customer expectations for travel time predictability.	• Reduce overall trip and person travel time through the corridor. • Improve travel predictability. • Increase transit ridership, with minimal increase in transit operating costs. • Maximize the efficient use of any spare corridor capacity, such that delays on other saturated networks may be reduced. • Facilitate intermodal transfers and route and mode shifts. • Improve commercial vehicle operations through and around the corridor.
Corridor Traveler Information – Travelers must be provided with a holistic view of the corridor and its operation through the delivery of timely, accurate and reliable multimodal information, which then allows travelers to make informed choices regarding departure time, mode and route of travel. In some instances, the information will "instruct" travelers to utilize a specific mode or network.	• Obtain accurate real-time information on the current operational status of all networks and cross-network connections and facilities within the corridor. • Expand the types of information gathered on corridor conditions (e.g., weather, air quality). • Combine network – collected information with data from other sources (e.g., construction, public safety), providing a complete ATIS database. • Expand coverage and availability of ATIS devices (e.g., in advance of potential modal or route "shift points" in the corridor, web, and links to private information providers). • Provide traveler information in a consistent manner (e.g., display formats, terms and their meanings), including a single graphical display of the corridor and all networks as appropriate.
Corridor Event and Incident Management – Provide a corridor-wide and integrated approach to the management of incidents, events, and emergencies that occur within the corridor or that otherwise impact the operation of the corridor, including planning, detection and verification, response and information sharing, such that the corridor returns back to "normal conditions" as quickly as possible.	• Provide/expand means for communicating consistent and accurate information regarding incidents and events between corridor networks and public safety agencies. • Improve pre-planning (e.g., developing response plans) for incidents, events, and emergencies that have corridor and regional implications. • Provide an integrated and coordinated response during major incidents and emergencies, including joint-use and sharing of response assets and resources among stakeholders, and development of a common command structure. • Develop a comprehensive and on-going training program – involving all corridor networks and public safety entities – for corridor event and incident management.

[1] Mobility is defined here as the ability and knowledge to travel from one location to another using a multimodal approach; while reliability addresses how much the ease of movement varies from day to day, and the extent to which the traveler can predict these temporal variations.

These corridor-wide goals and objectives recognize that the traveler's (i.e., "customer's") perspective is that there is only one surface transportation system; and that the public generally does not care which jurisdiction or agency is responsible for the road or transit network on which they are currently traveling. As taxpayers and fare/toll payers, they want and deserve a safe and reliable trip – one that provides a consistent level-of-service with minimal congestion, and is predictable in terms of travel time. They also deserve accurate and timely information so that they can make informed decisions before and during trips. Table 4-2 maps these goals against the various corridor needs (as discussed in Chapter 3).

Table 4-2. Relationship Between Corridor Goals and Needs

Problems and Needs (Refer to Chapter 3)	Corridor Perspective	Corridor Mobility & Reliability	Corridor Traveler Information	Event & Incident Management
Poor freeway LOS during peak (recurring)	○	●	○	
Poor arterial LOS during peak (recurring)	○	●	○	
Bus operations along arterials (schedule variations)	○	●	○	○
Better utilization of spare capacity (regional rail)	○	●	○	○
Impact of incidents, events, emergencies (non-recurring)	○	○	○	●
Corridor-wide/multi-modal view	●	○	○	○
Improved coordination & integration between stakeholders	●	○	●	●
Inter-agency information sharing/connectivity	●	○	●	●
Information clearinghouse (real-time ATIS)	●	○	●	●
Consistent presentation of traveler information	○	○	●	
Standards for system integration & interoperability	●		○	
Accurate corridor simulation models	●	○	○	○
Joint-use of resources and ITS infrastructure	●	○	●	●
Coordinated response to incidents/events /emergencies	○	○	○	●
Information linkages between first responders & TMC's	●		○	●
Commercial vehicle operations within/ through corridor	●	●	○	
Public outreach regarding corridor management	●		○	

Problems and Needs (Refer to Chapter 3)	Corridor Perspective	Corridor Mobility & Reliability	Corridor Traveler Information	Event & Incident Management
Funding for corridor initiatives, including O&M	●	○	○	○
Performance measures	●	○	○	○
Legend: ● = Goal Directly Addresses Need ○ = Goal Indirectly Addresses Need.				

4.2 Application of ICM Approaches and Strategies

Guidance – This section identifies the proposed ICM approaches and strategies, and how they satisfy the subject corridor's goal and objectives. The results of this section will be a list of those ICM approaches and strategies that will likely be part of the ICM program and system.

To determine possible ICM approaches and strategies for the generic corridor, a "Corridor Type"/"ICM Approach & Strategy" analysis was initially conducted based on the guidance and screening matrices provided by the U.S. DOT. Specific findings and parameters in this regard included:

- The Generic Corridor's "type" is – Roadway with Managed Lanes (HOV) and Transit (In Both Roadway ROW and Separate ROW).
- Various types and events requiring ICM, including recurring congestion, roadway incident, transit incident, planned event, and emergency (evacuation).
- Each of these types of incidents/events encompasses a wide range of potential durations (both short and long-term) and severities.
- Available spare capacity does exist in the corridor.

Using the ICM screening matrices available from US DOT, an initial list of potential ICMS strategies were identified for the Generic Corridor. The corridor stakeholders then participated in a workshop and discussed and evaluated each of these candidate strategies with respect to their potential effectiveness in achieving the corridor goals and objectives, and the associated operational, technical, and institutional integration issues. As the analysis evolved, the corridor stakeholders also identified the following six scenarios the ICMS would need to address:

- Daily Operations (recurring congestion)
- Scheduled event – work zone
- Roadway incident (major and minor)
- Transit incident (major and minor)
- Major scheduled event
- Evacuation

These scenarios also guided the selection of ICMS strategies, the results of which are shown in Table 4-3. (Note – Table 4-3 is organized by the ICM "approaches" identified in the ICM materials developed by US DOT).

Table 4-3. Proposed ICMS Approaches and Strategies for the Generic Corridor

Information Sharing/Distribution

- Manual information sharing (i.e., voice communications)
- Automated information sharing (real-time data and video) between all stakeholders
- Shared control of "passive" ITS devices, such as CCTV (i.e., camera selection, pan/tilt)
- Information clearing-house – Corridor agencies can access this Information Exchange Network (IEN) to enter their own information and to view information for all the participating agencies and networks. A key attribute of the IEN will be that the agency/network information is displayed on a single graphical representation of the corridor, showing all the networks and cross-network connections that comprise the corridor. This information is also processed and archived for subsequent analyses.
- A corridor-based advanced traveler information system (ATIS) database that provides information to travelers pre-trip (e.g., via websites and 511).
- Access to corridor ATIS database by Information Service Providers (ISPs) and other value-added entities.
- En-route traveler information devices (DMS, 511, transit public announcement systems) being used to describe current operational conditions on another network(s).
- A common incident reporting system and asset management (GIS) system that allows the transportation and public safety agencies to share and view incident information for the entire corridor, as well as to use the infrastructure and resources of all agencies to provide the best incident response.

Improve Operational Efficiency of Network Junctions & Interfaces

- Signal priority for the Generic Bus Authority vehicles (e.g. extended green times to buses that are operating behind schedule) along Main Street and Broadway.
- Signal pre-emption/"best route" for emergency vehicles.
- Multi-modal (i.e., Regional Rail and Generic Bus Authority) electronic payment.
- Transit hub connection protection – holding buses at rail stations while waiting for rail service to arrive.
- Multi-agency/multi-network incident response teams and service patrols, along with training exercises for various types of incidents and events.
- Coordinated operation between ramp meters and arterial traffic signals in close proximity.

Accommodate/Promote Cross-Network Route and Modal Shifts

In general, the ICMS will merely provide information to users via the information sharing strategies noted above, and accommodate any user – determined network shifts:

- Modify arterial signal timing to accommodate traffic shifting from freeway.
- Modify ramp metering rates and HOV by-pass policies to accommodate traffic, including buses, shifting from arterials to the freeway.
- Modify transit priority parameters to accommodate more timely bus service on Main Street, Broadway and network connectors.

During major incidents and events, and if agreed to by all affected stakeholders, network shifts will be promoted as follows:

- Route shifts between freeway and the arterials via en-route traveler information devices (e.g. DMS, HAR, "511") advising motorists of congestion ahead, directing them to adjacent freeways/arterials.
- Modal shifts from roadways to the transit networks via en-route traveler information

devices (e.g. DMS, HAR, “511”) advising motorists of congestion ahead, directing them to rail transit and providing real-time information on the number of parking spaces available in the park and ride facility.

- Shifts between Regional Rail and Generic Bus services via en-route traveler information devices (e.g. station message signs and public announcements) advising riders of outages and directing them to a connecting rail or bus service.

Manage Capacity – Demand Relationship Within Corridor – “Real-Time”/Short Term

Cross-network shifts assume that spare capacity exists on the adjacent networks and the cross-network linkages and junctions (e.g. park and ride facilities). If not, it may be necessary to either temporally increase the capacity of these alternate networks and/or reduce the corridor demand.

- Lane use control (e.g., contraflow operation, convert lanes to emergency – only) .
- Add transit capacity by adjusting headways and number of vehicles on the Regional Rail network and the Generic Bus Authority service.
- Add temporary new transit service (e.g., “bus bridge” around rail outage/incident).
- Coordinate scheduled maintenance and construction activities among corridor networks such that the total corridor capacity (i.e., the sum of the individual network capacities) is not reduced below some minimum acceptable level. In the event of an unscheduled event that further reduces capacity, this strategy may also involve (if possible) immediately stopping the maintenance/construction activity and restoring full capacity.
- Increase roadway capacity by opening the freeway HOV lanes/shoulders.
- Modify HOV restrictions (increase minimum number, make bus only).
- Restrict freeway ramp access (metering rates, closures).
- Modify transit fares to encourage ridership.
- Modify parking fees.
- Restrict/Reroute Commercial Traffic. During special events or major incidents, it may be necessary to completely restrict commercial traffic access to and within the corridor.

Manage Capacity – Demand Relationship Within Corridor – Long Term

- Low cost infrastructure improvements to cross-network linkages and junctions, specifically additional spaces at transit station park and ride lots.
- Guidelines for work hours during emergencies/special events.
- Peak spreading and other TDM activities (i.e. promote flexible work hours/telecommuting in order to lengthen the peak hours and reduce congestion during those hours).

As previously noted, these ICM strategies were selected by the corridor stakeholders based, in part, on their contribution to achieving the goals and objectives identified for the Generic Corridor. A high – level mapping of these strategies and their contribution to the ICM goals is provided in Table 4-4. Additional considerations are discussed below.

The strategies within the “Information Sharing/Distribution” Approach will provide the informational foundation for ICM operations. This is the first step to the integration of the individual network systems. The focus on travelers is supported by the trip information services that will be implemented.

The “Improve Operational Efficiency” strategies address many of the corridor deficiencies that affect the efficiency of transit operations. These strategies will reduce travel times and increase the reliability of the Generic Bus Authority operations, as well as enhancing the convenience of rail travel. The strategies use cross-network operations to improve each individual network’s performance by taking advantage of another network's functions. This, in turn, builds a foundation for a corridor perspective as well as changing the focus to the traveler's trip performance.

"Accommodating/promoting shifts" among networks makes efficient use of any spare capacity within the corridor to better manage congestion and facilitate reliability. Shifting trips among corridor networks – whether via "inform" of "instruct" – is the essence of a corridor perspective and supports a traveler focus by informing corridor users of all their transportation alternatives and the conditions on each.

The "Manage Capacity-Demand Relationship (short-term)" approach provides operational strategies to increase the corridor capacity and/or reduce demand, building upon the route/mode shifts to further enhance corridor mobility and reliability. As a general rule, these strategies will be deployed only during major incidents, events, and/or emergencies.

Table 4-4. Relationship Between ICM Operational Strategies and Corridor Goals

ICM Strategies	Corridor Perspective	Corridor Mobility & Reliability	Corridor Traveler Information	Event & Incident Management
Automated information sharing (real-time data and video)	○	○	●	○
Shared control of "passive" ITS devices (CCTV)	○	●	○	●
Information clearing-house (IEN)/Data archiving	●	●	○	○
A corridor-based ATIS database – access by travelers and ISPs	○	○	●	○
ATIS devices (e.g., DMS) describe conditions on other network(s)	●	○	●	○
Common incident reporting system & asset management (GIS)	●	○	○	●
Transit signal priority	●	●		
Emergency vehicle signal preemption	○			●
Multi-modal electronic payment	●	●		
Transit hub connection protection	●	●		
Multi-agency incident response teams and service patrols	●	○		●
Coordinated operation between ramp meters and traffic signals	●	●		○
Modify arterial signal timing to accommodate shifting traffic	●	●		○
Modify ramp metering to accommodate shifting traffic	●	●		○
Modify transit priority to accommodate more timely bus service	●	●		○
Promote shifts (between roadways)	●	●	○	●
Promote shifts (from roadways to transit)	●	●	○	●
Promote shifts (between transit services)	●	●	○	●

ICM Strategies	Corridor Perspective	Corridor Mobility & Reliability	Corridor Traveler Information	Event & Incident Management
Lane use control (e.g., contraflow operations)	●	●		●
Adjusting transit headways and number of vehicles	●	●		●
Temporary new transit service (e.g., bus bridge)	●	●		●
Coordinate scheduled maintenance and construction activities	●	●		●
Open freeway HOV lanes/shoulders	●	●		●
Modify HOV restrictions (higher capacity vehicles)	●	●		●
Restrict freeway ramp access	●	●		●
Modify transit fares to encourage ridership	●	●		●
Modify parking fees	●	●		●
Restrict/Reroute Commercial Traffic	●	●		●
Legend: ● = Strategy Directly Supports Goal. ○ = Strategy Indirectly Supports Goal.				

The "long-term Capacity-Demand Management" strategies are considered "long term" in terms of the amount of time required for developing and deploying the strategies, and/or the time required for the desired results to accrue. They are not ICM "operational strategies," per se, and are therefore not included in Table 4-4. Nevertheless, they can certainly benefit and enhance integrated corridor management and the associated strategies. This approach addresses the lack of adequate parking for the Regional Rail service and any other physical constraints that may limit integrated operations.

4.3 ICM Concept Asset Requirements and Needs

Guidance – This section focuses on what is needed to implement the list of strategies that make up the ICMS concept for the subject corridor. A high-level list of asset-based "requirements" — including network systems and technologies, information, communications subsystems, as well as other attributes — for implementing the various ICM strategies should be developed and summarized in this section.

The ICMS concept for the Generic Corridor has been outlined by the selection of the approaches and strategies as identified in the previous section. This section identifies the assets that will be needed to implement and support these strategies. No consideration is given as to whether these assets already exist or are currently planned (that is discussed in the next section), only to the fact that these assets are needed for the ICMS to operate properly. Table 4-5 lists these ICMS "requirements"[4] in the following categories:

[4] In the parlance of systems engineering, the ICMS requirements will be developed in a subsequent step in the overall process, and documented in an ICMS Requirements Document. These requirements will be based on the information contained in Table 4-5 and 4-6.

