REGIONAL TRANSPORTATION AUTHORITY
REGIONAL TRANSIT ITS PLAN PROJECT

FINAL REPORT

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TABLE OF CONTENTS

Introduction........................................................................................................................................Tab 1

Executive Summary .........................................................................................................................Tab 2

Tasks 1-2 Report: Identify Stakeholders, Assess ITS projects .............Tab 3
Evaluate Traveler Information Needs

Task 3 Report: Illinois Transit Hub (ITH) Functional Requirements .....Tab 4

Task 4 Report: Illinois Transit Hub Conceptual Network Design ....Tab 5

Task 5 Report: Public Private Partnership and Interagency ..............Tab 6
Agreement Opportunities

Tasks 6-7 Report: ITS Deployment Benefits and Costs ......................Tab 7
ITS Deployment Strategy
INTRODUCTION

This is the final report for the Regional Transportation Authority’s (RTA) Regional Transit Intelligent Transportation Systems Plan (RTIP) project. RTA has pursued this plan with the purpose of presenting a vision and an approach for further transit Intelligent Transportation Systems (ITS) deployment throughout northeastern Illinois, and for promoting coordination and integration of various transit ITS projects.

The RTIP addresses the following transit ITS subjects:

- Traveler information needs of transit travelers
- Current and planned ITS projects in the region
- Functional requirements and site analysis for the Illinois Transit Hub (ITH), a centralized information source for regional transit information
- Communications network requirements for linking the ITH, RTA, service boards and the GCM Gateway system
- Public-private partnership opportunities
- Interagency agreement requirements
- Project costs and benefit impacts
- A deployment strategy and plan for transit ITS deployment in the region
- Public involvement and comment approach

This volume is divided by tabs into seven sections. Here are short descriptions of the remaining six:

- The Executive Summary incorporates the key findings from all RTIP project task reports.
- The Tasks 1-2 Report addresses the selection and involvement of RTIP stakeholders: transit information needs of travelers; service boards; traffic managers and information service providers; and existing and planned Transit Intelligent Transportation Systems (ITS) projects.
- The Task 3 report describes and provides functional requirements for the Illinois Transit Hub, planned as the centralized source of transit traveler information from public sources. It also identifies barriers to further development of transit ITS.
- The Task 4 Report addresses communications requirements. It includes an inventory and gap analysis for current service board networks, a conceptual network design for the ITH, and a site analysis for location of the ITH.
- The Task 5 Report identifies potential opportunities for the use of public-private partnerships for development and deployment of transit ITS in the region. It also addresses requirements for interagency agreements (IA) and memoranda of understanding (MOUs) to facilitate continued progress in transit ITS deployments.
• The Tasks 6-7 Report addresses costs and benefits of selected transit ITS projects, a transit ITS deployment strategy, a public involvement and comment approach, and a transit ITS deployment plan. The deployment plan incorporates both project and institutional tasks; it provides a timeline with milestones for progress in nine key project areas.
The Regional Transportation Authority (RTA) of northeastern Illinois is leading the development of an Intelligent Transportation System (ITS) Program for transit in the Chicago region. The RTA’s ITS Program provides a blueprint for the application and integration of technology to improve transit services and provide operators and customers with information that supports seamless, multi-modal travel for users of the transportation system. A wide variety of ITS technologies have been deployed throughout the transit industry to increase both operational efficiency and customer satisfaction. Through the ITS Program, the RTA, CTA, Metra and Pace are working together to evaluate existing capabilities and investigate emerging technologies that will improve our ability to share information and coordinate regional services.

One of the RTA’s key missions, as outlined by the RTA Act is to ensure a comprehensive and coordinated public transit system for the residents of northeastern Illinois. Since 1991, when the federal government designated the Gary-Chicago-Milwaukee (GCM) ITS Priority Corridor, transportation agencies and other key stakeholders in Illinois, Indiana and Wisconsin have worked together to develop solutions to regional transportation problems and create a coordinated strategy for transportation technology investments for the 16 county region.

Corridor programs stress the importance of interoperability and information sharing among transit and highway departments and other agencies providing emergency and medical services. The RTA’s role in this effort aims to ensure that the technologies deployed by the CTA, Metra and Pace are coordinated with other transportation entities throughout the GCM Corridor. The coalition of GCM participants developed a GCM Corridor Program Plan, originally adopted in 1995 that detailed a corridor ITS framework, including RTA and service board participation, that would support a regional Multi-modal Traveler Information System (MMTIS). The key factor supporting this plan continues to be regional coordination and integration of the ITS installations of many agencies throughout the Corridor.

**Transit Intelligent Transportation Systems (ITS)**

In support of the regional vision for ITS, RTA and the service boards continue to evaluate and deploy ITS infrastructure projects to improve operational
efficiency, safety and security of transit trips, and customer satisfaction. These projects fall into four distinct ITS infrastructure components: Transit Management, Traffic Signal Control, Electronic Fare Payment and Traveler Information.

Transit Fleet Management systems include satellite-based vehicle location systems, on-board processors, wireless communications, computer aided dispatching and computer assisted service coordination. These applications generate the real time vehicle location and schedule adherence data that are essential to the provision of traveler information to cooperating agencies and the traveling public. Projects completed and underway in this area include—the CTA Rail Service Management System (RSMS), CTA BusWatch system, and Bus Emergency Communications System (BECs), Metra’s Train Information Management System (TIMS) and GeoFocus, and Pace’s Intelligent Bus System (IBS). Full implementation of the region’s Fleet Management systems also provides the enabling technology for the RTA’s proposed Transfer Connection Protection (TCP) system.

In the Traffic Signal Control area, the RTA is coordinating a Regional Transit Signal Priority (TSP) Integration Plan to guide the development of transit signal priority systems for improved bus service and operating efficiency. The approach involves a multi year program to identify priority transit routes and corridors and assess operational impacts through both model simulation and field demonstrations. Ultimately, a regional implementation plan which details functional specifications, long term funding, installation requirements, operation and maintenance of a regional TSP system will be developed. Technologies under investigation include radio, infrared and loop based detection systems.

In the area of Electronic Fare Payment, CTA and Pace have implemented Automatic Fare Collection (AFC) systems for rail and bus operations. Further studies are being conducted for technological solutions for a regional fare media.

Finally in the Traveler Information area service board transit management systems will generate up-to-date on-time status information through RSMS, BusWatch, TIMS, GeoFocus and IBS installations. Other service board systems will supply regularly-updated schedule and fare information. RTA and the service boards are collaborating to evaluate several means of delivering this information. The RTA Traveler Information Center (TIC) and Itinerary Planning System (IPS) currently provide fare and schedule information. The future Illinois Transit Hub (ITH) will collect service board information, both static and real-time, and serve as a centralized source and
distribution point for regional transit information as outlined by the GCM Corridor Program Plan. Information displays such as Active Transit Station Signs (ATSS), Regional Traveler Information Kiosks, and Parking Management Guidance Systems (PMGS) will be demonstrated under the RTA’s ITS and Regional Technical Assistance Programs. The vision of 24 hours-7 days multi-modal traveler information availability will support emergency communications and response for both transit operators and highway travelers.

The deployment of transit ITS on a regional scale presents both challenges and opportunities for coordination. The challenges include:

- Developing guidelines and standards for information exchange and display to enable data sharing and distribution among various stakeholders.
- Identifying institutional and technical requirements necessary to support effective ITS installations and long-term operations and maintenance.
- Supporting long-term planning through investigative studies and demonstrations of ITS technologies in order to prove operational concepts and estimate benefits and costs.

Some opportunities include:

- Service improvements through better dispatching information and tools that provide decision support for inter-agency transfers and transit signal priority operations.
- Traveler information availability that includes not only schedules and fares, but also up-to-date on-time status for buses and trains.
- Sharing of information between transit and traffic managers, improving both highway and transit performance and safety and security of trips.

**REGIONAL TRANSIT ITS PLAN (RTIP)**

In May 2000, RTA responded to the above challenges and opportunities by initiating development of a Regional Transit Intelligent Transportation Systems Plan (RTIP). Its broad purpose is to present a vision and approach for further transit ITS deployments that assure regional coordination and integration. In so doing, it also insures that transit ITS are compatible with the multi-modal components under development as part of the GCM program.

The RTIP was developed using number of other key elements, including:
- Identification of traveler information needs
- Development of functional requirements for the Illinois Transit Hub (ITH), a centralized source for static and real-time transit information
- A conceptual communications network design linking the ITH, RTA, service boards, and the GCM Gateway system
- An assessment of public-private partnership possibilities
- Analysis of project costs and benefit impacts
- A deployment strategy for ITS installations
- Provisions for public involvement and comment

Figure 1 illustrates the scope of the RTIP. Under the umbrella of multi-modal travel management and traveler information, it includes transit ITS projects in each of the four ITS infrastructure components identified earlier.

Figure 1: Regional Transit ITS Plan

Comprehensive traveler information support addresses the traveler’s needs during each of the following trip stages. 1) Pre-trip – planning the trip and
assessing travel options, travel times and current on-time status, 2) En-route at stops or stations – determining the status and expected arrival of the next vehicle on the desired route and “if delayed” – assessing options and diverting to alternative service if available, and 3) End-trip – navigating from the final stop or station to destination. Key design themes identified for transit traveler information tools include:

- Using fixed and mobile delivery as necessary to provide the traveler with constant tracking and decision support information from the start of the trip to the reaching final destination.
- Trip itineraries should encompass pedestrian or auto legs on each end of trip where appropriate. Tools should be personalized, with the ability to save regular trips and special needs for quick retrieval.
- Emergency communications and re-route directions for travelers
- Consistent graphical representations of the transit network should be used, including routes and types of equipment.

It is important that traveler information be reliably accurate, complete and timely. A series of guiding principles for development of transit ITS in the region are identified and described below:

**RTA services should function as a unified entity:** Smooth, reliable connections and common information formats contribute to the goal of seamless transit service across all three service boards.

**Fully accessible information for all travelers:** Information will be provided through a variety of media and delivered so as to assure that all travelers can access the information they need.

**Decision aids for motorists:** Automobile commuters will be provided information about transit alternatives for completing their trips.

**Single transit fare medium:** Transit travelers will be able to purchase transportation from all three service boards using a single fare instrument such as a smart card.

**Improved service reliability and on-time performance:** Transit ITS holds the promise of improving service management through vehicle location and dispatch systems, and improving on-time performance through the use of Transit Signal Priority (TSP) technology.

**Convenient and more reliable transit connections:** Information on current on-time status will be used to monitor key connections and alert service
boards if a connection is in danger of being missed. This will lead to shorter waits at connection points.

**Safe transit trips:** A transit vehicle operator will be able to reliably request emergency assistance. It will be possible to monitor on-board events as they unfold through audio and video systems. Also, with time at transfer points reduced, connecting service will be safer.

**Transit web site:** Transit information will be available to the public through a web site, as well as other media such as live customer service, cable TV, personal mobile devices such as smart cell phones or personal digital assistants (PDAs).

**RTIP DEPLOYMENT PLAN**

The most desired benefits from RTIP – including service reliability and traveler information improvements, are the end product of numerous project tasks, including ITS infrastructure development, process changes, institutional shifts and successful integration of many disparate systems. A successful deployment strategy will assure that the lower level infrastructure tasks are successfully completed and fine tuned before detailed design is completed for the next higher level deployment.

The Chicagoland area encompasses a multi modal transportation network including bus, rail, highways, freight, and air with various institutional issues. Because transit services overlap and support the region's transportation network, the RTA's RTIP project allows for the joint development of a strategic plan for deployment of transit ITS and a concept known as the Illinois Transit Hub (ITH). As the facilitating system for integration of transit information, the ITH will receive and disseminate transit information via connections with the service boards, RTA, field devices and the Gateway MMTIS.

The RTIP represents a high-impact, best-case plan for the deployment of integrated transit ITS throughout northeastern Illinois. It assures full participation in the regional ITS vision of the GCM Corridor Coalition. It encompasses the installation of fundamental ITS service management and data collection systems by the service boards, along with the use of that data to provide integrated regional transit traveler information that is timely, complete, accurate, and reliably available. In addition, it promotes improved service reliability, enhanced safety and security, and regional coordination between transit and traffic managers.
The RTIP Deployment Plan is divided into nine major groupings of transit ITS deployment activity. All current, planned and visionary transit ITS investments fall into one of these summary plan elements:

**Service Board infrastructure: CAD/AVL, network and staff:** All investments in transit management systems such as CTA RSMS, BusWatch, and BECS, Pace IBS, Metra TIMS and GeoFocus as well as CTA and Pace Paratransit AVL/dispatch all fall into this category. It also includes studies of service board systems and network infrastructure, and any necessary upgrades. Experience in this region and elsewhere indicates that dedicated project management staff is key for technical infrastructure projects.

**Service Board Data Integrity Initiatives:** This summary plan element encompasses various initiatives designed to assure high data quality: i.e. completeness, accuracy, timeliness, availability, and logical consistency. A data integrity program is a critical part of any effort to provide consistently high quality traveler information. It utilizes data monitoring tools, training, procedures, technology and relentless follow-up to discover and correct sources of errors as promptly as possible. Data integrity for transit ITS is a new initiative for the RTA and the service boards that will coincide with the deployment of their respective service management systems.

**Provide ITH and networking connectivity:** In this plan element, the Illinois Transit Hub is taken from concept to full interconnection and functionality in three steps. **ITH1** includes basic networking of the service boards, RTA and the Gateway. Data currently flowing between service boards and the RTA will be migrated to ITH1 as soon as practical. **ITH2** involves the upgrade of the ITH to receive process, store and distribute a full range of service board transit information, including current on-time status. **ITH2** also includes provision of a public web site with transit information and decision tools; this project appears in the traveler information component of the plan. **ITH3**, represents a series of projects such as TCP that build off of the basic transit information to provide added value.

**Provide integrated transit fare payment instrument:** Integrated regional transit fare payment media is one of the three legs (service, payment, information) that will be needed to support truly seamless regional transit service. Integrated regional transit fare payment means that a common cashless fare medium would be good for travel on all three RTA service boards: CTA, Metra and Pace.
Provide Quality Transit Traveler Information Region-wide: This plan element represents the most visible aspect of RTIP: Region-wide transit traveler information that is:

- Available and fully accessible
- Provided through a wide variety of media devices
- High quality: Accurate, complete, logically consistent

This information should ultimately encompass most or all items shown by studies to be important to travelers, including but not limited to: carriers, routes, station/stop locations, fares, connections, transfer instructions, current on-time status, delays & causes, and surface directions to the initial stop/station and the ultimate destination. Traveler information delivery media included in this plan element are traveler information kiosks, Active Transit Station Signs (ATSS), Parking Management Guidance Systems (PMGS), the ITH Web site, and RTA’s Itinerary Planning System (IPS). This summary plan element also includes a new initiative for the study, design and deployment of door-to-door traveler decision aids. These will provide information and decision support throughout the trip using mobile devices and terminals on vehicles or at stops. These tools will be built around the RTA’s IPS.

Provide ITS-based transit service and efficiency improvements: This summary plan element incorporates all ITS projects and tasks targeted toward operational efficiency and service reliability. Transit Signal Priority (TSP) is perhaps the most visible of these for service reliability. Transfer Connection Protection (TCP) will also lead to improvements in the reliability of connection services. Other components include the installation at service boards of the GCM Warmap display for regional highway status, sharing of Highway-Rail Intersection (HRI) information between Metra and regional traffic management centers, and the upgrade of passenger counter equipment to allow real time updates.

Provide improved traveler safety and security through ITS: This plan element includes two projects for improving traveler safety and security. One is the eventual use of full motion video cameras on board vehicles to deter incidents, reduce accident claims, and document incidents for future adjudication. The other is the investigation and deployment of collision avoidance systems on transit vehicles to guard against vehicle-vehicle and vehicle-pedestrian accidents.

Equip TMCs with a full range of relevant transit information: This plan element covers the provision of transit data to traffic and emergency and
incident management centers via the GCM Gateway. There are two potential projects included. One is the provision of current service board incident reports to the GCM Gateway so that incident management agencies can follow up. The other is the potential future use of transit vehicles as “probes” to estimate travel times on roadways not already instrumented for travel time estimation.

Given the number of initiatives already underway and the diverse operating environment indicative of the Chicago area, the RTA’s RTIP project offers a unique opportunity for an in depth look at regional coordination for transportation systems. By taking the lead in this effort, the RTA aims to ensure that the region’s ITS standards are consistent with national and local architectures and that ITS technologies deployed by the region’s transit operators are coordinated with other transportation entities.

In summary, the RTA is providing guidance to the region’s transit operators in pursuit of ITS projects to support a centralized source of transit traveler information. Enhanced coordination and communication with regional traffic, emergency and incident management centers will improve transit capabilities for future emergency response planning.
REGIONAL TRANSPORTATION AUTHORITY
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TASKS 1-2 FINAL REPORT
IDENTIFY STAKEHOLDERS AND ASSESS ITS PROJECTS
EVALUATE USER NEEDS AND PRIORITIES FOR TRAVELER INFORMATION

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# TABLE OF CONTENTS

1 INTRODUCTION .................................................................1
2 PROJECT GOALS AND OBJECTIVES ........................................2
3 PROJECT STAKEHOLDERS ..................................................3
  3.1 Introduction ........................................................................3
  3.2 Entities with Potential Interest ..............................................3
  3.3 Approach to Stakeholder Involvement .....................................6
  3.4 Composition of Groups ......................................................7
4 USER NEEDS AND PRIORITIES ...........................................8
  4.1 Introduction ........................................................................8
  4.2 Identification of Users ........................................................8
  4.3 Transit Provider and Oversight Agency Needs .........................8
  4.4 Traffic Management Centers and Agencies ...........................9
  4.5 Information Service Providers .............................................9
  4.6 Current and Potential Travelers .........................................10
  4.6.1 CTA Customer Satisfaction Survey – 1999 .........................10
  4.6.2 Pace Customer Satisfaction Index Program .......................11
  4.6.3 Implications of Research Results .....................................12
  4.7 RTA and Service Board Research .........................................12
  4.7.1 I-95 Corridor Coalition User Needs Assessment (1995) ........12
  4.7.2 Advanced Traveler Aid Systems for Public Transportation (1994) ....13
  4.7.3 Needs of Travellers: An Analysis Based on the Study of their Tasks and Activities (1999) ..........................................................14
  4.7.4 Des Moines Area ITS Traveler Information Needs Study (1996) .....15
  4.7.5 TCRP Project A-20A, Strategies for Improved Traveler Information (forthcoming) .................................................................16
  4.8 Synthesis of Transit Traveler Information Needs ......................16
  4.8.1 Pre-trip traveler information support .....................................17
  4.8.2 En-route traveler information support ...................................18
  4.8.3 End-trip traveler information support ...................................19
  4.8.4 Technologies and functions for traveler information ................19
  4.8.5 Design themes for transit traveler information tools ...............20
  4.10 Priorities for Transit Traveler Information ...............................20
  4.10.1 Pre-trip priorities .........................................................21
  4.10.2 En-route priorities ........................................................22
  4.10.3 End-trip priorities ........................................................22
5 INSTALLED AND PLANNED ITS ........................................23
  5.1 Introduction ........................................................................23
  5.2 Project Descriptions .........................................................24
5.2.1 Active Transit Station Signs (ATSS) ................................................................. 24
5.2.2 Automatic Fare Collection (AFC) System -- CTA ........................................... 24
5.2.3 Automatic Fare Collection (AFC) System – Pace ........................................ 25
5.2.4 Automatic Passenger Counting (APC) System – CTA .................................. 25
5.2.5 Automatic Passenger Counting (APC) System – Pace .................................... 26
5.2.6 BusWatch .................................................................................................... 26
5.2.7 Cicero Smart Corridor Expansion ................................................................ 27
5.2.8 Constant Time Warning Devices .................................................................. 28
5.2.9 DuPage County Paratransit Coordination .................................................... 28
5.2.10 Gateway Traveler Information System (GTIS) .............................................. 29
5.2.11 Illinois Transit Hub (ITH) ........................................................................... 29
5.2.12 Intelligent Bus System (IBS) ......................................................................... 30
5.2.13 Interactive Transit Information Kiosks.......................................................... 30
5.2.14 Paratransit Automation -- CTA ..................................................................... 31
5.2.15 Paratransit Management System – Pace ....................................................... 31
5.2.16 Parking Management Systems (PMS) ........................................................... 32
5.2.17 Rail Centralized Control System Assessment ............................................... 33
5.2.18 Rail Service Management System (RSMS) .................................................. 33
5.2.19 Regional Transit Signal Priority .................................................................... 33
5.2.20 Traffic Management Center (TMC) – CDOT .............................................. 34
5.2.21 Traffic Systems Center (TSC) – IDOT .......................................................... 34
5.2.22 Train Information Management System (TIMS) .......................................... 35
5.2.23 Transfer Connection Protection System (TCP) ........................................... 35
5.2.24 Travel Information Center (TIC) Itinerary Planning System (IPS) ............. 36
5.3 National ITS Architecture (NITSA) – Preliminary Analysis ......................... 41
1 INTRODUCTION

This is the first report produced from the RTA’s Regional Intelligent Transportation Systems Plan (RTIP) project. Its purpose is to present the findings from Tasks 1 and 2. Task 1 is entitled “Identify Key Stakeholders and Assess Legacy and Proposed ITS”, while Task 2 is “Evaluate User Needs and Priorities for Traveler Information”.

In Section 2 of this report, project goals and objectives are identified. The goal of the RTIP is to develop a strategic ITS plan for transit that will represent a vision for coordinated deployment of transit ITS technologies throughout the region. The RTA also has numerous objectives that the RTIP will help address.

Section 3 identifies project stakeholders. In this section, a number of entities with potential interest are identified and characterized, drawing from a wide range of groups in order to help achieve the greatest possible participation. Then a basic approach for involving stakeholder groups is introduced, consisting of three groups: the Core Providers Group, responsible for project oversight and review of deliverables; the Core Advisory Group, invited to meetings and encouraged to participate, and the Public Advisory Group, whose members will receive a letter describing the project and soliciting input, then have the opportunity to review and respond during public comment after the Draft Plan has been completed.

Section 4 identifies user needs and priorities for transit travel information. First, four groups of users are defined: 1) transit providers and oversight agencies; 2) traffic management centers and agencies; 3) information service providers; and most importantly, current and potential travelers. Next, the needs of each group are identified. For current and potential travelers, service board, U.S. and international research results on transit traveler information needs are synopsized. Then all the research results are synthesized into working sets of specific traveler information needs. Finally, these needs are given an initial priority, with prioritization reported in research findings used as a guide.

Section 5 identifies twenty-four transit-related ITS projects that are installed or planned by stakeholders. These projects are grouped by “owning” agency. A summary description and timeline (where available) is provided for each. They are then summarized by one of 5 projected implementation periods – installed/being implemented, short, medium, long or vision. Finally, a first cut National ITS Architecture (NITSA) “sausage diagram” is provided, illustrating the physical subsystems and communications types that are expected to be included in the ITS plan. A complete NITSA compliance analysis will be performed as part of Task 3, then updated after Task 4 if necessary.
2 PROJECT GOALS AND OBJECTIVES

The goal of the RTIP project is to develop a strategic ITS plan for transit that will represent a vision for coordinated deployment of transit ITS technologies throughout the region. As new technologies are developed and incorporated into advanced transit vehicle operations, consideration must be given to the integration of those systems and technologies in the transit-operating environment. The plan will incorporate functional requirements for the Illinois Transit Hub (ITH), envisioned in the Gary-Chicago-Milwaukee (CGM) Priority Corridor Architecture. The ITH will serve as the conduit for collecting and disseminating transit traveler information and forwarding it to the Gateway Traveler Information System (GTIS), where it can then be shared with other transportation agencies. The RTIP will also incorporate a conceptual communications architecture to support the functions and systems identified.

The RTA has identified a number of objectives that the RTIP will help address. These include the following:

- To develop a centralized source or hub (the ITH) for regional transit information that will support the region’s Multi-Modal Traveler Information System (MMTIS).
- To evaluate regional ITS initiatives including lead agencies and partners, key issues, anticipated outcomes, estimated costs, deployment schedules, and operator training opportunities.
- To establish interagency agreements that provide a framework to facilitate long term working relationships between transit and other transportation agencies on current and future ITS issues.
- To develop the specific functionality and data flows for sending static and real-time transit information to the GTIS.
- To facilitate the adoption of an open architecture and standard documents to ensure compatibility among various transportation agencies and to establish customer friendly, easy-to-access and understandable information sources.
- To identify appropriate ITS technologies that are adaptable to future needs.
- To identify institutional issues that may impact ITS deployment.

The RTA envisions a multi-jurisdictional effort, with broad-based agency participation at all levels of government.
3 PROJECT STAKEHOLDERS

3.1 Introduction

The success of the Regional Transit ITS Plan depends primarily on its serving the needs of the many constituencies with an interest in the quality of regional transit. As a result, a thorough stakeholder analysis and identification is a necessity. This section reports on the stakeholder analysis done in support of the RTIP project.

3.2 Entities with Potential Interest

This section examines a number of entities with a potential stake in the systems covered by the RTIP:

Current and potential transit users: Current and potential transit users are intended to be the ultimate beneficiaries of transit ITS investment in the region. Individual travelers’ stakes in this project are represented in the process through various public organizations discussed below.

RTA Service Boards: The three RTA service boards, CTA, Metra and Pace, have a strong stake in the RTIP. They are both producers and users of transit ITS and the information they provide.

RTA: The RTA is a key funding agency for transit ITS work in the region; it is also charged with regional transit ITS integration, working toward the goal of a seamless regional public transportation system. In addition, its Travel Information Center (TIC) Itinerary Planning System (IPS) is an important component of transit ITS facilities in the region.

Amtrak: Amtrak is the national intercity rail passenger carrier. Amtrak provides substantial train service from its hub at Chicago Union Station (CUS), which it owns and operates. Amtrak may have an interest in providing its schedules, fares and/or current on-time status to the ITH for inclusion in regional multimodal traveler information applications.

Greyhound: Greyhound provides intercity passenger coach service throughout the U.S. It has a terminal in Chicago on the south end of the downtown area, as well as outlying stops in Chicago and its suburbs. Greyhound may have an interest in providing its schedules, fares and/or current on-time status to the ITH for inclusion in regional multimodal traveler information applications.
Planning Agencies: A variety of municipal planning agencies, particularly CATS, the region’s MPO, have an interest in plans for regional transit technology deployment and implementation. Many have committees or working groups focusing on transportation issues.

Business Associations and Advocacy Groups: Businesses in northeastern Illinois have a strong interest in accessibility for jobs and customers. Through the Chicagoland Chamber of Commerce and other business organizations, business leaders have also organized committees or even organizations to address issues of adequate transportation. ITS technologies can help contribute to that goal of improved accessibility. The Lake-Cook Transportation Management Association (TMA), a group of businesses and other organizations focused on improving accessibility in the Lake-Cook Road corridor, is another entity in this category.

IDOT: The Illinois Department of Transportation plays a key role in transit ITS in the region through its various divisions. In particular, the Division of Highways and the Division of Public Transportation are involved in transit ITS initiatives concerning transit signal priority. The IDOT ITS Program Office is the source of much of the funding for regional ITS initiatives. IDOT is the provider of incident management activities and real-time traveler information for the region’s expressway system. The Traffic Systems Center, Emergency Traffic Patrol, and the Communications Center are all owned and operated by IDOT. The ITS office also provides valuable oversight for regional ITS projects, and is the owner of the Gateway Traveler Information System (GTIS).

City of Chicago Office Of Emergency Communications/911: OEC/911 coordinates and dispatches emergency response for incidents requiring immediate police and/or fire department action. Previous discussions between CDOT, OEC/911 and CTA resulted in a proposal for a direct communications link between the CTA Bus Emergency Communications System (BECS), part of the BusWatch program, and OEC’s 911 Center.

CDOT: The City of Chicago Department of Transportation (CDOT) is completing an ITS Strategic Plan to lay out an overall approach for developing and integrating ITS into the city transportation system.

The Chicago Department of Streets and Sanitation (CDSS) Bureau of Electricity (BOE) is responsible for the installation and maintenance of approximately 2700 signals in the city of Chicago. Accordingly, the BOE is responsible for inspecting and testing of all traffic control equipment installed in the City of Chicago.

City of Chicago Department of Aviation: The Chicago Department of Aviation operates Chicago’s two major airports. They are cooperating with the upcoming demonstration of Active Transit Station Signs (ATSS) at both airports, to inform travelers of the availability and next departure for transit. Lessons learned during this demonstration will help guide final ATSS design and implementation.
County DOTs: The Departments of Transportation in Lake, McHenry, Will, DuPage and Kane Counties have jurisdiction over highway and signal systems in their respective counties. They also operate or are planning traffic management centers (TMCs). As such they also have an interest in transit signal priority activities and in efforts to improve traffic flow.

Municipal Governments: Cities and villages in the RTA service area have a strong interest in accessibility, from the standpoint both of economic development and quality of life. Good transit service means that residents can access their jobs throughout the region, and that workers can access jobs in the community. As a result, municipalities have a strong interest in transit ITS to the extent it can help in these areas.

Municipal governments often approach issues of common interest through associations. In the Chicago area, these include the CATS Council of Mayors, Metropolitan Mayors Caucus, and a number of councils of government, such as DuKane Valley Council, DuPage Mayors and Managers Conference, Lake County Municipal League, Northwest Municipal Conference, South Suburban Mayors and Managers Conference, Southwest Conference of Local Governments, West Central Municipal Conference, and Will County Governmental League.

This category also includes school districts whose pupils use public transportation for school trips.

Private Information Service Providers: Organizations such as Metro Networks/Shadow Traffic and AAA Chicago Motor Club are in the business of collecting and selling transportation information. In addition, various local media outlets also collect and provide transportation information. While the primary focus of these efforts is usually traffic conditions, the organizations also collect and disseminate information on late trains or buses, as well as transit service cancellations, closures or detours. They thus have an interest in Transit ITS installations that may provide an automated flow of such information.

Gary-Chicago-Milwaukee (GCM) ITS Priority Corridor Program: The GCM ITS Priority Corridor Program was formed in 1993, with the objective of improving the efficiency and effectiveness of transportation in the corridor through the deployment of ITS applications. The linchpin of its efforts has been the development of the GCM Corridor Program Plan, including a regional ITS architecture for the corridor.

The GCM Program has an Executive Committee for overall direction, made up of DOT Secretaries of Indiana, Illinois and Wisconsin, and the Division Administrator for the Federal Highway Administration (FHWA). The GCM ITS Deployment Committee oversees the Coordination Work Group and the implementation of the Corridor Program Plan. It includes representatives from
state DOTs, USDOT, regional planning organizations and transportation agencies. The Coordination Work Group, made up of the ITS program managers from the three states, FHWA and FTA, provides technical, planning and administrative support to the ITS Deployment Committee on the coordination and implementation of the GCM Corridor Program Plan (CPP) and conformance with the National ITS Architecture (NITSA).

In its oversight and coordination role, the GCM program has a strong interest in transit ITS and its integration with other regional ITS applications. RTA and service board transit ITS projects financed under GCM CPP funding include the following: Active Transit Station Signs (ATSS), Transfer Connection Protection (TCP), CTA BusWatch, Pace IBS, and Parking Management Systems (PMS).

**Illinois State Toll Highway Authority (ISTHA):** ISHTA owns and operates four toll highways in the region: the Tri-State, North-South, Northwest, and East-West Tollways. Certain Pace bus routes use the Tollway system, in some cases with preferred access to the roadway. In addition, parking management systems (PMS) may be installed on tollways to inform users of available parking and transit alternatives for completing their trips.

**U.S. Federal Transit Administration (FTA):** FTA’s mission includes the promotion of transit ITS for purposes of improving efficiency and effectiveness. FTA is also the source of much of the capital funding used for transit ITS development in the region, as well as a source of guidance and oversight for transit ITS projects.

**U.S. Federal Highway Administration (FHWA):** FHWA has taken an active role in promoting multimodal ITS in the region, and is a key funding source. FHWA has a strong interest in regional integration of ITS, and thus in highway-related transit ITS projects involving integration.

**Private Providers:** There are a number of private organizations that provide transportation to people in the region, including contract paratransit operators, contract fixed route operators, taxis, airport transportation providers, and private scheduled bus lines. Many of these have a stake in the development of transit ITS. It may serve as a means to give visibility to their services or to improve the efficiency of their operations. It may also become a requirement for those wishing to do business as contractors for RTA service boards or other organizations. One group representing the interest of such providers is the Metropolitan Transportation Association.

### 3.3 Approach to Stakeholder Involvement

For the RTIP project, we have identified three stakeholder groups characterized by the level and nature of their involvement. They are described below:
• The **core providers group** consists of CTA, Metra, Pace, Amtrak, Greyhound, RTA, and the IDOT ITS Office (owner of the GTIS). All these organizations are users and/or providers of traveler information.

• The **core advisory group** consists of agencies that do not have direct responsibility for implementation of transit ITS projects, but are involved as ITS architects, infrastructure owners, funding sources, agency overseers, regional ITS associations, municipalities in the region, private transportation operators, and private providers of transit traveler information. Since there is overlap between some of the groups, certain individuals may contribute on behalf of more than one organization. This group would be invited to stakeholder meetings and could attend at their discretion.