- Network Systems – These are the required network-based systems. They are identified by the National ITS Architecture nomenclature of “Market Package” for ease of reference to functionality.
- Network Subsystems & Technologies – This column provides additional information on these minimum network ITS-based requirements (e.g., specific field devices, hardware, system functionality).
- Information – This column lists the data and other information to be gathered by the network systems, and subsequently shared among the stakeholders and corridor travelers.
- Communication Subsystems – These assets are communications – related, including the types of communications (e.g., center – to – center) as identified in the National ITS Architecture, interfaces to systems, and associated ITS standards.
- Other/Performance – This column is used for other ICM – required assets that don’t “fit” into the other categories, such as the few regional/multi-system market packages, institutional assets (responsibilities and policies), and support tools.

Table 4-5. Generic Corridor Asset Requirements

Network Systems (Market Packages)	Network Subsystems & Technologies	Information	Communication Subsystems	Other (Operational) / Performance
• Network / Probe Surveillance • Surface Street control • Freeway Control • HOV Lane Management • Traffic Information Dissemination • Traffic incident Management • Traffic Forecast & Demand Management • Emissions Monitoring / Management • Parking Facility Management • Reversible Lane Management • Roadway Closure Management • Transit Vehicle Tracking • Transit Fixed Route Operations • Transit Passenger and Fare Management • Transit Traveler Information • ISP Traveler Information (broadcast, interactive, route guidance) • HAZMAT Management • Emergency Call Taking and Dispatch • Emergency Routing • Roadway Service Patrols • Transportation Infrastructure Protection • Early Warning • Wide Area Alert • Disaster Response & Recovery • Evacuation & Re-entry Management • Disaster Traveler Information • ITS Data Mart / Warehouse • Maintenance / Construction Vehicle & Equipment Tracking • Road Weather Data Collection • Weather Information Processing and Distribution • Work Zone Management • Maintenance & Construction Activity Coordination • Other (e.g., Asset Management System)	• Traffic detectors / roadway surveillance / vehicle probes • CCTV (video surveillance) • Traffic signal control / monitoring (TOD schedule) • Traffic signal control / monitoring (traffic adaptive) • Ramp Meters (local control) • Ramp Meters (central control) • HOV by-pass • DMS – roadway • Internet Traveler Information • Automated Incident Detection • Incident Detection (call – in, other) • Incident Response Plans / Guidelines / Teams • Incident Reporting System (GIS, common display) • Air quality sensors • Road Weather Information Sensors • Parking Surveillance/occupancy • Transit Vehicle Location / GPS • Transit Schedule Performance Monitoring • Passenger Counting Equipment • Electronic Fare / Parking Payment Equipment • DMS – transit • Transit Public Address System • Transit Trip Planning System • Spare transit vehicles / operators • Telephone – Based ATIS (511) • Transit priority equipment (Intersection &Transit Vehicles) • Public Safety CAD • Emergency vehicle priority / pre-emption (Intersection / Vehicles) • Service Patrol Vehicles • Real-time conditions data base / common displays • Maintenance Vehicle Location AVL / GPS	Roadways (Freeway, Arterial, Managed Lanes) • Link congestion levels • Link volumes • Link occupancies • Link / spot speeds • Link travel times • Intersection approach volumes • Ramp queues • Average Vehicle Occupancy Transit • Transit schedules • Transit vehicle location • Schedule or headway status/deviation • Transit vehicle headways • Link Travel Times • Priority requests • Next Vehicle Arrival • Average Waiting Time • Transit Fares • Average Vehicle Occupancy Equipment / Device Status • Locations • Surveillance / detectors • DMS • Other Traveler information Devices • Ramp meter • Traffic Signals • CCTV • Electronic toll / fare / parking equipment • Available transit vehicles / location Other • Video images / snapshots • Video control • Parking space availability • Incident location • Incident status / details • Maintenance/ construction events • Special events • Electronic payment account status • Emergency vehicle location • Maintenance vehicle location • Parking fees • Contact lists • Air quality • Road surface condition	• Center-to-Center • Center to field • Roadside to vehicle • Center to vehicle • ITS standards for data formats and data transfer functions • Video transport standards (digital, analog) • Voice communications • Subsystem Capacity for data distribution • Subsystem Capacity for video distribution • Subsystem capacity / frequencies for voice communications (including interoperability) • Interfaces to network systems • Interfaces to emergency service systems (CAD) • Interfaces to proprietary / legacy systems • Interfaces to ISP's (data and video export) • Interfaces to financial transaction network • Interfaces to Internet • Security firewalls	• Regional Traffic Control (MP) • Regional Parking Management (MP) • Multi-Modal Coordination (MP) • Regional / Sub-regional ITS Architecture • Information Exchange Network / Common displays for data entry/display • Data aggregation / storage of processed data for subsequent analysis • Availability of spare network capacity • Corridor Models (simulation) • Accuracy of data/information • Vehicle location accuracy • Surveillance coverage • Response plans • On – line decision support (for selecting response plans) • Definitions of responsibilities of agencies • Common policies for incident reporting and response • Special Event Plans • Common fare collection technology • Integrated back office systems • Dynamic fare pricing capability • Priority logic at intersections • System back up / disaster recovery

These various assets are not necessarily independent or separate from one another. There are several relationships across columns – for example, the Market Package "Network / Probe Surveillance" requires one or more of the items included in the "Network Subsystems & Technologies" column (e.g., traffic detectors, CCTV, road weather sensors), which in turn provide several of the elements listed in the "Information" column (e.g., link volumes and travel times, video images, air quality). The items included in the "Communications Subsystems" column are then necessary to technically integrate all of these systems and devices into a corridor-based system, while the "Other" items support corridor integration from an operational and institutional basis. There are also dependencies within columns, particularly for the various Market Packages (as described in the National ITS Architecture documentation).

These ICM asset needs are not of equal importance or priority. For example, the assets associated with monitoring air quality are identified as a requirement in support of corridor-wide performance monitoring, whereas other surveillance devices and real time information (e.g., link travel times) are of higher priority as they may impact the selection and management of various ICM strategies within the corridor.

4.4 Comparison of ICM Concept Asset Requirements with Current and Potential Assets

Guidance – This is a continuation of the previous analysis to identify the assets needed to support the proposed ICM concept. This section looks at those assets that already exist within the corridor or soon will exist (as identified in Chapter 3) and compares these current assets with the needed ICM assets. This analysis results in an identification of ICM concept needs. Identification of these high-level asset requirements provides a sense of the proposed changes / additions to the corridor systems and operations in support of the ICM concept, and also provides a basis for the subsequent development of detailed ICMS requirements.

Using the information from Chapter 3 about current and proposed corridor assets, a comparison was performed with the list of assets needed to support the ICM concept proposed for the Generic Corridor. Table 4-5 was revised to highlight assets that are already operating within the corridor or are potential assets based on current improvement plans. The results are shown in Table 4-6 using the following code:

- Bold Type and Gray Highlight – The asset is essentially deployed throughout the corridor, except for the necessary integration among the corridor stakeholders.
- Underline – The asset is only partially deployed within the Generic Corridor.
- None – Minimal, if any, deployment of the asset within the corridor.

There are several data and video collection systems and information needs that are partially deployed. In general, these subsystems are operating on a specific network level (e.g., freeway detectors, bus and rail vehicle AVL). Similar capabilities need to be expanded and added to other networks within the corridor – including the park & ride lots – and then integrated together. Another important source of corridor information is the Police and Fire Departments' Computer Aided Dispatch (CAD) System that supports emergency call taking and dispatch; although it is currently only accessible by the police and fire units.

Table 4-6: Comparison of Existing Corridor Assets with ICM Requirements

Network Systems (Market Packages)	Network Subsystems & Technologies	Information	Communication Subsystems	Other (Operational) / Performance
• Network / Probe Surveillance • Surface Street control • **Freeway Control** • **HOV Lane Management** • Traffic Information Dissemination • Traffic incident Management • Traffic Forecast & Demand Management • Emissions Monitoring / Management • Parking Facility Management • Reversible Lane Management • Roadway Closure Management • **Transit Vehicle Tracking** • **Transit Fixed Route Operations** • Transit Passenger and Fare Management • Transit Traveler Information • ISP Traveler Information (broadcast, interactive, route guidance) • HAZMAT Management • Emergency Call Taking and Dispatch • Emergency Routing • Roadway Service Patrols • Transportation Infrastructure Protection • Early Warning • Wide Area Alert • Disaster Response & Recovery • Evacuation & Re-entry Management • Disaster Traveler Information • ITS Data Mart / Warehouse • Maintenance / Construction Vehicle & Equipment Tracking • Road Weather Data Collection • Weather Information Processing and Distribution • Work Zone Management • Maintenance & Construction Activity Coordination • Other (e.g., Asset Management System)	• Traffic detectors / roadway surveillance / vehicle probes • CCTV (video surveillance) • **Traffic signal control / monitoring (TOD schedule)** • Traffic signal control / monitoring (traffic adaptive) • **Ramp Meters (local control)** • Ramp Meters (central control) • HOV by-pass • DMS – roadway • Internet Traveler Information • Automated Incident Detection • Incident Detection (call – in, other) • Incident Response Plans / Guidelines / Teams • Incident Reporting System (GIS, common display) • Air quality sensors • Road Weather Information Sensors • Parking Surveillance/occupancy • **Transit Vehicle Location / GPS** • **Transit Schedule Performance Monitoring** • Passenger Counting Equipment • Electronic Fare / Parking Payment Equipment • DMS – transit • Transit Public Address System • Transit Trip Planning System • Spare transit vehicles / operators • Telephone – Based ATIS (511) • Transit priority equipment (Intersection &Transit Vehicles) • Public Safety CAD • Emergency vehicle priority / pre-emption (Intersection / Vehicles) • Service Patrol Vehicles • Real-time conditions data base / common displays • Maintenance Vehicle Location AVL / GPS	Roadways (Freeway, Arterial, Managed Lanes) • Link congestion levels • Link volumes • Link occupancies • Link / spot speeds • Link travel times • **Intersection approach volumes** • Ramp queues • Average Vehicle Occupancy Transit • **Transit schedules** • **Transit vehicle location** • **Schedule or headway status/deviation** • **Transit vehicle headways** • Link Travel Times • Priority requests • Next Vehicle Arrival • Average Waiting Time • **Transit Fares** • Average Vehicle Occupancy Equipment / Device Status • Locations • Surveillance / detectors • DMS • Other Traveler information Devices • Ramp meter • Traffic Signals • CCTV • Electronic fare / parking equipment • Available transit vehicles / location Other • Video images / snapshots • Video control • Parking space availability • Incident location • Incident status / details • Maintenance/ construction events • Special events • Electronic payment account status • Emergency vehicle location • Maintenance vehicle location • Parking fees • Contact lists • Air quality • Road surface condition	• Center-to-Center • Center to field • Roadside to vehicle • Center to vehicle • ITS standards for data formats and data transfer functions • Video transport standards (digital, analog) • Voice communications • Subsystem Capacity for data distribution • Subsystem Capacity for video distribution • Subsystem capacity / frequencies for voice communications (including interoperability) • Interfaces to network systems • Interfaces to emergency service systems (CAD) • Interfaces to proprietary / legacy systems • Interfaces to ISP's (data and video export) • Interfaces to financial transaction network • Interfaces to Internet • Security firewalls	• Regional Traffic Control (MP) • Regional Parking Management (MP) • Multi-Modal Coordination (MP) • Regional / Sub-regional ITS Architecture • Information Exchange Network / Common displays for data entry/display • Data aggregation / storage of processed data for subsequent analysis • Availability of spare network capacity • Corridor Models (simulation) • Accuracy of data/information • Vehicle location accuracy • Surveillance coverage • Response plans • On – line decision support (for selecting response plans) • Definitions of responsibilities of agencies • Common policies for incident reporting and response • Special Event Plans • Common fare collection technology • Integrated back office systems • Dynamic fare pricing capability • Priority logic at intersections • System back up / disaster recovery

Traveler information is available within the Generic Corridor, but it is relatively sparse with respect to meeting the ICM goals and objectives for traveler information. The State DOT, the Regional Rail Agency, and the Generic Bus Authority all operate websites; but the information is network-specific, meaning travelers must go to each individual web site to get a corridor-wide (and still, incomplete) view of corridor operations. These three agencies also operate various DMS (i.e., at selected locations along the freeway, and smaller DMS at transit stations and bus stops); but as is the case with the web sites, the information displayed is limited to each agency's specific network. Moreover, additional DMS are required in advance of potential points of route and modal shifts.

Integrated operations within the Generic Corridor do occasionally occur; for example, the proposed electronic fare collection system being jointly developed by Regional Rail Agency and the Generic Bus Authority, and the various special event task forces. Otherwise, very little integrated operations exists within the Generic Corridor; for example, there is no coordination between freeway ramps and arterial signals, no transit signal priority along the major arterials, or transit "connection protection." Incident management tends to be very network-oriented, with the operating agency generally taking the lead. Coordination and active participation between transportation agencies and public safety agencies for incident and emergency management is in need of significant improvement as well.

Even for those assets bolded and highlighted in grey, the importance and effort required to integrate these assets should not be underestimated. This is evidenced by the relative lack of highlighted entries in the "Communications Subsystems" and the "Other (Operational)" columns; which is not surprising considering that the current level of coordinated operations within the Generic Corridor is minimal. In addition to the center-to-center communications linkages, specific ITS standards, system interfaces and firewall protection (particularly for the police and fire computer aided dispatch systems such that sensitive information regarding individuals is not obtained), the ICMS will also require central hardware and software for data aggregation and display, video sharing and control, internet access by travelers, access by ISP's, storage of corridor response plans, automated decision support, contact lists for incident response, calculation of performance measures, etc.

Numerous assets need to be implemented. The most significant of these proposed changes (from a field infrastructure and technical integration perspective) are summarized in Table 4-7. These and the other "missing" assets will be prioritized and accounted for when the high-level and detailed level component designs are developed as part of the systems engineering process. At the same time, the above discussion of current and proposed assets indicates that there is a strong basis from which the Generic Corridor can move forward with the development and deployment of an ICMS.

Table 4-6. Summary of Significant Changes and Additions to the Generic Corridor

Organizational Entity	Changes and Additions
State DOT	• Additional surveillance (volumes, queues) on freeway off ramps • Additional inbound and outbound DMS on the freeway in advance of cross-network connections • Enhanced ramp metering software and communications with adjacent Atlantis signals • GPS on service patrol/incident response/construction/maintenance vehicles (including system for tracking)
Atlantis	• Surveillance along the entire length of Broadway and cross-network connectors, providing volumes and average speeds/travel times. • Additional CCTV along Broadway, including coverage of bus stops • Inbound and outbound DMS on Broadway at critical locations • Transit priority and emergency preemption devices and enhanced controller firmware at signalized intersections along Broadway • Enhanced controller software and communications with adjacent freeway ramp meters • GPS on incident response/construction/maintenance vehicles (including subsystem for tracking)
Neptune	• Surveillance along the entire length of Main Street and cross-network connectors, providing volumes and average speeds/travel times. • Additional CCTV along Main Street, including coverage of bus stops • Inbound and outbound DMS on Main Street at critical locations • Transit priority and emergency preemption devices and enhanced controller firmware at signalized intersections along Main Street • GPS on incident response/construction/maintenance vehicles (including subsystem for tracking)
Regional Rail Agency	• Additional spaces at Park & Ride Lots (Beech St. & Pine St. stations) • Surveillance of park & ride lots at the three stations for real-time monitoring of parking availability • Software to calculate parking availability (number of vacant spaces) • Automated passenger counting technology (i.e., determine availability seating on each train)
Generic Bus Authority	• On-board devices for signal transit priority, including connection to schedule adherence subsystem
Public Safety Agencies	• Enhancements to Computer Aided Dispatch software to identify “best” routes • Interface to CAD, including protection/security of sensitive information

Organizational Entity	Changes and Additions
Corridor Wide	• Corridor simulation model • Communications linkages between transportation management and emergency service centers (connect to existing subsystems) • ITS standards for center – to – center communications • Interfaces to existing systems, including “translators” as required • Servers of information processing and aggregation, video sharing and control • Decision support software (logic that continuously looks at the various and changeable network performance parameters (e.g. volumes/occupancies, travel times, transit schedule adherence, confirmed incidents/location/severity, parking lot status, scheduled events, time of day); and through a series of IF, AND, OR and THEN logical statements, will implement the most appropriate pre-planned response plan – either automatically or with operator confirmation.

4.5 Generic Corridor Concept Operational Description

Guidance – The focus of this section is to provide a general description of the corridor under ICMS operations. The section should describe how the vision translates to corridor operations in relation to operational, technical, institutional, and stakeholder points of view. This description should provide all stakeholders with a consistent picture of what is envisioned for the corridor, and provide a basis to identify roles, responsibilities, and needs. This is a general description as compared to the specific scenario descriptions in section 5.

In the future, the ICMS will provide, to the greatest extent possible, efficient and reliable travel throughout the Generic Corridor and the constituent networks, resulting in improved and consistent trip travel times. Corridor operations will be adaptable with the ability to respond to any corridor conditions. Using cross-network strategies, the Generic Corridor will capitalize on integrated network operations to manage the total capacity and demand of the system in relation to the changing corridor conditions.

The Generic Corridor consists of multiple jurisdictions and agencies. The management and operations of the corridor and the ICMS will be a joint effort involving all the stakeholders. One centralized body, representative of these stakeholders, will manage the ICMS and corridor operations, including the distribution of responsibilities, the sharing of control and related functions among the corridor agencies. This centralized body will be the decision-making body for the Generic Corridor in relation to budget development, project initiation and selection, and overall administrative and operational policy.

The daily operation of the corridor will be similar to the transportation command center model that has been used for major special events; but will now be applied on a permanent basis for day-to-day operations. This will be accomplished via a virtual **Corridor Command Center (CCC)** operating among the corridor agencies. This virtual corridor command center will operate the ICMS as a “sub-regional” system managing the various networks and influencing trips that use the corridor. The virtual command center will consist of agency, network, and public safety **Agency/Service Operations Officers (ASOs).** The ASOs will be designated by their respective organizations and approved by the corridor centralized decision-making body. Each agency/service officer will be in charge of a specific corridor network or service with respect to ICM operations and coordination. The ASOs, with approval of the central body, will also designate a **Chief Corridor Operations Officer (CCOO)** every 3 years. The chief operations officer responsibilities will consist of coordinating corridor operation on a daily basis and managing the response to any fluctuations in capacity and or demand.

All operations among corridor networks and agencies (e.g., activation of specific ICM strategies) will be coordinated by the corridor command center. The CCC will investigate and prepare corridor response plans for various scenarios that can be expected to occur within the Generic Corridor. The chief corridor operations officer will be responsible, with the other agency/service operations officers, for configuring the CCC with respect to its functions and staffing for all hours of operations. Staff will be assigned by the corridor stakeholders to support daily operations, develop response plans, analyze system deficiencies and needs, and general administration.

Performance measurement and monitoring will be the responsibility of the corridor command center. The agency/service operations officers, led by the chief corridor operations officer, will be accountable to the centralized decision-making body and make reports as the decision-making body designates.

Communications, systems, and system networks will be integrated to support the virtual corridor command center. Voice, data, video, information, and control will be provided to all agencies based on the adopted protocols and standards for the sharing of information and the distribution of responsibilities. The ICMS will support the virtual nature of the corridor command center by connecting the chief, agency/ service operations officers, and other critical staff on a real-time basis via communications and other ITS technologies. The chief corridor operating officer, ASOs, and other CCC staff will monitor corridor travel conditions 24/7, and use the response plans, real-time information, and the implemented corridor strategies to address any conditions that present themselves.

While all the ICMS operational strategies will be available for use, it is envisioned that only a subset of these strategies will be activated at any one time, depending on the operational conditions and events within the corridor. For example, strategies involving traveler information and coordination at network junctions (e.g., transit signal priority) will be important components for all scenarios; the “inform”/ accommodate any user-defined shifts will be a part of most scenarios involving roadway and transit incidents, with a more pro-active approach (“instruct”) towards route and modal shifts occurring during major incidents; and the various manage demand/capacity relationship strategies also coming into play during these major incidents and special events.

The corridor command center will conduct desktop scenario sessions to prepare, train and refine response plans for incidents, special events, weather, and evacuations. All the agency/service operations officers and staff will know their respective roles and responsibilities for any of the various situations the corridor may face and will be aided, when available, by response plans and ICMS decision support software. Moreover, agency operations officers will be able and authorized to improvise as situations may dictate.

Traveler information (on 511, websites, DMS, and through the media and ISPs) will be corridor-based, providing information on corridor trip alternatives complete with current and predicted conditions. Travelers will access or be given real-time corridor information so they can plan or alter their trips in response to current or predicted corridor conditions.

Each traveler will be able to make route and modal shifts between networks easily due to integrated and real-time corridor information, integrated fare/parking payment system, and coordinated operations between networks. Using one network or another will be dependent on the preferences of the traveler, and not the nuances of each network. Travelers will be able to educate themselves about the corridor so they can identify their optimal travel alternatives and obtain the necessary tools (e.g., smart card, available parking) to facilitate their use of corridor alternatives when conditions warrant.

The Generic Corridor will be an integrated transportation system – managed collectively and operated centrally (when circumstances dictate) – to maximize its utility to corridor travelers. All corridor assets will be attuned to obtain the goals and objectives of the corridor, as well as the goals of each individual traveler as there preferences prescribe. The corridor users will recognize the Generic Corridor as a seamless transportation system that provides them with multiple viable alternatives that they can select based on their specific travel circumstances and needs.

4.6 Alignment With Regional ITS Architecture

Guidance – This section compares the ICMS Concept to the Regional ITS Architecture to identify any possible issues and needs that may arise during ICMS design and deployment. Any potential revisions and or enhancements to the Regional ITS Architecture should be identified.

As discussed in Chapter 3, the Regional ITS Architecture has been established. The task force, with representatives of the BWRMPO Regional ITS Architecture Committee, have conducted a high-level comparison of the Regional ITS Architecture and the Generic Corridor ICMS concept. Their findings are as follows:

- Major focus areas of the Regional ITS Architecture include real -time information sharing (data, video) between all agencies, and providing a clearinghouse of real-time information covering all critical routes and modes within the region. The proposed ICMS includes these same functions (focusing on the "sub-region" as defined by Generic Corridor's boundaries), In fact, the ICMS will represent the initial implementation of the center-to-center linkages and the information sharing/storage capabilities in support of this functionality.
- The Regional ITS Architecture recommends the use of "ITS Standards as adopted by US DOT" for the purpose of information sharing; but no additional details are provided. The ICMS will also utilize ITS standards for the center-center connections (i.e. NTCIP, TCIP, IEEE[5] as appropriate) as well as for

[5] NTCIP refers to the "National Transportation Communications for ITS Protocol" standards; TCIP refers to the "Transit Communications for ITS Profiles" family of standards that specifies the rules and terms for the automated exchange of information in transit applications; and the IEEE family of standards focus on incident management.

any new center-to-field and field-to-field connections (e.g., transit signal priority). The specific standards for the ICMS will not be defined until system design.

- Another function of the Regional ITS Architecture is regional coordination support between transportation agencies and public safety agencies during "major" incidents, construction activities and special events (i.e., those for which the impacts cross most of the agency boundaries). The ICMS concept includes such inter-agency coordination, but goes much farther to address the integrated operations of the corridor networks on a daily basis, including recurring congestion and minor incidents.
- The Regional ITS Architecture does not include inter-agency operations or control of system components – each organization in the region and the corridor operate independently, maintaining control of all aspects of their respective systems. The ICMS concept changes this mode of operations, providing for proactive management of cross-network operations within the Generic Corridor, particularly during major incidents and events.

The ICMS concept is consistent with the Regional ITS Architecture. There are no conflicts, per se; but the ICMS concept does include significantly more information sharing (including command and control functions) and integrated operational capabilities than provided by the Regional ITS Architecture. Moreover, the ICMS concept includes a virtual CCC, which is not addressed in the regional architecture.

The task force, with the backing of Regional ITS Architecture Committee representatives, will propose to the Regional ITS Architecture Committee that the current regional architecture be modified to include the sub-regional ICMS concept and integrated operation of corridor networks and systems. This will include the depiction of sub-regional centers such as the Generic Corridor virtual CCC. Moreover, the ICMS design team will coordinate with the Regional ITS Architecture Committee to ensure that the specific ITS standards identified for the ICMS can be used throughout the region as well.

4.7 Implementation Issues

Guidance – This section reviews and discusses corridor and ICM concept issues, including any related strategy and system implementation issues. Many of these implementation issues will involve choices that cannot be fully addressed and subsequently resolved until later stages of the systems engineering process (e.g., design, procurement, and implementation). This section should nevertheless identify these critical issues such that all the stakeholders have a joint understanding of these issues and their possible impact on the successful development and implementation of the ICM concept.

The ICM concept represents a significant paradigm shift for management and operations within the Generic Corridor – from the current lack of any coordinated operations between corridor networks and agencies, to a fully integrated and pro-active operational approach that focuses on a corridor perspective rather than a collection of individual (and relatively independent) networks. Paralleling this "corridor-based" operational perspective (and the associated issues) is the institutional framework within the Generic Corridor. This institutional structure is multi-agency, multi-functional, and multi-modal. Moreover, the authority for transportation-related decision-making is dispersed among several different agencies, including the State DOT, Neptune, Atlantis, the Regional Rail Agency, the Generic Bus Authority, Metropolis, as well as the various enforcement agencies and fire departments. A more formal institutional structure with defined processes and documented policies, plus dedicated staff with the appropriate responsibility and authority to operate the corridor as an integrated system, will be necessary for the ICMS to be a success. A proposed institutional structure to support the implementation and on-going operation of the ICM concept is presented in the next section.

Table 4-8 highlights the major implementation and integration issues facing the Generic Corridor and the proposed ICM concept. Additional discussion of some of these issues is provided below.

The **technology** issues shaded in gray have already been addressed, albeit at a high level, in this ICM Concept of Operations. As shown previously in Table 4-7, the need for additional surveillance capabilities and information (i.e., Broadway and Main Street freeway off-ramps) additional CCTV coverage, parking lot surveillance for available spaces, GPS in maintenance and response vehicles) has been identified, as has need for additional DMS. The technical details – such as the distribution and actual location of the devices, and their respective capabilities, will be addressed during the Requirements and Design stages of the ICMS project.

There are two efforts underway that need to be coordinated with in relation to technology and system compatibility issues. The first effort is the development of the electronic fare payment systems by the Regional Rail Authority and the Generic Bus Authority. Identifying fare payment technology that is expandable to support parking payment and any future toll facilities will better support ICMS implementation. The other planned effort involves the enhancements to the Atlantis and Neptune signal systems, which include Broadway and Main Street, respectively, and the various cross-network connections in the Generic Corridor. These upgraded systems need to be compatible to implement many of the cross-network strategies. They will also influence any future technology purchases for implementing ICM strategies such as transit vehicle priority and coordinated operation between the signals and adjacent ramp meters.

Table 4-7. ICMS Implementation Issues

Technical Issues	Operational Issues	Institutional Issues
• ICMS architecture (logical and physical) • **Required enhancements to the individual network-based systems** • **Expanded surveillance coverage** • Distribution/placement of data collection points • **Capabilities of additional detection technologies** • Data accuracy • Data processing/aggregation/display • Data archiving/access for future analyses	• Development of operational response plans for numerous corridor scenarios and events • Up to date data base of contact personnel and locations • Updates to network operational parameters (signal timing, transit schedules) • Identifying available data and other information that should and should not be shared between agencies (e.g., personal information on drivers involved in an incident as input to police CAD)	• Identification and distribution of responsibilities (e.g., lead, support roles) for all ICMS activities • Hosting of ICMS hardware • Organizational and administrative framework/structure that supports ICMS operations and coordination • Compatibility of ICMS technologies and standards with agency IT requirements • Policy arrangements for ICMS activities and

Technical Issues	Operational Issues	Institutional Issues
• Real-time calculation of available capacity, and location within the corridor • **Expanded video coverage** • Distribution/placement of video collection points • **Expanded coverage of ATIS devices** • Distribution/placement of ATIS devices • Communication links/technologies between network-based systems and ICMS (C2C) • Communication subsystem capacity for data and video distribution • Communication subsystem for voice communications (including interoperability among all agencies) • Communications subsystem configuration (including possible shared use of agency communication resources • Other communication links/technologies (C2F, roadside to vehicle) • Data compatibilities and center-to-center standards (e.g., NTCIP, TCIP, IEEE for incident management, ATIS) • Network system interfaces (e.g., "translators for legacy systems). • Video sharing standards • Video switching standards • Communications to ISP's • Secure back up/disaster recovery • Firewall barriers for Internet based systems • **Common fare collection technology** • Real – time decision support (i.e., software-based response plan development/ selection/management tools) • Configuration management	• **Policy towards route/modal shifts (i.e., Inform vs. Instruct), and under what scenarios** • **Procedures and protocols for identifying route/modal shifts when spare capacity exists on multiple networks** • **Policies for implementing route/modal shifts when sufficient spare capacity is <u>not</u> available within the corridor** • **Policies for implementing demand/capacity management strategies** • **Common policies for incident response & reporting** • Pricing (fares, parking, tolls, HOT) strategies and policies • **Procedures and protocols for the shared use of resources and/or shared control of ITS devices** • **Resolution of multiple (and conflicting) requests for the same device** • **Priority strategy protocols between transit and emergency vehicles and control devices (traffic, transit, and emergency operations staff)** • **Disseminating traveler information in a consistent manner across networks** • **Video distribution/censoring policy** • **Safety concerns** • Corridor modeling (e.g., evaluate impact of strategies and operating parameters) • Corridor – wide performance measures and metrics • Marketing and outreach • On – going operations and maintenance of the ICMS	funding • ICMS funding mechanisms • System procurement/implementation approach • Policies and procedures for data sharing, access rights, filtering, etc. • Inter-agency liability • Policies and arrangements with private entities (parking, ISP) • Federal involvement • Inter-agency agreements documenting the resolution of the various operational, technical, and institutional issues • Updating the agreements

A major technology issue involves the adoption and implementation of ITS standards. As previously noted, the Regional ITS Architecture recommends the use of "ITS Standards as adopted by US DOT" for the purpose of information sharing; but no additional details are provided. Moreover, the Regional Architecture does not address coordinated operations or shared control. It is essential that all data elements exchanged between the network – specific systems in the Generic Corridor be defined in exactly the same way; that there be perfect understanding between the interfaced centers as to the meaning of these data – both status and control information. Several sets of ITS standards, data dictionaries, and message sets have been developed for this purpose, including:

- NTCIP (National Transportation Communications for ITS Protocol) suite of standards for data exchanges between centers.
- TCIP (Transit Communications for ITS Profiles) family of standards for the automated exchange of information in transit applications.
- IEEE family of standards for incident management communications.
- ATIS standards for data exchanges to support traveler information.