• The **public advisory group** includes a variety of organizations who may wish to provide input to the plan. These may include associations of municipalities, Lake-Cook TMA, chambers of commerce, planning organizations, civic associations, and other associations or commissions. This group will receive a mailing announcing the project and inviting specific input on needs or concerns. It will also have an opportunity for public comment on the Plan after the Draft Plan has been completed.

### 3.4 Composition of Groups

Table 3.1 below gives the proposed composition of the groups outlined above:

<table>
<thead>
<tr>
<th>Core Providers Group</th>
<th>Core Advisory Group</th>
<th>Public Advisory Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA</td>
<td>CATS Advanced Technology Task Force and CATS Policy Committee</td>
<td>Business Leaders for Transportation</td>
</tr>
<tr>
<td>Metra</td>
<td>Chicago DOT</td>
<td>CATS Council of Mayors</td>
</tr>
<tr>
<td>Pace</td>
<td>Chicago OEC/911 Center</td>
<td>Chicagoland Transportation and Air Quality Commission</td>
</tr>
<tr>
<td>RTA</td>
<td>County DOTs</td>
<td>Metropolitan Mayors Caucus</td>
</tr>
<tr>
<td>Amtrak</td>
<td>DuPage Mayors and Managers</td>
<td>Metropolitan Planning Council</td>
</tr>
<tr>
<td>Greyhound</td>
<td>FHWA</td>
<td>Metropolitan Transportation Association</td>
</tr>
<tr>
<td>IDOT/ITS</td>
<td>GCM ITS Deployment Committee</td>
<td>Northeastern Illinois Planning Commission</td>
</tr>
<tr>
<td></td>
<td>IDOT/DPT</td>
<td>Transportation Management Association of Lake-Cook</td>
</tr>
<tr>
<td></td>
<td>ISTHA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private ISP representative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private operator representative</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1: Composition of Stakeholder Groups
4 USER NEEDS AND PRIORITIES

4.1 Introduction

This section identifies the various users of information generated by transit and intercity surface transport operators, along with their respective information needs. For travelers as users of this information, a more detailed examination is then provided. First, relevant service board and RTA research on transit traveler information needs is reviewed. Then, U.S. and international research on the same subject is reviewed. Finally, research findings are synthesized, and initial priorities selected for transit traveler information in the RTA service area.

4.2 Identification of Users

Users of static and real time information generated by transit providers can be classified into several groups:

- Transport providers and oversight agencies use the information for operations management and coordination
- Traffic management centers or agencies can integrate incident reports and transit probe data into their operations
- Information service providers (ISPs) using a variety of delivery media can furnish or resell this information to travelers. This group also includes media outlets.
- Current and potential travelers receive this information as traveler information. It assists in pre-trip planning, en-route evaluation and decisionmaking, and post-trip navigation.

In the remainder of this section, we first summarize the needs of providers and ISPs for transit-generated data. The focus then turns to research efforts on the needs of current and potential travelers. Findings from several key studies are summarized. Finally, the information on traveler information is synthesized and research findings on information priorities is presented.

4.3 Transit Provider and Oversight Agency Needs

For this project, the three primary transit providers being served are the RTA service boards – CTA, Pace and Metra. In addition, intercity service providers such as Amtrak and Greyhound are being offered the opportunity to participate. Finally, RTA is included as a potential operator of the ITH and thus the operations support applications reside there, such as the Transfer Connection Protection (TCP) system.
These transit providers use transit data from other agencies for service coordination both at the strategic and tactical (static information) and operational (real time) levels. Specifically, they may use connecting carrier schedule, route and stop/station information for service and operations planning. They may also use real time information on schedule adherence and delays for purposes of operational coordination, such as providing substitute service. They may also receive alert information from the TCP system and any other transit operations coordination applications operating at the ITH.

These same providers may also need information available from the Gateway Traveler Information System (GTIS). The system can provide incident information, link travel times, closures and lane reductions, weather and other information. This information can be used by the providers to plan/adjust operations to minimize impacts on the traveler.

### 4.4 Traffic Management Centers and Agencies

The three RTA service boards operate in each of the six counties comprising the RTA service area. They also operate over Chicago streets managed by the Chicago Department of Streets and Sanitation (CDSS), freeways and arterials managed by IDOT, and tollways operated by ISTHA. When taken together, these represent the potential for eight or more distinct traffic management and/or incident management facilities.

Traffic management and incident management centers can use several types of data provided by transit operators:
- Incidents that may impact traffic flow
- Time and location readings for update of link travel times (or updated times themselves)
- Transit parking lot occupancies

They can also provide information of considerable value to transit operators:
- Incident information that may affect operations
- Highway-Vehicle Intersection (HVI) incidents that may affect commuter rail operations
- Construction and maintenance closures, lane reductions or other impacts
- Video feeds from key traffic surveillance points

Each of these information flows will be handled through the Illinois Transit Hub.

### 4.5 Information Service Providers
Information Service Providers (ISPs) that deal in transit information include but are not limited to urban traffic information specialists, radio and television stations that gather their own information, and web sites that provide information. These ISPs are primarily interested in the following information about transit service:

- What scheduled service is seriously behind schedule?
- What is the reason for delay?
- When can the vehicle be expected to arrive at destination?
- What services are not operating, have been rerouted, or are running at diminished capacity (e.g. one track open between station A and Station B)

4.6 Current and Potential Travelers

As the customers and end users of transit services, current and potential travelers have arguably the most important stake in timely, accurate and complete transit traveler information. Today, most of this information is static, and is provided on signs or printed materials. In the future, a substantial amount of the information may be provided electronically.

While it is easy to make assumptions about traveler information needs based on personal experience or common sense, a more sound base of research is much preferable. The remaining sections in this document review local, national and international research attempting to identify and prioritize transit traveler information needs.

4.7 RTA and Service Board Research

With the assistance of service board professionals, the consulting team was able to identify two service board market research studies bearing on traveler information. CTA’s 1999 Customer Satisfaction Survey touches on information as one dimension of the traveler’s feelings about CTA service. Pace’s ongoing Customer Satisfaction Index studies also address a number of information related elements. The remainder of this section examines the relevant findings from each data source.

4.7.1 CTA Customer Satisfaction Survey – 1999

The CTA commissioned a Customer Satisfaction Survey of CTA Riders, to be performed during 1999. The survey was performed by Northwest Research Group. This same firm had performed similar surveys for CTA in 1995 and 1997. The report on the 1999 survey focused, among other things, upon comparisons in customer satisfaction between 1997 and 1999.
Key findings from the Technical Report on the survey include:

- CTA achieved improvements in customer satisfaction “grades” for both bus and rail service between 1997 and 1999.
- Some specific areas still require improvement, such as keeping customers informed about service changes, especially for bus service.
- Targeted areas for improvement for bus include communications with passengers on board, both around delays or problems, and concerning route and schedule information requests.
- Targeted areas for improvement for rail include communications with passengers – particularly stop announcements, and explanations of delays or other problems.
- 51 percent of bus users surveyed had problems with determining when the next bus would be coming. This was the highest problem percentage of any of the 44 key “drivers” of bus customer satisfaction.
- Only 24 percent of rail users had the same concern about when the next train would be coming. In fact, there was a statistically significant improvement in the customer satisfaction score in this area among rail users. However, the CTA still received a low grade in this area.
- Access to information is apparently not a significant problem for current riders; the majority surveyed have never cancelled a transit trip because they didn’t know how to get information.
- A high percentage of CTA riders have Internet access at home or work, however few are using the CTA web site to get information.
- The report noted a statistically significant improvement in the effectiveness score among rail users for the CTA customer service hotline, and for availability of accurate route and schedule information.

4.7.2 Pace Customer Satisfaction Index Program

Pace uses an ongoing Customer Service Index (CSI) measurement program to determine how all aspects of its service are perceived by Pace users. One of the categories in the CSI is “information attributes”; this category includes five “service elements” relating to customer information. The service attributes include 1) Information Given by Drivers, 2) Ease of Reading Printed Schedules, 3) Route Information Availability, 4) Service Change Notice, and 5) Responses of Telephone Representatives.

CSI ratings are done on a 1-5 scale, with 4 and 5 considered to represent satisfaction. For the five categories above, the first three had mean scores between 4.0 and 4.1, while the last two had scores between 3.5 and 4.0. These scores indicate that while many customers are satisfied, there is still room for improvement in each of the areas.
4.7.3 Implications of Research Results

Both these customer satisfaction surveys indicate that there is room for improvement in the provision of traveler information to transit users in the RTA service area. However, it should be noted that without the kind of transit ITS projects being pursued by the service boards, it is impossible to provide travelers with some of the key pieces of information they want, such as, “When is the next bus/train coming”? This implies two things. First, ITS investments that support the provision of more complete transit information to travelers should be most aggressively pursued. Second, service boards will need to begin a transformation into organizations that view the provision of information to customers as a priority near or equal to that of providing the transit service itself.

4.8 U.S. and International Research

An extensive search was performed for outside research directly addressing the identification and prioritization of transit traveler information needs. Out of many studies reviewed, four particularly pertinent ones were identified, as well as one forthcoming study of interest. Key findings from each are summarized below.


The I-95 Corridor Coalition sponsored research about traveler information needs within the corridor, as part of efforts to design appropriate traveler information capabilities. This research included one focus group aimed at current transit users (Philadelphia), and telephone and on-board surveys of current transit users in the New York and Boston areas. Bus and transit rail users were broken out separately in this study.

For transit bus and rail users, key information needs identified through the surveys were:
- Transit schedules and current (pre-trip) delays (schedule adherence)
- En-route traffic delays
- Estimated Time of Arrival (ETA)
- Weather information

Other interesting findings:
- Close to half of the survey respondents were happy with schedules and maps for pre-trip information.
- A significant percentage were interested in electronic access to transit data
- The majority of respondents were unwilling to pay for electronic transit data
This report can be found at the I-95 Corridor Coalition web site, using the following URL:  http://www.i95coalition.org/PROJECTS/cc6-95-2.html

4.8.2  Advanced Traveler Aid Systems for Public Transportation (1994)

This FTA-sponsored research focused specifically on transit traveler information systems. The bulk of the study concerned the design of advanced systems to provide pre-trip and en-route transit information. However, a detailed analysis of needs and traveler decision trees was done in support of this effort.

A survey was conducted asking respondents to first imagine themselves in each of six situations, then rank the importance of various pieces of information under that particular situation. Five of the situations involved pre-trip information; the sixth concerned en-route information in case of delays. The six situations are shown below:

- Visiting an unfamiliar city
- Trip where arrival time is important
- Occasional shopping trips using transit
- Unexpected change in work trip plans
- Return from an occasional night or weekend entertainment trip
- Transit vehicle is late while en-route

As expected, the survey results showed that the importance of various pieces of information varied among the six situations. When a composite of results for the five pre-trip situations was constructed, the most important elements were:

- transit departure time
- return trip availability
- service frequency
- location of stops or stations
- arrival time

When a transit vehicle was late en-route, a different set of information requirements emerge around the process of adjusting trip plans. The respondents felt the most important pieces of information were:

- the arrival of an alternative mode at the final destination
- whether there would be further delays
- availability of an alternate mode
- departure time of alternative mode
- on-time status of alternative mode
- distance to terminal for the alternate mode
This survey is attractive because of its structure, level of specificity, and focus. However, it should be noted that the survey sample is a somewhat homogeneous group of students at the University of Delaware.

This document can be found in the National Transit Library at the following URL: [http://www.bts.gov/NTL/DOCS/ata.html](http://www.bts.gov/NTL/DOCS/ata.html). Note: the entire study text is hyperlinked to over sixty tables and figures. Click on the text and the relevant table or figure will appear.

### 4.8.3 Needs of Travellers: An Analysis Based on the Study of their Tasks and Activities (1999)

This comprehensive study was performed as part of the Infopolis2 initiative of the Commission of the European Communities. The study takes an ergonomic and behavioral approach by studying in detail the tasks travelers undertake as part of 1) pre-trip planning, 2) en-route tracking, and 3) end-trip analysis. Results were developed using four panels of 50 multimodal transit users each. There was one panel from each of these four cities: Brussels, Helsinki, Marseilles and Stuttgart.

Study results provide a detailing of traveler information needs at extraordinary levels of depth and specificity. For each of the three stages outlined above, information needs, questions asked, and tasks are identified in three areas: information use & needs; cognition (information treatment); and disruption & adjustment.

The study does not prioritize information needs, but does identify a key set of appropriate actions for transit operators and information providers to take in order to serve transit travelers. The actions are listed below in Table 4.1.
Table 4.1 Infopolis2 Recommended Transit Traveler Information Actions

This definitive study provides a foundation for determination of information needs that is behaviorally based. As a result, its findings make a strong contribution to the needs analysis for this project.

This study can be downloaded at the Infopolis2 web site at the following URL: http://www.ul.ie/~infopolis/library/del/del3.html

4.8.4 Des Moines Area ITS Traveler Information Needs Study (1996)

This study was undertaken as part of planning for ITS deployment in Des Moines, IA. It was performed by the Center for Transportation Research and Education at Iowa State University. The study was unique in that it focused on users of traveler information at hotels, retail centers and special events locations. Personal interviews were performed with employees at those facilities; out-of-town visitors, retail customers, and local attendees at meetings, events or conferences.

The results of this survey confirm the conventional wisdom about who uses transit. Employees showed a strong interest in both static and real time transit traveler information. Out of town visitors had little interest in transit information (not unusual for a smaller city with bus transportation only). Retail customers
were interested in static and real time transit information. Local attendees at events were only interested in transit information at a few locations – the stadium and two major hotels.

A copy of the report can be found at the following URL: http://www.ctre.iastate.edu/Research/eds/process.htm

4.8.5 TCRP Project A-20A, Strategies for Improved Traveler Information (forthcoming)

The objective of this project is to develop strategies for using information technology to improve individual mobility-related decisionmaking. The focus is on how public transportation providers can most effectively participate in advanced community-based information systems that support such technologies as hand-held devices (e.g., web enabled cell phones or hand-held computers), vehicle-mounted computers, kiosks, and web-based communications.

This project should describe what public transportation agencies must do to provide reliable, current traveler information. The project is also intended to define and assess new organizational structures and arrangements, including partnerships, that will ultimately be necessary if the full potential of better traveler information is to be achieved.

Research from this project is currently expected to be available in late 2001.

4.9 Synthesis of Transit Traveler Information Needs

There are at least two useful ways to classify the information from research on transit traveler information needs. One is according to the nature of the information. Some information is static, meaning it changes infrequently—for example, the location of a bus stop. Other information is real time, meaning it is updated frequently, such as the expected arrival time of a bus or train.

Another way to classify traveler information elements is according to when they are needed during the trip, combined with the on-time status of the trip. This breakout has been defined here as the following four categories:

- Pre-trip information (planning, up until arrival at the stop or station)
- En-route information (while traveling or waiting at stops/stations/terminals)
- En-route “if delayed” information (to support contingency planning and increase control)
- End-trip information (upon egress from final transit leg)
The following sections examine each of these four classifications in more detail.

4.9.1 Pre-trip traveler information support

In the pre-trip stage, the traveler’s need is for information to support trip planning and decisionmaking. The questions to be answered may include, for example: Shall I make this trip? By what mode(s) will I get to my destination? If transit, where and when will I access the service? How do I get to that point?

The information needed to address these questions include both static and real time information. Static information includes schedules, departure times for the trip and any return, stop/station location, path to the stop/station, and transit trip cost or fare. Real time information includes the current on-time status of the service to be used, current ETA at destination, current weather conditions, and any variable trip cost or fare. Table 4.2 summarizes this information.

<table>
<thead>
<tr>
<th>Pre-trip information element</th>
<th>Static/Real Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit schedules</td>
<td>Static</td>
</tr>
<tr>
<td>Scheduled arrival time</td>
<td>Static</td>
</tr>
<tr>
<td>Scheduled departure time</td>
<td>Static</td>
</tr>
<tr>
<td>Current on-time status</td>
<td>Static</td>
</tr>
<tr>
<td>Weather information</td>
<td>Real Time</td>
</tr>
<tr>
<td>Availability and schedule of return trip</td>
<td>Static</td>
</tr>
<tr>
<td>Transit routes</td>
<td>Static</td>
</tr>
<tr>
<td>Headway/frequency</td>
<td>Static</td>
</tr>
<tr>
<td>Stop or station location(s)</td>
<td>Static</td>
</tr>
<tr>
<td>Current predicted ETD</td>
<td>Real Time</td>
</tr>
<tr>
<td>Current delays and disruptions</td>
<td>Real Time</td>
</tr>
<tr>
<td>Alternative itineraries to destination</td>
<td>Static/real time</td>
</tr>
<tr>
<td>Access distance/path to the first stop or station</td>
<td>Static</td>
</tr>
<tr>
<td>Access distance/path from the end stop or station to destination</td>
<td>Static</td>
</tr>
<tr>
<td>Fare/cost of trip</td>
<td>Static</td>
</tr>
<tr>
<td>Requirement for transfer</td>
<td>Static</td>
</tr>
<tr>
<td>Transfer time</td>
<td>Static</td>
</tr>
</tbody>
</table>

Table 4.2: Pre-trip Traveler Information Requirements

The functions and technologies necessary to support the requirements are conceptually straightforward: planning and decision support tools providing access to static and dynamic information and facilitating the traveler’s analysis and choice from among options. Access to weather and traffic information is also helpful. Today, most transit users get their information from printed schedules, broadcast media, or a call to a traveler information line such as the RTA’s Travel Information Center. In the future, a suite of capabilities including itinerary planning could be made available via a variety of applications, including kiosks at key traffic locations, and personal information access via wireline or wireless.
Internet, personal digital assistant (PDA), cell phone, touch-tone or interactive TV applications.

4.9.2 En-route traveler information support

The en-route traveler is interested primarily in real time information in order to optimize the current trip. This can be true when service is on-time (e.g. can I catch an earlier run/train for my connecting service?), but is especially important during disruptions. Travelers are interested in real time information about their current segment, such as the reasons for delays, expected duration of delays, expected ETA at destination or transfer point, and announcements and direction in case of an emergency such as a derailment. They are also interested in the status of planned connections. At any time, but especially during disruptions, travelers may also be interested in the availability, status, ETA and accessibility of alternate routes or modes for reaching their final destinations. Questions of this type include: Where is the stop/station for accessing the alternative route? What is the transfer distance to reach that stop/station? Is it on time? When would I reach my final destination?

A summary of En-route traveler information requirements is provided in Table 4.3.

<table>
<thead>
<tr>
<th>En-route information element</th>
<th>Static/Real Time</th>
<th>Standard/&quot;If Delayed&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>En route delays – cause and duration</td>
<td>Real Time</td>
<td>Standard &amp; If Delayed</td>
</tr>
<tr>
<td>Continuously updated ETA</td>
<td>Real Time</td>
<td>Standard</td>
</tr>
<tr>
<td>Advise on unsafe areas</td>
<td>Static</td>
<td>Standard</td>
</tr>
<tr>
<td>Network disruption information</td>
<td>Real Time</td>
<td>Standard</td>
</tr>
<tr>
<td>On-time status of alternative path service/make-miss information</td>
<td>Real Time</td>
<td>Standard &amp; If Delayed</td>
</tr>
<tr>
<td>On-time status and ETD of connecting service</td>
<td>Real Time</td>
<td>Standard</td>
</tr>
<tr>
<td>On-time status of current vehicle</td>
<td>Real Time</td>
<td>Standard</td>
</tr>
<tr>
<td>Alternative path arrival at destination</td>
<td>Real Time</td>
<td>If Delayed</td>
</tr>
<tr>
<td>Likelihood of further delay</td>
<td>Real Time</td>
<td>If Delayed</td>
</tr>
<tr>
<td>Availability of alternate path to destination</td>
<td>Static</td>
<td>If Delayed</td>
</tr>
<tr>
<td>Departure time of alternative path service from transfer point</td>
<td>Static</td>
<td>If Delayed</td>
</tr>
<tr>
<td>Distance from transfer point to alternative path service stop/station</td>
<td>Static</td>
<td>If Delayed</td>
</tr>
</tbody>
</table>

Table 4.3: En-route Traveler Information Requirements

Functions and technologies for en-route support include 1) stop/station based systems, 2) in vehicle systems, and 3) personal wireless devices. At stops/stations, interactive kiosks and audio-visual displays can be used to provide real time status information and tools for analyzing alternatives for
completing the trip. In vehicles, interactive terminals and audio-visual displays can be used for the same purposes. Finally, personal wireless devices can provide the same information and tools to travelers whether on board or at a stop/station. These same devices could also support routine individual connection decisionmaking.

4.9.3 End-trip traveler information support

As illustrated in Table 4.4, the main information need at the end of the transit trip is static information on the location and path information for the traveler’s destination. Today, this need is often supported by display maps at rapid transit stations. Advances in technology should make it possible to provide maps on hand-held wireless devices, perhaps with real time navigation assistance as well.

<table>
<thead>
<tr>
<th>Post-trip information element</th>
<th>Static/Real Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path to destination</td>
<td>Static</td>
</tr>
</tbody>
</table>

Table 4.4: Post-trip Traveler Information Requirements

4.9.4 Technologies and functions for traveler information

The Infopolis2 project identifies a variety of functions and/or technologies that would support the information needs collected from study participants. For pre-trip information, planning and decision support tools should be available at a home or business workstation or a wireless mobile device. For en-route information, stop/station displays, on-board displays, consistent signage layouts, and on-board or mobile analysis and retripping tools are suggested. For end-trip information, integrated transit and city maps are proposed.

A complete list of identified functions/technologies appears in Table 4.5.
### Function/Technology Pre-trip En-route End-trip

<table>
<thead>
<tr>
<th>Function/Technology</th>
<th>Pre-trip</th>
<th>En-route</th>
<th>End-trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning tools</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision support tools (e.g. itinerary planning)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Navigation tools</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Links to other information sources (e.g. weather)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active Transit Station Signs</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Analysis and retripping tools</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Variable message signs (VMS) on highways for transit and parking availability and status</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Connection management assistance tools</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consistent signage layouts, colors, etc.</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Integrated transit and city maps</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Home or business workstation</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wireless computing device</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 4.5: Functions and Technologies to Support Traveler Information

#### 4.9.5 Design themes for transit traveler information tools

The Infopolis2 project suggests a number of guidelines or themes for design of effective traveler information tools. These include:

- Consistent representations of the transit network and equipment types
- “Door to door” information logic – take full itinerary including walking and auto portions
- Constant tracking and support throughout the trip
- Personalization based on preferences, constraints, special needs
- Repetitive delivery of information via multiple means

Another recurring theme in research on traveler information and mode choice – a critical one to address – is a perceived loss of control for transit travelers. While it is not possible to give total control to transit travelers, a comprehensive information and support system with real time information and presentation of alternatives could significantly impact the perception of loss of control. This, in turn, would increase customer satisfaction and confidence.

### 4.10 Priorities for Transit Traveler Information

Two of the four studies cited above provided prioritized traveler information needs. The I-95 Corridor Coalition User Needs Assessment reports the highest priority results, but does not provide complete rankings. The Advanced Traveler
Aid Systems research is especially useful because actual survey scores are provided for each of the six questions mentioned above in Section 4.3.2. Since the priorities varied among situations, a range of normalized average scores was also provided as a composite rating for the five pre-trip situations. Scores from the en-route situation represent a prioritization for en-route information requirements.

The findings from these studies have been used here to assist in developing initial priorities for transit traveler information needs for both pre-trip and en-route transit traveler information. They are included in Table 4.4 for reference purposes.

4.10.1 Pre-trip priorities

Initial rankings for pre-trip transit traveler information priorities can be found in Table 4.4. Where ranges appear, they are based on normalized averages of survey rankings from the Advanced Traveler Aid Systems study.

<table>
<thead>
<tr>
<th>High Priority Pre-trip Needs</th>
<th>ATAS Range</th>
<th>Medium Priority Pre-trip Needs</th>
<th>ATAS Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current on-time status</td>
<td>Access distance/path from the end stop or station to destination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current predicted ETA</td>
<td>Access distance/path to the first stop or station</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headway/Frequency</td>
<td>0.80 – 0.83</td>
<td>Fare/cost</td>
<td>0.55 – 0.75</td>
</tr>
<tr>
<td>Return trip availability/</td>
<td>0.63 – 0.94</td>
<td>Requirement for transfer</td>
<td>0.58 – 0.70</td>
</tr>
<tr>
<td>schedule</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scheduled arrival time</td>
<td>0.60 – 0.98</td>
<td>Transfer time</td>
<td>0.58 – 0.72</td>
</tr>
<tr>
<td>Scheduled departure time</td>
<td>0.75 – 0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop or station location</td>
<td>0.66 – 0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit schedules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weather information</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4: Prioritization of Pre-trip Transit Traveler Information Needs

The most important items appear to be static schedule information (times, locations, frequency of service), known delays/ETA, and weather information (especially important for choice riders). Note that a trip itinerary or trip plan, while not listed as a requirement, would satisfy many of the information needs listed. Trip plans have not been represented in surveys as they are not currently available to travelers in many places.
4.10.2 En-route priorities

For en-route information, dynamic, real time information is the most useful to travelers. Both studies noted above also made contributions in this area. The initial prioritization can be found in Table 4.5.

<table>
<thead>
<tr>
<th>High Priority En-route Needs</th>
<th>ATAS Score</th>
<th>Medium Priority En-route Needs</th>
<th>ATAS Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative path arrival at destination</td>
<td>0.92</td>
<td>Advise on unsafe areas</td>
<td></td>
</tr>
<tr>
<td>Availability of alternate path to destination</td>
<td>0.90</td>
<td>Cause of En-route delays</td>
<td>0.47</td>
</tr>
<tr>
<td>Continuously updated ETA</td>
<td></td>
<td>Fare/cost of the alternate mode</td>
<td>0.53</td>
</tr>
<tr>
<td>Departure time of alternative path service from transfer point</td>
<td>0.88</td>
<td>Distance from current location to final destination</td>
<td>0.69</td>
</tr>
<tr>
<td>Distance from transfer point to alternative path service stop/station</td>
<td>0.86</td>
<td>Network disruption information</td>
<td></td>
</tr>
<tr>
<td>Likelihood of further delay</td>
<td>0.91</td>
<td>On-time status of alternative path service/make-miss information</td>
<td></td>
</tr>
<tr>
<td>On-time status of planned connecting service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-time status of current vehicle</td>
<td>0.86</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.5: Prioritization of En-route Transit Traveler Information Needs

4.10.3 End-trip priorities

The only end-trip information need identified is that for the distance and path to the actual destination. This will allow travelers who are unfamiliar with their destination or with how to get there from their current location to negotiate their trip with the most confidence and least delay. This is judged to be a moderate priority. Currently, this need is often served through integrated maps at transit stations/stops, but may also be met in the future with hand held display devices.
5 INSTALLED AND PLANNED ITS

5.1 Introduction

In this section, we identify all systems that meet one or both of these criteria for inclusion in the RTIP:

- Any ITS system that collects, produces or displays traveler information *that includes, or is designed to include, transit information*.
- Any ITS system that involves center to center communications between a service board transit management center and another transportation management center (service board, public agency, private agency, emergency and medical services).

Candidate systems for inclusion in the system were derived from two primary sources:

- The CATS Strategic Early Deployment Plan (SEDP) for ITS projects, completed in 1999, sought to identify all current or planned ITS in the RTA service area, both transit and non-transit. Projects were then ranked through a group process. Projects ranked about a threshold were then included in the plan along with expected implementation within 4 time periods: Short-term, Medium-term, Long-term and Vision. Multi-phase projects could span multiple time periods. This plan represents a baseline which has been enhanced and updated for the RTIP.
- Initial interviews were conducted with a number of agencies, including RTA Engineering and Technology, RTA Travel Information Center (TIC), CTA, Metra, Pace, IDOT ITS, CDOT, UIC, Argonne National Labs, and Amtrak. In some cases these led to identification of additional systems not included in the SEDP or conceived since it was finalized.

The remainder of this section consists of paragraph descriptions of each ITS project identified for incorporation in the RTIP. Additional projects can still be incorporated into the Plan until requirements have been finalized.

Also, at the end of this section, Table 5.1 categorizes all projects by five time periods:
- Implemented or in progress – 2000
- 2001-2002
- 2003-2005
- 2006-2010
- 2011+
5.2 Project Descriptions

5.2.1 Active Transit Station Signs (ATSS)

The ATSS project is an RTA feasibility study and demonstration of active sign technology for displaying “next vehicle” information at transit stops or stations. This technology can be driven automatically by an AVL/CAD system, a remote information source such as the ITH, or by manual input by an operator.

The design developed in Phase I supports the display of real time traveler information at various locations including bus stops, platforms and station entrances and from multiple service boards on a single sign at intermodal transfer points. Phase II, currently under development, will involve demonstration of the ATSS at 2 CTA rail stations and O'Hare and Midway CTA terminals.

Under the ultimate ITH architecture, individual active signs will be associated with a particular service board. Signs at stops or stations served by only one service board will receive their information directly from that service board’s AVL/CAD system. Intermodal signs will receive information for connecting carrier service from the ITH. If desirable, provisions can be made for making all signs addressable from the ITH.

5.2.2 Automatic Fare Collection (AFC) System -- CTA

CTA has a fully-implemented Automatic Fare Collection (AFC) system covering its entire rapid transit and fixed route bus services. This system uses primarily stored value mag stripe fare cards and transfers. Smart cards are also supported, but to date have been given only limited distribution.

The system uses turnstiles at rapid transit stations, and a card reader/encoder connected to the farebox on transit buses. Cards can be purchased or have value added at farecard machines at all rapid transit stations and a few other locations. Cards encoded with a pre-set value can also be purchased at area retail locations. Smart cards are only available direct from the CTA.

All fixed components of the AFC system are connected by a secure, dedicated network, including all farecard vending equipment, rapid transit turnstiles, and garage based equipment for probing the bus card printer/reader unit for the day’s transactions.

Future plans for the AFC system include expansion of channels for distributing precoded cards, and adding locations where value can be added to farecards.
At this point, no connection between the CTA AFC system and the ITH is planned, as the AFC system generates general management information in batch mode only. As technology evolves such a connection might be considered so that transit use levels and fare card events can be monitored for trends on a real time basis.

5.2.3 Automatic Fare Collection (AFC) System – Pace

Pace has implemented a complete Automatic Fare Collection (AFC) system covering its Pace owned and operated fixed-route buses. The system technology is fundamentally the same as that of the CTA AFC system, using primarily stored value mag stripe fare cards. Pace and CTA general-use farecards are interoperable between the systems. Not all fares are supported by the Pace system; its users are primarily those who transfer to/from CTA services.

Pace has garage probing equipment and a network for collecting the data. However, CTA and Pace process their fare data separately, and there are limited cross reimbursements between the two carriers.

At this point, no connection between the Pace AFC system and the ITH is planned. As technology evolves such a connection might be considered so that transit use levels and fare card events can be monitored for trends on a real time basis.

5.2.4 Automatic Passenger Counting (APC) System – CTA

CTA currently has an automatic passenger counting (APC) system serving its fleet of fixed route buses. It records passenger boardings and alightings by time and location (represented by odometer reading as a surrogate). Selected vehicles are equipped with the system, and are used to cover various routes as needed for the purpose of recording passenger boardings and alightings by stop. These figures are used to support operations planning, as well as stop location and design. The technology used to support the system includes pressure sensitive treadle mats at bus entrances/exits and a processor/recording unit. The processor/recorder has wireline connections to both the treadle mats and the bus odometer.

With the ongoing conversion of the fixed route fleet to low floor buses, CTA is planning to replace the existing treadle mat system with technology compatible with the low floor environment. The system will also get more precise and consistent location information from the BusWatch AVL system, thus no longer relying on the vehicle odometer. No other interfaces are planned at this time.
In the future, if available bandwidth permitted CTA to transmit real time passenger loadings to the BusWatch system, this information could be forwarded to the ITH. This would allow the TCP system to take bus loadings into account in analyzing potential connections.

5.2.5 Automatic Passenger Counting (APC) System – Pace

Pace has an existing automatic passenger counting (APC) system serving its fleet of fixed route buses. It creates time-stamped records for door openings, door closings, passenger boardings and passenger alightings. Selected vehicles are equipped with the system, and are used to cover various routes as needed for the purpose of recording passenger boardings and alightings by stop. These figures are used to support operations planning, as well as stop location and design. The technology used to support the system includes infrared beams to sense passenger movements, door opening/closing sensors at bus entrances and exits, and a processor/recording unit.

As part of its forthcoming IBS project, Pace is procuring new APC capabilities for up to 115 fixed route buses. The system will employ infrared or other similar sensors, but not treadle mats. The system will collect passenger boarding and alighting data, which will be stamped with trip, run, bus stop location, date and time obtained from the AVL system/on-board processor. The on-board processor will collect this information for nightly download to the computer-aided dispatch system.

In the future, if available bandwidth permitted Pace to transmit real time passenger loadings to IBS, this information could be forwarded to the ITH. This would allow the TCP system to take bus loadings into account in analyzing potential connections.