It is envisioned that the deployment of the Generic Corridor ICMS will use a single, standard protocol such as NTCIP C2C XML to exchange messages from several if not all of these standard message sets as needed. There is, however, the potential issue of “semantic interoperability” between these various C2C standards – that is, are the common data elements and message sets defined in exactly the same way. It may therefore be necessary to incorporate “translators” into the ICMS design that will enable a legacy system to present a standard interface to the other systems and the CCC in the Generic Corridor. Some translation may also be needed between data elements within different standard messages, although over time, further harmonization of the standard data elements by the standards development organizations should eliminate any such need. It will also be necessary to ensure that all of the desired information and data elements necessary to support the ICM strategies are covered by these standards and their respective data dictionaries and message sets.

Based on a cursory review of various standard documents and initial discussions with individuals that have been involved in the standards development process, such “data gaps,” message deficiencies, and semantic interoperability should not be major technical issues. The amount of overlap between the various C2C application areas is probably not significant, as there was a considerable degree of data harmonization effort between several of the Standard Development Organizations during their respective activities.

A related data sharing issue involves the interface to the various CAD systems used by the public safety agencies within the Generic Corridor. Many of these are proprietary systems. Moreover, regardless of how these CAD systems are integrated into the ICMS, the interfaces must include appropriate “filters” such that sensitive information is not released, shared, or otherwise compromised.

Another technical issue involves video sharing. The ICM concept for the Generic Corridor includes significant sharing of video between the corridor stakeholders and with the media/ISP’s. The desire is to have “full – motion” video in this regard; although this will significantly increase the bandwidth requirements for the C2C communications subsystem.

The **operational** issues must be resolved prior to system implementation if the various ICMS strategies are going to be applied consistently and in a manner that improves overall corridor performance. It is recommended by this task force that a preliminary Operations Plan and Manual be developed during the system design phase. As a minimum, the Plan should address those issues presented in bold type in Table 4-8. This plan will also serve as the basis for the ICMS Operations and Maintenance Plan as described in the ICM Implementation Guidance.

Some of these operational issues have already been resolved as described herein. For example, the policy towards route and modal shifts within the Generic Corridor will generally be one of "inform" – that is, providing complete and accurate information to the travelers and letting them determine whether a shift is appropriate for them (and then changing the operational parameters) to accommodate these route and modal shifts. The "instruct" approach will generally not be used except for major incidents (e.g., closure), events, or emergencies.

Information dissemination is crucial to the success of the ICM concept. Some of the technical issues associated with data gathering (surveillance coverage, types of information) and aggregation have already been noted. The associated operational issue involves the presentation of the information in a consistent manner across networks such that the users can make informed decisions regarding the travel decisions (e.g., route, mode, time of day). As discussed in the subsequent section on performance measures, the common convention for operations-based measures and AITS displays will likely be comparable link travel times. Consideration is also being given to the possibility of displaying travel conditions along each network and the cross-network connections (and the links that comprise these networks) on a graphic display using some sort of color code that indicates the "relative" rather than absolute levels of delays (e.g., green colored link means no delays, yellow means some delays, and red means significant delays); however the measures and criteria for what constitutes "green," "yellow," and "red" conditions along each network still need to be defined.

Another key operational issue is the development of operational response plans for numerous corridor scenarios and events, including location(s) of event, severity and impact, associated strategies (e.g., DMS messages, other traveler information displays, system operational parameters), contact personnel and locations, other resources, and implementation rules. The ICM response plans, along with the required input to the automated decision support mechanism, will be developed during ICMS implementation, and then evaluated and updated throughout the system's life.

Resolving the **institutional** issues is an on-going process of coordination and collaboration between corridor stakeholders. Moreover, it has already started (e.g., the establishment of the Generic Corridor Stakeholder Group and task forces, the development of this ICM Concept of Operations.) The next section describes the proposed institutional framework to support the management, operation, and administration of the ICMS for the Generic Corridor.

4.8 Generic Corridor ICM Concept Institutional Framework

Guidance – This section describes the proposed institutional framework by which the subject corridor's ICM concept will be implemented, operated, managed, and maintained. The section needs to explain how the institutional framework will be established, the responsibilities of the various units that comprise the framework (if there are more than one), the composition of leadership and staff, the distribution of decision-making authority, and how the framework will facilitate necessary external corridor interactions. The institutional framework proposed in this section must be an approach that will be implemented and backed by all the corridor stakeholders.

In developing the institutional framework, the task force considered many configurations and institutional arrangements to establish the centralized decision-making body and virtual command center. The concept presented herein represents the institutional framework endorsed by the Generic Corridor ICM Study Task Force stakeholders.

The management and operations of the corridor and the ICMS will be a joint effort involving all the stakeholders. To effectively manage and operate the ICMS concept as described in this Concept of Operations document, the task force recommends the creation of a central corridor decision-making body. This body – designated as the **Generic Corridor Operations Panel (GCOP)** – will consist of leadership level representatives from each of the stakeholders in the Generic Corridor. The GCOP will be the central decision-making body for the corridor, managing the distribution of responsibilities, the sharing of control, and related functions among the corridor agencies. The GCOP will be responsible for establishing the necessary inter-agency and service agreements, budget development, project initiation and selection, corridor operations policies and procedures, and overall administration. It is envisioned that the GCOP will be the next generation of the Generic Corridor ICM Study Task Force. The current task force, with some personnel changes, will comprise the initial GCOP. Staff of the BWRMPO will facilitate GCOP meetings.

To support the GCOP and other future corridor operations panels, the task force recommends that the **Regional ITS Architecture Committee** be restructured, re-chartered, and renamed to reflect an expanded scope that includes the promotion and stewardship of corridor-based coordinated operations throughout the metropolitan region. The new committee would be chartered to continue its duties in relation to the Regional ITS Architecture, but the duties will be expanded to promote coordinated operations within the various corridors that make up the region, as well as addressing any "inter-corridor" operational issues (i.e., be the coordinator of multiple corridor operation panels and ICM systems).

The task force recommends the creation of the **BWR Transportation Operations Council (BWRTOC)** to restructure the Regional ITS Architecture Committee. The BWRTOC will be the regional body to identify and investigate future coordinated operations opportunities, such as deploying Integrated Corridor Management systems in other corridors within the region. The BWRTOC representation will be expanded to include all operations and service representatives that operate in the metropolitan region. A sub-committee of this council will be responsible for the Regional ITS Architecture. The BWRTOC will still report to the Elected Officials

Committee and the Technical Officials Committee. The BWRTOC will coordinate all operations request for funding and present requests to the two main committees for approvals. The BWRTOC will review corridor operating procedures, policies, and technical standards in order to ensure consistency, compatibility, and compliance with the regional ITS architecture.

The GCOP will regularly report on corridor performance, and transmit budget requests to the BWRTOC and to each other agency from which they are requesting funds.

As discussed in previous Section 4.5 (Concept Operational Description), the Corridor Command Center (CCC) will handle the daily operations of the Generic Corridor. The CCC will be a virtual center capitalizing on ITS technologies to connect CCC leadership and staff. The CCC leadership will consist of **Agency/Service Operations Officers (ASOs)** that are nominated by their respective organizations and approved by the GCOP. Corridor Law Enforcement and Emergency Services will each provide one ASO. Each agency/service officer will be in charge of a specific corridor network or service with respect to ICM operations and coordination. Every three years the ASOs, with approval of the GCOP, will select a **Chief Corridor Operations Officer (CCOO)**. The CCOO will be in charge of all Generic Corridor Operations. The CCOO responsibilities will include day-to-day operations, monitoring and maintaining the performance of the corridor, identifying corridor deficiencies and needs, preparing budget requests, maintaining corridor systems configuration management, and managing the use of all corridor resources.

The ASOs will be responsible for the integrated, corridor-based operations of their respective network or service, supporting the CCOO in operating the corridor. Besides the ASOs and the CCOO, there will be two additional staff positions filled by the CCOO. The first position will be the CCOO's Administrative Director who will oversee and coordinate all administrative matters including budget, finance, and administrative liaison duties with other corridor stakeholder organizations. The second position will be the CCOO's Technical Director. The Technical Director will oversee the monitoring of corridor performance, corridor traveler information, the analysis of performance and identification of needs, configuration management of the system and the development of integrated corridor response plans including response plan operations protocols. Other CCC staff will come from each agency or service as determined by the stakeholders. Each ASO will assign staff to network and service operations, administration, and technical development in support of the ICMS.

The proposed institutional framework for the Generic Corridor ICMS as described above is shown in Figure 4-1. The virtual CCC staffing is summarized in Table 4-9.

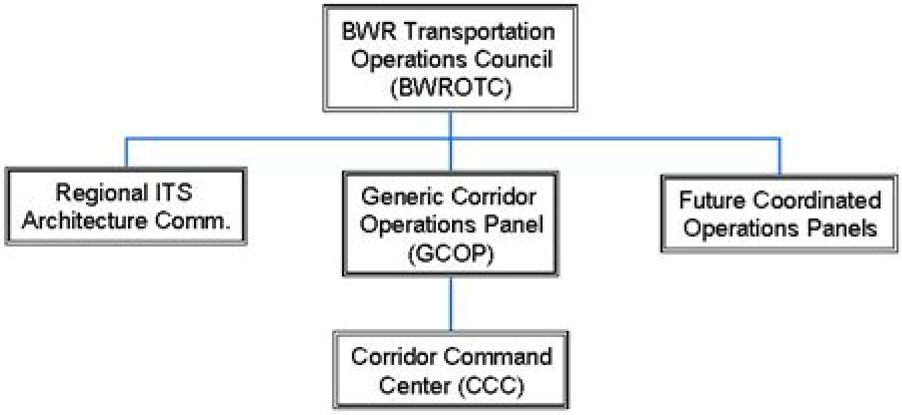

Figure 4-1. Institutional Framework of Generic Corridor ICMS

Table 4-8. Corridor Command Center Staff

Agency/Service	Responsibilities	CCC Aligned Staff
Corridor Command Center	• Corridor coordinated operations • Corridor Administration • Corridor Performance monitoring • Corridor Technical Management and Development	• Chief Corridor Operations Officer • Administrative Director • Technical Director • Staff support from other agencies/services to support coordinated ops and technical development
State DOT	• Daily Operations • Monitoring freeway traffic flow • DMS • Freeway surveillance • Enact response plans • Maintenance	• Agency/Service Officer • CCC Operations, Administration, and Technical support staff
Bus Authority	• Daily operations • Monitor bus on-time levels • Enact response plans	• Agency/Service Officer • CCC Operations, Administration, and Technical support staff
Rail Agency	• Daily operations • Monitor train schedules • Monitor parking conditions • DMS • Enact response plans	• Agency/Service Officer • CCC Operations, Administration, and Technical support staff
Neptune	• Daily operations • Signal systems • DMS • Arterial surveillance • Enact response plans	• Agency/Service Officer • CCC Operations, Administration, and Technical support staff
Atlantis	• Daily operations • Signal systems • DMS	• Agency/Service Officer • CCC Operations, Administration, and

Agency/Service	Responsibilities	CCC Aligned Staff
	• Arterial surveillance • Enact response plans	Technical support staff
Metropolis	• Daily operations • Signal systems • Enact response plans	• Agency/Service Officer • CCC Operations, Administration, and Technical support staff
Law Enforcement	• Coordination of law enforcement activities and incident response • Integration of CAD for corridor	• Agency/Service Officer • CCC Operations, Administration, and Technical support staff
Emergency Services	• Coordination of emergency services activities and response • Integration of CAD for corridor	• Agency/Service Officer • CCC Operations, Administration, and Technical support staff

Resources for all agency and service staff will be provided by their respective agency or service organizations, except for the CCOO's Administrative Director and Technical Director. These two positions will be jointly funded with each organization paying a portion for these positions.

ICMS procurement/implementation approaches and funding, and the individual agency responsibilities in this regard, are still being discussed by the stakeholders. Each network and agency has existing procurement policies and practices. Each procurement policy and practice has to be identified and understood in order to establish a corridor – wide procurement policy for the ICMS. The procurement policy may be a combination of policies or a policy that directs the use of the most appropriate agency practice for the item being procured. It has been determined that funding and procurement in support of corridor activities will be a joint effort with the Technical and Administrative Directors developing project, funding, and procurement scenarios (e.g., pooled funds) that take advantage of each agencies/service funding opportunities and procurement services. Recommendations will be made by the CCOO and the ASOs to the GCOP. Activities will be funded through a variety of sources. The process for each source of funding will have to be followed and all funds traced and accounted for jointly by the agency/service through which the funds are secured and the CCC.

The task force believes this is the best framework to facilitate the implementation and operations of this Generic Corridor ICMS. The task force has the endorsements of each stakeholder representative's agency/service leadership to pursue the creation of this institutional framework. As the ICMS project moves from concept to the design stage, formal inter-agency agreements will be developed and executed describing this institutional framework and structure in detail, including each agency's responsibilities.

4.9 Performance Measures and Targets

Guidance – This section identifies the performance measures and targets that will be used to evaluate ICMS operations. The information herein should address how the performance measures are related to the corridor goals and objectives, what level of each measure will indicate operational success, data collection methods and performance measure processing techniques, and the relationships between the corridor performance measures and network-specific measures.

The task force has identified a set of initial performance measures that can be used to measure the effectiveness of the ICMS strategies and operations in relation to the Generic Corridor goals and objectives. These corridor performance measures are identified in Table 4-10. However, the task force also acknowledges that as the corridor system matures and operational experience is gained, these performance measures will likely change as new collection methods and processing techniques are implemented.

Table 4-9. Generic Corridor Performance Measures and Targets

Goal	Performance Measure
Corridor Perspective	No quantitative measures, per se. Rather, improvements in the performance measures for the other goals will be a strong indication that the goal of a "corridor perspective" is being attained. Qualitative measures will also be reviewed as discussed below.
Corridor Mobility & Reliability	• Average Travel Time per Trip for the corridor and each network • Average Delay per Trip (for the corridor and each network) • 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). • 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. • Average parking availability per facility per time of day • Emissions (Number of days in exceedance of NAAGS)
Corridor Traveler Information	• Customer satisfaction with corridor traveler information as obtained from traveler surveys • Corridor-related ATIS website hits/511 calls • Number of "cross-network" messages displayed on all DMS
Corridor Event & Incident Management	• Average Delay per Trip; segregated by incident and event types (e.g., minor and major roadway incident, minor and major transit incident, weather, special event) for the corridor and each network • Travel Time Indices for various event types • Response/Clearance times for major incidents (involving multiple

Goal	Performance Measure
	corridor stakeholders) • Time required to evacuate Metropolis and environs via Generic Corridor

Each individual network will be responsible for collecting network-specific data related to each of the designated corridor performance measures and providing these network level data to the Corridor Command Center for processing and aggregation. Individual network-based performance level measures will also be tracked to assist in the identification of network and strategy interaction in relation to individual and integrated corridor performance. These data will also be archived for subsequent analyses (i.e., input to simulation models, performance trends, providing a reference for what constitutes “normal” and “typical” conditions vis-à-vis recurring congestion, updating decision support parameters).