5.2.6 BusWatch

The CTA BusWatch system is a comprehensive transit management system, making extensive use of information and communications technology to provide better tools for dispatchers, supervisors and operators. BusWatch is a new identity for two CTA bus ITS projects, the Bus Emergency Communications System (BECS), and the Bus Service Management System (BSMS). It is expected to lead to improved reliability, elimination of platooning, and provision of real time passenger information. The BusWatch project equips the entire CTA bus fleet with mobile data terminals, GPS-based location tracking, and emergency communications capabilities. In addition, a subset of the fleet is to receive the more advanced on-board “smart bus” capabilities of the BSMS.
including schedule adherence monitoring and full Automated Vehicle Location (AVL) capabilities in association with a new computer aided dispatch (CAD) system. The BusWatch project provides critical core infrastructure to support operations functions such as signal priority and connection protection and information functions such as active transit signing.

CTA’s current $34.1 million project will equip up to 1200 buses with BECS mobile data terminals and GPS location devices, as well as up to 250 buses with BSMS equipment: new radios and AVL capability with schedule adherence functions. The BECS system was accepted in 2000; its installation is complete. Currently underway is the upgrade of up to 250 buses to full BSMS capabilities. Installation of full BusWatch capabilities in newly purchased buses is also funded for 2000-2002. Related projects in the integrated operations and traveler information categories are not funded; these include the conversion of 200 traffic signals per year beginning in 2000 up to 1,000 total signals, and the deployment of up to 200 active transit signs per year.

The CTA BusWatch system is expected to provide schedule and on-time status information to the ITH, and will receive endangered connection alerts and updates from the ITH, as well as roadway and weather information from the Gateway via the ITH.

5.2.7 Cicero Smart Corridor Expansion

Expansion of the Cicero Smart Corridor, a CDOT test bed for integrated application of multiple ITS technologies, involves both extending the coverage area, and deploying additional technologies. Potential transit technologies for the corridor include automatic vehicle location, transit vehicle priority, automated passenger counting, automated stop announcements, and smart bus shelters with real-time bus service and arrival information. There could also be some crossover of automobile ITS applications to transit, such as in-vehicle devices for dissemination of information on congestion, road conditions, etc. Physical expansion of the corridor is planned to continue to I-290 (N) and I-294 (S) during 2000, and I-94 (N) and I-57 (S) in 2001. Specific plans for transit involvement at this time consist of the provision of multimodal information being made available at Midway Airport and at the CTA Orange Line terminal.

In its ultimate architecture, the ITH may supply some or all of the required multimodal information for active signs at the CTA Orange Line terminal at Midway. Other roles for the ITH may emerge as the design of the Corridor is advanced.
5.2.8 Constant Time Warning Devices

Metra has an ongoing effort to install constant time warning devices at grade crossing points. At signalized grade crossings without this feature, the signals are triggered when the train is at a fixed distance from the crossing. This results in variable waiting times for drivers; fast trains will arrive at the crossing relatively soon after the gates have lowered, while slow trains such as freights will appear after a longer interval. One of the problems with such situations is that drivers accustomed to a long interval before the arrival of slow freights might try to cross around lowered gates and find themselves in the path of a fast passenger train. This was the situation with the 1999 Amtrak accident in Bourbonnais, IL.

Constant time warning devices address this situation by maintaining a relatively constant interval between the activation of signals at a crossing and the arrival of the train. This is done by sensing train speed and calculating the precise time to activate signals on that basis.

These systems are expected to enhance safety at signaled grade crossings by reducing the unpredictability of the interval between signal activation and train arrival at grade crossings.

Metra already has a number of constant time warning devices in place, and is pursuing additional installations as funds are available. It is also looking at possible enhancements to the technology.

Since these devices work entirely for and within the grade crossing warning signals, the ITH is not expected to play any role in their operation.

5.2.9 DuPage County Paratransit Coordination

A Paratransit Coordination Technology Study commissioned by DuPage County was completed early in 2001. The coordination concept involves a single number for reservations and customer service, and a center linking a large network of paratransit sponsors and providers. This study will determine the technology configuration most appropriate for support of the Coordinator, sponsors and riders. It is expected that the technology will include at minimum some sort of mobile data terminals, wireless communications, and a central scheduling system.

The timetable for further action is still being finalized.

Like the service board paratransit contract operators, the DuPage Coordinator could receive connection status updates from the TCP system via the ITH. It could also forward ETA updates to the TCP system via the ITH.
5.2.10 Gateway Traveler Information System (GTIS)

The Gateway Traveler Information System (GTIS) is intended to be the information clearinghouse for collection of transportation-related data. It is decentralized, relying on regional hubs for data collection and most data fusion. The Gateway will present data to a wide variety of users through the Internet. It will also function as the means for transportation operators of all modes to share information and data with one another. Completion of the Gateway Traveler Information System consists of multiple projects for completion of Gateway connectivity with the Illinois Hub, and various other subregional hubs including the Illinois Transit Hub.

The Gateway is currently being implemented, with live operation scheduled for summer 2001.

Based on the needs of other agencies and of the Gateway Web site, the ITH will forward static and/or real time transit information to the Gateway as it is received from participating transportation providers. In turn, the ITH will receive traffic, weather, incident and video surveillance data from the Gateway based on the needs of the transportation providers.

5.2.11 Illinois Transit Hub (ITH)

The Illinois Transit Hub is primarily intended to be the focal point for collection and distribution of transit information in northeastern Illinois – specifically the RTA service area. It will collect information from – and provide it to – travelers, transit operators and traffic managers. Here are the specific objectives for the ITH:

- It will collect the following transit-related information from service board ITS installations and information systems: transit schedules, schedule adherence, fares, incidents and other specialized information.
- It will process the service board information and make it available to the Gateway TIS and to service board users according to their requests.
- It will be networked with both the Gateway/Illinois Hub complex and the service board ITS hubs.
- It will include a database for tracking of current or final on-time status for all runs/trains during the last 24 hours.
- It will serve a public web site designed to provide access to transit information to travelers and to regional information service providers (ISPs).
- As needed, it will facilitate transit operator access to information collected by the Gateway from Traffic Management Centers and various field instruments.
This information may include highway travel times, weather conditions and forecasts, incident information, and video feeds from monitoring cameras. In addition, much of this information can be made available via the Gateway TIS Web page.

- It will host selected regional applications involving information from multiple service boards, such as Transfer Connection Protection (TCP) and possibly Active Transit Station Signs (ATSS).

When service board AVL/CAD systems and the Illinois Transit Hub are implemented and fully connected, a full range of regional information applications will be available for travelers, system operators, traffic managers, and information service providers.

This report is part of the first phase of the ITH project. Phase 2, involving further design efforts, is scheduled for the 2001-2003 time frame. The timetable for ultimate ITH implementation is dependent on the deployment of service board data source systems such as CTA’s BusWatch, Metra’s TIMS, and Pace’s IBS. It is currently scheduled as a long range project in the 2004-2009 timeframe.

5.2.12 Intelligent Bus System (IBS)

The Pace IBS project involves the deployment of an integrated bus management system incorporating automatic vehicle location and computer aided dispatch technologies to optimize and enhance transit operations. It also includes management analysis capabilities utilizing data collected by IBS. These analyses are expected to result in gains in transportation operation efficiency and effectiveness.

Technologies provided for in the IBS design include AVL, CAD, on-board schedule adherence monitoring, signal priority request, automatic passenger counting with real time integration, and connection protection. There are also future options for addition of on-board interior displays for passenger information.

An RFP for procurement of the IBS system was issued in September, 2000. Notice to proceed is expected in the first half for 2001. A pilot installation is expected by late 2001 or early 2002.

IBS will provide schedule and on-time status information to the ITH, and will receive endangered connection alerts and updates from the ITH, as well as roadway and weather information from the Gateway via the ITH.

5.2.13 Interactive Transit Information Kiosks
As of this writing, CTA and CDOT are working to develop a pilot project for kiosk implementation. A grant application has been submitted; a response is expected shortly. Private funding is also under consideration. If the grant application is successful, kiosks could be operational in 2001.

Plans call for the kiosk displays to be Internet-based, offering a web page to receive information about public transport options. They are to be placed initially at tourist attractions in Chicago, such as the Art Institute, Adler Planetarium, etc. They would provide static and (when available) real time information about public transport services. Eventually, they could also provide additional tourist information such as restaurant menus.

Technology infrastructure for the kiosks would include a connection with the ITH for forwarding of information requests and receipt of real time and static public transport information. There would also need to be a composite GIS base map drawing on both CTA and City of Chicago map resources. Software would be provided by the RTA.

The kiosk program is integrated with a program to develop icons representing tourist attractions. The icons would be used on kiosk maps and on public transport signage/materials.

5.2.14 Paratransit Automation -- CTA

CTA Paratransit Operations is pursuing a plan to equip its contract operators with vehicle-based mobile data terminals (MDTs) with GPS capabilities, along with a computer aided dispatch (CAD) system. The contractor CAD systems will be network-connected with CTA so that information can be transferred in both directions between the CAD systems and the CTA Special Services system. Complete installation at a contract carrier will allow the transfer of reservations and of trip completions electronically, streamlining billing and payment, improving customer service, and substantially reducing paperwork for both parties. Carriers will also receive benefits of improved vehicle and driver productivity, as well as reduced no-shows and better customer service. Cook DuPage Transport, one of the Special Services contractors, installed such a system independently, and is now doing full electronic exchange with CTA. Other carriers are scheduled to be instrumented at CTA expense in 2001-2002.

If CTA contract paratransit operators participate in the Transfer Connection Protection (TCP) system, their reservations and CAD/MDT systems will receive alerts on delayed connections from mainline service, so that pickup times can be adjusted. Additionally, if there is agreement on the protection of connections to mainline service, then paratransit CAD/MDT systems will provide the ITH with updated ETAs at the connection point.
5.2.15 Paratransit Management System – Pace

The purpose of this Pace project is to deploy a paratransit management system covering Pace paratransit operations. This system will consist of integrated Mobile Data Terminals with AVL in conjunction with the Pace automated scheduling system. The system will provide for storage of manifest entries, transmission of adds and deletes from the manifest, tracing of vehicles, automatic odometer readings, and an interface with customer ID cards for automated pickup and drop-off reporting.

Planned development and deployment are anticipated in 2001-2004. The project can go forward after quotes have been received for upgrading Pace’s Trapeze PASS scheduling and dispatching software to a Windows version. This is expected to occur in 2001.

If Pace contract paratransit operators participate in the Transfer Connection Protection (TCP) system, their reservations and CAD/MDT systems will receive alerts on delayed connections from mainline service, so that pickup times can be adjusted. Additionally, if there is agreement on the protection of connections to mainline service, then paratransit CAD/MDT systems will provide the ITH with updated ETAs at the connection point.

5.2.16 Parking Management Systems (PMS)

The PMS project involves the use of real time inventory monitoring technologies at park-and-ride lots, along with variable message signs (VMS), to alert auto travelers to the availability of parking spaces and the schedules for public transportation services served by those spaces. The system would be primarily targeted at stations adjacent or near to freeways or tollways, where travelers could divert to avoid congestion.

The RTA’s Phase I feasibility study of PMS has been completed. With technical and financial assistance from the RTA, Metra is developing a Phase II PMS installation for demonstration and evaluation of the concept. A professional services RFP is planned for 2001. This will involve a conceptual layout, drawings, specifications, costing and project management. A procurement will be done based on the specifications developed. Metra expects to be testing the pilot system in late 2001 or early 2002. Further pursuit will depend on the results of those tests.

Service board PMS installations will provide the ITH with parking occupancy information. The ITH will forward the information via the IH to the Gateway, where it can be used to populate PMS messages on IDOT or ISTHA VMS. The
local PMS systems can also retrieve via the IH and ITH highway travel times for display on local or arterial VMS.

5.2.17 Rail Centralized Control System Assessment

This Metra project would involve an assessment of current signaling systems – identifying upgrades and reconfigurations required, as well as assessment of staffed towers controlling territory used by Metra. Integrated Metra and freight operations would be considered where this was an issue. An assessment of dispatch system upgrade or replacement would also be included.

There is currently no timeframe for this project.

5.2.18 Rail Service Management System (RSMS)

The RSMS is an AVL/CAD system covering CTA’s rail operations. It provides AVL capabilities through track sensors, linked with the control center and CAD system via wireline connections. In addition to CAD and AVL, RSMS includes schedule and headway adherence monitoring and extensive service restoration capabilities. There are also a handful of legacy station lights or bells signaling an impending train arrival, for example at South Blvd. on the Purple Line. Future plans include on-board and en-route passenger information displays and announcements, and integration with BECS/BSMS to provide connection protection between CTA bus and rail.

CTA uses G/Sched to develop schedules for rail operations. It is interfaced to RSMS via a WordPerfect file from which RSMS extracts the schedule information it requires.

The RSMS installation conforms to open systems principles. It is fully operational in revenue service.

5.2.19 Regional Transit Signal Priority

The goal of the RTA’s comprehensive plan is to develop regional standards and guidelines for design, procurement, testing, installation, operation and maintenance of a multi-jurisdictional transit signal priority system. The components of the plan include a Signal Inventory, Location Study, and a Technology Study. The Signal Inventory is completed with efforts underway to develop a regional GIS database of the signal data collected via survey. Phase I of the Location Study includes key stakeholders to help identify locations where signal priority would be effective. Phase II involves model simulation of signal
priority operations. The Technology Study includes service board demonstrations on Cermak Road and Western Avenue.

There are two broad categories of transit signal priority requests:

- **Vehicle to wayside**, where the vehicle communicates with the signal controller itself via a wayside device
- **Center to center**, in which the priority request is passed from the control center to a traffic management center where coordinated signal control is implemented. The request is processed there and instructions passed to the local signal controller where called for.

The ITH will not be directly involved in vehicle to wayside signal priority requests, since they are handled at the service board level. However, for center to center priority requests, service board CAD/AVL systems may pass a request to traffic management centers via the ITH, and may also receive back an acknowledgement via the ITH if necessary.

5.2.20 Traffic Management Center (TMC) – CDOT

This center will integrate traffic signals, video camera surveillance, and potentially the priority control for transit buses. It will also be linked to IDOT for provision of arterial traffic information. As of this writing, the design study for the center is underway. It is expected that the design process will be completed in 2001, with implementation in 2004 or 2005.

The CDOT TMC may in the future receive center-to-center signal priority requests from transit operators via the ITH and the Illinois Hub (IH). It may also receive and provide incident information via the ITH, IH and Gateway.

5.2.21 Traffic Systems Center (TSC) – IDOT

The IDOT Traffic Systems Center is the centralized source for an instrumented network that covers over 150 miles of roadway with well over 2000 loop detectors. It also operates over 100 ramp meters and over 20 on-line variable message signs, and monitors CB radios through remote dialup sites.

The TSC provides direct computer hookups to traffic information service providers in the region, some of whom supplement TSC information through their own data collection efforts.

A consultant contract has been awarded for completion of final design and installation of an upgraded TSC computer system. Phase One procurement of
system hardware has been completed, and system software development is underway.

The TSC has at least two potential links involving the ITH. It will 1) receive electronic incident reports from one or more service boards via the ITH and IH; and 2) potentially receive and integrate real-time probe data from transit or paratransit vehicles, also via the ITH and IH.

5.2.22 Train Information Management System (TIMS)

The purpose of Metra’s Train Information Management System (TIMS) is to provide real time train location and schedule adherence information to Operating Personnel, Passenger Service Representatives and the commuting public. In addition, the system provides automated audio and visual stop announcements aboard equipped trains, and two way messaging between train crews and land-based operations personnel. TIMS uses GPS, spread spectrum radio, a public or private ATCS (Advanced Train Control Systems) radio system, and a GIS system. Ground based systems receive and process location, velocity and acceleration data to determine location and on line status.

A pilot TIMS system installation on five Metra trains on two routes (Southwest Service and Milwaukee District North Line) has been in operation since 1999. As of this writing, Metra is proceeding with full deployment on all its owned and operated lines. Initial equipping of all lines is expected by the end of 2001.

TIMS may provide schedule and on-time status information to the ITH, as well as receiving endangered connection alerts and updates from the ITH.

5.2.23 Transfer Connection Protection System (TCP)

The RTA Transfer Connection Protection (TCP) System is designed to improve performance across intermodal connections between the services of CTA, Metra and Pace. It will do this by continuously examining current real time status of each service board’s services, and identifying endangered connections. Endangered connections are usually the result of the “from” vehicle running late, so that it will not arrive at the transfer point until after the “to” vehicle has departed. Under these circumstances, if provided with the information and able to do so without serious downstream impacts, the “to” carrier can hold its vehicle for the arrival of the “from” vehicle.

The TCP system is expected to reside with the Illinois Transit Hub to facilitate prompt exchange of information. Upon receipt of a schedule adherence report from a service board, the ITH will make a call to the TCP system with the new
information as an argument. The TCP system will then access the ITH database(s) to check schedules and connecting service. If it determines there is an endangered connection, it will create an Endangered Connection Alert message for the involved carriers and forward it to the ITH for delivery.

A feasibility study for the TCP system was completed in summer 2000. Detailed design and deployment are not expected to take place until at least two service boards have made substantial progress toward systemwide deployment of their CAD/AVL systems.

5.2.24 Travel Information Center (TIC) Itinerary Planning System (IPS)

The RTA TIC IPS was initially implemented in January, 1999. The IPS is used by customer service representatives to provide trip itineraries or trip plans to callers. The trip plans are based primarily on static route and run/train (schedule/timetable) information.

RTA also makes the IPS available to the traveling public via an Internet interface. It allows entry of desired parameters for a trip, and replies with a proposed trip plan. This capability was rolled out at the end of 2000.

The IPS is expected to be integrally tied to the ITH as its principal source of static and real time transit data. It may also forward information requests to the ITH. If the ITH is collocated with the IPS at the RTA TIC, these information exchanges may take place across the ITH local area network (LAN).
<table>
<thead>
<tr>
<th>Project</th>
<th>Agency</th>
<th>In deployment or operation</th>
<th>2001-2002</th>
<th>2003-2005</th>
<th>2006-2010</th>
<th>2011+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Transit Station Signs (ATSS)</td>
<td>RTA</td>
<td></td>
<td>Phase II demonstration</td>
<td>Further service board implementation</td>
<td>Further service board implementation</td>
<td>Stops and stations completely equipped</td>
</tr>
<tr>
<td>Automatic Fare Collection (AFC) System</td>
<td>CTA</td>
<td></td>
<td>System fully implemented with mag stripe cards.</td>
<td>Investigation of further smart card use.</td>
<td>Additional locations for adding value.</td>
<td></td>
</tr>
<tr>
<td>Automatic Fare Collection (AFC) System</td>
<td>Pace</td>
<td>Full system implementation with mag stripe cards.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic Passenger Counting (APC)</td>
<td>CTA</td>
<td>Treadle mat system in place in selected buses</td>
<td>Complete RFP &amp; vendor selection for expansion</td>
<td>Begin installation</td>
<td>Ongoing installation</td>
<td></td>
</tr>
<tr>
<td>Automatic Passenger Counting (APC)</td>
<td>Pace</td>
<td>Existing infrared system in selected buses</td>
<td>Installation in 115 IBS buses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BusWatch</td>
<td>CTA</td>
<td>BECS fully implemented</td>
<td>BSMS installation and pilot deployment</td>
<td>Completed BSMS implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cicero Smart Corridor Expansion</td>
<td>CDOT</td>
<td>Corridor in operation</td>
<td>Corridor physical expansion</td>
<td>Additional instrumentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant Time Warning Devices</td>
<td>Metra</td>
<td>Installed base of systems</td>
<td>Ongoing installation</td>
<td>Ongoing installation</td>
<td>Ongoing installation &amp; enhancements</td>
<td>Installed at all grade crossings with signals</td>
</tr>
<tr>
<td>Project</td>
<td>Agency</td>
<td>In deployment or operation</td>
<td>2001-2002</td>
<td>2003-2005</td>
<td>2006-2010</td>
<td>2011+</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-----------------</td>
<td>--------------------------------------------</td>
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<td>---------------------------</td>
<td>---------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>DuPage County Paratransit Coordination</td>
<td>DuPage County</td>
<td>Technology Study completed</td>
<td></td>
<td></td>
<td></td>
<td>One-call concept; better service &amp; resource utilization</td>
</tr>
<tr>
<td>Gateway Traveler Information System (GTIS)</td>
<td>IDOT</td>
<td>Predecessor system (C-TIC) in operation</td>
<td>Live implementation in summer 2001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illinois Transit Hub (ITH)</td>
<td>RTA</td>
<td>Phase 1 study underway</td>
<td>Phase I completed</td>
<td>Phase II design</td>
<td>Detailed design and deployment</td>
<td></td>
</tr>
<tr>
<td>Intelligent Bus System (IBS)</td>
<td>Pace</td>
<td>System procurement</td>
<td>Pilot implementation</td>
<td>Further implementation</td>
<td></td>
<td>Full installation: Pace &amp; contractor vehicles</td>
</tr>
<tr>
<td>Interactive Transit Information Kiosks</td>
<td>CTA/RTA</td>
<td></td>
<td>Grant acquisition, design, specification and procurement Initial implementation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paratransit Automation</td>
<td>CTA</td>
<td>Electronic exchange with CDT MDT/AVL</td>
<td>Instrument other two carriers</td>
<td></td>
<td></td>
<td>Near-real time records transfer</td>
</tr>
<tr>
<td>Paratransit Management System</td>
<td>Pace</td>
<td></td>
<td>Update scheduling system &amp; begin development</td>
<td>Development and deployment</td>
<td></td>
<td>Integrated installation on all vehicles</td>
</tr>
<tr>
<td>Project</td>
<td>Agency</td>
<td>In deployment or operation</td>
<td>2001-2002</td>
<td>2003-2005</td>
<td>2006-2010</td>
<td>2011+</td>
</tr>
<tr>
<td>----------------------------------------------</td>
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<td>---------------------------</td>
<td>-----------</td>
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<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td>Parking Management Systems (PMS)</td>
<td>Metra/RTA</td>
<td>Feasibility study completed. Pilot system RFP Pilot system installed</td>
<td></td>
<td></td>
<td></td>
<td>Parking status and next train information displayed on VMS on expressways and SRAs near stations</td>
</tr>
<tr>
<td>Rail Centralized Control System Assessment</td>
<td>Metra</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Track and signaling upgrades enabling integrated control of all Metra-owned lines at a single facility</td>
</tr>
<tr>
<td>Rail Service Management System (RSMS)</td>
<td>CTA</td>
<td>Implemented</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional Transit Signal Priority</td>
<td>RTA</td>
<td>Signal inventory completion GIS signal inventory completion Implementation of key signals Implementation of additional signals</td>
<td>Implementation of key signals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Management Center (TMC)</td>
<td>CDOT</td>
<td>Center design</td>
<td>Construction and implementation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Systems Center (TSC)</td>
<td>IDOT</td>
<td>Hardware/software upgrade underway. TSC upgrade complete</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>Agency</td>
<td>In deployment or operation</td>
<td>2001-2002</td>
<td>2003-2005</td>
<td>2006-2010</td>
<td>2011+</td>
</tr>
<tr>
<td>----------------------------------------------</td>
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<td>----------------------------------------------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Train Information Management System (TIMS)</td>
<td>Metra</td>
<td>Feasibility study and pilot installation complete</td>
<td></td>
<td></td>
<td></td>
<td>Future implementation in new cars subject to funding and programming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Full implementation subject to funding and programming</td>
<td></td>
<td></td>
<td></td>
<td>Real-time status available for all Metra trains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Real-time status available for all Metra trains</td>
<td></td>
<td></td>
<td></td>
<td>Real-time status available for all Metra trains</td>
</tr>
<tr>
<td>Transfer Connection Protection System (TCP)</td>
<td>RTA</td>
<td>Feasibility study completion</td>
<td></td>
<td></td>
<td></td>
<td>Implementation of pilot system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phase II design</td>
<td></td>
<td></td>
<td></td>
<td>Real-time connection monitoring and alerts to service boards</td>
</tr>
<tr>
<td>Travel Information Center (TIC)</td>
<td>RTA</td>
<td>IPS in production test since 1999.</td>
<td></td>
<td></td>
<td></td>
<td>Real-time connection monitoring and alerts to service boards</td>
</tr>
<tr>
<td>Itinerary Planning System (IPS)</td>
<td></td>
<td>IPS completion and acceptance, March 2001</td>
<td></td>
<td></td>
<td></td>
<td>Real-time connection monitoring and alerts to service boards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public Internet access - 2001</td>
<td></td>
<td></td>
<td></td>
<td>Real-time connection monitoring and alerts to service boards</td>
</tr>
</tbody>
</table>

Table 5.1: RTA RTIP Projects by Time Period
5.3 National ITS Architecture (NITSA) – Preliminary Analysis

Based on the project information identified above, the project team did a preliminary analysis of transit-related architecture components. This analysis was done at the physical subsystem level. Results of the analysis are represented in the standard NITSA physical architecture “sausage diagram” shown in Figure 5-1.

![Diagram of Preliminary RTIP Physical Architecture](image)

Figure 5-1: Preliminary RTIP Physical Architecture Diagram

The diagram identifies four types of centers involved in the RTIP: Information Service Providers, Traffic Management, Emergency Management, and Transit Management. Two roadside subsystems are involved. The Roadway subsystem encompasses wayside or pavement-based devices to support transit signal priority. The Parking Management Subsystem includes parking management systems used to inform current and potential transit travelers of park and ride opportunities. Transit Vehicles are included as a vehicle subsystem supporting fleet management features and en-route transit traveler information. Finally, transit travelers are supported through the Remote Traveler Support (public devices) and Personal Information Access (personal devices) subsystems, as well as by devices on-board transit vehicles.
Three of four types of communications are also incorporated in the RTIP architecture: Wireline Communications, for center to center and center to device communications; Wide Area Wireless Communications, for center to vehicle and center to personal device communications support; and Dedicated Short Range Communications (DSRC), for vehicle to roadside communications. The Vehicle to Vehicle Communications Subsystem was not included because, although there are projects calling for vehicle to vehicle communications, these are either through a center or contain small amounts of data. The Vehicle to Vehicle Communications subsystem is meant to cover high volume, line-of-sight data communications between vehicles for support of advanced control systems.
REGIONAL TRANSPORTATION AUTHORITY
REGIONAL TRANSIT ITS PLAN PROJECT

FINAL TASK 3 REPORT:
ILLINOIS TRANSIT HUB FUNCTIONAL REQUIREMENTS

Prepared by:
Wilson Consulting
TranSmart Technologies, Inc.
Unisource Network Services, Inc.
Multisystems, Inc.

May 4, 2001
# TABLE OF CONTENTS

1 INTRODUCTION .................................................................................................................................. 1  
1.1 Background – RTIP Overview ........................................................................................................... 1  
1.2 Purpose of this document .................................................................................................................. 2  
1.3 Document Organization ...................................................................................................................... 2  
1.4 Glossary of Terms ............................................................................................................................... 3  
1.5 Related Reports ................................................................................................................................. 11  
2 A VISION FOR REGIONAL TRANSIT ITS INTEGRATION .............................................................. 12  
2.1 Traveler impacts of Transit ITS Deployment ...................................................................................... 12  
2.2 Service Board Impacts of Transit ITS Deployment ........................................................................... 14  
2.3 Integration of Highway and Transit ITS ............................................................................................ 16  
2.4 Infrastructure Needs ......................................................................................................................... 16  
2.5 Public Policy Outcomes ..................................................................................................................... 17  
3 ILLINOIS TRANSIT HUB OVERVIEW ............................................................................................ 19  
3.1 Introduction ........................................................................................................................................ 19  
3.1.1 National ITS Architecture ............................................................................................................. 19  
3.1.2 GCM Corridor Architecture ........................................................................................................ 19  
3.2 System Objectives ............................................................................................................................. 24  
3.3 System Description ............................................................................................................................ 25  
3.3.1 General ........................................................................................................................................ 25  
3.3.2 Functionality ................................................................................................................................. 25  
3.3.3 Traveler View of the ITH ............................................................................................................. 28  
3.3.4 Transit Operator View of the ITH ................................................................................................. 28  
3.4 NTCIP ................................................................................................................................................ 29  
3.5 TCIP .................................................................................................................................................. 30  
3.6 LRMS ................................................................................................................................................ 31  
3.7 ITH System Architecture ................................................................................................................... 31  
3.8 Data Providers ................................................................................................................................... 33  
3.8.1 Amtrak ......................................................................................................................................... 33  
3.8.2 CTA ............................................................................................................................................ 33  
3.8.3 DuPage Paratransit Coordinator ................................................................................................... 34  
3.8.4 Gateway TIS ............................................................................................................................... 34  
3.8.5 Greyhound ................................................................................................................................. 34  
3.8.6 Metra ........................................................................................................................................... 35  
3.8.7 Pace ............................................................................................................................................ 35  
4 SYSTEM REQUIREMENTS .................................................................................................................. 36  
4.1 Data Acquisition Subsystem ............................................................................................................. 36  
4.1.1 CORBA (Common Object Request Broker Architecture) ............................................................ 36  
4.1.2 Enterprise Java Bean (EJB) + Extensible Markup Language (XML) ........................................... 38  
4.2 Data Validation And Fusion Subsystem ............................................................................................ 39  
4.3 Data Storage Subsystem .................................................................................................................... 40
4.4 Data Distribution .................................................................................40
4.5 Monitoring/Logging/Notification (MLN) Subsystem ...............................41
4.6 Administrative Subsystem ..................................................................41
4.7 ITH Reference Files ...........................................................................42
4.8 Transfer Connection Protection (TCP) System .....................................42
4.9 Graphical User Interface (GUI) Subsystem ...........................................43
4.10 Cooperative Control Pass Through ....................................................45
4.11 Operation ............................................................................................45
4.12 Backups ...............................................................................................46
4.13 Transfer Techniques Supported .........................................................46
5  GENERAL REQUIREMENTS .....................................................................48
  5.1 National ITS Architecture Compliance ..............................................48
     5.1.1 Introduction ..................................................................................48
     5.1.2 ITH Physical Architecture ...............................................................48
     5.1.3 ITS Architecture Interconnects .......................................................50
     5.1.4 ITH Market Packages ....................................................................54
  5.2 GCM Corridor Architecture Compliance ............................................59
     5.2.1 Overall Compliance .......................................................................60
     5.2.2 Applicable GCM Guidelines ..........................................................60
  5.3 National Standards Compliance .........................................................61
     5.3.1 Compliance to NTCIP Standards ..................................................62
     5.3.2 Compliance to TCIP Requirements ...............................................62
  5.4 Service Board And ITS Subsystem Requirements ..................................62
  5.5 Open Systems ......................................................................................62
  5.6 Topology ..............................................................................................63
  5.7 Object Orientation .................................................................................63
  5.8 Flexibility ...............................................................................................63
  5.9 Scalability .............................................................................................64
  5.10 Security ................................................................................................64
  5.11 Reliability ............................................................................................65
  5.12 Fault Detection And Recoverability ....................................................65
  5.13 Performance .........................................................................................66
  5.14 Error Detection ...................................................................................66
  5.15 Privacy ................................................................................................67
  5.16 Support For Future Technologies ........................................................67
  5.17 Training ..............................................................................................67
  5.18 Maintenance .........................................................................................68
6  HARDWARE REQUIREMENTS ...................................................................69
  6.1 Performance ..........................................................................................69
  6.2 Reliability ...............................................................................................69
  6.3 Safety .....................................................................................................70
  6.4 Testing ....................................................................................................70
  6.5 Server Machines ....................................................................................70
  6.6 System Components .............................................................................71
  6.7 Main Storage ..........................................................................................72
  6.8 Off-Line Storage .....................................................................................72
1 INTRODUCTION

1.1 Background – RTIP Overview

During 2000, the RTA has initiated efforts to develop a Regional Transit Intelligent Transportation Systems Plan (RTIP). Its broad purpose is to present a vision and a template for planned deployment and integration of transit ITS. The RTIP will encompass:

- Current and planned transit ITS installations through the region, with analysis of associated costs and benefits
- A vision of a seamlessly integrated public transportation system in northeastern Illinois, facilitated in part by ITS
- A centralized information source for current static and real time transit information, the Illinois Transit Hub (ITH)
- A conceptual communications network design
- An assessment of public-private partnership possibilities
- Provisions for public involvement and comment
- A deployment strategy for future ITS installations

The RTIP will contribute to RTA’s stated goals of:
- Studying and developing new transportation technologies (such as ITS)
- Ensuring regional coordination of service board programs
- Developing regional standards and requirements to support design of a integrated, seamless, regional public transportation system

With the RTIP in place, the RTA service boards (CTA, Metra and Pace), will be able to design, develop, and test promising ITS technologies in order to determine their applicability for full implementation.

The ITS projects and installations encompassed by the RTIP are part of the regional Gary-Chicago-Milwaukee (GCM) ITS Priority Corridor Architecture. The GCM Corridor is a 16 county corridor from Gary, Indiana, through Chicago, Illinois, to Milwaukee, Wisconsin. The GCM Corridor Program was formed in 1993 by the state departments of transportation of Illinois, Indiana and Wisconsin along with the Federal Highway Administration. Its objective is to improve the efficiency and effectiveness of the Corridor’s transportation infrastructure through the planning, design, deployment and evaluation of new ITS applications.

The Multimodal Traveler Information System (MMTIS) is an essential element of the GCM Architecture. The MMTIS has at its core the Gateway Traveler
Information System (Gateway TIS or Gateway), which collects information from the entire corridor and makes it available to participating agencies and the public. Four hubs are identified to facilitate this process: Indiana, Illinois and Wisconsin regional hubs, and the Illinois Transit Hub. These hubs, in turn, will be connected to all ITS installations in the region for purposes of data collection, fusion, storage and dissemination.

Additional discussion of the GCM Corridor Architecture and the Gateway TIS, including graphical representations, can be found in Section 3.5.

1.2 Purpose of this document

The purpose of this document is to identify and detail the functional requirements for the Illinois Transit Hub (ITH). The ITH is part of Gateway Traveler Information System (TIS), a core component of the GCM Corridor Architecture. The ITH will support not only the business goals of the RTIP, but also the requirements of the Gateway TIS and the ITS design and deployment efforts of the RTA service boards: CTA, Metra and Pace.

The functional requirements provided in this document are intended as testable statements of ITH design and operation. They will serve as a baseline for future detailed design efforts for the ITH.

As the ITH is part of the Gateway TIS and the overall GCM Corridor Architecture, this system will also conform to the guidelines presented in various GCM Corridor Architecture documents, including GCM Documents #2-8140.02, Gateway Functional Requirements, #17200, Corridor Architecture Functional Requirements, and #17300, Corridor Architecture Interface Control Requirements.

1.3 Document Organization

Section 2 of this document presents a vision for regional transit ITS and traveler information. This vision also will serve as the guiding principal for the RTIP. Section 3 is an overview of the ITH objectives and concept. Section 4 of this document presents system requirements for the ITH, including all requirements concerning functional operation of the system. Section 5 discusses general requirements for design of the ITH. Section 6 discusses the hardware requirements for the ITH. Section 7 identifies requirements for commercial software for the ITH. Section 8 lays out requirements for ITH custom software. Section 9 identifies requirements for the ITH World Wide Web interface. Finally, Section 10 identifies impediments to the implementation of seamless regional ITS.
All specific requirements in this document will be identifiable as fifth or sixth level document sections – e.g. 1.2.3.4.5 or 1.2.3.4.5.6.

1.4 Glossary of Terms

This section defines the acronyms used in this document, as well as selected other terms or organizations.

**ADA**
Americans with Disabilities Act

**AIX**
Advanced Interactive eXecutive. An IBM implementation of UNIX.

**Amtrak**
Amtrak is a Federally chartered for profit corporation charged with providing intercity passenger rail service. Generally, Amtrak operates its trains over trackage owned and managed by private railroad companies. Amtrak also owns and operates Chicago Union Station.

**APC**
Automatic Passenger Counting system (or Automatic Passenger Counters). These devices use a variety of technologies to sense and record passenger boardings and alightings. If networked with an on-board processor, they can also provide real time information.

**ATM**
Asynchronous Transfer Mode

**ATMS**
Advanced Transportation Management Systems

**ATSS**
Active Transit Station Signs. This identifies both an RTA project for uniform multi-carrier transit audio/visual signing throughout the region, and the signs themselves. ATSS will display expected arrival times for each route served by the stop, regardless of which service board is involved. It will also display advisory and emergency messages.

**AVL**
Automatic Vehicle Location. A system, usually using satellite based sensing such as Global Positioning Satellite (GPS), that allows a vehicle with the proper equipment to locate itself either in absolute latitude and longitude, or relative to known spatial objects such as a building or a road.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B2B</td>
<td>Business to business</td>
</tr>
<tr>
<td>BECS</td>
<td>CTA’s Bus Emergency Communications System. Part of the BusWatch program. This system provides fundamental ITS infrastructure for CTA buses, including a silent alarm, an on-board processor with AVL, and wide area wireless communications.</td>
</tr>
<tr>
<td>Borman</td>
<td>The central element of the Indiana effort to interconnect and support ITS installations in Indiana.</td>
</tr>
<tr>
<td>BSMS</td>
<td>CTA’s Bus Service Management System. Part of CTA’s BusWatch program. An advanced set of “smart bus” capabilities that build upon basic on-board processors by adding signal priority capabilities, advanced on-board location tracking and schedule adherence calculation, and exception based schedule adherence reporting. All on-board ITS functions are connected by a “vehicle area network” – a vehicle based local area network.</td>
</tr>
<tr>
<td>BusWatch</td>
<td>CTA’s comprehensive program for advanced management of bus operations and service through application of a variety of ITS technologies. It includes the BSMS and BECS projects.</td>
</tr>
<tr>
<td>C2C</td>
<td>Center to Center</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer-Aided Dispatching. An ITS technology that receives reports on vehicle location and schedule adherence, then presents them to the assigned dispatcher along with a variety of decisionmaking tools. It also allows dispatchers to manage communications (voice and data) between with vehicles.</td>
</tr>
<tr>
<td>CDOT</td>
<td>Chicago Department of Transportation.</td>
</tr>
<tr>
<td>CDSI</td>
<td>Communication &amp; Data Systems Infrastructure. CDSI is the Wisconsin system for providing an infrastructure to interconnect and support various Wisconsin ITS installations.</td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>CGI</td>
<td>Common Gateway Interface. Programs on the Web server that perform actions when, for example, a button on the screen is clicked.</td>
</tr>
<tr>
<td>COM</td>
<td>See IDOT COM Center</td>
</tr>
<tr>
<td>CORBA</td>
<td>Common Object Request Broker Architecture. A means for managing communications and interoperability between disparate applications systems within or between organizations.</td>
</tr>
<tr>
<td>COSE</td>
<td>Common Open Software Environment</td>
</tr>
<tr>
<td>COTS</td>
<td>Commercial Off The Shelf. This term usually refers to hardware, software and systems that can be readily purchased and used for the problem at hand with little or no modification.</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit. The brains of a computer.</td>
</tr>
<tr>
<td>CTA</td>
<td>Chicago Transit Authority. The CTA operates or contracts for fixed route bus, rapid rail and ADA paratransit services in the City of Chicago and ring suburbs.</td>
</tr>
<tr>
<td>DATEX-ASN</td>
<td>A network protocol for exchanging encoded ASN.1 data. Developed by the NTCIP Center-to-Center working group, and used in the current generation of TCIP Business Area Objects.</td>
</tr>
<tr>
<td>DCOM</td>
<td>Distributed Component Object Model. Microsoft’s distributed version of its general purpose feature for encapsulating functions and services. It supersedes OLE (Object Linking and Embedding).</td>
</tr>
<tr>
<td>DDL</td>
<td>Data Definition Language</td>
</tr>
<tr>
<td>DML</td>
<td>Data Manipulation Language</td>
</tr>
<tr>
<td>DNS</td>
<td>Domain Name Services</td>
</tr>
<tr>
<td>DS-1</td>
<td>Digital Service, Level 1. Represents 1.544 Mbps digital trunk service over a T-1 line.</td>
</tr>
<tr>
<td>DSI</td>
<td>Data Source Interface</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td>DTD</td>
<td>Data Type Document. The DTD is used to define the data elements appearing in an XML message.</td>
</tr>
<tr>
<td>EJB</td>
<td>Enterprise Java Bean</td>
</tr>
<tr>
<td>ETA</td>
<td>Estimated Time of Arrival</td>
</tr>
<tr>
<td>Exception reporting</td>
<td>A scheme by which a mobile vehicle does not report its schedule adherence unless it is early or late by more than the respective exception reporting threshold. This is done to conserve bandwidth.</td>
</tr>
<tr>
<td>“From” vehicle</td>
<td>In a transfer connection, the vehicle bringing a passenger to the connection. If both vehicles come to the connection with passengers for the other, then both vehicles are both “from” vehicles and “to” vehicles.</td>
</tr>
<tr>
<td>GCM</td>
<td>Gary-Chicago-Milwaukee</td>
</tr>
<tr>
<td>GCOM</td>
<td>Gateway Corridor Object Model. The GCOM is being developed as part of the Gateway ITS design. It will encompass all information elements handled by the Gateway. It is expected that the transit elements of GCOM will correspond to the TCIP Business Area Objects, which are part of the NTCIP standards.</td>
</tr>
<tr>
<td>Greyhound</td>
<td>Greyhound Lines, Inc. Initial contact has been made with Greyhound about participating in the ITH.</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface. For example, the standard Windows 98 desktop.</td>
</tr>
<tr>
<td>HRI</td>
<td>Highway-Rail Interface. Also known as a railroad grade crossing.</td>
</tr>
<tr>
<td>HTML</td>
<td>HyperText Markup Language. The language used to author Web pages.</td>
</tr>
<tr>
<td>HTTP</td>
<td>HyperText Transfer Protocol. The protocol used for moving Web pages from web servers to browsers on user computers.</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output. The machine process of reading data into, and writing it from, a program</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>IBS</td>
<td>Pace’s Intelligent Bus System. A comprehensive ITS system for managing Pace bus service, including on-board processors, vehicle area network, computer-aided dispatching, automatic vehicle location, wide area wireless communications, and management information functions.</td>
</tr>
<tr>
<td>ICD</td>
<td>Interface Control Document</td>
</tr>
<tr>
<td>IDL</td>
<td>Interface Definition Language</td>
</tr>
<tr>
<td>IDOT</td>
<td>Illinois Department of Transportation</td>
</tr>
<tr>
<td>IDOT COM Center</td>
<td>IDOT Communications Center. The COM Center is IDOT’s consolidated incident management center. It also controls the Kennedy Expressway reversible lanes and the highway advisory radio around the region.</td>
</tr>
<tr>
<td>IDOT TSC</td>
<td>IDOT Traffic Systems Center. The IDOT TSC is responsible for monitoring traffic flow and responding to them with the tools available to them. It also operates a number of variable message signs (VMS) used to provide advisory messages to motorists.</td>
</tr>
<tr>
<td>IH</td>
<td>Illinois Hub</td>
</tr>
<tr>
<td>I-Pass</td>
<td>The electronic toll collection system of the Illinois State Toll Highway Authority (ISTHA)</td>
</tr>
<tr>
<td>IPC</td>
<td>Inter-Process Communications</td>
</tr>
<tr>
<td>IPS</td>
<td>Itinerary Planning System. The software package installed by the Regional Transportation Authority’s Travel Information Center (TIC) to generate trip itineraries for callers inquiring about transit service.</td>
</tr>
<tr>
<td>IPX/SPX</td>
<td>Internetwork Packet eXchange/Sequenced Packet eXchange. A pair of network protocols associated with Novell NetWare.</td>
</tr>
</tbody>
</table>
ISP  Information Service Provider


ITH  Illinois Transit Hub

ITS  Intelligent Transportation Systems. Transportation technology systems enabled by computer processors and/or communications.

Java  A programming language designed for programs to be installed at Web sites and downloadable over the Internet to client PC’s.

LAN  Local Area Network

Linux  A robust, historically shareware version of UNIX which is becoming popular as an operating system for enterprise servers.


Mbps  Megabits (million bits) per second

Metra  The RTA Service Board charged with providing commuter rail services in northeastern Illinois.

MLN  Monitoring/Logging/Notification subsystem

Mobil Speedpass  A small cylindrical passive transponder typically mounted on a key chain that returns its ID number when activated by a reader. Used by Mobil customers to activate Mobil pumps simply by waving the Speedpass in front of a reader in the pump.

MTBF  Mean time between failures

NITSA  National ITS Architecture
NPRM  Notice of Proposed Rulemaking
NTCIP'  National Transportation Communications for ITS Protocol
OEC  City of Chicago Office of Emergency Communication
ORB  Object Request Broker
Pace  Pace Suburban Bus Service. Pace provides fixed route bus services, along with contracted community dial-a-ride, ADA paratransit services, and sponsored vanpool services.
PDA  Personal Digital Assistant
PMS  Parking Management System
Positive Reporting  A system for reporting location and schedule adherence from vehicles to a CAD system. Under positive reporting, vehicles regularly report their location and schedule adherence regardless of whether they are on time or not, or whether they are on route or not. This method uses more bandwidth than exception reporting.
POSIX  Portable Operating System Interface uniX. A universal interface from UNIX to applications programs that would improve interoperability because it would run on most hardware.
PPP  Point to Point Protocol
PT  Paratransit
QAP  Quality Assurance Procedure
RAID  Redundant Array of Inexpensive Disks
RMI  Remote Method Invocation
RSMS  Rail Service Management System. CTA’s control system for rapid transit trains.
RTA  Regional Transportation Authority
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTIP</td>
<td>Regional Transit ITS Plan</td>
</tr>
<tr>
<td>SCSI</td>
<td>Small Computer System Interface. A standard and a bus for communications</td>
</tr>
<tr>
<td></td>
<td>between a PC CPU and peripheral devices such as disk drives and scanners.</td>
</tr>
<tr>
<td>SMP</td>
<td>Symmetric Multiprocessor</td>
</tr>
<tr>
<td>SNMP</td>
<td>Simple Network Management Protocol</td>
</tr>
<tr>
<td>SQL</td>
<td>Structured Query Language</td>
</tr>
<tr>
<td>SQL2</td>
<td>An extended version of the SQL standard</td>
</tr>
<tr>
<td>SSL</td>
<td>Secure Socket Layer</td>
</tr>
<tr>
<td>TCIP</td>
<td>Transit Communications Interface Profiles</td>
</tr>
<tr>
<td>TCP</td>
<td>Transfer Connection Protection</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>Transmission Control Protocol/Internet Protocol. A networking protocol that</td>
</tr>
<tr>
<td></td>
<td>supports communications across networks between diverse computers and</td>
</tr>
<tr>
<td></td>
<td>operating systems.</td>
</tr>
<tr>
<td>TDD</td>
<td>Telephone Device for the Deaf. See TTY/TDD.</td>
</tr>
<tr>
<td>TIC</td>
<td>RTA Travel Information Center</td>
</tr>
<tr>
<td>TIMS</td>
<td>Metra’s Train Information Management System. A system employing GPS AVL</td>
</tr>
<tr>
<td></td>
<td>receivers on trains to provide frequent updates on location. This system</td>
</tr>
<tr>
<td></td>
<td>will support better passenger information. It could also serve as Metra’s</td>
</tr>
<tr>
<td></td>
<td>point of interface with the ITH.</td>
</tr>
<tr>
<td>TIS</td>
<td>Traveler Information System</td>
</tr>
<tr>
<td>“To”</td>
<td>In a connection between vehicles, the vehicle that takes passengers</td>
</tr>
<tr>
<td>vehicle</td>
<td>away from the connection point. See “from” vehicle.</td>
</tr>
<tr>
<td>TRMS</td>
<td>Transit Management System</td>
</tr>
<tr>
<td>TSS</td>
<td>Traffic Signal Systems. See IDOT TSS.</td>
</tr>
</tbody>
</table>
TTY/TDD  A technology allowing the hearing impaired to converse over standard telephone lines.

Turbo Architecture  A new (2000) software package distributed by USDOT to facilitate the development of regional and project ITS architectures in conformance with the National ITS Architecture (NITSA).

UNIX  A computer operating system

UPS  Uninterruptable power supply

USDOT  United States Department of Transportation

VAN  Vehicle Area Network. A network connecting ITS and other devices on a vehicle.

VMS  Variable Message Sign

VPS  Visual Paging System. Metra’s system for displaying information at outlying train stations.

WAN  Wide Area Network

WWW  World Wide Web

XML  eXtensible Markup Language. A language for encoding information in documents for transmission across the web.

XSL  eXtensible Style Language. A language used in XML style sheets to control how the data in the XML document will be presented.

1.5 Related Reports

This document is the second of a series of documents being produced as part of the RTIP. The first report is the Tasks 1-2 Final Report. This report identifies RTIP stakeholders, transit information needs of travelers, service providers and information service providers, and existing and planned Transit ITS projects. Future task reports will identify a conceptual communications network, public private partnership opportunities, costs and benefits of existing and planned transit ITS projects, and a deployment plan.
2 A VISION FOR REGIONAL TRANSIT ITS INTEGRATION

This section describes a vision for the deployment of transit ITS projects throughout the region, and for integration of these projects with others in the regional GCM Priority Corridor Architecture. This vision builds upon the project base described in the Tasks 1-2 report by adding visionary elements envisioned by the RTA, regional agency staff, the National ITS Architecture, and the Wilson Consulting Team.

The components of the vision described here require not only continuing technological advances and new system deployment, but also – perhaps more importantly – the development of interagency agreements and ongoing cooperation. It is not enough for agencies to be networked together. Nor is it sufficient to have data exchange agreements, common formats, and automated information flow. The critical elements are 1) interagency agreement on all parameters of information exchange and cooperation, and 2) full commitment on both sides to make the coordination work. This latter requirement means that if something doesn’t seem right (e.g. there have been no reports received for 12 hours), a cooperating agency must move proactively to contact the partner agency, notify them of the situation, and follow it through to resolution.

The cooperation noted above cannot take place without the involvement, understanding, and full support of agency senior management. Thus, the vision will also require an ongoing effort to engage and inform senior managers about the vision, its benefits, and what will be required of their agencies. These managers will also have valuable input into the vision and its components as they evolve.

The remaining sections present the vision in five parts:

- How will transit ITS deployment and integration affect the traveler (current or potential)?
- How will transit ITS deployment and integration affect Service Boards and the operational, management and policy levels?
- How will traffic and incident managers benefit from integration of highway and transit ITS?
- What will the infrastructure look like?
- What will be the public policy outcomes?

2.1 Traveler impacts of Transit ITS Deployment

In the vision for regional Transit ITS deployment, transit travelers will enjoy fully seamless travel, payment and information across all transit facilities in the region. The transit system will appear to function as a unified entity, with consistent
information presentation and a single shared payment medium that may also be usable for other purchases – transportation and otherwise. Travelers will also be provided with information and decision support before, during and at the end of their journeys, allowing them to check the status of their current, planned or alternate services. All information will be fully accessible to all individuals, including those with disabilities.

Here are some more specifics about this vision:

- All transit display signage will have consistent colors, graphics, audio and information formats across the entire region.
- Before their trips, travelers will be able to access static route and schedule information, and real time schedule adherence and delay information, along with planning and decision support tools such as itinerary planning. All this information may be requested from the RTA Travel Information Center (TIC) via telephone or TDD, from the ITH web site, touch tone telephone or interactive cable TV, in addition to existing media outlets.
- Travelers at stops or stations will be provided with routes and times to next arrival, along with advisory and general information messages. These will be delivered via audio and visual Active Transit Station Signs (ATSS) and/or interactive terminals. They will display information about all modes and routes serving that station.
- Information available on-board will include audio and visual displays providing next stop, estimated time of arrival (ETA), connecting service information, and advisory messages. If safety information about the surrounding network is available, it can be included also. In addition, on-board terminals will allow travelers to access specific information and decision support tools.
- End trip information will include integrated transit and stop/station-area maps to assist in navigation to final destination. (Transit travelers continuing their trip by auto will be served by in-vehicle highway navigation tools.)
- Travelers with personal wireless devices will be able to use them to access most, if not all of the above information. In addition, these travelers will be able to receive proactive alerts of service delays or disruptions that may impact upcoming trips.
- Information kiosks at strategic activity locations will also provide access to the above information by accessing or providing links to the ITH web site and/or the RTA TIC Itinerary Planning System (IPS).
- Full accessibility to information by the disabled will be accomplished through 1) Telephone and TTY/TDD access to all information through the RTA TIC; 2) full ADA compliance in all Web sites; and 3) full ADA compliance in all stop/station and on-board displays and interactive devices.
- The Gateway web site will provide travelers with a graphical interface for determining travel times between any two locations. Both highway and transit times will be provided, based on real-time information.
- Travelers will have an array of choices for cashless payment of transit fares for all service boards, as well potentially other transportation providers or
facilities, and non-transportation purposes. At minimum, travelers will enjoy a single fare medium good on all RTA services, with transfers and zone fares handled automatically. In addition, regional transportation electronic payment solutions such as I-Pass may evolve to include hand-held versions that could be read on transit vehicles. Also, commercial smart cards with embedded chips (e.g. American Express Blue or similar offerings from Master Card and Visa) may come into widespread use and become a transit fare payment alternative. Finally, cell phone or PDA payment with real time activation of the turnstile, farebox or other device could be possible as well. All of these potential solutions would require the establishment of neutral coordinators or clearinghouses that would settle funds between agencies and fare instrument issuers.

- Variable message signs (VMS) on tollways, highways and arterials will display parking availability and transit travel times information for nearby transit park and ride lots. This information will be provided by Parking Management Systems (PMS) installed at the parking facilities. It will allow automobile travelers whose destinations are served by transit to make an intelligent choice on whether to continue driving or divert to transit.

2.2 Service Board Impacts of Transit ITS Deployment

Service board implementation of ITS technologies will drive regional traveler information applications. The core applications are the automatic vehicle location (AVL), mobile voice and data communications, and computer-aided dispatch (CAD) systems. These applications generate the real time location and schedule adherence data that are essential to provide a seamless regional transportation system and give travelers enough information to enhance their sense of having options and being in control.

The motivation of service boards for pursuing ITS technology includes not only the provision of traveler information, but also the anticipated operational benefits. The benefits to service boards from base CAD/AVL systems include the following:

- Improved information for dispatcher decision making and service restoration
- Improved dispatcher – driver communications
- Better information for customer service agents
- A wealth of data useful for analysis of trends and identification of potential operational improvements

Moving beyond core systems, service boards can expect additional benefits from regional integration of ITS projects as described in the RTIP. Some of these are described below:

- Highway-related information from the Gateway will be useful in improving operations. This includes:
  - Current roadway link travel times
- Road closures and lane reductions due to construction and maintenance
- Incident information
- An integrated flat panel display, the GCM Warmap, that integrates the above information
- Video feeds from key traffic surveillance locations

- Detailed weather information and forecasts will be available to aid dispatchers and terminal managers in planning for inclement weather.
- The Transfer Connection Protection (TCP) system will alert each service board when one of its scheduled connections with another service board is in danger of being missed. This will give the service board an opportunity to take corrective action.
- Region-wide signal priority request capabilities will assist transit buses in maintaining or restoring on-time operation. This will be accomplished using both vehicle-to-wayside and center-to-center priority requests.
- Since all the information will be received from other systems electronically, service board dispatchers and analysts will no longer have to rekey that information into their own applications.
- Increased coordination among service boards for service planning

Interconnection of on-board vehicle systems and ITS components via a vehicle area network (VAN) will create new opportunities for information integration and real-time notification. These are described below:

- Future improvements in communications capacity will allow enhancements in transit vehicle security. On-board cameras will provide still frame or full motion video feeds from on-board cameras to dispatchers. Silent emergency alarms allow the driver to signal for help undetected, and activate a microphone to allow dispatchers to hear what is going on in the vehicle. Through the dispatch center, precise location information is forwarded to emergency response agencies to facilitate a prompt response.
- On-board passenger counting or load measurement systems will be interconnected with the on-board processor. They will continuously calculate current loading and make it available on request to the on-board processor, so that it can be passed with location and schedule adherence reports to the control center. This will allow dispatch systems and the TCP system to consider this information when planning service restoration actions.
- Interconnection of on-board vehicle systems and ITS components via a vehicle area network (VAN) will enable real time transmission of vehicle system readings that may indicate upcoming or imminent mechanical problems. This will allow maintenance staff to evaluate and respond appropriately.
- An integrated data feed with all information collected on board will be collected and downloaded daily for analysis. This integrated data feed will combine complete information on passenger boardings and alightings, operation of ADA boarding features, farebox events, and door openings and closings. All will be time and location stamped to show the true sequence of events.
Advanced instrumentation of highway and rail transit vehicles (and rail rights of way) with collision avoidance technology will help insure safer operations, reducing accidents and claims exposure.

Finally, the development and deployment of automated highway technology may provide a vehicle for advancing concepts such as Bus Rapid Transit, with buses moving at high speed and close headways on dedicated guideways able to move more people faster and more safely.

### 2.3 Integration of Highway and Transit ITS

Municipalities and agencies with traffic management responsibilities will also gain from the integration of transit ITS with highway/traffic ITS:

- Reports by bus transit operators of transportation-impacting incidents will be forwarded electronically by CAD systems to the Gateway TIS, where they will be available in data feeds to the impacted agencies/municipalities and the public.
- Passenger railroads and traffic management agencies/municipalities will have full electronic information exchange concerning planned and unplanned blockage of HRIs, whether caused by the railroad or by a highway incident.
- Bus transit vehicles will serve as “probe” vehicles, calculating their running time over predefined segments and forwarding this information to traffic management agencies/municipalities. This feature is especially useful for developing travel time estimates for key arterials served by bus transit. Such estimates will provide important support for dynamic route guidance for highway vehicles.
- Emergency and medical dispatching access to traffic monitoring for real-time arterial management

### 2.4 Infrastructure Needs

As noted earlier, the key enabling technologies for service board ITS are AVL, mobile voice and data communications, and CAD systems. The key infrastructure required for regional integration includes the following:

- An Illinois Transit Hub (ITH) that would serve as:
  - Collection and distribution point for information being generated by or provided to transit agencies
  - A current reference database for transit operations status (including on-time performance status)
- Host for the Transfer Connection Protection (TCP) system, that would examine transit operations status, then identify any endangered connections and inform the involved service boards
- Host for the Active Transit Station Signs (ATSS) subsystem, which will drive updated information to active signs hosted by a single service board but requiring information from additional transit operators serving that stop or station.
- A provider of information to the public, as well as agencies, via an Internet web site providing static and real time information
  - A regional “wireline” communications network linking the ITH with service boards, other core transportation providers such as Amtrak and Greyhound, and the Gateway.
  - A regional wireless communications solution with adequate bandwidth to eliminate present restrictions on location and schedule adherence data collection from transit vehicles, as well as to handle future voice, data and video transmission requirements of fully realized integrated ITS.
  - Coordinated policies and standards for collection of information from service boards and other core providers, to assure consistent, accurate and complete data is provided to users via the ITH and various delivery mechanisms. These policies and standards must assure that the traveler information system continues to function on a core set of routes even if adverse weather conditions or extreme traffic conditions cause widespread delays in transit service.

2.5 Public Policy Outcomes

The realization of the vision for integrated transit ITS in the RTA service area should significantly advance a number of public policy goals. Many of these coincide with formal RTIP objectives. Here are some of the expected outcomes:

- More travelers will try transit. This will occur for several reasons:
  - More of these people will become regular riders, because ubiquitous information availability will provide them with a greater measure of control. In addition, more travelers will be retained by transit.
  - Improved security and information about the safety of surrounding areas will make travelers more comfortable with transit.
  - Improved transit times, wait times and reliability, enabled by better information and the use of traffic signal priority requests, will help transit attract and retain more riders.
- Transit agencies will be able to collect and utilize a great deal of information about their operations, as well as ridership statistics. Location and time stamped fare and boarding/alighting statistics will be especially useful in optimizing schedules and driver/crew utilization.
- Transit will be operationally safer, with vehicles instrumented for collision avoidance/positive separation and HRI safety.
• All means of delivering transportation information to the public will include transit information as an integral component. In fact, when transit ITS installations are mature, on-time information may be supplemented by transit travel times in the same format as highway (e.g. “CTA Purple Line – Linden to the Mart, currently 38 minutes).

• Accurate transit information will be available even during weather emergencies or other severe service disruptions, when travelers need it most.

• Transit operations will be more efficient and cost effective

• It will be possible to develop more efficient emergency response plans for re-routes and service interruptions
3 ILLINOIS TRANSIT HUB OVERVIEW

3.1 Introduction

This section provides a high level overview of the Illinois Transit Hub (ITH) functional requirements as a framework for the discussion of detailed functional requirements in Section 4.0 below.

3.1.1 National ITS Architecture

The National ITS Architecture (NITSA) is a common template for the design and development of individual ITS projects. It helps assure that functionality and integration options are taken into account by ITS planners and designers. It was developed over a five-year period on the basis of contributions from a wide range of participants encompassing a wide variety of relevant disciplines.

The NITSA provides a framework for various physical entities or subsystems, and defines the information flows that occur in an integrated system. Use of the NITSA on all the ITS projects in a region further facilitates integration, as the project architectures built using the NITSA can be consolidated into a regional ITS architecture.

The FTA’s National ITS Architecture Policy on Transit Projects, which became effective April 9, 2001, details specific requirements for ITS projects and their consistency with the National ITS Architecture. For the ITH/RTIP project, the requirements are as follows:

- The project must employ systems engineering analysis – this is a structured multi-step project including identification of stakeholder roles and responsibilities, formal requirements definition, alternatives analysis, conceptual design and analysis of financing and procurement options.
- Since there is no approved regional architecture for this region, a project architecture must be developed in accordance with the National ITS Architecture.

The RTIP project has fulfilled both of these requirements. The RFP scope of work was structured so as to meet the requirements of a system engineering approach. Also, an RTIP/ITH project architecture has been developed using Turbo Architecture, Version 1.0. The project architecture is in full accord with the National ITS Architecture.

3.1.2 GCM Corridor Architecture
The Gary-Chicago-Milwaukee (GCM) Corridor links the transportation infrastructures of sixteen urbanized counties in the states of Illinois, Indiana, and Wisconsin including all major freeways, airports, transit, commuter and freight rail systems. This corridor was selected by the U.S. Department of Transportation (USDOT) to receive priority funding under the ISTEA legislation for the deployment of ITS initiatives. A twenty-year Corridor Plan has been developed which outlines the creation of a state-of-the-art, integrated corridor with a transportation information system (TIS) known as the Gateway as its core.

The Gateway TIS is an integrated information system designed to gather, compile and coordinate static and dynamic traffic data from transportation management systems within the GCM corridor through regional hubs in each of the three participating states. This information is then distributed to operating agencies through their respective regional hubs and to travelers through Internet Service Providers and the Internet. The organization of the Gateway as it is envisioned in the Ultimate Phase of development is shown in Figure 3-1.

The GCM Corridor architecture is made up of the Illinois Hub (IH) and the Illinois Transit Hub, Borman ATMS in Indiana, and CDSI in Wisconsin. The regional hubs are responsible for processing any data that is received from their sources and passing this information to Gateway. The Gateway would then complete any processing necessary and redistribute the information back to the regional hubs. Figure 3-2 shows the hierarchy of systems within the GCM corridor. It can be viewed as a local hub that shares many of the characteristics of the larger state hubs.

The Illinois Transit Hub's intended function is to coordinate and process data from Northeast Illinois based transit providers. Unlike the other regional hubs however, in the Corridor design the ITH does not interface directly with the Gateway but instead uses the Illinois Hub (IH) as an intermediary.

As the facilitating system for integration of transit information, the ITH will be a critical component of the multimodal Gateway TIS concept. Preliminary information about the ITH concept has been presented in at least two GCM ITS Priority Corridor architecture documents:

- Gateway Corridor Architecture Functional Requirements (section 2.2.6)
- Gateway Interface Control Requirements (section 6.16)

The purpose of this document is not to provide design specifications for the ITH. Rather, the functional requirements presented here are meant to guide future designers. However, there are some design statements made in this document which are important to the understanding of the ITH’s functionality.
FIGURE 3-1: GATEWAY ULTIMATE PHASE CONTEXT DIAGRAM
In addition, as with the requirements for other components of the GCM Architecture, the requirements in this document can be expected to change and evolve as the RTA service boards and other operators deploy and fine tune their ITS systems. For example, if additional bandwidth is made available to the service boards, they might choose to begin transmitting additional information from the vehicle in real time. If this information was of wider interest, it might need to be incorporated in these functional requirements. As a result, it is recommended that this document be periodically validated and updated until the ITH detailed design efforts begin.

### 3.2 System Objectives

The Illinois Transit Hub is primarily intended to be the centralized information source for transit information in northeastern Illinois – specifically the RTA service area. It will collect information from – and provide it to – travelers, transit operators and traffic managers. Here are specific objectives for the ITH:
1) The Illinois Transit Hub (ITH) will collect transit schedules, schedule adherence, fares, incidents and other information from regional transit operators.
2) The ITH will make this information available to the Illinois Hub and to other transit operators and highway entities according to their requests.
3) The ITH will incorporate a database for tracking of current or final on-time status for all buses and trains during the last 24 hours.
4) The ITH will provide a Web site for access to transit information by the public and by regional information service providers.
5) As needed, the ITH will facilitate transit operator access to highway and weather-related information from the Gateway TIS on a subscription basis. This will be in addition to the transit operator’s option to access this information from a Gateway TIS Web page.
6) The ITH will host selected regional applications involving information from multiple transit operators, creating value added information for transit operator, traveler and traffic manager use.
7) The ITH will support interagency coordination and service maintenance functions during weather related disasters and emergencies, toward the end of maintaining minimum service levels.

When the Illinois Transit Hub and transit operator ITS systems are implemented and fully connected, a full range of regional information applications will be available for travelers, system operators, traffic managers, and information service providers. The vision for this regionally integrated system was presented in the previous section.

3.3 System Description

3.3.1 General

As the centralized information source and repository for transit operations data, the ITH will comprise a hub complex which will include a main server, operator and administrative workstations, an I/O server, and a variety of internetworking equipment. It will be connected to the GCM Corridor Wide Area Network (WAN) for communication with the Illinois Hub.