As noted in the above Table, the “Corridor Perspective” goal does not readily lend itself to quantitative measurements. For such a goal that focuses on all the stakeholders sharing an “integrated perspective,” a more qualitative approach is necessary. This will involve conducting a periodic assessment that provides the means by which the corridor transportation agencies can measure the effectiveness of their coordination and integrated operations from a high-level, institutional view. Examples of questions to be addressed include: do the corridor agencies meet regularly with one another, and with other agencies and organizations; have inter-agency agreements defining responsibilities for ICMS operation, maintenance and funding been developed and executed; are the results of coordinated operations reviewed, discussed, and acted upon, particularly following major events or activities; etc. This periodic assessment of the corridor perspective will be a group exercise, involving as many stakeholder representatives as possible, including representatives from the Generic Corridor Operations Panel (GCOP), the Regional ITS Architecture Committee, and individual agency management, along with the Agency/Service Operations Officers (ASOs) and the Chief Corridor Operations Officer (CCOO).

Taking into account the vision, goals, and current conditions within the Generic Corridor, the task force also identified “success“ targets for several of the performance measures. These “Performance Measures Success Thresholds,” listed in Table 4-11, provide an indication that the corridor goals have been achieved. The listed performance levels/thresholds are long-term targets that reflect the future vision of how the corridor will operate. Upon deployment of the ICMS, any movement toward the thresholds will indicate that ICMS is having the desired effect.

Table 4-10. Potential Performance Measure Targets

Performance Measure	Performance Measure Success Threshold
Average Travel Time per Trip for the corridor and each network (includes long and short trips)	Corridor – 20 minutes Freeway – 15 minutes Freeway HOV – 10 minutes Arterials – 25 minutes Rail – 20 minutes Bus – 25 minutes

Performance Measure	Performance Measure Success Threshold
Average Delay per Trip for the corridor and each network	Corridor – 10 minutes Freeway – 5 minutes Arterials – 7 minutes Rail – 5 minutes Bus – 8 minutes
Travel Time Index	Corridor daily vs. off peak – 1.2 Corridor Incident vs. peak – 1.3 Freeway daily vs. off peak – 1.1 Freeway incident vs. peak – 1.4 Arterials daily vs. off-peak – 1.3 Arterials incident vs. peak – 1.4 Rail daily vs. off peak – 1.0 Rail incident vs. peak – 1.4 Bus daily vs. off peak – 1.2 Bus arterial incident vs. peak – 1.4
Buffer Index	Corridor wide buffer index of 30 percent
Average parking availability per facility per time of day	Zero average availability at end of peak period only 90 percent of the time
Customer satisfaction as obtained from traveler surveys	80 percent overall satisfaction with corridor 80 percent satisfaction with corridor traveler information and accuracy

The performance measures and targets discussed above focus on assessing the overall effectiveness of the ICMS and corridor operations for purposes of needs identification and improvement selections. Such parameters, however, are not conducive to day-to-day assessments of alternatives by travelers and are not sensitive to quickly changing conditions within the corridor. Accordingly, additional measures of real-time operations of the corridor have been identified. CCC operators may use these measures as foundation for their selection and activation of response plans.

Corridor operations measures will provide information about the real-time performance of travel alternatives on a network link basis. They will also consist of travel times on selected comparable network links, and on a full-corridor trip and half-corridor trip basis. These measures will be disseminated to travelers through corridor information systems such as the ICMS web page, 511 and DMS.

The common convention for operations-based measures incorporates comparable link travel times, which consists of the unit travel time on each specific network link by class of travel unit (e.g., car/truck, bus, train, car HOV, bus HOV). The following corridor operations measures have been identified:

- Network corridor link travel time per network travel unit, car/truck, bus, train, car HOV, bus HOV.
- Network “full-corridor trip” and “half-corridor trip” travel times per network travel unit.
- Real-time number of available parking spaces per facility.

- Locations of capacity-reducing incidents, and their expected duration and impact on the travel times.

Data collection for the performance measures (i.e., overall assessment) and operations measures will be identical, using the information collected by each of the individual network systems. However, there respective processing will be different. Travel times and delays for bus and rail on the unit basis will be a direct collection per the bus AVL technology and train tracking technology. Freeway and arterial travel times will be an indirect measure of link speed and distance. Parking availability (number of spaces) will be collected by new parking management systems. For assessment measures, the true travel time will be calculated for all network/modes. An average parking time for driving and for bus and rail mode transfer and wait times will be added, along with the potential impact of any incidents.

An education campaign will accompany the use of the operations measures so travelers understand what the travel times represent and how to make assessments between network/mode combinations (i.e., what is and what is not accounted for in each of the measures).

5 Operational Scenarios

Overview – This chapter presents representative scenarios in the corridor, and details how the Integrated Corridor Management System (ICMS) and the various networks and stakeholders are expected to operate during these events.

This chapter provides examples of representative scenarios for the generic corridor, identifying how the Integrated Corridor Management System (ICMS), the connected corridor networks, and the virtual Corridor Command Center (CCC) will respond to the scenario conditions. The examples are not meant to be all inclusive but they do provide an understanding of ICMS processes and operations given certain corridor events.

An underlying assumption for all the scenarios is that the Chief Corridor Operations Officer (CCOO) and the Agency/Service Officers (ASOs) have developed pre-planned response plans on a foundational level, that these response plans have been approved by the Generic Corridor Operations Panel (GCOP),[6] and that the appropriate database has been developed and entered into the ICMS Decision Support System. Moreover, the ICM corridor command center has conducted desktop scenario sessions to prepare, train and refine response plans for incidents, special events, weather, and evacuations represented in these scenarios. It is also noted that the CCOO and the ASOs are able and authorized to improvise as situations may dictate.

Operational scenarios addressed in this chapter include the following:

- Daily operational scenario (e.g., recurring congestion)
- Scheduled event scenario (planned special events or work zone operations)
- Evacuation scenario
- Incident scenarios (roadway and transit incident)
- Major planned special event scenario

As noted, the first scenario represents the condition of recurring congestion, while the remaining scenarios address different types of non-recurring congestion. For the generic corridor the Washington State DOT and Washington State Transportation Center definitions[7] for recurring and non-recurring congestion have been adopted:

- **Recurring congestion**: Congestion caused by routine traffic volumes operating in a typical environment. In layman's terms it might be thought of as "the congestion present on a normal day if nothing bad has happened on the roadway." In essence, this definition is grounded in the concept of "expected

[6] AS the GCOP consists of leadership level representatives from each of the stakeholders in the Generic Corridor, GCOP approval also constitutes approval of the individual stakeholders and their respective networks.

[7] *Measurement Of Recurring Versus Non-Recurring Congestion: Technical Report*; Technical Report and Final Report Research Project T2695; Washington State Transportation Center (TRAC); Washington State Transportation Commission, Department of Transportation and in cooperation with U.S. Department of Transportation Federal Highway Administration; October 2003

congestion" if no "unusual circumstances" occur. It is dependent on time and location.

- **Non-recurring congestion**: Unexpected or unusual congestion caused by an event that was unexpected and transient relative to other similar days." Non-recurring congestion can be caused by a variety of factors, including, but not limited to:
    - Lane blocking accidents and disabled vehicles
    - Other lane blocking events (e.g., debris in the roadway)
    - Construction lane closures
    - Significant roadside distractions that alter driver behavior (e.g., roadside construction, electronic signs, a fire beside the freeway)
    - Inclement weather and weather-related events
    - Heavier that normal vehicle merging movements
    - Significant increases in traffic volume in comparison to "normal" traffic volumes

It is emphasized that these definitions can be expanded to include transit operations. For example, recurring congestion would include the 'typical" waiting times at stations and "normal" crowding in transit vehicles; whereas non-recurring congestion (and possibly increased delays and crowding) might be caused by increased demand (e.g., due to an event), disabled transit vehicles, or other outages within the transit infrastructure.

Each scenario and the overall response is briefly described, followed by a graphic of the generic corridor showing the situation. A summary table is also provided with each scenario identifying the specific ICM strategies to be deployed and other operational details (e.g., potential DMS messages); and the respective roles (e.g., lead/support) and responsibilities for the ICMS CCC and the other agencies during the scenario. It is emphasized that while this section focuses on ICMS strategies and the supporting technologies and system automation, integrated corridor management will always require some degree of "manual" communications between centers (e.g., via phone and radio) and interaction between stakeholders (e.g., meetings to discuss and resolve issues).

5.1 Daily Operational Scenario

This scenario addresses corridor management activities and strategies in response to "typical" day-to-day transportation flows and recurring congestion; that is, no accidents (roadway, transit or arterial), road or track maintenance, weather events, or other non-routine events impacting the networks and requiring an active response. It also includes the peak hour traffic demands normal to the system.

Each stakeholder monitors and operates their respective systems in accordance with their network-specific operational procedures and the CCC-established, agency approved ICMS protocols. The latter includes a variety of operational parameters (e.g., signal timing, metering rates, headways) that have been developed for various times of the day (reflecting different demands). These are implemented by the operating agencies as appropriate. No "lead" agency is required for this scenario.

The ICMS focus during these “typical” conditions is on information sharing/distribution and the operational efficiency at network junctions and interfaces. In the event of significant variations (from the norm) in demand, the CCC (via the ASOs) may **suggest** (i.e., no direct control) adjustments to network operating parameters, DMS messages, etc. for implementation by the network systems.

This scenario captures the daily operations and information sharing procedures used to establish the baseline operational conditions on which the other “non-recurring” scenarios described herein build on. Additionally, the long-term strategies to manage the demand – capacity relationship (low- cost capacity improvements, TDM activities) are an on-going activity.

Table 5-1. Daily Operational Scenario (Recurring Congestion)

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Automated information sharing Shared control of “passive” ITS devices Information clearing-house A corridor-based traveler information database En-route traveler information devices used to describe current operational conditions on another network(s) within the corridor Transit signal priority Multi-modal electronic payment Transit hub connection protection Multi-agency/multi-network incident response teams and service patrols Coordinated ramp meter/traffic signal operation Accommodate cross-network shifts – implemented as a CCC suggestion – for extreme fluctuations in corridor demand/recurring congestion.	CCC	Monitor all conditions within corridor (including performance measures) Coordination – ensuring accurate traveler information and the proper coordination of network junctions *Suggest* adjustments to network operating parameters/DMS messages (via ASOs) in the event of significant variations in corridor/network demands resulting in route/modal shifts
	State DOT	Monitor freeway sensors and CCTV Monitor HOV lanes Monitor/operate ramp meters Monitor/operate DMS Operate freeway service patrols
	Neptune City	Monitor traffic sensors Monitor arterial CCTV Monitor signal operations/adjust signal timing Monitor/operate DMS
	Atlantis City	Monitor traffic sensors Monitor arterial CCTV Monitor signal operations/adjust signal timing Monitor/operate DMS
	Generic Bus Authority	Monitor bus headways/schedules Passenger counts
	Regional Rail Agency	Monitor train headways/schedules Monitor parking availability Passenger counts
	Emergency Services	Regular operations/patrols

5.2 Scheduled Event Scenario

The scheduled event for this scenario is a work zone on the freeway between Cherry St. and Locust Blvd., blocking one travel lane (inner) in both directions beginning just after the AM peak hour and scheduled to end just prior to the PM peak hour. The scheduled event is therefore expected to have some impact on both the AM and PM peak travel periods. Since this is on the State DOT's system, the ASO for the State DOT ASO has been designated as the corridor coordination lead and the State DOT as the operational lead. The CCC worked with the State DOT to schedule this work on a day when no other capacity-reducing activities were planned by the other stakeholders within the corridor, thereby minimizing the overall corridor-wide impact.

Based on the results of modeling analyses of this scenario, delays on the freeway are expected to be up to 30 minutes during the peak fringe periods. The work zone information has been broadcast in the days leading up to the work so that travelers that normally use the freeway in the area of the work zone during the affected hours are aware of the potential delays. Options for inbound passenger cars on the freeway are to exit at Chestnut or Beech Street or and travel Main St. or Broadway to avoid the work zone. Options for outbound passenger cars on the freeway are to exit at Pine or Maple Street and use either of the aforementioned arterials. Neptune expects an increase in traffic along Main Street due to the arterial's proximity to the freeway. Atlantis does not expect as much overflow traffic since Broadway is farther from the freeway as compared to Main Street; although it does provide direct access to and from the Metropolis CBD.

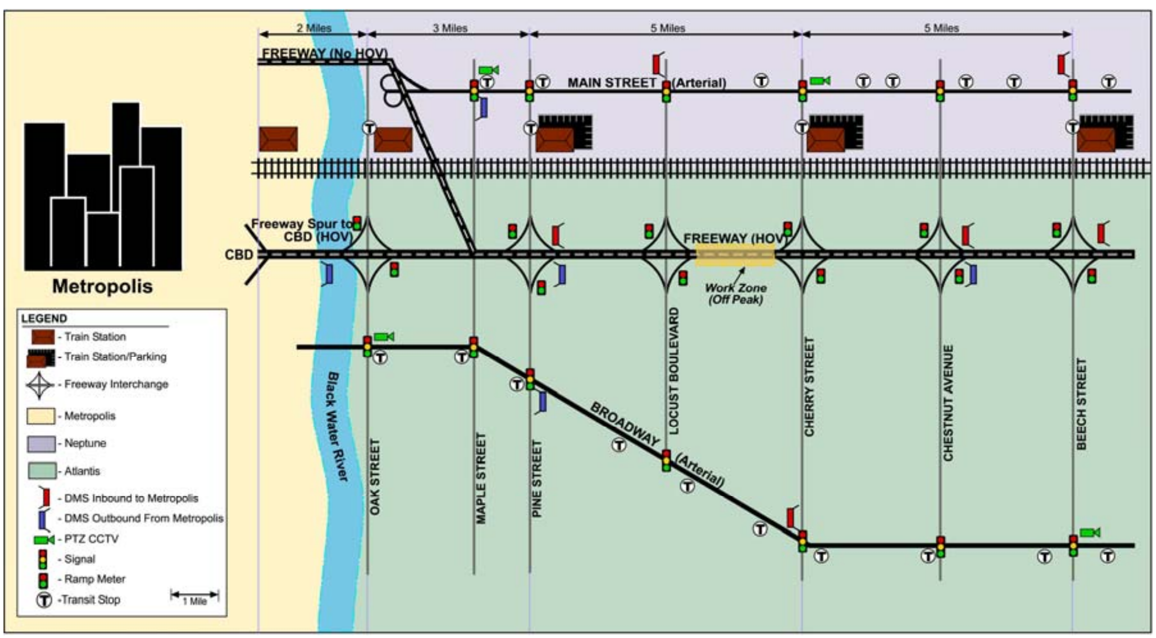

Figure 5-1. Scheduled Event Scenario

The ICMS focus during this "planned event" scenario builds upon the activities and strategies during "typical" conditions (i.e., information sharing/distribution and the operational efficiency at network junctions and interfaces), as well as a more pro-active role in using en-route traveler information devices used to describe current operational conditions on the other network(s) within the corridor (e.g., arterial DMS to identify the freeway delays resulting from the work zone) and accommodating any user-determined shifts (primarily from the freeway to the adjacent arterials).