3.3.2 Functionality

Functionality of the ITH can be separated into classes corresponding to each of the ITH objectives identified in the last section. These classes are discussed below.
3.3.2.1 Data provided to the ITH

The RTA service boards and other transit operators will provide a variety of information to the ITH. This will include:

- Route and schedule information
- Fare information
- Current schedule adherence (on-time status)
- Delay and disruption information, including cancellations/missed pullouts/annulments, late pullouts/train starts, and routes/lines out of service
- Parking inventory updates from stops or stations equipped with Parking Management Systems (PMS)
- Emergency assistance requests/incidents

In addition, transit operators will switch certain requests and advisories through the ITH to traffic management centers unless there is direct center to center communications:

- Center-to-center traffic signal priority requests (not vehicle to roadway)
- Advisories of HRI closings by surface rail operators
- Requests for traffic or HRI advisory information from traffic managers
- Highway travel times for comparison in PMS

3.3.2.2 Transit Operations Data forwarded by the ITH

The ITH will process and store the information it receives, then forward selected information to the Illinois Hub. This information will be provided to the Illinois Hub through the subscriber/publisher function. It is expected to be provided through scheduled feeds, currently assumed to be every 1 minute. Primary users of this data will include 1) traffic management agencies (incidents; transit probe travel times); 2) traveler information services provided by the Gateway through its public web site, and 3) private information service providers.

In addition, the ITH will be able to forward transit operations information back to transit operators if they so desire. This could be useful for service boards that wish to monitor the quality of information received by the ITH, that want (via mutual agreement between agencies) to enhance operations coordination with other operators, or who desire to use the TCP system to monitor intra-agency connections.

3.3.2.3 ITH Data Repository

The ITH will maintain a database that will store limited information about scheduled runs/trains. This information will include whether or not the run/train
operated/is operating/will operate, the current schedule adherence status, and any current known disruptions such as reroutes or short turns.

3.3.2.4 ITH Web Site

The ITH will provide an associated web site that will give the public and transit operators access to current information on routes, schedules, fares and current schedule adherence (on-time status). It is possible that this web site will evolve as an enhancement to be managed and provided by the RTA Travel Information Center (TIC), perhaps via public web access to the Itinerary Planning System, with enhancements to incorporate real time data.

3.3.2.5 ITH Provision of Traffic Information to Transit Operators

The ITH will provide transit operators with the opportunity to request subscriptions for electronic traffic-related information, including but not limited to:

- Traffic incidents affecting transit routes
- Link travel times for portions of transit routes
- Highway closures or lane reductions
- HRI closures or blockages

The data will be obtained by the ITH from the Gateway via the Illinois Hub through the subscriber/publisher function, then provided to the requesting transit operator. It is expected that updates would be provided at intervals greater than or equal to one minute.

3.3.2.6 Additional Services Provided by the ITH

The ITH will host several applications that will provide value-added services to transit agencies. They include:

- The Transfer Connection Protection (TCP) System will identify endangered connections pre-defined by transit operators, and alert them so that corrective action may be considered. It will do this by reviewing schedule adherence reports as they are received from transit operators, determining any connections that may be affected, examining the on-time status of those connecting vehicles, and generating an alert message if so warranted. It will also update the alerts as additional reports are received, if desired, until the vehicles have left the connection point.
- The Active Transit Station Signs (ATSS) subsystem will be capable of driving information to display signs at multi-modal transit facilities. In the case where signs are being driven primarily by a service board hub, the subsystem will
work cooperatively with that hub to provide updated information on other transit operators’ routes/lines that may also be served by that sign.

- System administration tasks supported by the system will include the monitoring of subsystem status and message processing status and resolution of problems. Also included will be the requirement to reconcile transit operator reference files such as schedules and route files received from multiple operators, dealing with such issues as inconsistent identification of protected connections.

### 3.3.3 Traveler View of the ITH

Travelers will interact with the ITH directly only through the ITH Web Site. This web site will provide access to static and real-time information about transit operations, including schedules, fares, and current on-time status. It is possible that this web site will be jointly operated with the RTA Travel Information Center (TIC), with much of the functionality provided through a web offering of its Itinerary Planning System (IPS).

Travelers will benefit from information provided by the ITH in a variety of ways. First, ITH information will appear on many Active Transit Station Signs. Second, ITH information will be forwarded to the Gateway TIS, and will be used by information service providers in radio and television traffic reports that include transit status information. Finally, the ITH will provide value-added services to transit operators through the Transfer Connection Protection System (TCP), facilitating better connection management and service.

In short, the region will appear to have a seamless transit system, with transfers easily made.

### 3.3.4 Transit Operator View of the ITH

Transit operators will see the ITH primarily as a centralized information source and information exchange partner. They will provide the ITH with static and real-time information on their operations, including transit schedule adherence and parking lot inventory status. They will also report rail or highway-related incidents that may have an impact on transportation flows, as well as highway-rail intersections (HRI) closures. Finally, they will also provide requests for traffic-related information from the IH.

Transit operators will receive status information from other operators as well as endangered connection alerts and updates from the TCP system. In addition, they will receive traffic-related information that they have requested from the IH, including link travel times, incidents that may affect their operations, highway closures of HRIs, and road closures or lane reductions.
3.4 NTCIP

The National Transportation Communications for ITS Protocol (NTCIP) is a set of communications protocols and data definitions that have been designed to accommodate the needs of the user services and subsystems defined by the National ITS Architecture. The goal of these standards is to allow for full interoperability and interchangeability between ITS devices and systems. The NTCIP standards are designed to deal with the requirements of two different sets of relationships: communications between a management center and field devices, and communications between two or more management centers. The NTCIP Standards Framework as seen in Figure 3-3 describes these types of communications as Center-to-Center and Center-to-Field. The standards framework is used to determine the series of standards, known as a “protocol stack”, that it is possible to use in the transmission of a message. Standards are considered compatible if there is a continuous line from one standard to another.

![NTCIP Standards Framework Diagram]

Figure 3-3: NTCIP Standards Framework
The standards, which apply to the communications between the ITH and IH and between the ITH and the service boards and other transit providers are those for Center-to-Center communications. The GCM corridor will incorporate these standards as they are developed. The ITH will also be designed to be compliant with the NTCIP standards. However, since the NTCIP standards are still in the process of development and acceptance, and since new technologies such as XML can reasonably be expected to be given future consideration for inclusion in NTCIP, the requirements outlined in this document that are based on the current NTCIP standards may be subject to future revision.

3.5 TCIP

The Transit Communications Interface Profiles (TCIP) are a subset of the NTCIP standards. They were developed through thousands of hours of volunteer transit professionals’ time, under the auspices of the Institute for Transportation Engineers (ITE), and in cooperation with the Federal Transit Administration (FTA), the Federal Highway Administration (FHWA), and the American Public Transit Association (APTA). Funding came from the U.S. Department of Transportation’s Joint Program Office for Intelligent Transportation Systems. The standards are designed to provide the interface structures that will allow for the transfer of information between different transit and ITS components such as vehicle, transit management centers, and traffic management centers.

The Transit Communications Interface Profiles currently comprise the following Business Area Objects:

- Fare Collection
- Scheduling/Runcutting
- Passenger Information
- Incident Management
- Vehicle On-board
- Transit Control Center
- Traffic Management
- Spatial Representation
- Common Public Transportation Data

The ITH will be designed to be compliant with the Transit Communications Interface Profiles as they apply to its functions. In particular the ITH will involve functions that are covered as part of the Passenger Information, Incident Management, Transit Control Center and Traffic Management business areas.

In its second phase, currently underway, TCIP developers are building “dialogs” representing typical information exchange sequences between transit functions. It is expected that these dialogs may be applicable to future detailed ITH design.
3.6 LRMS

The GCM architecture has adopted and the ITH will adopt the Location Referencing Message Specification (LRMS) to describe locations. The LRMS is intended to provide a practical approach to standardization where spatial references need to be made between different types of spatial data sets. The standard, as described in the LRMS Information Report (SAE J2374), is made up of seven profiles:

- The Geometry Profile – which provides referencing formats for locations based on fundamental spatial objects, such as points, nodes, links, and polygons;
- The Geographic Coordinate Profile – which contains record formats for the geographic coordinates of latitude, longitude, and altitude expressed with reference to an established geodetic datum;
- The Grid Profile – which is intended for use in bandwidth-limited applications;
- The Linear Referencing Profile – which is intended for linear references that identify a location on a network by an offset along network links from known locations on the network;
- The Cross-Streets Profile – which uses cross street names and coordinates of intersections;
- The Address Profile – which uses an address of known location;
- The MDI Profile – which supports link and offset referencing and coordinate-based referencing using global coordinates.

The Gateway will support only some of these profiles in the Initial Phase but may support most or all as part of the Ultimate design. All traveler information distributed by Gateway, as well as all incoming data from the ITH and other regional hubs, and outgoing data from Gateway is required to be in the GCM LRMS format.

3.7 ITH System Architecture

A high-level architecture diagram for the ITH is shown in Figure 3-4. It reflects flows of data from agency vehicles and subsystems to the systems that will serve as service board/transit operator hubs. From these hubs, static and real time transit information flows to the ITH, where it is acquired, validated and fused. Then, it is further handled in the following ways:
• ITH databases are updated with new information.
• ITH applications such as TCP are initiated depending on the type of data received.
• Data defined as part of the Gateway TIS data feed is forwarded at the next scheduled transmission.

Information returned to the ITH from the Gateway TIS includes traffic, highway and weather information requested by transit operators or presented as part of the ITH Web site. This information is then passed back to service board hubs along with outputs of ITH functions such as endangered connection alerts. This information is then shared by the hubs with various agency systems.

A complete list of NITSA Architecture flows included in the ITH design can be found in Appendix A to this report.

3.8 Data Providers

This section describes data providers to the ITH and the data they will provide. This data is classified as existing, planned or visionary architecture flows. Flow names used are the same names as architecture flows from the NITSA.

3.8.1 Amtrak

As of this writing, the relationship between the ITH and Amtrak is still under discussion. It is anticipated that if Amtrak chooses to participate in the ITH, it will provide transit and fare schedules. This architecture flow includes all transit schedules, including real time schedule updates if produced by the operator's CAD system, such as annulments and cancellations, and short turns. It also includes all fares, including any time-of-day variations. Finally, it includes real time schedule adherence, including late pullouts.

Initially, it is expected that Amtrak will include only static schedule and fare information. In the future, there is the potential for addition of real-time information on on-time status of Amtrak operations in northeastern Illinois.

3.8.2 CTA

CTA will provide the following architecture flows to the ITH:
• Transit and fare schedules – all static and real time aspects, covering both bus and rail services
• Transit incident information – this flow includes reports of bus transit incidents that may impact transportation flows.
• **Transit Management Systems (TRMS) Coordination** – this visionary flow includes customer requests for transfer connection protection for inter-carrier connections.

• **Transit and fare schedules and TRMS coordination** from CTA paratransit contractors, if they need to be switched through the CTA Control Center Hub.

• **Parking Information** – occupancy data from CTA Parking Management Systems (PMS)

*TRMS coordination and transit and fare schedules* for CTA Paratransit Operators may also be reported, and may be switched to the ITH via the CTA Control Center. These messages may include requests for transfer connection protection for trips involving fixed route connections, and ETA updates for such trips, respectively.

3.8.3 DuPage Paratransit Coordinator

DuPage County Human Services is planning to invest in technology to coordinate the deployment of paratransit resources throughout the county. When/if this effort proceeds to full deployment, and the Coordinator chooses to participate in the TCP system, the Coordinator may provide *TRMS coordination and transit and fare schedules* including requests for connection protection and ETA updates for trips involving a fixed-route connection.

3.8.4 Gateway TIS

The Gateway TIS, in addition to receiving selected transit information from the ITH, will provide *traffic information for transit* to the ITH based on pre-subscribed requests from transit operators. The *traffic information for transit* architecture flow may include the following:

- Current link travel speeds
- Current roadway conditions (e.g. rain, snow)
- Current incidents information
- Current link status (e.g. link delays)
- Vision: Predicted link travel times

3.8.5 Greyhound

As of this writing, the project team is still waiting for an initial response from Greyhound concerning their interest in participating in the ITH.

If Greyhound decides to participate, it is expected that they will provide *transit and fare schedules* in a manner similar to Amtrak.
3.8.6 Metra

Metra will provide these architecture flows to the ITH:

- *Transit and fare schedules* – all static and real time aspects, and including annulments and late train starts.
- *Railroad Schedules* – scheduled track occupancy and other information to allow forecasting of HRI closures.
- *Railroad Advisories* – Notification of rail incidents or advisories.
- *Transit Management Systems (TRMS) Coordination* – this visionary flow includes customer requests for transfer connection protection for inter-carrier connections.
- *Parking Information* – occupancy data from Metra Parking Management Systems (PMS). This information may be switched through the TIMS hub.

3.8.7 Pace

Pace will provide information analogous to that provided by CTA:

- *Transit and fare schedules* – all static and real time aspects, covering both bus and rail services.
- *Transit incident information* – this flow includes reports of bus transit incidents that may impact traffic flow.
- *Transit Management Systems (TRMS) Coordination* – this visionary flow includes customer requests for transfer connection protection for inter-carrier connections.
- *Transit and fare schedules and TRMS coordination* from Pace paratransit contractors, if they need to be switched through the Pace IBS Hub.
4 SYSTEM REQUIREMENTS

This section describes the ITH subsystems and their functional requirements. The subsystem diagram is shown in Figure 4-1.

![System Components and Control Flow Diagram]

Figure 4-1: ITH System Components and Control Flow

4.1 Data Acquisition Subsystem

There are several ways data can be acquired from service board hubs and Gateway TIS. Interfaces for serving this purpose are listed and evaluated below. However, the criterion for any one of these methods to succeed is to define a common data format and structure before data sharing.

4.1.1 CORBA (Common Object Request Broker Architecture)

Similar to Java RMI and Microsoft DCOM (Distributed Component Object Model), the CORBA is mainly used among heterogeneous computers and operating systems to facilitate information exchange. For instance, upgrades to existing Traffic Management Centers (TMC) usually use CORBA for two reasons: 1) to
design a standard way for new developed computer programs to talk to legacy TMC programs and hardware using IPC (Inter-Process Communications), and 2) to provide center-to-center communication.

IPC is needed because legacy TMC software has been developed mainly using UNIX. The CORBA is required for new features to be added to existing system. The center-to-center CORBA communication is designed for the TMC to receive data and invoke function calls to other computer systems in various agencies.

For the ITH system, because the computer systems at service boards are heterogeneous, CORBA could play an important role for ITH design depending on what services it will provide.

Advantages to the use of CORBA include:

- Provides more freedom for clients to receive advanced ITH services by using ITH application programs.
- A robust way for data transmission and function invocation across the Internet.
- A secure method.
- Allows communications between ITH servers and the client’s computer no matter what computer hardware/software they are using.

Disadvantages to the use of CORBA include:

- A steep learning curve even for IT professionals, because it involves cooperation among system engineers, software programmers, and security professionals to properly design the interface to optimize the system performance and minimize security risks.
- The client must have the same level of technical expertise to support this mutual-communication. This is necessary to minimize network traffic and avoid unnecessary functional calls to the ITH application server.
- Although CORBA provides more flexible data retrieval capabilities for clients, it may increase the system load to the ITH server due to its execution of remote procedures invoked by client computers.

![Figure 4-2: CORBA Interface between ITH and Service Boards](image-url)
4.1.2 Enterprise Java Bean (EJB) + Extensible Markup Language (XML)

XML + EJB is making rapid strides as a business to business (B2B) tool for data interchange. (EDI (Electronic Data Interchange) is the traditional method of B2B data interchange mechanism among enterprises.) XML evolved from SGML; it is becoming a more popular and efficient tool for large corporations to manage their financial data. The process has begun of XML gradually replacing EDI – a process experts now see as taking about 5 years for most mid size and large organizations. This is happening because of XML’s relative simplicity and flexibility, giving it the ability to serve as a standard way of interpreting data based on the data dictionary defined in XML. With its support of XSL (Extensible Style Language), the XML is able to create a professional layout for any kind of report in a web browser.

However, XML and XSL alone are only useful for data transmission and data presentation. They won’t support any executable operations that may be needed by ITH services. Nonetheless, using Java as the XML parser and doing the necessary execution and computation this way is gathering attention from B2B IT professionals.

It is expected that in the future the Gateway will support XML for some transactions. There are a number of advantages to this approach:
- XML is becoming a widely used standard for data transmission and presentation.
- It supports heterogeneous computing environments (hardware and operating systems) between the ITH server and service board systems if RMI (Remote Method Invocation) is used.
- Compared with CORBA, XML + EJB is much easier to learn and allows a system to be deployed in a shorter time.

There are also some disadvantages to the use of XML:
- XML + EJB supports simple data transmission and local computation only. More complex procedure calls between the ITH application server and client machine, if needed, will rely on Java RMI, which is currently still largely untested.

For compliance with the Gateway TIS Interface Control Requirements, we recommend the use of CORBA for communications between the ITH and the Gateway TIS. For communications between the ITH and the service boards, if at detailed design time XML has been approved as an NTCIP/TCIP protocol for center to center communications, and for Gateway use, XML and EJB shall be used. If not, CORBA shall be used by the ITH as the principal protocol for data sharing.
4.2 Data Validation And Fusion Subsystem

The purpose of data validation is to ensure the data received from service boards, Gateway TIS and other agencies are in correct syntax, contain correct information and are in the format that can be integrated with other information received from other agencies. After filtering out errors, the data fusion subsystem will combine data together before moving to into the database. For example, transit run number and scheduling data have to be fused with transit location obtained from AVL so that schedule adherence can be determined.

The functional requirements for data validation and data fusion are:

4.2.1.1.1 The data validation and fusion subsystem shall perform all data integrity checking.
4.2.1.1.2 It shall receive new data only from the data acquisition subsystem.
4.2.1.1.3 It shall examine individual data values to see if they are the appropriate type and have reasonable values.
4.2.1.1.4 If there is correspondence with existing data, data fusion shall be performed to merge data values and recognize updates, clarifications, duplicate reports, confirming reports, conflicting reports, or data errors.
4.2.1.1.5 When data is validated, it is submitted to the data storage subsystem for storage.
4.2.1.1.6 If data fusion occurred, the updates to existing data shall be communicated to the data storage subsystem.
4.2.1.1.7 If data is invalid or cannot be fused, the details will be reported to the monitoring subsystem for logging and report to the operator.

4.3 Data Storage Subsystem

Data stored in ITH database will be based on the services ITH will provide. The database schema shall be carefully designed to ensure the data integrity, information consistency, and to facilitate the data fusion process. It shall also allow future system expansion for storing more data without influencing existing services.

4.3.1.1.1 The data storage subsystem shall have robust database schema to accommodate different data sources and data types received from agencies in the region.
4.3.1.1.2 It shall interface with the permanent data store (database).
4.3.1.1.3 It shall provide data storage and update services for the ITH, service boards, Gateway TIS and other agencies in the region.
4.3.1.1.4 It shall provide various views of the data in the database and allow easy updates to the database.
4.3.1.1.5 It shall be implemented as a set of standard SQL procedure calls in providing access to the existing data schema and data values within the data store.
4.3.1.1.6 Data stored in the database will not be archived.

4.4 Data Distribution

Potential ITH data users can be categorized into transportation agencies, media, and the general public. The data distribution mechanism is different for each of these because of what they are using the data for and the systems they employ. The choices include XML, HTML and FTP across the Internet, dedicated lines, and CORBA options. For transportation agencies, the methods used in the data acquisition subsystem can also be used for data dissemination. For media and general public access, the web page may be the most efficient way. Advances in wireless communications are extending the capability to distribute information in this way.

4.4.1.1.1 The data distribution subsystem shall publish validated and fused data to the transportation agencies, media, and general public in a timely manner.
4.4.1.1.2 The system shall also provide the current state of non-volatile data types.
4.4.1.1.3 The system shall perform time based data expiration in a timely manner.
4.4.1.1.4 If a data unit is expired, the system shall update the database and publish a data expiration message.
4.5 Monitoring/Logging/Notification (MLN) Subsystem

The Monitoring/Logging/Notification (MLN) subsystem provides constant health checks for the ITH system and the quality of its services. It measures system response time and activity, and records any abnormal system behavior in the log file. Notification will be sent to the system administrator and operators to ask for a system check whenever a problem is discovered. System service level and error logs will be stored in the data storage subsystem.

4.5.1.1.1 The MLN subsystem shall monitor the execution of processes and devices within the ITH and produce logs of its status and error information.
4.5.1.1.2 Any error information shall be provided to the operators as they occur with both an audio and visual alert as appropriate.
4.5.1.1.3 The monitoring subsystem shall monitor and log the actions of ITH.
4.5.1.1.4 It shall monitor the status of incoming and outgoing connections and report problems with both an audio and visual alert.
4.5.1.1.5 It shall monitor the status of system resources and provide indications in the form of audio and visual alerts when resources are becoming scarce.
4.5.1.1.6 The monitoring subsystem shall alert the operator when intervention is necessary.
4.5.1.1.7 The monitoring subsystem will provide the facility to start or stop processes on machines in the ITH.

4.6 Administrative Subsystem

In conjunction with Graphical User Interface subsystem, the administrative subsystem shall serve as the entry point for overall system configuration. It shall allow system configuration change, user logon authentication, log viewing, and event reporting by operators, etc. The administrative subsystem is the central unit in ITH that does housekeeping tasks and performs subsystem coordination.

4.6.1.1.1 The administrative subsystem shall provide user identification and permissions information for the processes in the ITH.
4.6.1.1.2 The administrative subsystem shall compose system usage and error reports.
4.6.1.1.3 It shall provide for system service controls and configuration.
4.6.1.1.4 It shall provide for network administration.
4.6.1.1.5 It shall provide for TCP/IP administration and DNS (Domain Name Service) operation.
4.6.1.1.6 It shall provide e-mail services.
4.6.1.1.7 It shall allow systems to be started, stopped, or paused in operation.
4.6.1.1.8 It shall maintain administrative logs.
4.6.1.1.9 All user access permission functions shall be routed through this subsystem. If CORBA components are used, the CORBA security services in this subsystem shall be used to maintain and serve permissions information between the ITH and Gateway and/or other service board hubs.

4.7 ITH Reference Files

A number of reference files will be required to support ITH data validation and fusion. These files include service board route master files and service board schedule/run/train files.

4.7.1.1.1 The route reference file shall incorporate route definitions from each service board. The file shall include location references for each station, timepoint, terminal or endpoint for which schedule adherence events or other operating events may be reported to the ITH. These references shall conform to Gateway approved LRMS profiles.

4.7.1.1.2 The schedule/run/train reference file shall incorporate schedule, run and train definitions from service boards for scheduled services to be reported to the ITH. These definitions shall refer exclusively to stations, timepoints, terminals and endpoints defined in the route reference file.

4.8 Transfer Connection Protection (TCP) System

The Transfer Connection Protection (TCP) System shall operate as a resident application at the ITH. The TCP System is a decision engine that will be called or triggered upon the receipt of an updated schedule adherence report. It will draw upon the triggering schedule adherence report, current train/run schedules, predefined connection identification, and current schedule adherence for the connecting service. If the TCP system identifies an endangered connection, it will format an Endangered Connection Alert message for the service board operating the “to vehicle” for the connection, and optionally to the other service board involved. This message will indicate the ETA of the “from” vehicle at the connection point, so that the “to vehicle” service board can make a determination of whether or not to hold that vehicle in order to protect the connection. The TCP System will continue to track active connections, issuing Alert Update Reports when schedule adherence updates are received on one of the vehicles involved in the connection.

In the visionary stage, the TCP system may be able to incorporate current link travel times for highway vehicles and smart ETAs from rail carriers in order to produce more accurate ETA’s. Also in the visionary stage, should transit bus operators’ CAD/AVL systems be able to receive and incorporate current highway link travel times, it may be possible to develop transfer connection protection functionality that relies on peer to peer networking between service board hubs, resulting in quicker processes.
Finally in the visionary stage, it may be possible to consider handling customer requests for connection between service boards using the TCP system or comparable peer to peer functionality at the service boards. This would allow a traveler to board a vehicle, request a particular connection, and have the TCP functionality confer with both carriers’ dispatch systems in order to determine if the connection could be guaranteed. If it could, then the traveler would be given an affirmative response, and the dispatch systems would work to assure the connection was made.

4.8.1.1.1 The TCP system shall be called or triggered when a schedule adherence report is received from a transit operator.
4.8.1.1.2 The TCP system shall first determine whether the run/train represented by the schedule adherence reports is already included in an active endangered connection. If it is, the system will determine if the involved vehicles are still approaching the connection point, and if so make appropriate ETA calculations, create an Alert Update Report, and forward it to the data distribution system.
4.8.1.1.3 The TCP system shall next determine whether or not the run/train is included in any predefined connections not currently being monitored. If it is not, no further action is taken. If it is, the system then examines the current schedule adherence of the connecting vehicle, calculates ETAs at the connection point, and determines if the connection is newly endangered. If not, no further action is taken. If it is, then the system creates an Endangered Connection Alert for the involved carriers, and forwards it to the data distribution system.
4.8.1.1.4 In a visionary stage, the TCP will accept user requests for connections through the data acquisition subsystem and data validation/fusion subsystem. The system will log the user's request, then pass it to the connecting service board through the Cooperative Control Pass Through subsystem for final determination. It will then receive responses through this system and pass them back to the requesting carrier, logging the response. If the connection will be protected, the system then logs that connection as a temporarily defined connection, and will monitor it and issue alerts just as for a pre-defined connection.
4.8.1.1.5 The system shall have sufficient processing power to assure that Endangered Connection Alerts and Alert Update Reports are generated where appropriate in no more than 15 seconds after receipt of a schedule adherence report at the ITH.

4.9 Graphical User Interface (GUI) Subsystem

The Graphical User Interface subsystem allows the system administrator and operators to change system setup, view operational log, and start, stop and interrupt normal system operations. As one of crucial system components in console computer, the GUI subsystem is the gateway that provides easy operator access to the entire ITH system.
4.9.1.1.1 The GUI subsystem shall provide the interface between the operators and the other subsystems.  
4.9.1.1.2 It shall provide all necessary operator interactions with the data acquisition, data storage, data distribution, MLN and administrative subsystems.  
4.9.1.1.3 It shall display system status at all times on the operator console.  
4.9.1.1.4 The graphical displays shall use color to the maximum extent possible.  
4.9.1.1.5 User commands and responses shall be in accepted traffic engineering or other non-specialist terms that can be readily comprehended by a trained operator and shall not be cryptic.  
4.9.1.1.6 The GUI shall be equipped with multi-tasking capability and allow more than one user to access the ITH system.  
4.9.1.1.7 There are two (2) means by which the user can request actions to be taken by the system:  
  4.9.1.1.7.1 Operator request: Operator requests shall take place immediately and shall have priority over the activity scheduler.  
  4.9.1.1.7.2 Activity scheduler: This shall allow for operator generated requests to be scheduled for completion by time of day and day of week.  
4.9.1.1.8 The user interface shall be capable of providing the ability to:  
  4.9.1.1.8.1 Monitor accuracy and efficiency of all processes on a system including the receipt and transmittal of data.  
  4.9.1.1.8.2 List and/or print all system database and system monitoring information.  
  4.9.1.1.8.3 Maintain a record of actions by the operator in the form of a time sequential log including the details of the input commands and data  
  4.9.1.1.8.4 Provide statistical information on system operations.  
  4.9.1.1.8.5 Display a visual alarm and an audible alarm (beep on Operator Terminal) when a process has failed or has experienced an unusual condition.  
  4.9.1.1.8.6 Maintain and display process status lights, or other means, which provide a way of identifying the occurrence of a processing error condition or when a process has failed including both the operation of the process and data flows into and out of the process.  
4.9.1.1.9 The GUI subsystem shall be capable of displaying data in real-time as it arrives.  
4.9.1.1.10 Data entry shall be constructed so that it minimizes the operator’s use of keystrokes, mouse clicks, and time by adhering to the following data entry requirements:  
  4.9.1.1.10.1 The operator shall not be required to memorize any textual commands.  
  4.9.1.1.10.2 On-line help shall be available for all features.  
  4.9.1.1.10.3 The primary input device shall be the mouse.
4.9.1.10.4 The secondary input device shall be the keyboard using hot keys.

4.9.1.11 The operator interface shall incorporate consistency checks into the data entry process. It shall check for interrelationships between entry fields and limit entries based on programmed instructions (limitations) and data type and range checking where appropriate.

4.9.1.12 The operator interface shall meet the following performance requirements:

4.9.1.12.1 Ability to present desired screen, window or process no later than five (5) seconds after the request is made at least 95% of the time,

4.9.1.12.2 Ability to begin printing a desired, predefined report no later than thirty (30) seconds after the request is made, assuming an empty print queue,

4.9.1.12.3 Operator usage shall not affect the ability of other operators to perform their functions.

4.10 Cooperative Control Pass Through

The Cooperative Control Pass Through subsystem shall transmit commands or requests sent by one service board to the destination agency if the ITH itself is not designed to or not able to respond to the request. This subsystem shall have the intelligence to determine where to re-route the message in most efficient way.

4.10.1.1 This subsystem shall pass through ITH any cooperative control message from one agency to another.
4.10.1.2 This subsystem shall find the most efficient path in the network to re-direct an un-serviced message.

4.11 Operation

The ITH shall maintain highly reliable 7x24 operations. ITH system operations include daily routine data collection and data dissemination, and emergency response.

4.11.1.1 The ITH shall be designed to operate in an unattended mode to the extent possible.
4.11.1.2 The ITH shall be designed to continue operation in the event of the failure of any of its subsystems to the maximum extent possible.
4.11.1.3 The ITH shall be staffed during regular business hours, but system design will not rely on operator involvement and regular staffing.
4.11.1.4 The ITH shall provide for controlled shutdown and startup.
4.11.1.1.5 The ITH shall include self-diagnostic routines for determining errors or system parameters with values near tolerance.
4.11.1.1.6 Shutdown of the ITH system shall be performable in 10 minutes or less.
4.11.1.1.7 Startup of the ITH system shall be performable in 10 minutes or less.

4.12 Backups

Regular backup is essential in part of system operations. Even with RAID (Redundant Array of Inexpensive Disk) 5 and UPS (Uninterruptable Power Supply), backup is the best defense against system crashes.

4.12.1.1.1 The ITH shall perform backups of database tables and other files onto long term storage media both in a full backup mode and in an incremental backup mode.
4.12.1.1.2 Full backups shall be performable in less than four hours.
4.12.1.1.3 Incremental backups shall be performable in less than one hour.
4.12.1.1.4 ITH operation shall be able to continue while backups are being performed. Backups shall not seriously affect the responsiveness of the ITH.
4.12.1.1.5 An automated or operator initiated backup of the system shall be supported.
4.12.1.1.6 For automated backup, the system shall support archiving without operator intervention.
4.12.1.1.7 The system shall be capable of performing a backup of each physical disk on an appropriate media.
4.12.1.1.8 The system shall be capable of performing a database backup independently of a physical disk backup.
4.12.1.1.9 The backup process shall perform a backup media verification process in that the contents of the file on disk will be compared with the contents of the backup media.

4.13 Transfer Techniques Supported

Besides the CORBA, XML, and HTML feed used by Data Acquisition subsystem and Data Distribution subsystem, this section defines the data transfer techniques and their requirements for system operations.

4.13.1.1.1 The ITH system shall be capable of supporting a subset of these types of incoming data:
   4.13.1.1.1 Fax reception, followed by operator entry into the system.
   4.13.1.1.2 Pager reception, followed by operator entry into the system.
   4.13.1.1.3 Pager received by computer program and automatically entered (or subject to operator verification).
4.13.1.1.1.4 E-mail, followed by operator entry into the system.
4.13.1.1.1.5 E-mail analyzed by computer program and automatically entered (or subject to operator verification).
4.13.1.1.1.6 Other text reception (telephone, mail, pagers, anecdotal information), followed by operator entry into the system.
4.13.1.1.1.7 Serial data interface through standard modems.
4.13.1.1.1.8 Distributed video.
4.13.1.1.1.9 Networked connection communication through TCP/IP.
5 GENERAL REQUIREMENTS

5.1 National ITS Architecture Compliance

5.1.1 Introduction

The National ITS Architecture (NITSA) is a common framework for use by ITS system planners and designers. It provides both logical and physical views of the full range of ITS functions, physical entities and information flows. One of the things it particularly aids in accomplishing is the incorporation of all relevant functions for a particular application.

Consistency with the NITSA (or an approved regional architecture consistent with NITSA) is now required under the FTA's recently finalized National ITS Architecture Policy on Transit Projects. The same policy also requires most projects to follow a structured "systems engineering analysis" similar to the process employed for the RTIP project.

This section defines the ITH and the overarching RTIP in terms of several principal components of NITSA. First, the high level Physical Architecture identifies the subsystems and communications links relevant to the ITH/RTIP. Second, Architecture Interconnects show the logical linkages between system elements (subsystems and terminators). Finally, Market Packages are logical groups of functionality and equipment that might typically be considered for implementation by system planners and designers.

This review is based on NITSA Version 3.0, the current version as of this writing. The ITH/RTIP project architecture has been built using Turbo Architecture V1.0.

5.1.2 ITH Physical Architecture

At its highest level, the NITSA Physical Architecture view is comprised of Subsystems, Communications Links and Terminators. Subsystems represent actual physical entities such as vehicles, roadway, traffic and transit management centers, and travelers. Communications links represent the generic types of communication links that can be present between subsystems. Terminators are people, devices, organizations or other entities that interact directly with ITS but are not part of the architecture itself. Examples include travelers, kiosks, and metropolitan planning organizations.

A view of the high level Physical Architecture without terminators is shown in Figure 5-1. For the ITH/RTIP, there are nine subsystems involved; each
represents one or more actual entities. Four are Centers: Traffic Management, Information Service Provider (one of which is the ITH), Emergency Management and Transit Management. Two fall into the Roadside category: Roadway and Parking Management. Two represent Travelers: Remote Traveler Support and Personal Information Access. Finally, Transit Vehicles are included from the Vehicles category.

These subsystems are linked together conceptually via the following generic communications link types: Wireline Communications, which encompasses all links between non-mobile entities, whether wireline or wireless (e.g. microwave); Wide Area Wireless Communications, supporting mobile travelers, mobile transit supervisors and vehicles; and Dedicated Short Range Communications (DSRC), which enables technologies such as local signal priority request and parking inventory management.

Figure 5-1: ITH High Level NITSA Architecture Diagram
5.1.3 ITS Architecture Interconnects

The current ITH project architecture contains 58 selected interconnects (excluding interconnects between systems and personnel who operate them). These interconnects are identified by pairs of entities they link. An interconnect may represent either a one-way or two-way flow of information between the entities.

Please note that the interconnects do not always indicate a direct physical connection between the entities. In some cases, messages between the two entities may be switched through an entity such as the ITH or the IH.

The ITH project architecture interconnects are shown in Table 5.1. Each flow appears twice for ease of reference.
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Pace Paratransit Contractor Vehicles
Pace Paratransit Contractor Dispatch
Pace PMS
Roadway
RTA Travel Information Center
User Personal Computing Devices

Entity
Table 5.1: ITH Architecture Model Interconnects

Amtrak
CDOT Traffic Management Center
Chicago 911/OEC
CTA ATSS
CTA Bus Transit Vehicles
CTA Control Center
CTA Paratransit Contractor Vehicles
CTA Paratransit Contractor Dispatch
CTA/Chicago Information Kiosks
CTA PMS
CTA Rapid Transit Vehicles
DuPage Paratransit Coordinator
DuPage Paratransit Coordinator Vehicles
Gateway/Illinois Hub
Greyhound
IDOT COM center
IDOT TSC
IDOT TSS
Illinois Transit Hub
Internet Access via the WWW
ISTHA
Metra ATSS
Metra Consolidated Control Facility/TIMS Hub
Metra PMS Installations
Metra Trains
Metra Visual Paging System
Pace ATSS Systems
Pace Bus Transit Vehicles
Pace Dispatchers
Pace IBS Hub
Pace Paratransit Contractor Vehicles
Pace Paratransit Contractor Dispatch
Pace PMS
Roadway
RTA Travel Information Center
User Personal Computing Devices


5.1.4 ITH Market Packages

Market Packages are subsets of the NITSA Physical Architecture that address specific functions or services, such as Transit Vehicle Tracking. A market package collects together several different subsystems, equipment packages, terminators, and architecture flows that provide the desired service. Market Packages can be used by ITS planners and designers to quickly access the components of NITSA that are relevant to the particular requirement being addressed.

There are twelve Market Packages included in whole or part in the ITH project architecture. These Market Packages are briefly described in the following subsections along with their applicability to the ITH and/or RTIP.

5.1.4.1 Demand Response Transit Operations

This market package provides a full range of information and management systems to demand responsive transit managers, including ADA paratransit operators and conventional paratransit or “dial-a-ride” operations. It includes software support for demand responsive scheduling, and full AVL and Computer Aided Dispatching with information analogous to that of the Transit Fixed-Route Operations. In this Market Package, the prospective traveler works with the Information Service Provider Subsystem to request service and receive a reservation – it may be operated by the transit manager or by a third party such as a broker.

In the ITH design, demand response transit operators can request connection protection for their trips connecting with fixed route services. They can then receive alerts and updates when connecting service is delayed. If there is provision for holding connecting fixed route services, the paratransit CAD system will be required to report ETA updates to the TCP subsystem.

Paratransit operators would also be able to receive weather and roadway advisories, although this flow does not occur in the current vision or architecture as it is assumed that these relatively small operators would employ ad hoc web access to this information if they desired it.

5.1.4.2 Emergency Response

This market package provides the computer-aided dispatch systems, emergency vehicle equipment, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. It includes coordination with other agencies, including transit operators. Specifically, this market package
includes architecture data flows covering the initial notification of an emergency at a transit stop or on a transit vehicle, as well as further coordination as additional details become available and the response is coordinated.

5.1.4.3 Incident Management System

The Incident Management System Market Package includes all aspects of gathering information on incidents and making it available to emergency management, traffic management and other subsystems. This market package does not include emergency response to transit silent alarms – that is covered by emergency management. Rather, it includes the receipt of incident reports from transit operators along with subsequent follow-ups.

As in the NITSA, incident reports from transit are actually provided to an information service provider (in this case the Gateway TIS), which will then provide the incident information via data feeds to incident management units. These feeds may be as frequent as one per minute.

5.1.4.4 Multi-modal Coordination

This market package involves communications between transit operators and between transit and traffic agencies for improved service coordination. This increases traveler convenience at connection points, and improves operating efficiency. It also involves coordination with traffic management to the extent that transit performance can be improved without degrading traffic network performance. Signal priority capabilities are also included in this market package.

This market package encompasses at least two of the core functions in which the ITH is involved: center to center signal priority, and transfer connection protection. The latter function can be viewed as an Information Service Provider (ISP) embedded within another ISP.

5.1.4.5 Parking Facility Management

This market package encompasses a range of functions and technology for monitoring and managing parking facilities. These include electronic parking fee collection, occupancy monitoring, and provision of that occupancy data to parking management, traffic management agencies and information service providers.

As part of the ITH design and the RTIP, transit operators also take on a portion of the role of parking management role. Those who install Parking Management Systems at park and ride lots serving their routes will collect real time parking
occupancy information and forward it to the ITH. It is expected that, in turn, that the ITH will pass that parking occupancy information on to the Gateway TIS.

5.1.4.6 Railroad Operations Coordination

The purpose of this market package is coordination between surface rail operators and traffic management agencies around the issue of grade crossing (a.k.a. highway-rail intersection or HRI) closures. Rail operators provide train schedules, maintenance schedules, and any other forecast events that will result in HRI closures. This information is used to develop forecast HRI closure times and durations. These may be used in advanced traffic control strategies or to enhance the quality of traveler information.

This is a visionary element of the RTIP and ITH design. Its actual implementation is complex for a variety of reasons. One of these reasons is that current rail dispatch and control systems are primarily designed for safe operation, not precise location determination. Another, and perhaps the most important, is the fact that Metra provides its service over at least four contractor railroads, as well as its own lines. This means that operational coordination will require some degree of system integration of five different dispatch centers located in Illinois, Wisconsin, Texas, Virginia and Nebraska. In some cases, the carriers involved may not agree to make such an effort a high priority for their technical staff.

These capabilities could ultimately go beyond transit to include freight railway operations, since the enhancements would be made in many cases to systems and infrastructure shared by passenger and freight rail service. This vision could include a commuter rail and freight rail regional coordination center with dispatch responsibilities for the Chicago region.

5.1.4.7 Standard Railroad Grade Crossing

This market package encompasses all HRI (grade crossing) warning equipment for standard (not high-speed) passenger and freight rail operations. This includes everything from the crossbuck warning sign, to standard lights and gates, to advanced protection systems. The systems may also be integrated with traffic signals for coordinated control and operation.

Metra and CTA, as well as the many freight rail carriers serving northeastern Illinois, all have such devices installed at their HRIs.

Metra’s Constant Time Warning System is part of this market package. It adjusts the activation time for lights and gates based on the speed of the
approaching train in order to maintain a constant interval between the activation of lights and gates and the arrival of the train at the HRI.

5.1.4.8 Transit Fixed-Route Operations

This market package handles routing, scheduling, driver assignment and monitoring for fixed route vehicles. It incorporates not only what the dispatcher sees at a console, but also the operations planning, mechanical and personnel administration functions that produce the instructions, guidelines and parameters according to which the service will operate.

This market package will provide the ITH with data on transit schedules, fares, and current schedule adherence. It therefore encompasses the ITS installations at each RTA service board that deal with scheduling, vehicle tracking and dispatching ITS.

5.1.4.9 Transit Passenger and Fare Management

This market package involves the collection, storage and dissemination of information on fare paid and passenger loadings. Vehicle mounted devices or sensors collect the information. It is communicated as needed to the Transit Management Subsystem using wireless links. In addition, this market package covers the use of a neutral clearinghouse such as a financial institution for handling disbursement of funds from purchases of fare instruments.

The ITH will have the ability to receive, maintain and forward current passenger counts or load factors from transit runs/trains. This would, for example, be able to show a traveler that the approaching bus (or a planned one) was full. This is a visionary feature, however, as wireless communications constraints and limited installation of networked automatic passenger counters (APC) are expected to severely limit the real time transmission of passenger loadings.

The ITH will collect static fare information from transit operators to be included in its Web site offering and forwarded to the Gateway TIS. It is not currently planned or envisioned that actual fare transaction data will be collected by the ITH. Rather, an integrated, seamless fare payment system for the region will require, at minimum, a formula for reconciliation of funds, and an interagency agreement covering the formula and the means for administering it.

It should be noted, that major developments in regional E-commerce for transportation are quite likely in the coming decade. These will most certainly affect the direction for regional payment as well as its implementation. One of these could be the emergence of a single fare medium for use on all three RTA service boards, as well as other potential uses. This would require changes in
the handling of fare payment data and fare media sales receipts, with a coordinator or clearinghouse accepting all payments and disbursing based on fare transaction data indicating actual transportation service provided by a carrier. It would require compatible equipment for all service boards, and would also be contingent on a viable approach for its use on a non-barrier system such as Metra.

Another may be wider shared use of payment tags such as I-Pass between tollways, parking facilities and other entities. If such a tag were made in a portable version as well (e.g. Mobil Speedpass), it could be also used for transit payment. Again, this would require compatible equipment at all service boards.

A third could be the wider use and acceptance of commercial smart cards such as American Express Blue and competing products from MasterCard and VISA. These cards have an embedded chip which can store a variety of profile and preference information (and could also hold stored value, similar to a current transit card or a telephone card).

A fourth could be expanded use of emerging technology that allows cell phones to trigger items such as vending machines, with charges being added to the phone or bill. This would require ample wireless bandwidth to allow immediate triggering of the farebox, turnstile or other fare collection device.

Finally, fare payment systems could be capable of more extensive use for operations and general management. Fare payment transactions from transit fareboxes can be used as a crosscheck to passenger count information, in either batch or real time. Real time information could be monitored at turnstiles as an early warning of increased demand (e.g. a performance or pro game has ended at a nearby facility) or as a supplementary means to identify equipment problems (e.g. turnstile 6 shows no activity). Most of these uses will require technological advances as well as transit operator adoption.

Because of the uncertainty around how these technologies will evolve, and what regional solution(s) will be adopted for fare integration, as well as the likelihood that the ITH will not be involved, the project architecture currently does not reflect the flow of fare transactions beyond its collection from vehicles.

5.1.4.10 Transit Traveler Information

This market package includes all methods of providing transit traveler information. Among the methods are:

- Access at fixed devices such as a Internet-enabled home or office computer, cable TV or touch tone phone
- Mobile or remote access using kiosks, two-way pagers or Web enabled mobile computing devices
• Access at stops or stations through active signs or information terminals
• Access on board vehicles, again through active signs or information terminals
• Media or other information service providers

This functionality is perhaps the principal driver behind the ITH. The ITH functional requirements fully support provision of static and real time information for support of these devices, either directly or indirectly.

5.1.4.11 Transit Security

This market package provides for the physical security of transit passengers and the driver/operator/crew. It encompasses the silent emergency alarm available to the driver for emergency notification, along with the on-board microphone that can be activated by the dispatcher. It may also include such features as on-board surveillance systems to warn travelers of potential hazards, and surveillance monitoring of transit stops/stations and parking lots.

The design for ITH envisions emergency notification by transit drivers/operators going directly from service board systems to emergency management centers to avoid any overhead or delay. No other functionality from this subsystem is included in the design or vision at this time. If such technology is included in the future, it could have significant implications for wireless or wireline communications requirements.

5.1.4.12 Transit Vehicle Tracking

The market package provides for tracking of transit vehicles via an Automated Vehicle Location (AVL) system, as well as real-time schedule updates. Relevant information about location and schedule adherence is passed from the Transit Vehicle Subsystem to the Transit Management Subsystem. This subsystem processes the information and makes it available to the Information Service Provider Subsystem via wireline communications. This market package is duplicative of portions of the Transit Fixed-Route Operations package, with the exception that this market package also provides the location along with the schedule adherence – a critical factor in use of the data.

The ITH will receive the information from the transit operators’ systems, then make it available via its Web site and also forward it to the Gateway TIS.

5.2 GCM Corridor Architecture Compliance
5.2.1 Overall Compliance

5.2.1.1 The ITH shall be designed to be compliant with the GCM Corridor Architecture Guidelines.

5.2.2 Applicable GCM Guidelines

This section will outline the ITH functional requirements that are derived from the GCM Gateway architecture and interface requirements.

5.2.2.1 Communications Requirements

5.2.2.1.1 All electronic communication between the ITH, its subsystems, and the IH shall conform to the following requirements:

5.2.2.1.1.1 It shall conform to the NTCIP standards.
5.2.2.1.1.2 It shall use networking protocols (e.g., ATM, TCP/IP, etc.) and be organized as a Wide Area Network (WAN).
5.2.2.1.1.3 Where it is a permanent high-speed link (DS-1 or greater), it shall be an ATM (Asynchronous Transfer Mode) network.

5.2.2.1.2 Networking between the ITH and the IH shall operate using the ATM protocol.

5.2.2.1.3 The networking shall operate IP (Internet Protocol) over ATM and will connect the local LANs at the IH and at the ITH.

5.2.2.1.4 Networking between the service boards and other subsystems and the ITH shall, if the bandwidth requirements are DS-1 or greater, be a similarly compliant ATM network.

5.2.2.1.5 Lower bandwidth connections between the ITH and the service boards and other subsystems shall be PPP (Point to Point Protocol) connections.

5.2.2.1.6 The PPP connections shall operate the IP protocol.

5.2.2.1.7 The connections between the ITH and the service boards and other subsystems may be LAN to LAN connections; however, they are not required to be. Instead, various firewalls may be used to control and secure the connection.

5.2.2.2 Data Exchange Requirements

5.2.2.2.1 There are currently two exchange techniques compliant with the Corridor Architecture. These are communications through the GCM Corridor.
Common Object Model (GCOM) using the Common Object Request Broker Architecture (CORBA) or through Web technologies (HTTP, HTML, CGI, Java).

5.2.2.2.2 All interprocess communications between the IH and the ITH and between the ITH and the service boards and other subsystems shall be through remote method invocations on GCOM objects using CORBA. (Note: the consulting team recommends that XML + EJB be used in lieu of CORBA between the ITH and the service boards, if that has been approved as an approach at detailed design time. Otherwise, this requirement would stand as written. See Section 4.1 and its subsections.)

5.2.2.3 Data Input

5.2.2.3.1 The ITH shall operate a CORBA ORB. The ITH shall operate a subset of available CORBA services (as determined by system design).

5.2.2.4 LRMS Requirements

The Location Referencing Message Specification (LRMS) is a standard format for describing geographic locations associated with entities or events. It is being adopted by the National ITS Architecture. As part of the GCM Corridor Architecture, the ITH architecture shall also use the GCM LRMS standards where applicable.

5.2.2.5 Transit Schedules

5.2.2.5.1 Data regarding transit routes, schedules and fares shall be made available to the ITH from the service boards and other subsystems. The ITH shall make this information available to the GCM corridor through the Gateway/IH. The Gateway shall include a link to transit providers’ web pages.

5.2.2.6 Transit Schedule Adherence

5.2.2.6.1 Data regarding real-time schedule adherence for active transit services shall be made available to the ITH from the service boards and other subsystems. The ITH shall make real-time schedule adherence data available to the GCM Corridor through the IH.

5.3 National Standards Compliance
5.3.1 Compliance to NTCIP Standards

5.3.1.1 The design of the ITH shall be compliant with NTCIP standards.

5.3.1.2 The draft NTCIP protocol recommends the use of TCP/IP communications as the primary network protocol.

5.3.1.3 The NTCIP defines two application level protocols for center-to-center communications between computers: Data Exchange in ASN.1 (DATEX-ASN) and Common Object Request Broker Architecture (CORBA).

5.3.2 Compliance to TCIP Requirements

5.3.2.1 The design of the ITH shall employ Transit Communications Interface Profiles (TCIP) dialogs where available. XML data tags shall correspond to the "descriptive names" identified in the relevant TCIP Business Area Objects.

5.4 Service Board And ITS Subsystem Requirements

5.4.1.1 To simplify ITH interface design and system maintenance, it is desired that the ITH shall connect to one single contact point in each service board and agency in the region for data retrieval and submittal. The information content and its representation in service board subsystems shall be compliant with national standards (NITSA, NTCIP, TCIP) to facilitate interoperability among agencies.

5.4.1.2 Service boards and agencies shall provide a single contact point or "hub" for exchange of information with the ITH.

5.4.1.3 The data provided by service boards and other agencies shall be presented according to TCIP standards to facilitate data sharing and data fusion.

5.5 Open Systems

To ensure interoperability, portability and scalability across agencies, the ITH system design shall follow NTCIP, TCIP, and NITSA. The ITH system shall follow software engineering structured system design procedures to ensure open architecture in its software, hardware, and communication protocol.

5.5.1.1 The system shall be compliant with established and mature open system characteristics.
5.5.1.2 It shall ensure interconnectivity for connecting and seamlessly exchanging information with other systems.
5.5.1.3 It shall ensure interoperability for the seamless access of distributed data across hardware and among software applications.
5.5.1.1.4 It shall have the portability to move applications from one vendor’s computer system (hardware and operating system) to another with minor or no modifications required.
5.5.1.1.5 It shall have the scalability to run applications without modification on larger or smaller computer systems.
5.5.1.1.6 It shall be capable of integrating future technologies with existing or legacy systems.
5.5.1.1.7 Its design shall consider maintainability and modularity.

5.6 Topology

The ITH shall be a distributed 3-tier client/server design. That is, the application server and database server shall be in place to share the responsibility of storing data and processing data (to support TCP subsystem and interfacing with Gateway and other agencies).

5.6.1.1.1 The ITH shall be capable of interfacing with the Gateway TIS and other agencies in the region.
5.6.1.1.2 A distributed 3-tier client/server architecture shall be used for the ITH.
5.6.1.1.3 The client processes and the server processes do not need to be on the same physical machine, though it is acceptable if they are.

5.7 Object Orientation

To facilitate future system expansion and integration, it is crucial that the ITH design is object-oriented. With object-oriented design, each component can be updated or replaced straightforwardly in the future without impacting other parts of the system. This will also help ensure the scalability and portability of the ITH.

5.7.1.1.1 Object oriented technology shall be used for designing, developing, and implementing the application software.
5.7.1.1.2 Object oriented technology shall be used for data modeling.
5.7.1.1.3 Distributed objects implemented through CORBA or XML/EJB shall be used for application to application interfaces.
5.7.1.1.4 CORBA Interface Definition Language (IDL) or XML DTD (Document Type Definition) schema shall be used to define the application to application interfaces.

5.8 Flexibility

The ITH system design and software development shall be flexible enough to allow adding or replacing any component in the system and shall not be limited to products from certain software and hardware vendors. The ITH shall work in
different environments and domains with minimal code changes and recompilation.

5.8.1.1.1 The software shall be flexible and shall allow for future additions.  
5.8.1.1.2 Design shall allow new attributes and methods to be added to objects without requiring existing programs to be rewritten.

### 5.9 Scalability

Scalability is one of the most important system design criteria for the ITH. It is highly possible that demands, information volume and number of agencies that participate in ITH services will increase in the future. The ITH design must be able to accommodate future expansion.

5.9.1.1.1 The ITH shall allow future expansion to at least 3 times of its initial capability.  
5.9.1.1.2 The ITH architecture (software and hardware) shall be scalable; i.e. the architecture shall allow for the inclusion of additional resources (e.g., memory, disk space) and shall be able to take advantage of those resources. The architecture shall also allow for additional usage (e.g., more connections).

### 5.10 Security

The data stored in the ITH come from agencies in the region. The design of the ITH must guarantee that the information stored there cannot be misused or stolen by unauthorized persons. Security procedures and software shall protect against misuse by both internal users and external intruders.

5.10.1.1.1 The ITH shall provide at least these two distinct areas of security:  
5.10.1.1.1.1 Logon authentication, which dictates who gets into the system and what functions are available once they are in.  
5.10.1.1.1.2 Data access permission, which determines what data a user can access, and what type of access is allowed (e.g. read only; read-write).

5.10.1.1.2 The system shall allow its security features to be maintained by administrative users.

5.10.1.1.3 ITH communication links connecting the Gateway and agencies, as well as individual systems, shall be protected from unauthorized access by using one of the following:

5.10.1.1.3.1 Use of secure private, dedicated lines,  
5.10.1.1.3.2 Password access for dial-up lines (modems),  
5.10.1.1.3.3 Data encryption for public networks (such as the Internet).

5.10.1.1.4 The ITH design shall allow for future security enhancement.
5.10.1.1.5 The DBMS (Database Management System), the CORBA security service, and the Enterprise Java Bean security component shall provide data security within the ITH.

5.10.1.1.6 The ITH shall be secured through the use of firewalls. This shall be accomplished with the use of multiple firewall routers which can create various zones of accessibility, and an application (or I/O) server which can intercept and validate any requests coming into the ITH from the regional WAN or through other connections.

5.10.1.1.7 A similar scheme may be used by ITS subsystems to secure their own local networks.

5.10.1.1.8 An attempt shall be made to avoid sending plain-text passwords over the ITH WAN.

5.11 Reliability

Because of its role as the bridge among service boards and transportation agencies, it is essential that the ITH shall be reliable and robust enough to be the regional transit hub.

5.11.1.1.1 Based on regular scheduled maintenance, the ITH shall provide safe, reliable and efficient control and monitoring operations under a full range of working conditions, continuously 24 hours per day, 7 days a week, 365 days a year including unattended operation for the life of the system.

5.11.1.1.2 The data validation subsystem shall be responsible for the checking of any data transferred to and from the ITH. It shall incorporate error-checking methods to make sure that data is delivered correctly.

5.11.1.1.3 The system shall be designed for a life of at least 10 years with suitable maintenance.

5.11.1.1.4 Attended operation with a high level of user interaction will generally occur during normal weekday working hours. The system shall be capable of unattended operation including monitoring of the subsystems and providing event and status logging, at all times.

5.11.1.1.5 The ITH shall provide reasonable system operation without a full complement of system equipment (i.e., operate in a degraded mode or be able to perform its functions with the loss of some or several external interfaces to the extent practical).

5.11.1.1.6 Under degraded mode operation, the ITH shall provide alert and status messages to connected systems where possible.

5.12 Fault Detection And Recoverability

The ITH shall be able to detect any abnormal situation occurring during system operation. Warning messages shall be logged and sent to system administrators and operators so that appropriate action can be taken to remedy potential
problems. To prevent hard disk failure, a RAID 5 fault tolerant configuration shall be deployed. Any faulty device shall be replaced as soon as reasonably possible after the problem is discovered.

5.12.1.1.1 The ITH shall be capable of identifying component or subsystem failure and erratic operation and localize the effect and source of the foregoing conditions.
5.12.1.1.2 It shall discover unrecoverable faults such as CPU and disk failure, or unusual system or equipment conditions. The system shall be automatically and safely terminated in an orderly manner to minimize the potential damage.
5.12.1.1.3 Upon return of power, ITH equipment shall be capable of returning to operation automatically with little or no operator intervention required. This shall include the following: no file system operations (transactions) will be left incomplete and the structure of disk volumes will remain intact without the need to run a disk repair utility, database operations shall be rolled-back to the time of failure.
5.12.1.1.4 Appropriate logs and operator indicators shall be provided to indicate faults, fault status, fault repair, and possible data loss that occurred during a system fault.
5.12.1.1.5 Under no circumstances shall the loss of any connection impact the remaining operations or efficiency of the ITH.

5.13 Performance

The ITH shall provide reasonable response times to information requests, even during periods of peak demand.

5.13.1.1.1 The ITH shall be capable of receiving information and exchanging data among its external data interfaces with no frequent, continual, noticeable loss of system performance (such as: transfer speed, reliability, etc.).

5.14 Error Detection

The Monitoring/Logging/Notification subsystem shall detect errors and abnormal conditions during system operation. The system administrator and operators shall adopt appropriate action to resolve the error and resume system function in the shortest reasonable time possible.

5.14.1.1.1 The ITH shall continuously monitor its component equipment and subsystems in order to determine if any errors exist in equipment operation, communication, or data integrity.
5.14.1.1.2 Any detected errors or out of tolerance conditions shall be logged and reported to the operator.
### 5.15 Privacy

The information processed, stored and provided by the ITH is primarily public information. However, some of the information, for example paratransit trip status for use by TCP, or future mobile user profiles, could be considered sensitive under some circumstances. In addition, ITH stakeholders may from time to time agree to limit public access to other information resident at the ITH. System provisions are necessary to provide for security and access control under these circumstances.

5.15.1.1.1 The ITH shall ensure that sensitive or restricted information is only made available to authorized users.
5.15.1.1.2 The data validation and fusion subsystems shall have the capability of stripping extraneous, private or otherwise sensitive information received from agencies before it is posted to the ITH database.
5.15.1.1.3 Appropriate encryption technology shall be available to protect any sensitive information passing across the Internet between the ITH and service boards or other agencies.

### 5.16 Support For Future Technologies

Computer and communication technology are constantly changing and evolving. Frequently this evolution brings about a better price-performance profile for a particular technology. The ITH design shall best use existing technologies, and seek to be open for the adoption of future technologies as well.

5.16.1.1.1 The ITH design shall anticipate the inclusion of emerging ITS technologies as they become commercially viable and available, and make accommodations for ease of integration of such emerging technologies.

### 5.17 Training

To ensure reliable 7x24x365 system operation, start-up and ongoing user and operator training are essential. The ITH owner shall host regular training workshops so that new operators will have enough knowledge to handle various system operation scenarios. Initial training prior to system deployment and operation must be provided for in project planning. The ITH system design team shall prepare a System Administration Manual and System Operations Manual as part of final project deliverables.

5.17.1.1.1 ITH shall conduct two types of initial and ongoing training:
- User training for operators
- Technical maintenance training for engineering and maintenance personnel.
5.17.1.1.2 An ITH operation manual shall be in place to assist operators and the system administrator in handling various situations such as software, hardware usage, emergency response, and error correction, etc.

5.18 Maintenance

ITH design and specification should take into account life cycle maintenance requirements for the ITH complex. Specific maintenance requirements and expectations should be accounted for in future system plans and procurement documents.
6 HARDWARE REQUIREMENTS

Computer software and hardware are two essential parts of ITH system. This section discusses the hardware requirements for ITH to meet its design purpose and provide reliable services to transit users, service boards, and other transportation agencies in the region.

6.1 Performance

The fundamental goal of ITH is to be a data warehouse to host transit service information in the region. The design of ITH shall be capable of handling information and requests from service boards and the Gateway TIS in a timely manner.

6.1.1.1.1 The ITH system shall be capable of allowing multiple operators (at least 2) simultaneously along with processing of incoming and outgoing information.
6.1.1.1.2 The system throughput shall be sufficient to process incoming data without any delay even during the peak hours.
6.1.1.1.3 The system shall be able to update and deliver all its output information within a reasonable time upon receiving request from users.
6.1.1.1.4 The system shall be able to serve ITH web pages and Data Distribution subsystem with acceptable response time.
6.1.1.1.5 To support future expansion, the system shall be designed to exceed its estimated peak performance requirements by at least a factor of 3 by adding resources.
6.1.1.1.6 The ITH system shall support a minimum of 120 concurrent inbound service board transactions per second while still supporting hosted applications and data exchange with the IH.

6.2 Reliability

To meet the ITH requirements for consistent, reliable transit traveler information, the ITH shall maintain an availability level of at least 99.9%. That is, no more than 45 minutes of down time a month.

6.2.1.1.1 To ensure system reliability, no components will be selected which have mean time between failures (MTBF) of less than two years.
6.2.1.1.2 The system shall provide continuous operation, 24 hours a day, 7 days a week.
6.2.1.1.3 The ITH system shall support 99.5% availability and not require non-scheduled maintenance more than once per month.
6.2.1.1.4 It shall be designed to remain stable in the face of communications or network connection failure.
6.2.1.1.5 The system components shall provide visual indications of whether or not they are in good condition or have experienced an error condition.  
6.2.1.1.6 Components shall be easily replaceable. They shall not be items of unique manufacture.

6.3 Safety

The ITH shall develop safety policy and guideline to ensure operators correctly operate hardware equipment. If it is possible, all hardware shall all be covered by case to prevent improper usage and cause injury.

6.3.1.1.1 The components of the system and its installation and operating environment shall be organized for the safety of the operators, system engineers, and the general public.  
6.3.1.1.2 Appropriate insulation shall exist to prevent accidental contact with electricity and short circuits.  
6.3.1.1.3 Appropriate warning labels shall indicate voltage areas and control switches that should not be accidentally contacted or pressed.  
6.3.1.1.4 Cables shall be managed so as not to cause either a fire or a tripping hazard.  
6.3.1.1.5 Access to the system hardware will be controlled.

6.4 Testing

ITH developers shall create a hardware and software testing plan as part of the system acceptance process. The hardware testing procedure shall be able to examine both performance and lifetime of the device.

6.4.1.1.1 The components of the system shall undergo an appropriate system engineering testing procedure for a period of continuous operation wherein they will not exhibit any hardware errors.

6.5 Server Machines

6.5.1.1.1 ITH shall have at least two servers – a database server and an application server – to handle data sharing and decision making. Selection of the ITH servers shall based on the most current technology available at the time.  
6.5.1.1.2 The main server machine shall be a symmetric multiprocessor machine capable of being scaled to four or more processors. Use of a SMP (symmetric
multiprocessing) machine allows for direct scalability for the main processing and database operations.

6.5.1.1.3 The CPU speed shall be adequate to handle data transmission and computation within acceptable response time.

6.5.1.1.4 The database server shall operate the database, perform data processing, and create reports and web page content.

6.5.1.1.5 The application server shall handle at least following tasks:
   - 6.5.1.1.5.1 Process incoming communications (data acquisition).
   - 6.5.1.1.5.2 Provide outgoing communications (data distribution).
   - 6.5.1.1.5.3 Operating the web server.
   - 6.5.1.1.5.4 Executing monitoring and administration software.
   - 6.5.1.1.5.5 Automatic archiving and backups.
   - 6.5.1.1.5.6 Firewall and related security and network management tasks.

6.5.1.1.6 The server design and selection shall consider scalability to handle future system expansion including computation, communication, and data storage.

6.5.1.1.7 The server machines shall be commonly and commercially available. They shall have a proven operational track record.

6.5.1.1.8 The server machines shall be easily replaced in the event of hardware failure.

6.5.1.1.9 Systems which are currently depreciated (discontinued or no longer supported) or scheduled for depreciation by their vendors shall not be used.

6.5.1.1.10 The servers shall be capable of continuous operation (possibly in a degraded mode) in the event of component failure.

6.5.1.1.11 The servers shall contain sufficient memory to avoid frequent swapping and to handle peak load periods.

6.5.1.1.12 The servers memory capacity will initially provide at least 2 GB of main memory and be scaleable with the ability to provide 16 GB or more of main memory.

6.5.1.1.13 Each server shall contain disk storage capable of storing their operating system, application software and associated libraries, and appropriate swap space for virtual paging activities. A minimum of 20 GB of disk space will be available in each server for this system software in addition to storage designated for ITH operations.

### 6.6 System Components

The ITH system hardware components shall be commonly and commercially available from hardware vendors. They shall be capable of operating at least 10 years, with a 3 years on-site labor and part changing warranty.

6.6.1.1.1 The server shall use common, commercially available hardware components with proven track records.

6.6.1.1.2 Components shall be easily replaced.
6.6.1.1.3 Components which are currently depreciated or scheduled for
deprecation by their vendors shall not be used.
6.6.1.1.4 Components shall, where appropriate, be manageable using SNMP
(Simple Network Management Protocol).
6.6.1.1.5 All ITH system components shall operate in a standard office
environment.
6.6.1.1.6 The servers shall use SCSI peripherals. Separate SCSI buses will be
used for the main disk storage and any alternative peripherals such as tape
drives, CD recorders, and communication equipment.
6.6.1.1.7 Servers will include consoles to be used for boot up and administrative
purposes, and to display running status logs.

6.7 Main Storage

The ITH server shall have adequate hard disk space to store information
collected from service board, Gateway TIS, and other agencies. An off-line
backup storage system shall be in place to recover data lost or system failure if it
occurs.