Table 5-2. Scheduled Event Scenario

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Information Sharing and Distribution (as in the "typical" scenario) Operational efficiency at network junctions (as in the "typical" scenario) Coordinate scheduled maintenance and construction activities among corridor networks. En-route traveler information devices used to describe current operational conditions on another network(s) within the corridor. • For example, on the Main St. DMS at Beech St.: "Work Zone on Freeway at Cherry St. Expect delays"	CCC	Work with State DOT and other stakeholders to schedule the work zone activity when the corridor-wide impact is minimal Monitor all conditions within corridor Coordination – particularly with State DOT as to the work zone activities and status – ensuring accurate traveler information and the proper coordination of network junctions Coordinate DMS messages along freeway and arterials regarding work zone activities and resulting delays. *Initiate* adjustments to network operating parameters to accommodate any route shifts between freeway and arterial (e.g., arterial signal timing, transit signal priority, ramp metering rates, coordinated operation between meters and signals) via State, Neptune, and Atlantis ASOs.
Accommodate cross-network shifts from freeway to arterial in advance of the work zone, and then back to freeway; including changes to signal timing along Main and Broadway, metering rates at ramps used to return to the freeway (e.g., inbound on – ramps at Locust and Pine; outbound on-ramps at Cherry and Chestnut), and transit signal priority parameters	State DOT	Lead role in terms of managing the work zone, including coordinating with the State police for on-site management/protection of traffic. Variable speed limits within and on the approaches to the work zone Provide additional freeway service patrols (in the vicinity of work zone and back up area) Monitor freeway sensors and CCTV, focusing on work zone and back up area Monitor/operate ramp meters, making changes per CCC Monitor/operate DMS, making changes per CCC
	Neptune City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS (per CCC)

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
	Atlantis City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS (per CCC)
	Generic Bus Authority	Monitor bus headways/schedules Passenger counts
	Regional Rail Agency	Monitor train headways/schedules Monitor parking availability Passenger counts
	Emergency Services	Regular operations/patrols The state police provide increased enforcement of work zone traffic laws and provide control of traffic.

5.3 Incident Scenarios

This section describes various incident scenarios within the Generic Corridor and the associated ICMS response. Four scenarios are addressed – two roadway incidents and two transit incidents, with both major and minor examples. The minor incidents have a duration of only a few hours at most, and the resulting impacts affect only a few of the corridor stakeholders. Major incidents have the potential to impact the entire corridor and all stakeholders for a duration of several days.

5.3.1 Minor Traffic Incident Scenario

At 5:00 PM on a weekday, two vehicles collide at the intersection of Main Street and Pine Street. While there are no injuries, the vehicles are disabled and cannot be driven away, resulting in a blocked lane limiting vehicle throughput on both streets. The crash is reported to the Neptune Police by one of the drivers (via cell phone and "911") and entered into the CAD system. As a result of the ICMS center-to-center linkages and system interfaces, this also automatically activates an incident alarm on the operator workstations at Neptune TMC, the Generic Bus Authority TMC, and the various ICMS workstations (including the CCOO and the ASO's). A "tentative accident" icon (identifying the location of incident) is also placed on the graphical maps of the aforementioned workstations. The ICMS decision support system automatically selects the closest camera and the appropriate preset such that this camera provides an image of the intersection and the accident scene, which in turn is transmitted to and displayed at the Neptune TMC, Generic Bus Authority, Neptune Police, and the various ICMS workstations.

Upon review of the real-time video images by the Neptune Police and the Neptune DOT, the intersection crash and the basic information provided by the initial caller (e.g., number of vehicles) is verified; and a determination is made that this is indeed a minor incident. It is also estimated that it will take approximately one hour for the police investigation to be completed and the vehicles cleared from the intersection – information that is input to the CAD and displayed on the workstations.

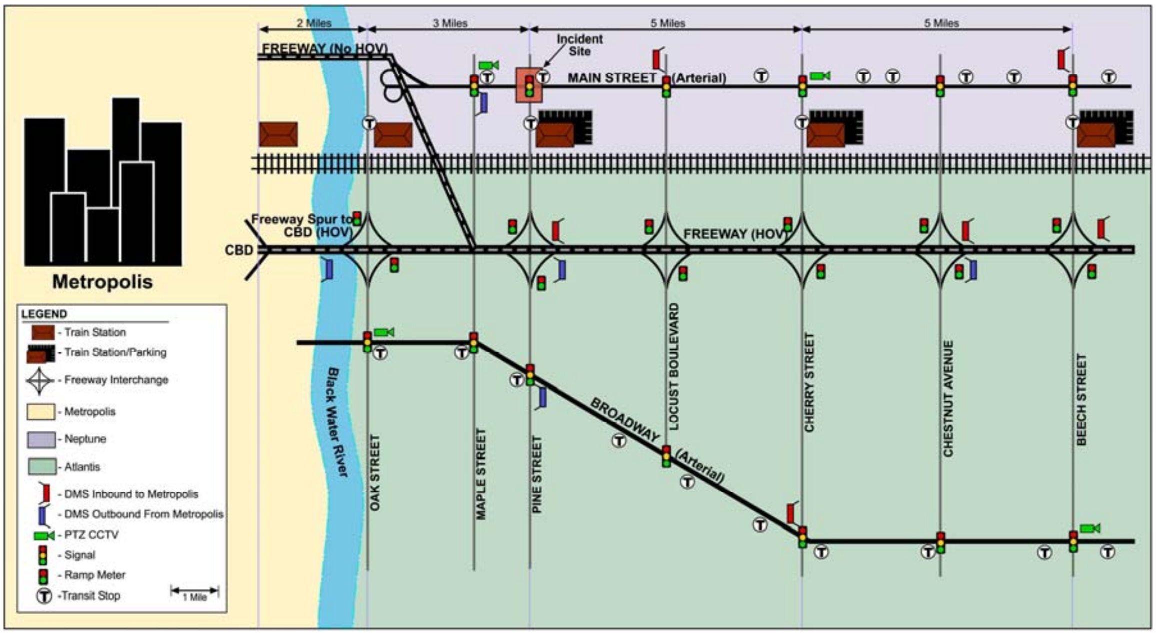

Figure 5-2. Minor Traffic Incident

In accordance with the pre-developed and approved ICM protocols, the lead transportation management role for such a “minor” incident is assumed by the jurisdiction/agency where the incident is located (i.e. Neptune DOT), with local police responsible for accident investigation and related enforcement activities. Related activities include:

- The Neptune police dispatcher contacts a patrol car near the scene via radio to proceed to the scene for investigation and on-scene management.
- Neptune DOT operators modify signal timing (e.g., increased cycle length) at the affected intersection to improve throughput given the blocked lanes. The increased cycle length is a multiple of the system cycle length so as to provide some degree of coordination.
- Neptune DOT operators contact a local towing company (from a list of approved companies) to obtain wrecker service to move the crash vehicles.
- The ASO for Neptune coordinates the Neptune DOT and police activities with other stakeholders within the Generic Corridor, providing the CCC with updates. This includes notifying the Generic Bus Authority of the incident and anticipated duration and impact. As a result of these discussions, it is determined to not reroute any Main Street Buses, but to modify the operational parameters for transit signal priority to maintain overall headways to the greatest extent possible. The State DOT is also contacted with information that the accident may increase outbound traffic in the Generic Corridor, possibly requiring a change in metering rates on selected ramps. Additionally, it is requested that a message regarding the incident be posted on the outbound freeway DMS near the Oak Street interchange.
- Neptune DOT operators continue to monitor the incident clearance process via CCTV, inputting new and revised information (arrival time of wreckers, estimated duration, incident cleared). This updated information is displayed

on the various workstations (e.g., Police CAD, Generic Bus Authority, CCC) throughout the Generic Corridor.

Once the incident is cleared, Neptune DOT inputs an "all clear," but continues to monitor the traffic flow through the intersection, providing a "normal operation" status after the incident-induced queues have dissipated.

Table 5-3. Minor Traffic Incident Scenario

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Information Sharing and Distribution (as in the "typical" scenario) Operational efficiency at network junctions (as in the "typical" scenario) A common incident reporting system and asset management (GIS) system Modify transit priority parameters to accommodate more timely bus service along Main Street En-route traveler information devices used to describe current operational conditions on another network(s) within the corridor. • For example, on the outbound freeway DMS near the Oak Street interchange. "Accident at Main and Pine Street. Expect Delays in Vicinity of Intersection" Accommodate cross-network shifts from arterial to freeway in advance of the intersection, including changes to ramp meter rates.	CCC	Monitor all conditions within corridor Coordination – particularly with Neptune DOT and police as to the accident investigation and clearance activities and status – ensuring that the Generic Bus Authority and State DOT are kept up-to-date on these activities. Coordination, ensuring accurate traveler information and the proper coordination of network junctions S*uggest* DMS messages along freeway and arterials regarding the crash and resulting delays. *Suggest* adjustments to network operating parameters to accommodate any impacts on the bus schedules (e.g., transit signal priority) and any route shifts from the arterial to the freeway (e.g., ramp meter rates) via Neptune, State DOT, and Generic Bus Authority ASOs.
	State DOT	Monitor freeway sensors and CCTV, Monitor/operate ramp meters, making changes per CCC suggestions Monitor/operate DMS, making changes per CCC suggestions
	Neptune City	Lead role in terms of contacting wreckers to tow away vehicles, and updating information on the incident clearance activities and resulting delays at the intersection Coordinate all activities with the Neptune Police and their incident investigation and other on-scene activities Monitor arterial CCTV, particularly in vicinity of Main/Pine Monitor traffic sensors/volumes, modifying Main Street signal timings and transit signal priority parameters per CCC suggestions Monitor/operate DMS

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
	Atlantis City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations Monitor/operate DMS
	Generic Bus Authority	Monitor bus headways/schedules, identifying any problems as a result of the crash of the intersection (via ASO) Passenger counts
	Regional Rail Agency	Monitor train headways/schedules Monitor parking availability Passenger counts
	Emergency Services	Receive initial call(s) regarding crash, and enter into CAD On scene accident investigation

5.3.2 Major Traffic incident Scenario

At 2:00 PM on a weekday, two eastbound tractor-trailers traveling along the freeway collide, knocking into and damaging an overpass bridge pier/structure at Locust Street. The accident and resulting damage has shut-down all eastbound lanes of the freeway, as well as Locust Street between Main and Broadway. The accident area covers approximately 300 feet of the freeway and will take approximately six hours to clear, well through the evening commute. Moreover, it is estimated that it will require a minimum of three days to assess and repair the damage to the bridge overpass structure, during which time the eastbound freeway lanes and Locust Street will remain closed to traffic.

During the initial evening peak, all outbound freeway traffic will be required to exit at Pine Street and reroute to Broadway or Main, and then travel along the arterials to Cherry to re-enter the freeway (or continue along the arterials to another freeway ramp). Once the incident is cleared, the State DOT will implement a temporary traffic control scheme; with both directions of the freeway traveling in the westbound lanes (two in each direction using the HOV lane and shoulders) and a reduced speed limit. The State DOT works overnight to secure traffic control and open the revised lane configuration by the morning commute. The freeway will remain constrained (two lanes in each direction within the westbound lanes) and Locust Street will remain closed until the investigation and repair work to the overpass structure is completed.

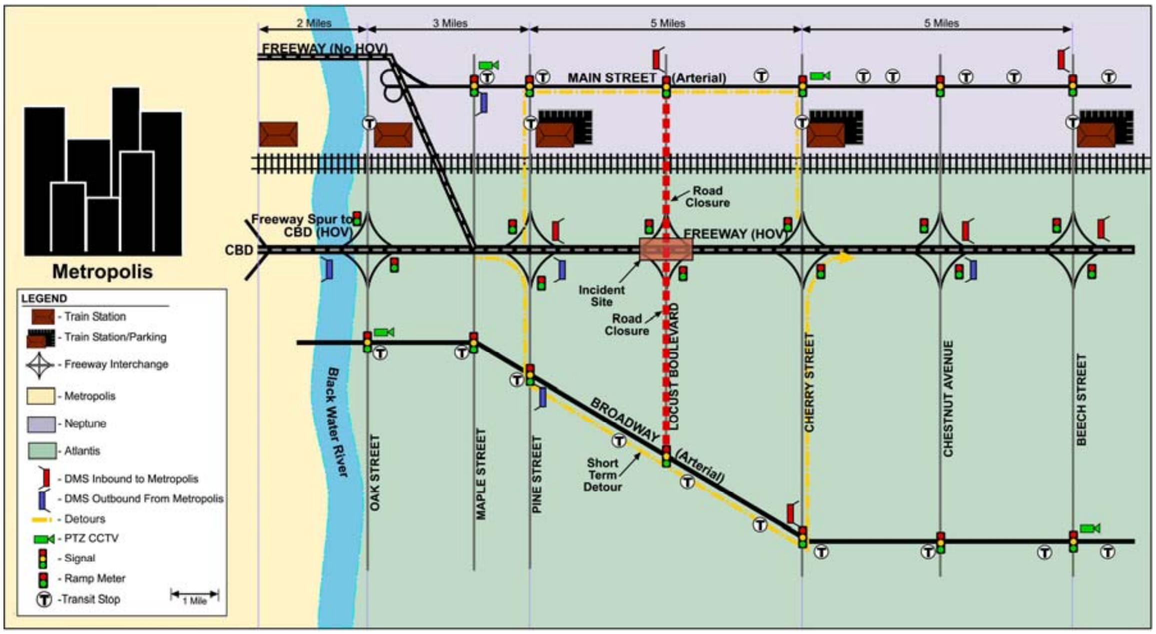

Figure 5-3. Major Traffic Incident

From the perspective of the ICMS and its decision support mechanism, this scenario involves three individual events – a short-term closure of the eastbound freeway with no advanced notice; a longer-term closure of the eastbound freeway with advance notice, and closure of a section of Locust Street in the vicinity of the freeway interchange. While all these scenarios have been incorporated into the decision support system, some manual alterations and decision making will be required to combine these into a unified and comprehensive response. The ICMS CCC is designated as the lead for coordinating the various responses to this major incident, including assuming "direct control" of DMS, arterial signal timing, and ramp metering rates via the ASOs for State DOT, Atlantis, and Neptune. Close coordination is also maintained between the CCC, the Regional Rail Agency and the Generic Bus Authority through their respective ASOs. Neither of the trucks involved in the incident were carrying hazardous materials, so it is determined that the Incident Command Structure does not need to be activated. Nevertheless, all traffic management activities and shifts are closely coordinated with the Police and other emergency services.

The initial activities and strategies in direct response to the accident are summarized below, with the longer-term activities summarized in Table 5-4.

- **CCC** – Coordinates with State DOT, Atlantis, and Neptune to establish the detours. Establishes required traveler information messages – including DMS transit PA, and web – promoting (and in some instances, instructing) route and modal shifts. Monitors traffic flows and delays on all roadway networks, initiating adjustments (i.e., direct control via the agency ASOs) to system operating parameters (e.g., signal timing for Broadway, Main, Pine, and Cherry; ramp metering rates and coordination with adjacent signals; transit signal priority parameters to improve bus operations vis-à-vis the published schedule; and best route messages on a portable DMS at the Pine Street off ramp so as to balance/equalize the delays) depending on actual traffic flows and route shifts, congestion, and bus delays. Contacts outlying parking facilities, initiating pre-arranged emergency contracts for additional parking, with shuttle service to the rail stations to be provided by Generic Bus Authority.

- **State DOT** – Contacts private company with appropriate towing vehicles to remove truck from the freeway. Also contacts the truck owners instructing them that they have 3 hours to arrive and off-load the trucks. Works with Atlantis to set up detour at Pine Street interchange, including a portable DMS on the off-ramp to provide information on the "best route" between the Broadway and Main Street detours. Posts the required messages on DMS (fixed and portable) per the CCC directions. Commences work on establishing the revised traffic pattern (i.e., two lanes in each direction using the westbound lanes).
- **Atlantis** – Works with the State DOT to set up detour at Pine Street Interchange. Coordinates with the CCC, monitoring the significant increase in traffic along Broadway, Pine, and Cherry, changing signal timing parameters and plans per CCC directions. Posts the required messages on DMS per the CCC directions.
- **Neptune** – Coordinates with the CCC, monitoring the significant increase in traffic along Main Street, Pine, and Cherry, changing signal timing parameters and plans per CCC directions. Posts the required messages on DMS per the CCC directions. Following discussions with the CCC, removes a work zone on Main Street (opening up all lanes to traffic early), and instructs the contractor not to close any part of the roadway for the next several days.
- **Generic Bus Authority** – Reroutes the Locust Street bus routes, and re-routes the express buses to Main Street. Coordinates with CCC regarding schedule adherence and transit signal priority. Commences preparation for providing shuttle bus service between temporary park and ride lots and rail stations (operation to start the next day and continue until the roadways are reopened).
- **Regional Rail Agency** – Makes announcements on station PA systems regarding roadway closures and rerouting of buses. Commences preparation for revised operations (additional transit vehicles/reduced headways) to start the next day and continue until the roadways are reopened.
- **Police and Emergency Services** – Provide on-scene incident investigation and flow management. Station police officers at key points along the detour routes (e.g., Pine Street interchange, intersections of Pine/Main Street, Pine/Broadway, Cherry/Main, Cherry/Broadway).

Table 5-4. Major Traffic Incident Scenario

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Information Sharing and Distribution (as in the "typical" scenario) Operational efficiency at network junctions (as in the "typical" scenario) A common incident reporting system En-route traveler information devices used to describe current operational conditions on another network(s) within the corridor. • For example, on the freeway DMS at Beech St: "Significant Freeway Delays Use Regional Rail Parking Available at XXX" Transit hub connection protection (particularly between regional rail and shuttle bus service) Multi-agency/multi-network incident response teams and service patrols (particularly in the area between Pine and Cherry St.) Coordinate scheduled maintenance and construction activities among corridor networks. Modify transit priority parameters to accommodate	CCC	Lead role in managing traffic throughout the corridor via ASOs Monitor all conditions within corridor (including performance measures) Coordination with all agencies, ensuring that all are kept up-to-date all activities and the potential impact on their respective operations. Coordination, ensuring accurate traveler information, including promoting ride sharing, telecommuting, etc. Coordination of network junctions, with particular emphasis on transit hub connection and transit signal priority Coordinate DMS messages throughout corridor regarding network operations/delays, and promoting shifts as appropriate. *Initiate* messages via ASOs. *Initiate* adjustments to network operating parameters to accommodate any route shifts between freeway and arterial and between freeway and transit parking (e.g., arterial signal timing, ramp metering rates, coordinated operation between meters and signals) via ASOs. *Initiate* adjustments to transit signal priority parameters to enhance bus operations (via ASOs). Coordinate with State Police regarding truck restrictions and rerouting

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
more timely bus service Modify arterial signal timing to accommodate traffic shifting from freeway (e.g., traveling to parking for transit, bypassing the constrained freeway traffic pattern) Modify ramp metering rates to accommodate shifted traffic returning to freeway Promote modal shifts from roadways to the rail transit network Increase capacity by using shoulders for traffic/opening the HOV lanes Contraflow operations Add transit capacity by adjusting headways and number of rail vehicles Add temporary new transit service (shuttle buses to temporary lots) Restrict freeway ramp access (closures) Restrict/reroute commercial traffic Peak spreading by outreach to media/commuters on ridesharing and telecommuting during repairs.	State DOT	Lead role in terms of dispatching incident team to set up and manage the contraflow operation of the freeway, including portable DMS and coordinating with the State police for enforcement and safety within the contraflow zone Variable speed limits within and on the approaches to the contraflow operation (via portable DMS) Provide additional freeway service patrols (in the vicinity of the contraflow zone) Monitor freeway sensors and CCTV, focusing on contraflow zone Monitor/operate ramp meters, making changes (per CCC) Monitor/operate DMS, making changes (per CCC)
	Neptune City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS (per CCC)
	Atlantis City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS (per CCC)
	Generic Bus Authority	Provide shuttle bus service between rail stations and temporary parking lots Coordinate with Regional Rail Agency and CCC for connection protection Reroute express bus service as required Monitor bus headways/schedules Passenger counts
	Regional Rail Agency	Coordinate with Generic Bus Authority and CCC for connection protection Add transit capacity by adding rail service (additional vehicles/reduced headways) Monitor train headways/schedules Monitor parking availability Passenger counts

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
	Emergency Services	Regular operations/patrols The state police provide increased enforcement of contraflow zone, and enforce truck restrictions

5.3.3 Minor Transit incident Scenario

At about 7:30 AM on a weekday, an express bus traveling from the Cherry Street Train Station to Metropolis breaks down in the HOV lane of the freeway, blocking the HOV lane. This minor transit incident will take approximately one to two hours for the response and clearance activities (i.e., dispatch another bus, transfer passengers, tow away disabled bus, clear the devices used for traffic management at the scene), and will cause congestion on the inbound freeway during the morning rush hour.

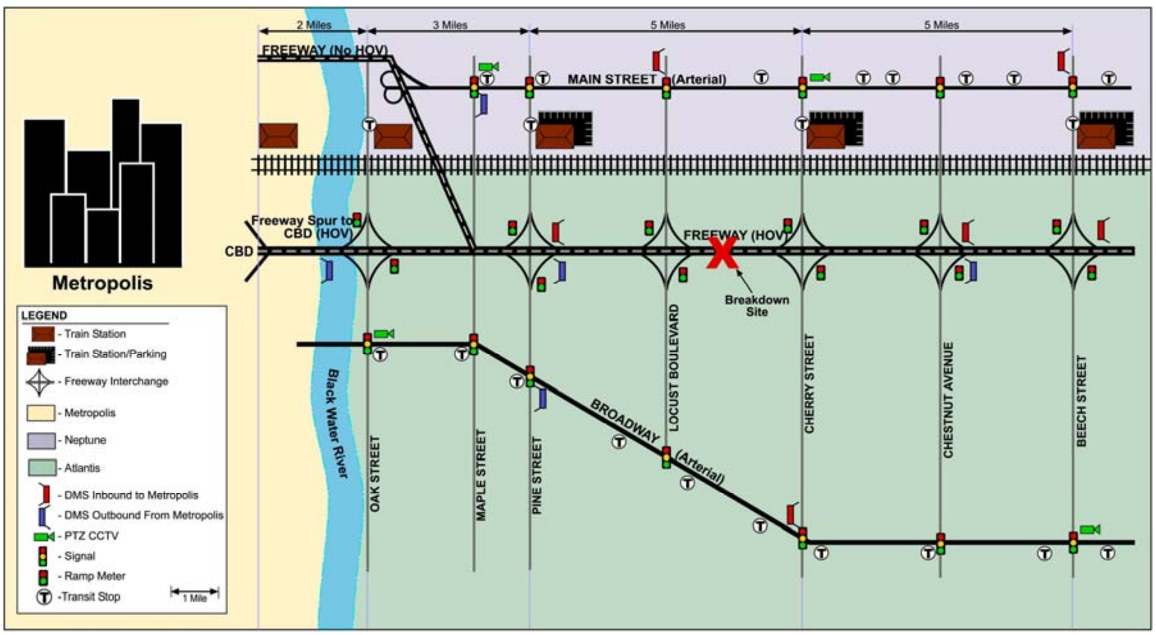

Figure 5-4. Minor Transit Incident Scenario

The bus driver notifies the dispatcher at the Generic Bus Authority TMC. The information is entered into the bus CAD, resulting in an incident alarm and map icon (and information regarding the incident) being activated on workstations at the CCC, State DOT, State Police, Regional Rail Agency and Neptune in accordance with the ICMS protocols. The ICMS also includes a plan for such an incident (as developed by the CCOO and ASOs, and approved by the GCOP), resulting in the following sequence of actions:

- State DOT is designated as the lead agency, with the ASO for the State DOT working closely and coordinating with the Generic Bus Authority and the State Police, as well as Neptune DOT and the Regional Rail Agency.
- A Generic Bus Authority wrecker and another bus and driver are dispatched to the incident site. The expected time of arrival (and the actual time) for

these vehicles is input to the transit CAD by the bus dispatcher, and this information/updates are automatically displayed on the ICMS incident tracking screen on all workstations within the corridor.

- The State DOT dispatches a crew to set up a "safety zone" in the vicinity of the bus (to allow the passengers to safely get off the disabled bus and get on the replacement bus), including a portable DMS upstream of the incident. The State Police also dispatch a patrol car to the incident scene to assist with the on-scene management and enforcement. (This information and the associated arrival times are also input, with the ICMS incident tracking screen automatically updated).
- The Generic Bus Authority monitors traffic flow and travel times on the freeway and Main Street, and makes a decision as to whether the express bus service should be rerouted to Main Street. In the event the decision is made to reroute the express bus service, the ASO for the Generic Bus Authority notifies Neptune of the express bus route changes, and together work on modifying the transit signal priority parameters to minimize any schedule variations for the buses.
- The CCC coordinates traveler information, suggesting messages to be displayed on the State and Neptune DMS (in advance of Locust Street), and messages at the Beech and Cherry St. rail stations.
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Table 5-5. Minor Transit Incident Scenario

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Information Sharing and Distribution (as in the "typical" scenario) Operational efficiency at network junctions (as in the "typical" scenario) A common incident reporting system Modify transit priority parameters to accommodate more timely express bus service along Main Street (as required) En-route traveler information devices used to describe current operational conditions on another network(s) within the corridor. • For example, on the inbound freeway DMS near the Beech and Chestnut Street interchanges.	CCC	Monitor all conditions within corridor (including performance measures) Coordination – particularly with Generic Bus Authority, State DOT and State Police (via ASOs) as to the response and clearance of the disabled, such that HOV lanes are reopened in a timely manner Coordination, ensuring accurate traveler information and the proper coordination of network junctions Coordinate and *suggest* DMS messages along freeway arterials regarding the HOV lane blockage and resulting delays. Coordinate and *suggest* DMS/PA messages at rail stations regarding the HOV lane blockage and the re-routing of express bus service, and potential delays. Coordinate with Neptune DOT and *suggest* adjustments to network operating parameters to accommodate any impacts on the express bus schedules (e.g., transit signal priority)

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
"Accident in HOV Lane at Locust Blvd. Travel Time to Metropolis XX Minutes" • DMS and PA system at the Beech and Cherry rail stations: "Express Bus Service to Metropolis Being Rerouted Due to Freeway Accident. Expect Some Delays"		Coordination occurs via the Neptune, State DOT, Generic Bus Authority, and Regional Rail Agency ASOs.
	State DOT	Lead role in terms of on-scene incident response and overall management Dispatch incident team to scene to set up safety zone, including portable DMS in advance of disabled bus Monitor freeway sensors and CCTV, focusing on congestion resulting from bus blockage Monitor/operate ramp meters Monitor/operate DMS, making changes per CCC suggestions Operate freeway service patrols
	Neptune City	Monitor arterial CCTV Monitor traffic sensors/volumes, modifying Main Street signal timings and transit signal priority parameters per CCC suggestions Monitor/operate DMS, making changes per CCC suggestions
	Atlantis City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations Monitor/operate DMS
	Generic Bus Authority	Dispatch replacement bus and wrecker to incident scene Input incident information and status into transit CAD Monitor bus headways/schedules Compare travel times on freeway and Main Street, re-routing express bus service as appropriate Passenger counts
	Regional Rail Agency	Monitor/operate in-stations DMS and PA, making changes per CCC suggestions Monitor train headways/schedules Monitor parking availability Passenger counts
	Emergency Services	On scene support (safety) for transferring passengers between buses

5.3.4 Major Transit Incident Scenario

Recent heavy rains have caused a stream running parallel to the railroad tracks to overflow its banks. This flooding has closed a section of track between the Cherry Street and Pine Street Stations – a situation that is expected to last at least three days. The CCC takes the lead role in coordinating the various corridor stakeholders and their respective activities and strategies in response to this incident (in accordance with the pre-approved ICMS plan). The primary strategies include the following:

- **Generic Bus Authority**: Provides a “bus bridge” along Main Street between the Cherry St and Pine St. Rail Stations; and also provides additional express bus service (i.e., reduced headways) during the AM and PM peak. The CCOO assigns the operational response lead to the ASO for the Generic Bus Authority as it will have the greatest impact on addressing the transit user service needs within the corridor.
- **Regional Rail Agency**: Allows the park & ride lots to be used for dynamic carpool creation.
- **State DOT**: Increases the HOV-lane requirements from HOV-2 to HOV-4 as a means to better accommodate the additional express bus service operating in these lanes,, and also opens the shoulder to traffic during the same periods (to accommodate the predicted increase in auto use). Also provides additional service patrols during the peak periods (as one of the shoulders will be used as a travel way.
- **Neptune and Atlantis**: Modifies the transit signal priority parameters to provide more timely bus service for the “bus bridge” operation and for the express bus service along Beech and Cherry Street (i.e., servicing the rail stations from the freeway).
- **State Police**: Enforcement of the revised HOV requirements.