6.7.1.1.1 The system shall provide main data storage to hold information
collected from agencies, service boards, and the Gateway TIS.
6.7.1.1.2 In addition to the above, the system shall have considerable excess
capacity to handle unforeseen events and moderate growth. This excess shall be
at least three times the initial needed capacity.
6.7.1.1.3 It shall use SCSI storage devices for better disk read/write operations.
6.7.1.1.4 It shall use a RAID 5 (Redundant Array of Inexpensive Disks) disk
stripping and parity checking configuration for fault tolerance.
6.7.1.1.5 Access time for the main storage drives shall be within the boundaries
common to the industrial standard.
6.7.1.1.6 Disk drives shall be checked for reliability during a testing period. Drives
that exhibit any errors or cannot meet the requirement shall be replaced.

6.8 Off-Line Storage

The ITH storage system shall have off-line backup devices and data recovering
procedure to resume system operation if mishap occurs.

6.8.1.1.1 The system shall have the capacity to archive and backup data to
magnetic tape, CD-ROM or comparable medium.
6.8.1.1.2 If a tape system is used, it shall be a high capacity system (e.g., a
35GB DLT).
6.8.1.1.3 The ITH shall perform weekly fully backup and daily incremental backup
during non-peak hours.
6.8.1.1.4 The backup system shall support data compression.
6.8.1.1.5 The system shall have the capacity to perform a backup in unattended mode.

6.8.1.1.6 System backups shall be accomplished either by:
   6.8.1.1.6.1 Providing adequate system capacity to hold the backup, or
   6.8.1.1.6.2 Providing an automatic tape loader or multi-tape peripheral or comparable device.

6.9 **Local Area Network**

All ITH components shall be connected in local area network (LAN) for resource and information sharing. A redundant LAN shall be in place to ensure the continuous communication among components if main LAN service disrupts.

6.9.1.1.1 The ITH servers, workstations and printers shall be connected by a Local Area Network.
6.9.1.1.2 The LAN shall operate at speeds of at least 100Mbps or greater.
6.9.1.1.3 The LAN shall be a secure LAN. Firewall technology shall be utilized to prevent unauthorized access to the LAN from the outside.

6.10 **Operating Environment**

The ITH hardware components shall operate in a normal computer room environment without the need of special attention. Devices shall be firmly mounted to ensure operational safety. System access control mechanism and policy shall be deployed for security purpose.

6.10.1.1.1 The system shall be housed in a standard office area; however, temperature, humidity, and dust will be controlled using appropriate air conditioning equipment.
6.10.1.1.2 Wherever possible, the components of the system shall be housed in standard equipment racks equipped with rack fans.
6.10.1.1.3 Equipment shall be secured to the equipment rack wherever possible.
6.10.1.1.4 Appropriate cable management practices shall be followed in cabling the components together (e.g., designated cable runs, removal of excess cable slack).
6.10.1.1.5 Cables shall be labeled and, where possible, color-coded.
6.10.1.1.6 Cable lengths shall not exceed industry standards to avoid signal attenuation.
6.10.1.1.7 Air conditioning shall operate 24 hours a day.
6.10.1.1.8 Filtered, fresh air shall be introduced into the air conditioner for comfort of the system operators.
6.10.1.1.9 Room lighting shall be dimmable and shall be oriented to prevent glare on workstation screens.
6.10.1.1.10 Sufficient lighting to identify room exits and walkways shall be provided as well as sufficient lighting for equipment maintenance and repair.

6.10.1.1.11 Non-static surfaces and carpeting shall be used.

6.10.1.1.12 A non-liquid based fire prevention system is recommended in the operating room.

6.10.1.1.13 Noise-reduction treatments shall be used.

6.10.1.1.14 Access to the operating room shall be limited, possibly through separate keys, access cards, or a combination lock system.

6.11 Power

The ITH shall have adequate power to maintain its normal operation for all devices. A power surge protection device shall be used to protect the system. Backup power supply and power generator shall be in place in case of an electricity outage.

6.11.1.1.1 The system shall be powered by standard, commercially available power.

6.11.1.1.2 Wattage requirements of the selected system components shall be followed.

6.11.1.1.3 A backup generator shall be installed to provide electric power for ITH operation during commercial power interruptions.

6.11.1.1.4 An uninterruptable power supply (UPS) shall be part of the system to provide an orderly system shutdown in the event of power interruption.

6.11.1.1.5 The UPS shall condition the incoming power.

6.11.1.1.6 The UPS shall have sufficient capacity to operate all parts of the system for one hour or more without incoming power.

6.11.1.1.7 The UPS shall support warning the servers or any operators logged on that power is going off to allow the servers to shutdown gracefully or the operator to perform a system shutdown.

6.11.1.1.8 The UPS shall be able to page an attendant in order to alert them that there is no line-power to the system.

6.12 Startup/Shutdown

The ITH system startup and shutdown procedure shall be documented in the operation manual. The operation manual shall also provide an emergency system shutdown procedure if abnormal operation occurs (natural disaster, power outage, etc.).

6.12.1.1.1 The ITH system startup and shutdown shall not exceed 10 minutes.

6.12.1.1.2 Power failure at the ITH shall cause the system to automatically shut down in a recoverable fashion. Equipment will be connected to the UPS and
will continue to operate up to the limit of the UPS and thereafter shut down in a recoverable fashion.

6.12.1.1.3 Upon return of power, the system shall automatically restart, perform necessary condition operations including recovering the system state at shutdown and recommence automatic operation. The recovery process shall automatically restart any ITH devices that are necessary for reliable system operation.

6.12.1.1.4 The recovery process shall include the automatic re-connection of networked systems along with notifying the attached systems that the ITH has returned to normal operation.

6.12.1.1.5 All systems shall be designed so that they may be started in any order without affecting the ITH operation.
7 COMMERCIAL SOFTWARE

The ITH design shall utilize available commercial software as much as it can to minimize system development time. The selection of commercial software shall consider its interoperability and compatibility with existing system in service boards and Gateway TIS. The ITH also shall consider if the software vendor will continuously support and provide upgrades to the selected software in the future.

7.1 Overall Requirements

7.1.1.1.1 The system shall make use of COTS (commercial off the shelf) products where possible.

7.2 Operating System

ITH operation system selection shall consider available COTS and be able to interface with systems in service boards and Gateway TIS. It shall have GUI to allow operators and administrator to control system easily.

7.2.1.1.1 The ITH operating system shall be one of the following operating systems:

- Various Unix system (Solaris, AIX, etc.)
- Microsoft Windows 2000
- Microsoft Windows NT
- Microsoft Windows 98

7.2.1.1.2 If a Unix operating system is used, there shall be only one Unix variety used (unless a lower cost, freely available UNIX is selected for particular supporting machines).

7.2.1.1.3 The operating system shall comply closely with POSIX standards.

7.2.1.1.4 Operating systems selected shall not be currently depreciated (discontinued or no longer supported by the vendor) or scheduled for depreciation by their vendors.

7.2.1.1.5 Newest versions of operating systems shall be used unless common opinion is that that newest version is unstable.

7.2.1.1.6 The main server operating system shall support the following characteristics:

- Multi-processors
- Preemptive multitasking
- Multithreading
- Multi-user support
- C2 security Level
- Virtual memory
• Multiple process priorities
• File system security
• System resource sharing control

7.2.1.1.7 The operating system selected shall operate using at least 32-bit memory addressing.
7.2.1.1.8 The operating system selected must support the CORBA, XML and Java tools selected.
7.2.1.1.9 The system shall be Year 2000 compliant.
7.2.1.1.10 It shall automatically monitor and test the operation of the server, all peripheral equipment and store the result to log files.
7.2.1.1.11 It shall inform the operator and administrator if abnormal operation occurs.

### 7.3 Graphical User Interface (GUI)

The ITH shall have GUI for ease of system control and manipulation. The GUI subsystem shall allow error correction, parameter changing, and performance monitoring without interrupting system operation.

7.3.1.1.1 The system shall display its user interface using a standard graphical user interface package.
7.3.1.1.2 The GUI platform shall be one of the following:
• Browser based using HTML and Java
• X Windows (and extensions, such as COSE)
• Microsoft Win32
7.3.1.1.3 Standard "look and feel" practices shall be used in designing the operation of the GUI. These include windowing behavior, use of the mouse, standard icons and visual controls, etc.

### 7.4 Networking Support

The ITH network shall support, at minimum, the TCP/IP communication protocol. It shall also support additional IPS/XPS and Novell NetWare protocol if ITH is required to connect to systems that use these protocols.

7.4.1.1.1 The ITH shall perform network management using SNMP (Simple Network Management Protocol) for the entire ITH system. The ITH shall be responsible for managing the routing parameters for the regional WAN.
7.4.1.1.2 The ITH shall operate the master DNS (Domain Name Services) for the ITH domain.
7.4.1.1.3 The ITH shall support a standard SMTP (Simple Mail Transfer Protocol) and POP3 based e-mail system.
7.5 Database Requirements

How data, commands, and messages are stored in the ITH system impacts the
its performance in terms of ease of system operation and message update/insert
time. Hence, the memory cash, buffer size, shared pool, and sort area in the ITH
database management system shall be configured to maximize system
performance. The database schema shall be carefully designed to fully
accommodate all information provided by the service boards and the Gateway
TIS.

7.5.1.1.1 The ITH shall use databases to stored message set, request
commands, and information received from service boards, Gateway TIS and
agencies in the region.

7.5.1.1.2 The ITH shall use a COTS database management system.

7.5.1.1.3 The message library shall be designed to hold messages and
commands shared by system components.

7.5.1.1.4 The data dictionary shall be designed as a logical structure for storing
detailed information of data element used by the system. It does the bookkeeping
task for maintaining the data definition, including how data can be retrieved,
modified, and generated. The data dictionary shall be consulted any time when
data retrieval or update operation is performed.

7.5.1.1.5 As part of data dictionary, the metadata shall be designed to provide
the information of “data about data.” The metadata shall include who
(transportation agency in real world and software process in computer system) is
responsible for generating and maintaining this data, data life cycle (i.e., how
often the data being updated), data accuracy, coordinate system used if it
contains information regarding spatial location, etc.

7.5.1.1.6 A formal data definition language (DDL) shall be used to define data
elements in an unambiguous way. This data definition language shall specify
how the data are stored and define a set of access methods and instructions to
facilitate the implementation details of data manipulation.

7.5.1.1.7 Depending upon the details of the design, the database component of
the ITH may be either an object-oriented database, or a relational database with
an object interface for easy system operation and maintenance.

7.5.1.1.8 It shall support the necessary transaction speed required by the
incoming and outgoing data transaction requirements.

7.5.1.1.9 It shall be scaleable (i.e., additional disk or memory shall increase
database storage and throughput capabilities).

7.5.1.1.10 It shall support and take advantage of operation on a symmetric
multiprocessor (SMP) machine.

7.5.1.1.11 It shall support the ability to coordinate data access among
processes with data locking facilities.

7.5.1.1.12 It shall support multiple, simultaneous transactions without
corruption.

7.5.1.1.13 It shall support extended transactions and shall allow rollbacks of
uncommitted transactions.
7.5.1.1.14 It shall support and take advantage of operation on a RAID storage unit.
7.5.1.1.15 The ITH database architecture shall be capable of supporting a distributed data model and support heterogeneous environment in that it shall perform transparent data management across different computing platforms.
7.5.1.1.16 It shall be capable of supporting parallel queries and parallel servers.
7.5.1.1.17 It shall be capable of handling all operators accessing the database simultaneously without a significant perceived decrease in user response time.
7.5.1.1.18 It shall be capable of supporting disk striping and RAID technologies.
7.5.1.1.19 It shall maintain concurrency control or the ability to lock data to prevent inconsistent views of the data.
7.5.1.1.20 It shall support the SQL2 standard and significant portions of the SQL3 standard.

7.6 Interprocess Communication

The object-oriented concept shall be adopted in ITH software design so that software components can be reused. The interprocess communication among components shall use DCOM (Distributed Common Object Model) IPC (Inter-Process Call), CORBA’s ORB, or Java RMI (Remote Procedure Call).

7.6.1.1.1 Interprocess communication between ITH and Gateway shall follow Gateway’s publisher and subscriber CORBA interface standard.
7.6.1.1.2 An ORB server shall at least operate on one ITH server for the communication with Gateway TIS.
7.6.1.1.3 Only the data storage subsystem shall access data from the databases directly. All other subsystems shall use IPC, CORBA or RMI calls to the data storage subsystem to obtain, add, delete, or modify data values.
7.6.1.1.4 The ITH shall design a Naming Service scheme to provide an interface between ITH and system in service boards and Gateway in order to data sharing.
7.6.1.1.5 The Event Service shall be used for appropriate event driven actions within the ITH and transit agencies in the region.
7.6.1.1.6 The Security Service shall be designed to insure the identity and authorizations of all transactions and requests within ITH system.

7.7 Web Server

The ITH shall have one web server to provide transit related information on its web site.

7.7.1.1.1 A COTS web server program shall be used
7.7.1.1.2 The web server machine shall be directly connected to the Internet.
7.7.1.1.3 The web server shall support the use of SSL (Secure Sockets Layer) data encryption.
7.7.1.1.4 The web server shall support "push" technology and the dynamic web content.

7.8 Testing

ITH shall design a software test procedure for the commercial software acceptance.

7.8.1.1.1 All ITH COTS software shall undergo an approved period of testing to determine if it meets ITH functional and design requirements.
7.8.1.1.2 Software acceptance and testing procedure shall clearly identify the pass and fail criteria for each software function.
7.8.1.1.3 Based on test results, the software vendors shall modify the component that fail to meet the requirement and re-submit the software for acceptance test within an approved period time.
8 ITH DEVELOPED SOFTWARE REQUIREMENTS

The ITH system is composed of commercial software and software that is designed to support specific ITH requirements. The ITH developed software shall mainly be the interface between components and core processes to serve as the decision-making engine in ITH.

8.1 Implementation Language

The selection of programming language and database DML (Data Manipulation Language) shall consider the compatibility with selected operating system, database management system, commercial software, and the future maintainability of ITH.

8.1.1.1.1 The programming language selected for the ITH software design shall be compliant to industrial standard (such as C/C++, and Java)
8.1.1.1.2 It shall be supported by major software vendors
8.1.1.1.3 It shall be capable of strong error and exception handling
8.1.1.1.4 It shall support multi-threading and multi-tasking
8.1.1.1.5 It shall support object-oriented design and modularity
8.1.1.1.6 It shall be commonly used by software developer

8.2 Implementation Model

The ITH design shall follow either the waterfall model or the spiral model of software engineering. It shall be well-planned, designed, implemented, and tested before system deployment.

8.2.1.1.1 The ITH system shall be implemented either by waterfall model or spiral model to build a system prototype before full-scale system design.
8.2.1.1.2 Design of the system shall use object-oriented strategies wherever possible.
8.2.1.1.3 A library of objects shall be created to support a range of applications within the system.
8.2.1.1.4 Data within the system shall be modeled using object-oriented approaches.

8.3 Software Engineering Requirements

The ITH system designer shall follow standard software development procedures by starting out from the high-level system architecture design and interface
control identification, then proceeding with software coding, system testing and system deployment.

8.3.1.1.1 The ITH system design team shall deliver the following items before, during and after system development.

- System Design Document
- Software Development Document
- Interface Control Document
- System Acceptance and Test Plan
- Database Schema Document
- System Administration Manual
- System Operation Manual
- Software source codes and executable codes
- Software Source Code Document

8.3.1.1.2 The system design document shall have the system architecture and data flow diagram to provide an overview of the ITH software system.

8.3.1.1.3 The Interface control document shall list all ITH software components, interfaces among them, and the functional requirements of the interfaces.

8.4 System Interface Requirements

At the early stage of ITH system design, it is essential to identify system components, interfaces, and data flow and execution flow between system components before conducting software programming.

The interface between components provides a flow control mechanism for isolating the inside operations in one component from the outside world to expedite system development process and to facilitate the effort of system maintenance. Because the interface access control is essential to an object-oriented system, it shall be carefully documented in the Interface Control Document (ICD) as part of system engineering processes. The interface in CORBA, DCOM or EJB (Enterprise Java Bean) shall be described formally in Interface Definition Language (IDL).

8.4.1.1.1 The Interface Control Document (ICD) shall be developed by system designers and reviewed by RTA.

8.4.1.1.2 For each interface, the ICD shall include interface specifications, data flow diagram, data type, data source, data destination, data identification, and data description etc.

8.5 Software Quality Requirements
As part of the system engineering procedure, the software quality assurance plan defines project quality control procedures, along with the risk management plan for ITH system development.

8.5.1 Compatibility

8.5.1.1 The software designed for ITH system shall be compatible with existing systems in service boards and Gateway TIS to ensure the interoperability. The compatibility consideration includes the selection of operating system, database management system, communication protocol, and message set, etc. Conducting an inventory of existing systems at the service boards and the Gateway is the first step for ITH system development.

8.5.2 Scalability

Scalability represents the ease with which a system can be expanded to a larger one when the time comes. The ITH shall be flexible enough to accommodate future expansion.

8.5.2.1 The ITH software shall be compatible with the existing operating systems and database management systems used by the service boards. It shall not only be able to handle baseline traffic flows, but also be scalable to satisfy future levels of demand.

8.5.2.1.1 To ensure the quality of ITH software development and system design, the Quality Assurance Procedure (QAP) shall be prepared by ITH system design team and approved by RTA.

8.5.2.1.2 In the quality assurance plan, the available resources and systems management organization shall be identified along with the emergency handling procedure (step-by-step working sequence) should a system crash or software bug occur.

8.5.2.1.3 The ITH system design and software development shall consider the compatibility, scalability, and reliability for the future system expansion.

8.6 Software Acceptance And Testing

System test and performance evaluation is the last phase of system development cycle before system deployment. Requirements for system acceptance are listed in the following to ensure the ITH meets functional requirements, performance requirements, and software design requirements.

8.6.1.1 A set of software test procedure shall be prepared by ITH system design team and approved by RTA as part of system acceptance plan.
8.6.1.1.2 The software acceptance plan shall include both functional and performance criteria for testing of system components, interfaces, and data elements.
8.6.1.1.3 All ITH developed software shall be thoroughly tested and subject to standard code reviews and analysis by independent analysts.
8.6.1.1.4 A series of tests shall be developed to ensure the operation of the ITH under standard and extraordinary operating conditions.
8.6.1.1.5 Software shall be developed to simulate data overload, bad data formats, incorrect requests, etc. for purposes of testing the ITH software and operation under these conditions.
9 WEB INTERFACE

The ITH Data Distribution subsystem uses a web page as one of its major ways of data dissemination. Because web site is mainly for providing transit service information to general public, it is critical that its design and information content shall be easily manipulated and digested by users.

9.1 Information Content

The ITH web site shall provide transit service information across service boards. It shall provide transit schedule, schedule adherence, fare, and estimate times of arrival at the stop/station. It shall also provide emergency messages on the web page if service is delayed due to human or natural causes.

9.1.1.1.1 ITH shall have web site to provide real-time and scheduled transit service.
9.1.1.1.2 It shall also provide freeway traffic condition information collected from Gateway TIS.
9.1.1.1.3 The ITH web site shall provide transit information for all service boards.
9.1.1.1.4 It shall avoid, if it is possible, duplicate information posted in service boards’ web site.
9.1.1.1.5 If it is necessary, both the public web page and the protected web page shall be provided to serve general public and transportation agencies in the region.
9.1.1.1.6 Public pages shall be provided to the general public and shall not be password protected.
9.1.1.1.7 Protected web pages shall be provided to identify agencies and broadcast media in the region. These pages shall provide more detailed information than information provided to the public.
9.1.1.1.8 The web information shall be updated at least once every five minutes; however, an update frequency greater than this is desirable depending upon cost and technology available at the time of design and development.

9.2 Technology

The ITH web page shall adopt latest web design technology to provide transit service information dynamically. It shall have security control mechanism to protect both public and private web pages.

9.2.1.1.1 The basic web pages shall support a wide range of browsers. The appearance of the pages shall be checked on Netscape Navigator and Microsoft Internet Explorer browsers.
9.2.1.1.2 The ITH shall provide public web pages supporting standard HTML (with allowed CGI actions) and using graphical presentation as much as it can to convey the message.
9.2.1.1.3 The ITH web page shall maintain an availability to the public of at least 99.9% on a 24/7 basis.
9.2.1.1.4 It shall also include a more advanced and interactive set of public web pages using Java.
9.2.1.1.5 The protected web page shall apply SSL (Secure Socket Layer) to logon encryption and authentication.
9.2.1.1.6 The ITH protected web page shall consider XML data feed as one of the options for data sharing among service boards.
9.2.1.1.7 The private pages shall allow privileged users to logon to the system with approved username and password for retrieval of critical information.
10 IMPEDIMENTS TO SEAMLESS REGIONAL TRANSIT ITS

There are a number of current or potential impediments to achieving the vision articulated in this document. These include technology and funding constraints, as well as institutional issues.

The rest of this section discusses a number of important impediments identified by the project team.

10.1 Technical Staff Resources

RTA service boards have done an excellent job of working with the resources available to them to maintain and upgrade their information technology (IT) infrastructure. However, they are regularly faced with the challenge of attracting and retaining staff with state of the art expertise.

The deployment of regional ITS will intensify this problem for service board IT departments. They will need to support additional systems involving leading edge technologies. This problem will be further exacerbated if service board technical staffs must learn and support CORBA at their sites. Service board IT departments may also face salary structure and other barriers to staffing up or upgrading staff to accomplish this.

In addition to key IT staff, user representatives from the Operating function and other essential functions must be able to devote the full necessary time for implementing these projects. Thus, backup support and/or consulting assistance may be required in these areas as well, so that assigned staff have adequate time and resources to fully address the needs of the project.

Finally, all systems and processes related to generating data for the ITH should be reexamined (and if necessary updated) to assure consistent, timely delivery of the needed information. For example, the process of service boards generating new schedules should be reviewed to assure that updated versions are forwarded to the ITS in a timely fashion.

These important service board infrastructure requirements should not be neglected as ITS advancements are planned for the region.

10.2 CAD/AVL systems

Based on current designs, there is cause for concern about the adequacy of data from service board CAD/AVL systems for driving regional traveler information
and service coordination applications of ITS. There are two principal factors contributing to this:

- Wireless bandwidth limitations, particularly at CTA and Pace, limit the amount of information that can be collected in real time from vehicles. There is only so much “space” available for data transmission. (For Metra, the wireless communications approach for full implementation of the TIMS system is still to be determined.)
- In order to implement usable AVL/CAD systems, CTA Bus and Pace are planning to use exception reporting protocols for data collection. This conserves bandwidth by only having a vehicle report if it is late or early by more than pre-defined thresholds. For regional ITS applications such as active signs, this means that vehicles late by less than the threshold will appear to be on time. Further, the threshold rates can be varied independently by each service board, and are unlikely to be uniform at any given time. This will affect the accuracy and acceptance of regional ITS systems. It also means that regional service coordination efforts such as the TCP system will be less effective.

One solution to overcoming this impediment would be the identification of a comprehensive regional wireless solution such as use of a public network. Such networks have the potential for providing the full capacity needed, and could be put in place without having to obtain new frequency assignments.

10.3 Exception Reporting

Unless and until the wireless communications issue is addressed and exception reporting is replaced with positive reporting, there is an additional problem for regional ITS systems. Unless told otherwise, these systems will assume that a scheduled service is operating and on time. However, current COTS CAD/AVL systems may not have the capability to report all service disruption events, including but not limited to:
- Missed pullouts or train starts due to driver/crew/relief failure to report
- Cancellations or annulments
- Short turns or other service adjustments to restore normal service

Here is a practical example. A bus is scheduled to pull out at 5:05 a.m., drive a short distance, then start a scheduled run. However, the bus driver is delayed getting to work and does not report until 5:20a.m. If there are no extra board or other drivers available, the bus will not depart until after 5:20. Since the run has not yet begun, and the driver has not signed in aboard the bus, there will be no schedule adherence reports issued. Therefore, regional ITS/traveler information systems will assume that the run is on time, and make that information available to the public.
Solutions to this situation include some combination of 1) modifications of CAD systems, 2) automation of garage-based driver/crew management functions, and 3) integration between the garage based systems and the CAD/AVL system. In an idealized situation, it could work like this: Drivers report in automatically to a reporting system using a smart card. When the reporting system notices a driver's failure to report, it sends a message to the CAD/AVL system indicating a late departure. The CAD/AVL system forwards this to the ITH as well as any systems it controls. The bus is then shown as “delayed”, with no ETAs reported until there is more definitive information.

This situation will need to be addressed in order to achieve truly accurate and reliable regional ITS.

10.4 Service Collaboration

The RTA Service Boards currently do a good job of coordinating plans for new service, and of working together to respond to emergencies. However, the unprecedented availability of extensive real-time data on operations and on service problems will create new opportunities for routine, day-to-day collaboration and service improvement.

In order to take advantage of these opportunities, it will be necessary to propagate a culture of collaboration between the service boards, through senior management example, training, and procedures. Senior management should particularly be aware of this opportunity and ensure that it is exploited in their organizations.

10.5 Data Sharing

It is common for surface transportation companies, freight and passenger, to resist sharing detailed performance information with the public. This is because people or organizations may try to use the information to damage the company and/or bring it under closer public scrutiny. For example, a local elected official may be able to monitor chronically late services in his or her municipality, then decide to hold hearings and bring pressure on the company to improve.

Since a core requirement of the RTIP and ITH is complete real time sharing of service data, any concerns of the service boards need to be fully explored and addressed if possible. These may include such things as additional funding to support increased checking of data integrity and consistency prior to a report being sent to the RTA.
10.6 Risks

Finally, it is important to keep in mind that the scale of transit ITS integration envisioned here has not been achieved anywhere in the United States, and is not common even in Europe or Asia. With such a leading edge effort, there is an inevitable degree of risk of failure. In particular, there is no COTS software for functions such as inter-carrier connection protection, or for integration between disparate transit dispatch systems.

This risk factor suggests that the RTA, service boards and transit professionals should be realistic about the possibility of failures, and look at ways such “failures” can be embraced as learning experiences, rather than feared as potential disasters. Extensive use of pilot projects and prototyping are two ways this can be accomplished. With realistic expectations and thorough testing, the risk should be manageable – and the rewards substantial.

10.7 Funding

Overall availability of funds for transit ITS projects in the region represents perhaps the biggest constraint on advancing the goals of the RTIP. This is true for several reasons:

- Competition for ITS technology funding at the national, state and local levels
- Lack of visibility of many ITS infrastructure improvements
- The substantial capital funding shortfall for the region’s transit system infrastructure.

Integration of service board ITS installations at the regional level cannot be done without additional funding that goes beyond individual service board needs. Adequate funding levels on a consistent basis will be required in order to achieve this integration and to comply with the spirit of the Final FTA Policy on Architecture Conformity.
APPENDIX A

ITH ARCHITECTURE FLOWS
The Illinois Transit Hub, part of the GCM Corridor Gateway ultimate design, will be a repository of real time and static transit information. This information will serve both travelers and transit agencies. The ITH will also drive some regional applications.

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FlowName: yellow pages information  
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<td>Pace ATSS Systems</td>
</tr>
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<td>Planned</td>
<td>Illinois Transit Hub</td>
<td>Pace ATSS Systems</td>
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<td>Planned</td>
<td>Illinois Transit Hub</td>
<td>Pace IBS Hub</td>
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<td>Illinois Transit Hub</td>
<td>Pace PT Contractors Dispatch</td>
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<td>Planned</td>
<td>Illinois Transit Hub</td>
<td>RTA Travel Information Center</td>
</tr>
<tr>
<td>transit and fare schedules</td>
<td>Planned</td>
<td>Illinois Transit Hub</td>
<td>RTA Travel Information Center</td>
</tr>
<tr>
<td>ISP operating parameter updates</td>
<td>Planned</td>
<td>Illinois Transit Hub_Personnel</td>
<td>Illinois Transit Hub</td>
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<th>FlowName</th>
<th>Status</th>
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<td>Metra TIMS/CCF</td>
<td>Metra PMS installations</td>
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<td>Planned</td>
<td>Metra TIMS/CCF</td>
<td>Metra Trains</td>
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<td>transit traveler information</td>
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<td>Metra TIMS/CCF</td>
<td>Metra Visual Paging System</td>
</tr>
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<td>Planned</td>
<td>Metra Trains</td>
<td>Metra TIMS/CCF</td>
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<td>Pace IBS Hub</td>
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<td>IDOT TSS</td>
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<td>Illinois Transit Hub</td>
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<td>Illinois Transit Hub</td>
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<td>Planned</td>
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<td>Planned</td>
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<td>Pace PT Contractor Vehicles</td>
<td>transit operations planning data</td>
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</tr>
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<td>Pace PT Contractors Dispatch_Personnel</td>
<td>transit operator display</td>
<td>Planned</td>
</tr>
<tr>
<td>Pace PT Contractors Dispatch_Personnel</td>
<td>Pace PT Contractors Dispatch</td>
<td>transit fleet manager inputs</td>
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</tr>
<tr>
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<td>Pace PT Contractors Dispatch</td>
<td>transit operator management data</td>
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</tr>
<tr>
<td>Roadway</td>
<td>CDOT TMC</td>
<td>request for right-of-way</td>
<td>Planned</td>
</tr>
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<td>Roadway</td>
<td>IDOT TSS</td>
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<td>CDOT TMC</td>
<td>request for right-of-way</td>
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<td>IDOT TSS</td>
<td>signal control status</td>
<td>Planned</td>
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<td>RTA Travel Information Center</td>
<td>Illinois Transit Hub</td>
<td>ISP coordination</td>
<td>Planned</td>
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<td>Illinois Transit Hub</td>
<td>transit information request</td>
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<td>RTA Travel Information Center_Personnel</td>
<td>ISP operating parameters</td>
<td>Planned</td>
</tr>
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<td>User Personal Computing Devices</td>
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Destination: User Personal Computing Devices

FlowName: yellow pages information  
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FlowName: ISP operating parameter updates  
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Destination: RTA Travel Information Center

FlowName: transit information user request  
Source: User Personal Computing Devices  
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FlowName: yellow pages request  
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REGIONAL TRANSPORTATION AUTHORITY
REGIONAL TRANSIT ITS PLAN PROJECT

FINAL TASK 4 REPORT:
ILLINOIS TRANSIT HUB
CONCEPTUAL NETWORK DESIGN

Prepared by:
Wilson Consulting
Unisource Network Services, Inc.

August 31, 2001
# TABLE OF CONTENTS

1 INTRODUCTION ............................................................................................................. 1  
1.1 Background ............................................................................................................... 1  
1.2 Purpose of this document ......................................................................................... 1  
1.3 Glossary of Terms ..................................................................................................... 2  
1.4 Related Reports ........................................................................................................ 8  

2 OUR APPROACH ......................................................................................................... 9  
2.1 The Assessment Process ......................................................................................... 9  
2.2 Principles Employed ............................................................................................... 10  

3 TECHNOLOGY GUIDELINES ..................................................................................... 12  
3.1 Gary-Chicago-Milwaukee (GCM) Corridor Project .................................................. 12  
3.2 Illinois Hub/Gateway ............................................................................................. 12  

4 NETWORK ARCHITECTURE BASELINE ASSESSMENT ........................................... 14  
4.1 Chicago Transit Authority (CTA) ............................................................................ 14  
4.1.1 CTA Control Center .......................................................................................... 16  
4.2 PACE ....................................................................................................................... 19  
4.3 Metra ......................................................................................................................... 21  

5 ILLINOIS TRANSIT HUB CONCEPTUAL NETWORK DESIGN .............................. 24  
5.1 Introduction ............................................................................................................. 24  
5.2 Vision ......................................................................................................................... 26  
5.3 Gap Analysis Results .............................................................................................. 28  
5.3.1 Network Design .................................................................................................. 28  
5.3.2 Illinois Transit Hub Facility Assessment ......................................................... 31  
5.4 Network Architecture Design ................................................................................. 38  

6 RECOMMENDED NEXT STEPS ............................................................................ 41  

APPENDIX A: NETWORK MANAGEMENT .................................................................. 43  
APPENDIX B: ATM SWITCH REQUIREMENTS ......................................................... 44  
APPENDIX B: ATM SWITCH REQUIREMENTS ......................................................... 45  
APPENDIX C: WIRELESS TECHNOLOGIES ............................................................ 47
1 INTRODUCTION

1.1 Background

During 2000, the Regional Transportation Authority (RTA) initiated efforts to develop a Regional Transit Intelligent Transportation Systems Plan (RTIP). Its broad purpose is to present a vision and a template for planned deployment and integration of transit Intelligent Transportation Systems (ITS). Once complete, the RTIP will encompass:

- Current and planned transit ITS installations through the region, with associated cost/benefit analyses.
- A vision for a seamlessly integrated public transportation system in northeastern Illinois, facilitated in part by ITS.
- A centralized information source for current static and real time transit information – i.e. Illinois Transit Hub (ITH).
- A conceptual communications network design.
- An assessment of public-private partnership possibilities.
- Provisions for public involvement and comments.
- A deployment strategy for upcoming ITS installations.

The RTIP will contribute to RTA's stated goals of:
- Studying and developing new transportation technologies.
- Ensuring regional coordination of service board programs.
- Developing regional standards and requirements to support the design of an integrated, seamless, regional public transportation system.

The RTIP will enable the RTA service boards (CTA, Metra and Pace) to design, develop, and test promising ITS solutions in order to determine their applicability for full implementation.