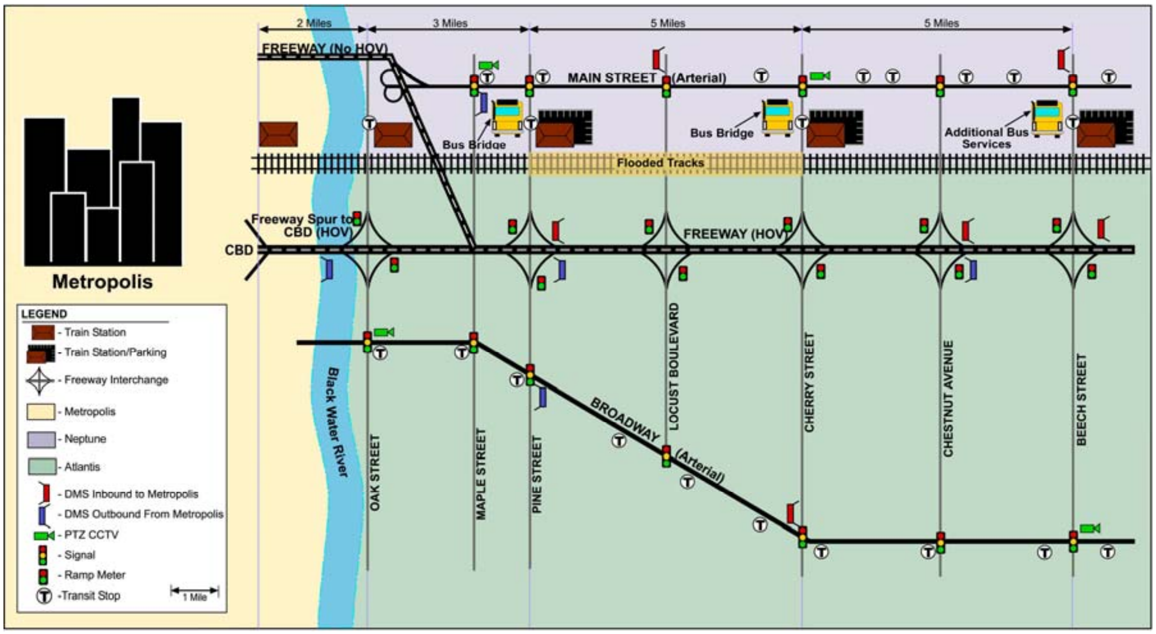

Figure 5-5. Major Transit Incident

Table 5-6. Major Transit Incident Scenario

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Information Sharing and Distribution (as in the "typical" scenario) Operational efficiency at network junctions (as in the "typical" scenario) En-route traveler information devices used to describe current operational conditions on another network(s) within the corridor. • For example: arterial DMS indicating that the freeway HOV lanes require a minimum of 4 occupants per vehicle.	CCC	Lead role in coordinating the various ICM management strategies throughout the corridor via ASOs Monitor all conditions within corridor (including performance measures) Coordination with all agencies, ensuring that all are kept up-to-date all activities and the potential impact on their respective operations. Coordination, ensuring accurate traveler information, including promoting ride sharing, telecommuting, etc. *Initiate* adjustments to transit signal priority parameters to enhance bus operations (via ASOs). Coordinate with State Police regarding HOV enforcement

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Modify transit priority parameters to accommodate more timely bus service Modify HOV restrictions (increase minimum number from 2 to 4) Increase roadway capacity by using shoulders for traffic (peak periods Add transit capacity (express bus service during peak periods) by adjusting headways and number of buses Add temporary new transit service (bus bridge between Cheery and Pine Street rail stations) Peak spreading by outreach to media/commuters on ridesharing and telecommuting during closure of the section of rail.	State DOT	Provide additional freeway service patrols during peak periods (when shoulders are used as travel lanes) Monitor freeway sensors and CCTV, focusing on contraflow zone Monitor/operate ramp meters Monitor/operate DMS (including messages regarding revised HOV restrictions/use of shoulders)
	Neptune City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS
	Atlantis City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS
	Generic Bus Authority	Operational Lead Provide a “bus bridge” along Main Street between the Cherry St and Pine St. Rail Stations Provide additional express bus service (i.e., reduced headways) during the AM and PM peak. Monitor bus headways/schedules Passenger counts
	Regional Rail Agency	Monitor train headways/schedules Monitor parking availability Passenger counts
	Emergency Services	Regular operations/patrols The state police provide increased enforcement of HOV lanes and the revised requirements

5.4 Major Planned Special Event Scenario

The Metropolis metropolitan area is abuzz about hosting the “championship” game at the new downtown stadium, located within the CBD. The pre-game events start at 5 PM, and parking downtown will be quite challenging since parking space availability will compete with the workforce up until about 6 PM. Moreover, many roads will be closed in and around the stadium.

As has been the case for other recent major events in Metropolis requiring special transportation management measures at both the regional and corridor level, a special event task force has been created to address the event’s impact, looking at all aspects of venue management and security, including transportation. Planned special event management has typically included the establishment of a central command for transportation that is responsible for planning, preparations, and event-day operations command. With the implementation of the ICMS, this central command for the championship game will be aided by the CCC, with the BWR Transportation Operations Council assuming the lead for transportation-related planning and the development of operational strategies for the region (aided by the GCOP for management and operations within the Generic Corridor.

Working with the public safety agencies and stadium management, the BWRTOC determines that access to and from Metropolis during the day of the championship game should be transit-oriented – including during the AM commute – thereby minimizing traffic on the streets in the vicinity of the stadium during preparations. Security is also a concern, and it is determined that trucks will not be allowed access to the stadium area after 3 PM unless they have a special permit.

The various activities associated with managing this Special Event – public safety, security, transportation, etc. – will be conducted from the Emergency Operations Center (EOC) located in Metropolis. The CCOO (and selected ASOs) will operate the virtual CCC for the Generic Corridor from the EOC.

Table 5-7. Major Planned Special Event Scenario

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Information Sharing and Distribution (as in the "typical" scenario) Operational efficiency at network junctions (as in the "typical" scenario) En-route traveler information devices used to describe current operational conditions on another network(s) within the corridor. Coordinate scheduled maintenance and construction activities among corridor networks (i.e., no maintenance/construction activities the day of the event). Add transit capacity – additional trains/reduced headways during AM peak and prior to event (inbound), and additional trains/reduced headways during PM peak and after event (outbound) number of buses Add temporary new transit service (shuttle buses to/from temporary lots) Modify transit fares to encourage ridership Modify parking fees (increased in the Metropolis CBD; decreased at transit Park & Ride and temporary lots)	CCC	Lead role in managing traffic throughout the corridor via the CCOO (located in the EOC) and ASOs, mitigating effects of special event. Coordinate implementation and operation of special event response plan Monitor all conditions within corridor (including performance measures), and adjust plans. Coordination with all agencies, ensuring that all are kept up-to-date on all activities and the potential impact on their respective operations. Coordination, ensuring accurate traveler information, including promoting transit use and telecommuting during the day of the event. Coordinate DMS messages throughout corridor regarding network operations/delays, and promoting shifts as appropriate. *Initiate* messages via ASOs. *Initiate* adjustments to network operating parameters to accommodate any route shifts between freeway transit parking (e.g., arterial signal timing, via ASOs.

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Modify transit priority parameters to accommodate more timely bus service (shuttle buses) Promote modal shifts from roadways to the rail transit network Modify arterial signal timing to accommodate traffic shifting from freeway (e.g., traveling to parking for transit) Modify HOV restrictions (increase minimum number from 2 to 4) throughout the day Restrict freeway ramp access (closures) Restrict/reroute commercial traffic Peak spreading by outreach to media/commuters on ridesharing and telecommuting during the day of the event		*Initiate* adjustments to transit signal priority parameters to enhance shuttle bus operations (via ASOs). Coordinate with State Police regarding truck restrictions and rerouting
	State DOT	Monitor freeway sensors and CCTV Monitor/operate ramp meters Monitor/operate DMS, making changes (per CCC) Close ramps (per CCC)
	Neptune City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS (per CCC)
	Atlantis City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS (per CCC)
	Generic Bus Authority	Provide shuttle bus service between rail stations and temporary parking lots Monitor bus headways/schedules Passenger counts
	Regional Rail Agency	Add transit capacity by adding rail service (additional vehicles/reduced headways) Reduce transit fares/parking fees Monitor train headways/schedules Monitor parking availability Passenger counts
	Emergency Services	Regular operations/patrols The state police provide increased enforcement of HOV lanes and enforce truck restrictions

5.5 Evacuation Scenario

A category 4 hurricane is approaching Metropolis and the Governor has issued an evacuation order for the city and surrounding areas. Local officials have notified the ICMS stakeholders of a pending evacuation order for the region encompassing the integrated corridor. Based on previous modeling and analyses of such an emergency scenario (performed on a regional, statewide, and multi-state basis), it is well understood that the evacuation order will significantly impact all modes of transportation within the Generic Corridor, with the freeway facility being the primary route for the evacuation. Rail service to outlying stations combined with bus service from the stations to designated shelters (outside the zone of predicted storm surge) will also need to be provided for those residents who do not own cars.

Evacuation routes, designated shelters, and related emergency procedures have been identified as part of a statewide hurricane evacuation plan. This includes incorporation of the formal Incident Command System (ICS) management structure for controlling personnel, facilities, equipment, and communications. The GCOP has also developed an ICMS response plan that is aligned with this statewide plan (and is included as an annex to the plan). The hurricane evacuation scenario has also been the focus of several tabletop training exercises.

In accordance with the hurricane plan, the Emergency Operations Center (EOC) is activated for managing the evacuation, the storm impacts, and the aftermath. The State Police Captain for the Metropolis region is designated as the "Incident Commander." Located at the EOC, this individual has overall responsibility and command authority for the Metropolis Region, and also coordinates directly with the State Department of Emergency Services as well as with FEMA.

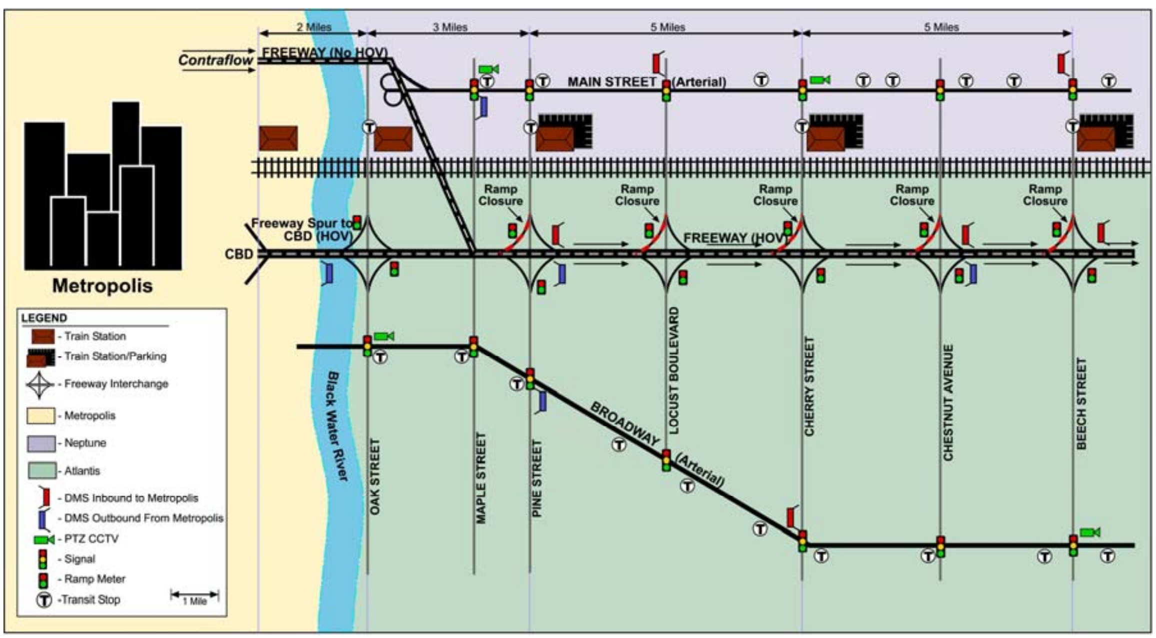

Figure 5-6. Evacuation Scenario

The CCC is designated the lead for implementing, coordinating and operating the transportation elements of the evacuation response plan within the Generic Corridor. The CCOO relocates to the EOC, reporting to the Incident Commander, and coordinates with all of the ASOs who oversee and coordinate the network-specific responses, including the following:

- **State DOT**: Set up contra-flow operations such that all lanes – including HOV and one shoulder – operate in the outbound direction; closing selected on-ramps, and reversing flow on several off-ramps (such that they become on ramps for the contra-flow operation). The State DOT also sends out safety patrols to pre-determined locations to provide operations assistance and respond to any problems.

- **Regional Rail Authority:** Discontinues the normal scheduled service, providing predominately outbound service with reduced headways. Fares are eliminated.
- **Generic Bus Authority:** Discontinues the normal scheduled service, providing shuttle bus service to the rail stations within Metropolis, Neptune, and Atlantis; and providing service from outlying stations to designated shelters. Fares are eliminated.
- **Neptune and Atlantis**: The inbound lanes on Broadway are converted to "police/emergency vehicle only" to facilitate the movement of emergency and rescue personnel and equipment into Metropolis and environs as needed. Pre-planned coordinated signal timing schemes are implemented that complement the contra-flow freeway operations. Transit signal priority parameters are implemented that favor the shuttle buses that service the regional rail stations.

Table 5-8. Evacuation Scenario

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Information Sharing and Distribution Operational efficiency at network junctions En-route traveler information devices used to describe current operational conditions on another network(s) within the corridor. Modify transit signal priority to accommodate buses serving the Regional Rail stations Signal pre-emption/"best route" for emergency vehicles (e.g., along Broadway). Transit hub connection protection (between regional rail service and shuttle buses) Multi-agency/multi-network incident response teams and service patrols A common incident reporting system Promote network shifts (use of freeway or regional rail/shuttle bus for evacuation) Add transit capacity by adjusting headways and number of transit vehicles (regional rail)	CCC	Lead role in managing traffic throughout the corridor via ASOs Monitor all conditions within corridor (including performance measures) Coordination with all agencies, ensuring that all are kept up-to-date all activities and the potential impact on their respective operations. Coordination with EOC/reporting to Incident Commander Coordination, ensuring accurate traveler information, including information on road closures/contraflow operations, revised transit service, infrastructure damage, debris removal, and restoration activities related to transportation systems and facilities. Assign appropriate personnel at key sites to oversee operations and to provide consistent, verified public information to emergency management agencies, public information officers, and the media. Coordination of network junctions, with particular emphasis on transit hub connection and transit signal priority

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
Add temporary new transit service (shuttle bus service to regional rail stations, and from outlying stations to shelters) Contraflow freeway operations Open the freeway HOV lanes/shoulders Restrict/revise freeway ramp access (closures, reverse direction) Modify transit fares to encourage ridership Coordinate scheduled maintenance and construction activities among corridor networks (close down all such activities).		Coordinate DMS messages throughout corridor regarding evacuation/network operations/delays, and promoting shifts as appropriate. <u>*Initiate*</u> messages via ASOs. <u>*Initiate*</u> adjustments to network operating parameters to accommodate any evacuations (e.g., arterial signal timing) via ASOs. <u>*Initiate*</u> adjustments to transit signal priority parameters to enhance bus operations (via ASOs).
	State DOT	Lead role in terms of setting up the contraflow operation of the freeway, including portable DMS Variable speed limits within and on the approaches to the contraflow operation (via portable DMS) Provide additional freeway service patrols Monitor freeway sensors and CCTV, Monitor/operate DMS, making changes (per CCC)
	Neptune City	Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS (per CCC)
	Atlantis City	Set up "emergency vehicle only" lanes on Broadway Monitor traffic sensors/volumes Monitor arterial CCTV Monitor signal operations/adjust signal timing (per CCC) Monitor/operate DMS (per CCC)
	Generic Bus Authority	Provide shuttle bus service to rail stations, and from outlying stations to shelters Coordinate with Regional Rail Agency and CCC for connection protection Monitor bus headways/schedules Passenger counts

ICM Strategies/Other Operational Details	Agency/Entity	Role and Responsibilities
	Regional Rail Agency	Coordinate with Generic Bus Authority and CCC for connection protection Add transit capacity by adding rail service (additional vehicles/reduced headways) to accommodate evacuation Monitor train headways/schedules Monitor parking availability Passenger counts
	Emergency Services	State Police assume overall lead role, working out of EOC.

It is noted that this plan focuses only on the evacuation scenario. Additional plans have been developed for coordinating transportation clean-up and clearance activities (e.g., prioritize and perform emergency repairs); and for re-entry into the evacuated areas.

FHWA-JPO-06-032 EDL #1428