1.2 Purpose of this document

The purpose of this document is to provide an overview of the existing technology environments for each service board. In addition, this document provides a conceptual communications infrastructure design document highlighting the recommended technology usage and placement, the capacity designations of the communications facilities and the communications infrastructure management tool requirements.

The conceptual design provided in this document is intended to serve as a proof of concept and will evolve in conjunction with the ITH. This design is based on the functional requirements document in Draft Task 3 Report: Illinois Transit Hub Functional Requirements, dated December 5, 2000; the overall GCM Corridor Architecture, including GCM Documents #2-8140.02, Gateway Functional Requirements, #17200, Corridor Architecture Functional Requirements, and #17300, Corridor Architecture Interface Control Requirements; and, data gathered during interview sessions with key stakeholders.
This section defines the acronyms and selected other terms used in this document.

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABR</td>
<td>Available Bit Rate. ABR is an ATM layer service category for which the limiting ATM layer transfer characteristics provided by the network may change after connection establishment.</td>
</tr>
<tr>
<td>AFC</td>
<td>Automated Fare Collection.</td>
</tr>
<tr>
<td>AMPS</td>
<td>Advanced Mobile Phone Service.</td>
</tr>
<tr>
<td>Amtrak</td>
<td>Amtrak is a Federally chartered, for profit corporation charged with providing inter-city passenger rail service. Generally, Amtrak operates its trains over trackage owned and managed by private railroad companies. Amtrak also owns and operates Chicago Union Station.</td>
</tr>
<tr>
<td>ATM</td>
<td>Asynchronous Transfer Mode.</td>
</tr>
<tr>
<td>AToMMIB</td>
<td>ATM Optical Interface Management Information Base.</td>
</tr>
<tr>
<td>ATSS</td>
<td>Active Transit Station Sign Subsystem.</td>
</tr>
<tr>
<td>Backbone</td>
<td>The primary trunk/pipe carrying voice, data and video traffic between switches.</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>Size of the pipe through which data travels, or the amount of transport capacity.</td>
</tr>
<tr>
<td>BPSK</td>
<td>Bi-Phase Shift Key. BPSK is a digital frequency modulation technique used for sending data over a coaxial cable network.</td>
</tr>
<tr>
<td>CAC</td>
<td>Connection Admission Control.</td>
</tr>
<tr>
<td>CCF</td>
<td>Consolidated Control Facility. Metra main location for train operations and monitoring.</td>
</tr>
<tr>
<td>CDMA</td>
<td>Cellular Digital Multiple Access. CDMA is spread spectrum technology platform that enables multiple users to occupy the same channel and frequency spectrum at the same time.</td>
</tr>
<tr>
<td>CDOT</td>
<td>Chicago Department of Transportation.</td>
</tr>
<tr>
<td>CDPD</td>
<td>Cellular Digital Packet Data.</td>
</tr>
<tr>
<td>CDSI</td>
<td>Communication &amp; Data Systems Infrastructure. CDSI is the Wisconsin system for providing an infrastructure to interconnect and support various Wisconsin ITS installations.</td>
</tr>
<tr>
<td>Channel</td>
<td>The pathway between two locations on voice, data, and video network.</td>
</tr>
<tr>
<td>TERM</td>
<td>DEFINITION</td>
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<tr>
<td>-----------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>CIC</td>
<td>Customer Information Center. CTA’s primarily location for bus and rail operations and monitoring.</td>
</tr>
<tr>
<td>CORBA</td>
<td>Common Object Request Broker Architecture. A means for managing communications and interoperability between disparate applications systems within or between organizations.</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit. The brains of a computer.</td>
</tr>
<tr>
<td>CTA</td>
<td>Chicago Transit Authority. The CTA operates or contracts for fixed route bus, rapid rail and ADA paratransit services in the City of Chicago and ring suburbs.</td>
</tr>
<tr>
<td>Data Protocols</td>
<td>The protocols are standard, formal descriptions of rules and conventions that govern how devices on the network exchange information.</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Control Protocol.</td>
</tr>
<tr>
<td>DMZ</td>
<td>Demilitarized Zone.</td>
</tr>
<tr>
<td>DNS</td>
<td>Domain Name Services, which is used by the TCP/IP protocol to discover and maintain addressing information distributed amongst the various network devices. DNS references devices by name (unis.com), instead of IP Address (172.84.12.15).</td>
</tr>
<tr>
<td>DS-1</td>
<td>Digital Service, Level 1. Represents 1.544 MBPS digital trunk service over a T-1 line.</td>
</tr>
<tr>
<td>DSI</td>
<td>Data Source Interface.</td>
</tr>
<tr>
<td>DSL</td>
<td>Digital Subscriber Line.</td>
</tr>
<tr>
<td>EDGE</td>
<td>A physical device which is capable of forwarding packets between legacy inter-working interfaces (e.g., Ethernet, Token Ring, etc.) and ATM interfaces. These interfaces are based on data link and network layer information. However, they do not participate in the execution of any network layer routing protocol.</td>
</tr>
<tr>
<td>EFCI</td>
<td>Explicit Forward Congestion Indication. EFCI is an indication in the ATM cell header. A network element in an impending-congested state or a congested state may set EFCI so that this indication may be examined by the destination end-system.</td>
</tr>
<tr>
<td>FCAPS</td>
<td>Fault, Configuration, Accounting, Performance And Security. The Open Standard Interface core for network management.</td>
</tr>
<tr>
<td>FES</td>
<td>Fixed End System.</td>
</tr>
<tr>
<td>GCM</td>
<td>Gary-Chicago-Milwaukee.</td>
</tr>
<tr>
<td>GCOM</td>
<td>Gateway Corridor Object Model. The GCOM is being</td>
</tr>
<tr>
<td>TERM</td>
<td>DEFINITION</td>
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<td>---------------------</td>
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<tr>
<td>developed as part of the Gateway ITS design. It will encompass all information elements handled by the Gateway. It is expected that the transit elements of CGOM will correspond to the TCIP Business Area Objects, which are part of the NTCIP standards.</td>
<td></td>
</tr>
<tr>
<td>GPRS</td>
<td>General Packet Radio Service.</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning Satellites.</td>
</tr>
<tr>
<td>Greyhound</td>
<td>Greyhound Lines, Inc. Initial contact has been made with Greyhound about participating in the ITH.</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System For Mobile.</td>
</tr>
<tr>
<td>ICD</td>
<td>Interface Control Document.</td>
</tr>
<tr>
<td>IDL</td>
<td>Interface Definition Language.</td>
</tr>
<tr>
<td>IDOT</td>
<td>Illinois Department of Transportation.</td>
</tr>
<tr>
<td>IDOT COM Center</td>
<td>IDOT Communications Center. The COM Center is IDOT’s consolidated incident management center. It also controls the Kennedy Expressway reversible lanes and the highway advisory radio around the region.</td>
</tr>
<tr>
<td>IDOT TSC</td>
<td>IDOT Traffic Systems Center. The IDOT TSC is responsible for monitoring traffic flow and responding to them with the tools available to them. It also operates a number of variable message signs (VMS) used to provide advisory messages to motorists.</td>
</tr>
<tr>
<td>IH</td>
<td>Illinois Hub.</td>
</tr>
<tr>
<td>ILMI</td>
<td>Integrated Local Management Interface. An ATM Forum defined interim specification for network management functions between an end-user and a public or private network and between a public network and a private network.</td>
</tr>
<tr>
<td>IPS</td>
<td>Itinerary Planning System. The software package installed by the Regional Transportation Authority’s Travel Information Center (TIC) to generate trip itineraries for callers inquiring about transit service.</td>
</tr>
<tr>
<td>IPX/SPX</td>
<td>Inter-network Packet eXchange/Sequenced Packet eXchange. A pair of network protocols associated with Novell NetWare.</td>
</tr>
<tr>
<td>TERM</td>
<td>DEFINITION</td>
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</tr>
<tr>
<td>ISP</td>
<td>Information Service Provider.</td>
</tr>
<tr>
<td>ISUP</td>
<td>ISDN User Part. Layer of SS7 Protocol. ISUP Trunk Signaling replaces multi-frequency in-band signaling for inter-office calls. ISUP Trunk Signaling provides the functionality for interoffice CLASS services and is a critical element in advanced intelligent network (AIN) functionality.</td>
</tr>
<tr>
<td>ITH</td>
<td>Illinois Transit Hub.</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation Systems. Transportation technology systems enabled by computer processors and/or communications.</td>
</tr>
<tr>
<td>ITU</td>
<td>International Telecommunication Union.</td>
</tr>
<tr>
<td>KYD</td>
<td>Kensington Yard Station.</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network.</td>
</tr>
<tr>
<td>LMDS</td>
<td>Local to Multi-point Distribution System, a wireless technology for voice and data application.</td>
</tr>
<tr>
<td>MBPS</td>
<td>Megabits (million bits) per second.</td>
</tr>
<tr>
<td>MDBS</td>
<td>Mobile Data Bus Station.</td>
</tr>
<tr>
<td>MDIS</td>
<td>Mobile Data Interface Station, which is part of CDPD system.</td>
</tr>
<tr>
<td>MDS</td>
<td>Mobile Database Station.</td>
</tr>
<tr>
<td>Metra</td>
<td>The RTA Service Board charged with providing commuter rail services in northeastern Illinois.</td>
</tr>
<tr>
<td>MIB</td>
<td>Management Information Base.</td>
</tr>
<tr>
<td>MTBF</td>
<td>Mean time between failures.</td>
</tr>
<tr>
<td>NAMPS</td>
<td>Narrow Band Analog Mobile Phone Service.</td>
</tr>
<tr>
<td>NAT</td>
<td>Network Address Translation. IP addresses for the private side of the network that are converted by a device to access the public network.</td>
</tr>
<tr>
<td>NNI</td>
<td>Network Node Interface. An interface between ATM switches defined as the interface between two network nodes.</td>
</tr>
<tr>
<td>NTCIP</td>
<td>National Transportation Communications for ITS Protocol.</td>
</tr>
<tr>
<td>OC-12</td>
<td>A fiber optic line that operates at 622 MBPS.</td>
</tr>
<tr>
<td>OC-3</td>
<td>A fiber optic line that operates at 155 MBPS.</td>
</tr>
<tr>
<td>TERM</td>
<td>DEFINITION</td>
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<tr>
<td>------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>OSI</td>
<td>Open Standard Interface.</td>
</tr>
<tr>
<td>OSPF</td>
<td>Open Shortest Path First.</td>
</tr>
<tr>
<td>Pace</td>
<td>Pace Suburban Bus Service. Pace provides fixed route bus services, along</td>
</tr>
<tr>
<td></td>
<td>with contracted community dial-a-ride, ADA paratransit services, and</td>
</tr>
<tr>
<td></td>
<td>sponsored vanpool services.</td>
</tr>
<tr>
<td>PCR</td>
<td>Peak Cell Rate.</td>
</tr>
<tr>
<td>PCS</td>
<td>Personal Communication System.</td>
</tr>
<tr>
<td>PMS</td>
<td>Parking Management System.</td>
</tr>
<tr>
<td>PNNI</td>
<td>Private Network-Network Interface.</td>
</tr>
<tr>
<td>PPP</td>
<td>Point to Point Protocol.</td>
</tr>
<tr>
<td>PT</td>
<td>Paratransit.</td>
</tr>
<tr>
<td>PVC</td>
<td>Permanent Virtual Circuits.</td>
</tr>
<tr>
<td>RAID</td>
<td>Redundant Array of Inexpensive Disks.</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency.</td>
</tr>
<tr>
<td>RFC</td>
<td>Request for Comments.</td>
</tr>
<tr>
<td>RFI</td>
<td>Request For Information.</td>
</tr>
<tr>
<td>RMON/RMON2</td>
<td>Remote Network Monitoring Version 1 And 2.</td>
</tr>
<tr>
<td>RSS</td>
<td>Randolph Street Station.</td>
</tr>
<tr>
<td>RTA</td>
<td>Regional Transportation Authority.</td>
</tr>
<tr>
<td>RTIP</td>
<td>Regional Transit Intelligent Transportation Systems Plan.</td>
</tr>
<tr>
<td>SCSI</td>
<td>Small Computer System Interface. A standard and a bus for communications</td>
</tr>
<tr>
<td></td>
<td>between a PC CPU and peripheral devices such as disk drives and scanners.</td>
</tr>
<tr>
<td>SLA</td>
<td>Service Level Agreement.</td>
</tr>
<tr>
<td>SMI</td>
<td>Structure Of Management Information.</td>
</tr>
<tr>
<td>SMP</td>
<td>Symmetric Multiprocessor.</td>
</tr>
<tr>
<td>SNMP</td>
<td>Simple Network Management Protocol, a standard used in managing TCP/IP</td>
</tr>
<tr>
<td></td>
<td>networks. SMNP communicates information between the network management</td>
</tr>
<tr>
<td></td>
<td>console(s) and network devices.</td>
</tr>
<tr>
<td>Sonet</td>
<td>Synchronous Optical Network.</td>
</tr>
<tr>
<td>TERM</td>
<td>DEFINITION</td>
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<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SVC</td>
<td>Switched Virtual Circuit. A connection established via signaling. The user defines the endpoints when the call is initiated.</td>
</tr>
<tr>
<td>TACS</td>
<td>Total Access Communication System.</td>
</tr>
<tr>
<td>TCIP</td>
<td>Transit Communications Interface Profiles.</td>
</tr>
<tr>
<td>TCP</td>
<td>Transfer Connection Protection.</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>Transmission Control Protocol/Internet Protocol. A networking protocol that supports communications across networks between diverse computers and operating systems.</td>
</tr>
<tr>
<td>TDMA</td>
<td>Time Division Multiple Access.</td>
</tr>
<tr>
<td>TIC</td>
<td>Travel Information Center.</td>
</tr>
<tr>
<td>TIMS</td>
<td>Metra’s Train Information Management System. A system employing GPS AVL receivers on trains to provide frequent updates on location. This system will support better passenger information. It could also serve as Metra’s point of interface with the ITH.</td>
</tr>
<tr>
<td>TIS</td>
<td>Transportation Information System.</td>
</tr>
<tr>
<td>TMN</td>
<td>Telecommunication Management Network.</td>
</tr>
<tr>
<td>Trunk</td>
<td>A switch to switch, or switch to Tandem connection.</td>
</tr>
<tr>
<td>TTY/TDD</td>
<td>A technology allowing the hearing impaired to converse over standard telephone lines.</td>
</tr>
<tr>
<td>UNI</td>
<td>User-Network Interface. An interface point between ATM end-users and a private ATM switch, or between a private ATM switch and the public carrier ATM network.</td>
</tr>
<tr>
<td>UNIX</td>
<td>A computer operating system.</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptable power supply.</td>
</tr>
<tr>
<td>USDOT</td>
<td>United States Department of Transportation.</td>
</tr>
<tr>
<td>VCC</td>
<td>Virtual Channel Connection. A concatenation of VCLs that extends between the points where the ATM service users accesses the ATM layer.</td>
</tr>
<tr>
<td>VCI</td>
<td>Virtual Channel Identifier. A unique numerical tag as defined by a 16-bit field in the ATM cell header that identifies a virtual channel over which the cell is to travel.</td>
</tr>
<tr>
<td>VPI</td>
<td>Virtual Path Identifier. An eight-bit field in the ATM cell header, which indicates the virtual path over which the cell should be transmits data.</td>
</tr>
</tbody>
</table>
### TERMS AND DEFINITIONS

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
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</thead>
<tbody>
<tr>
<td>routed.</td>
<td>Virtual Source/Virtual Destination.</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide Area Network, a data network that provides connection between several campus locations/sites, either within the same city or between cities and countries.</td>
</tr>
<tr>
<td>W-CDMA</td>
<td>Wideband Code Division Multiple Access.</td>
</tr>
<tr>
<td>WWW</td>
<td>World Wide Web.</td>
</tr>
</tbody>
</table>

#### 1.4 Related Reports

This document is the third of a series of documents being produced as part of the RTIP. The reports, to date, are as follows:

- **Draft Tasks 1-2 Report**, which identifies RTIP stakeholders, transit information needs of travelers, service providers and information service providers, and existing and planned Transit ITS projects.
- **Draft Task 3 Report: Illinois Transit Hub Functional Requirements**, which identify and details the functional requirements for the ITH.
2 OUR APPROACH

2.1 The Assessment Process

To prepare for conducting the analysis, Unisource met with Wilson Consulting to gain a better understanding of transit systems and all the specifications relevant to the delivery of the project. In addition, pertinent contact information was provided for each of the service boards associated with the project. Based on information ascertained in the meetings, it is Unisource’s understanding that the primary driver for the conceptual design is the Gary-Chicago-Milwaukee (GCM) Regional Architecture, which conforms to the National Intelligent Transportation Systems Architecture (NITSA). Other sources critical to the ITH conceptual design include the RTA RTIP Draft Task 3 Report (Functional Requirements) and information gathered from the interview sessions with each service board.

Unisource continued the process by scheduling and conducting a series of interviews with essential stakeholders. The objectives of this exercise was to learn more about the technology environment, gather network design data, understand any technical issues or concerns, and discern the business direction from a technology standpoint. Table 2.1.1 provides a summary of the participants.

<table>
<thead>
<tr>
<th>Transit Entity</th>
<th>Name</th>
<th>Representing</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA</td>
<td>Andy Rizzuto</td>
<td>Information Systems</td>
</tr>
<tr>
<td>CTA</td>
<td>Tom Pleuger</td>
<td>Control Center</td>
</tr>
<tr>
<td>CTA</td>
<td>Ruben Madrigal</td>
<td>Fiber-optics/Network Infrastructure Maintenance</td>
</tr>
<tr>
<td>Metra</td>
<td>Sharon Austin</td>
<td>Customer Communications and Station Services</td>
</tr>
<tr>
<td>Metra</td>
<td>Steve Wojtkiewicz</td>
<td>Information Systems and Telecommunications Network Architecture</td>
</tr>
<tr>
<td>Metra</td>
<td>Harry Kamer</td>
<td>Information Systems End-user Computing</td>
</tr>
<tr>
<td>Metra</td>
<td>Dick Corrin</td>
<td>Consolidated Control Facility</td>
</tr>
<tr>
<td>Metra</td>
<td>Bruce Marcheschi</td>
<td>Communications and Engineering</td>
</tr>
<tr>
<td>PACE</td>
<td>John Rosengarten</td>
<td>Information Systems</td>
</tr>
<tr>
<td>IDOT/Parsons Transportation Group</td>
<td>Herb Nitz</td>
<td>Illinois Hub/Gateway</td>
</tr>
<tr>
<td>RTA</td>
<td>Milton Stanley</td>
<td>Information Systems</td>
</tr>
<tr>
<td>RTA</td>
<td>Phillip Shayne</td>
<td>Travel Information Center</td>
</tr>
</tbody>
</table>

Table 2.1.1 - Interviews
Information gathered during this phase of the project was used to establish the baseline technology platform for each entity.

The final step in the assessment involved a comprehensive review and analysis of the ITS specifications and ITH functional requirements in comparison to the baseline information. The results of this analysis are the catalyst for the creation of the ITH Conceptual Network Design.

2.2 Principles Employed

One of the most significant factors in the evolution and acceleration of the information era has been the advent of digital network transport. Digital and fiber optic transmission communication (i.e. wave division multiplexing) are raising the baseline expectations for speed, capacity and overall performance of digital data communication. The LAN and WAN speeds are converging to create seamless high-speed connections across the backbone.

When designing a network, specific emphasis is placed on the means for transporting data; protocols that will be used to transmit data over the backbone; and the network topology. In addition, a hardware evaluation is typically conducted to assess the type of hardware that would be required to meet the functionality and performance expectations, as well as manage the environment. Another study that is generally performed is an analysis of the applications that will be used in the environment. The focus of such analysis would be to understand the idiosyncrasies of the applications and their potential impact to the network design.

Taking all of the above into consideration, it is important to establish guiding principles and adhere to them throughout the process to ensure a quality design. Unisource adopted the following “best practice” design engineering principles, where appropriate, to establish the conceptual communications network design for the ITH:

- **Requirements Analysis** - The process which documents the functional and performance requirements of the network design. Typically, this analysis addresses the technical requirements that have been derived from the business goals, objective, and/or vision.
- **Networking Direction** – Examination of the standard and emerging technologies.
- **Traffic Engineering** - Maintaining the network at an optimal level, using proper management tools to monitor and allocate bandwidth resource for prioritized traffic and adhere to SLAs or other quality of service parameters.
- **Addressing Scheme** – Understanding which class of Internet addresses would be deployed—Class A, B or C; and, documenting the number of devices and access points in the network to ensure adequate addresses for the environment.
- **Transmission Selection** – Identifying the appropriate physical media to be used to transport multi-media traffic.
- **Hardware Selection** - The process to identify the main components of network design, understand the characteristics of the devices, generate specifications, and evaluate standard compliance requirement.
• Protocol Selection – The process of identifying the methods for communicating between devices. LAN and WAN protocols are selected based on the type of data transmission in use and the requirements of the applications installed in the environment. The most common standard protocols for providing communication among network devices and applications are the Transmission Control Protocol (TCP) and Internet Protocols (IP).

• Service Selection – The process of evaluating “who” will be responsible for operational support, and establishing the appropriate service level agreements (SLA) and contractual obligations.

• Vendor Selection - The process of selecting qualified vendors to provide various devices or components of the network.

• Network Management - The system or means by which the network is monitored and maintained to ensure maximum availability, and a trouble-free operational environment.

• Capacity Planning – An analysis of the major network components to establish an acceptable level of “growth” and assess if the components are within those limits.
3 TECHNOLOGY GUIDELINES

3.1 Gary-Chicago-Milwaukee (GCM) Corridor Project

The Gary-Chicago-Milwaukee (GCM) Corridor links the transportation infrastructures of sixteen urbanized counties in the states of Illinois, Indiana, and Wisconsin including all major freeways, airports, transit, commuter and freight rail systems. This corridor was selected by the U.S. Department of Transportation (USDOT) to receive priority funding under the ISTEA legislation for the deployment of ITS initiatives. A twenty-year Corridor Plan has been developed which outlines the creation of a state-of-the-art, integrated corridor with a transportation information system (TIS) known as the Gateway as its core.

The GCM Corridor architecture is made up of seven levels. The Gateway is located at the top layer known as the Corridor Hub level. Below this layer is the Regional Hub Level which is made up of the Illinois Hub (IH), Borman ATMS in Indiana, and CDSI in Wisconsin. The ITH is defined as a Subregional Hub that communicates directly with the Illinois Hub (currently part of the Gateway). The regional hubs are responsible for processing any data that is received from their sources at the ITS Subsystem Level and passing this information to Gateway. Similarly, the ITH processes data it receives and forwards it to the Illinois Hub. The Gateway then processes and stores the information. Subsequently, it makes the information available to users (via the Regional Hubs and ITH) through its Subscriber/Publisher functions and through its Web Site. There is also a provision for a Data Source Interface (DSI) Level to allow for conversion from subsystem protocols, data formats to the Corridor standard protocols, and data formats, where necessary.

3.2 Illinois Hub/Gateway

The Illinois Hub (IH) is currently co-located with the Illinois Gateway Communication Platform. At present, the IH is not designed. Therefore, for the purposes of the ITH Conceptual Network Design, the IH and the Gateway will be referred to as one entity.

The Gateway’s primary function is to handle the interchange of data between the hubs located within the GCM Corridor—i.e. Indiana, Illinois, and Wisconsin. The Gateway is in its initial phase of implementation. The backbone for the Gateway will be ATM, using Marconi Data Systems equipment. The decision to use ATM was driven by the amount of video expected to be transported across the links to the various systems. Marconi’s solution for network management will be used to monitor and maintain the systems.Checkpoint Firewall has also been procured to address security in the network infrastructure. The Gateway design will use DSL technology, Fractional T1s, Full T1s or Frame Relay for sites that have no/minimal video requirements. Figure 3.2.1 depicts the Gateway Communications initial design that is currently being deployed. Additional information on the Gateway Communications can be found in Technical Memorandum Gateway Communications dated July 11, 2000, Parsons Transportation Group, Inc.
Figure 3.2.1

Network Diagram:
- Internet UIC Network
- AI Lab Main Router
- Public Web Server
- Secondary Public Web Server
- AI Lab to Gateway Router w/T1 CSU/DSU
- Gateway to AI Lab Router w/T1 CSU/DSU
- T1 Link
- Gateway Printer
- ATM Switch
- ESX3000
- Modem Bank
- Gateway Server
- Tape Backup
- Disk Array
- Firewall/NAT
- Future GCM ATM Network
- ISP
- ISP Router w/56k CSU/DSU
- ISP Chgo DSI
- ISP15 DSI
- Monitor DSI
- *999 Server
- NWCD DSI
- ETP DSI
- Router
- DSL Modem
- 256K DSL
- OC12
- 10BT
- 100BT
- 10BT
- 10BT
- OC3
- OC3
- OC3
- OC3
- OC3
- OC3
- 256K DSL
- 56K Link
- (Future)
- * (Shaded equipment supplied by IDC)
4 NETWORK ARCHITECTURE BASELINE ASSESSMENT

This section of the document addresses the results of the discussions held with each of the three RTA Service Boards. As previously mentioned, the purpose of these meetings was to:

- Understand the technology deployed in each environment.
- Gather network design data.
- Identify any technical issues or concerns.
- Gain knowledge of any business decisions that will have an impact on the technology platform.

A synopsis of the findings and a graphical representation of the technology infrastructure are provided in the succeeding subsections. This information serves as the baseline assessment for each service board, and it is used in the development of conceptual design.

4.1 Chicago Transit Authority (CTA)

The CTA has three main network environments:

- Information Systems located at Merchandise Mart.
- Automated Fare Collection (AFC) located at 901 W. Division Street.
- Control Center located at 120 N. Racine.

The CTA network services over 750 users throughout the Chicagoland region. These users include administration and support, rail platforms, buses, and the shops and garages. Below are the highlights of the network architecture:

- Primarily a mainframe centric technology platform with plans to transform to a more distributed architecture over the next few years.
- Wide Area Network (WAN) is based on Frame Relay (provided by Ameritech) and ATM technology.
- The Frame Relay extends to 35 remote locations.
- Transmission speed on the Frame Relay varies from 56K to T1 based on the site.
- All devices in the network converge to one core Cisco 7513 router.
- Most of the fiber in CTA terminates at the 120 N. Racine location.
  - Orange Line – eight strands T3 fiber optics from 120 N. Racine to Midway Airport. There is a fiber node at every rail station along the line.
  - Green Line – 96 strands from Harrison to 63rd street on the south and from Harlem to Clinton on the west. This line has OC3 and OC1 rings that were installed approximately 3 years ago. There is a fiber node at every rail station along the line.
  - Red Line – 96 strands from Howard Street to Mart Platform and around the loop to 17th Tower. This fiber was installed by 21st Century Telecom Group, Inc. Currently, there is no equipment installed with this fiber. The Red/Blue Project
will procure and install equipment at five node locations—Mart Platform, Armitage Tower, North Unit, Loyola, and Howard Tower.

- The Infrastructure Wiring Project will connect 25 locations (bus garages, rail shops, and terminals). However, due to some limitations in pulling cable over streets/under pavement, these locations may not connect back to the mainframe in the Information Systems Department. This project is part of a major effort to try to connect all fibers on all the rail lines, with the ultimate goal of migrating away from Frame Relay.
- The State Street Project will provide 49 strands of fiber optics and 75 copper cables in both tubes A (northbound) and B (southbound). These cables will be installed along State Street from Armitage to Roosevelt.
- The O'Hare/Blue Line Project will install fiber-optics cable from O'Hare to Jackson Park and will install eight nodes along the line.
- SONET Ring downtown.
- LAN Wiring is CAT5 and fiber.
- Protocols being used across the network are TCP/IP, IPX/SPX, and SNA. IP is used directly to the mainframe via a front-end processor. SNA is being handled via permanent virtual circuits (PVCs).
- Access to the Internet is provided through 21st Century Telecom Group, Inc.
- Currently, there are no network management tools deployed in the Information Systems network environment. Therefore, performance statistics are not available.
- The SONET network has minimal management tools available, and the network is monitored in a “reactionary” mode of operation. More sophisticated tools are needed to manage the operation in a proactive manner.
- Disaster Recovery Services are provided by Comdisco.

Typical data that flows within the CTA LAN/WAN includes, but is not limited to, road calls for the buses, email/internet access, historical data from the mainframe, and weather advisory messages. In the future, there are plans to install video on all rail lines. The fiber to support the video is already in place. In addition, there is a need to have cellular telephone service in the subways.

In the current design, the CTA core router is a single point of failure. Although spare parts are maintained onsite, the lack of a network management system coupled with a failure in the router could result in a major communication outage. Despite this shortfall, the CTA network architecture is, by far, the most complex and advanced network amongst the service boards. Figure 4.1.1 depicts the CTA Information Systems Network Architecture.

The focus of the ITH is to connect with the operating hubs of each service board. In the case of CTA, the Control Center is the hub for management of operations. The next section provides additional information about the Control Center facilities and installed systems.
4.1.1 CTA Control Center

The CTA Control Center is located at 120 N. Racine. This facility is the “heart” of the CTA Operation. Real-time status of the buses, trains, and power stations is monitored from this location. The Control Center is a 24x7 Operation, which employs 20 – 50 staff. The facility has two separate feeds coming in from ComEd, and has a building UPS with a battery life of 8-10 hours, backed up by six generators. The LAN is Ethernet using Cabletron Concentrators and CAT5 cabling. The primary protocol is TCP/IP. Application services are generated from three Sun Microsystem Servers and six Compaq/DEC Alphas. Unix Operating System and Oracle Database are used on all critical systems. The network infrastructure is being monitored and maintained using HP Openview. Checkpoint Firewall is being used to security. In the future, the Control Center expects to be transmitting and receiving video data.

For wireless communications, the Control Center is using Motorola Radio Systems. Currently, there is only enough bandwidth to manage the existing voice and data loads. The Control Center is working with the FCC to fractionalize the existing channels so they can gain more bandwidth access. Data traffic at this location is very static and predictable. At peak time, the capacity is running less than 30%. Therefore, there is minimal a possibility of lost data.

The Control Center is currently working with IDOT to share information for four systems:

- Automated Bus Management System/BusWatch - Orbital Sciences (Oracle based).
- Rail Systems – Sysca.
- Power Control - QEI Systems.
- Administrative business users.

A graphical representation of the Control Center Network is provided in Figure 4.1.1.1.
CTA Information Services
Network Architecture
(Apparel Center)

Legend:
- Fast Ethernet
- Fiber
- Token Ring
- Frame Relay
- FDDI

Frame Relay Network

Merchandise Mart
Located in Rooms 730, 714, 734, 768, 782

Figure 4.1.1
Figure 4.1.1.1
4.2 PACE

Pace’s network architecture is based on their PACENET backbone interfacing with multiple LANs with three operating systems—Window NT 4.0, Novell, and Hewlett Packard HP-UX. PACENET is Pace’s reference to its network backbone infrastructure. The backbone is a Cisco 3200 Catalyst Switch located at the headquarters office in Arlington Heights, IL. The switch provides WAN connectivity to 10 remote Pace locations and four vendor locations. A typical site will have an Amazon router and hub GFI controller, and data collection databases. All data is transmitted using TCP/IP. Data traveling across the backbone can operate at a maximum speed of 100 MBPS. The Internet Web services utilize a T1 circuit provided and maintained by Ameritech. In the current design, there is minimal redundancy built into the infrastructure, and the core switch is a single point of failure. Figure 4.2.1 depicts the Pace Network Architecture.

Pace has plans to upgrade the network infrastructure, thus enhance the data processing capabilities of the overall environment. The plan includes an expansion of the infrastructure to connect nine additional dispatching division located within six counties. In addition, Pace will be upgrading the databases for the Traffic Signal Priority and Engine Transmission Maintenance Systems. Current plans are to procure two SQL 7.0 servers operating at 866 MHz with 9.1 GB disk storage, configured in Raid 5. These systems will house the relational databases. In addition, three routers with redundant power supplies are being procured for the environment. Pace has issued a Request for Information (RFI) to identify potential vendors that may be contracted to support this effort.
PACENET SD

Cisco 10/100 Switch

HEWLETT PACKARD NetServer LH Pro

INTERNET T1

Figure 4.2.1
4.3 Metra

Metra’s Customer Information Center (CIC) gathers information from all rail lines and disseminates the data to users on an “as needed” basis. Possible recipients of the data include:

- RTA Travel Information Center.
- Shadow Traffic.
- Metra Passenger Services.
- Metra Police.
- Metra Media Relationships.
- Customers on rail platforms.

The Customer Communications Network Group is currently working on installing an Internet connection to pass information currently being handled by the telephone—notifications of delays, etc. Today, only Metra headquarters and the Consolidated Control Facility (CCF) have an installed LAN. The four remote offices have no LAN/WAN connectivity. Most of the data generated at Metra is batch-oriented and is earmarked for the mainframe computer.

The Customer Communications Network Group is currently piloting the GeoFocus TrainTrac system, known on Metra as the Train Information Management System (TIMS). TIMS is a train tracking system based on global positioning. This system uses satellite for transmitting and receiving data. The Group has received approval from the Metra Board to move forward with the pilot and investigate implementation of the system on all train lines.

The CCF is the core communication facility for Metra. The CCF uses an Alstrom Control/Communications System to monitor operators who are lining the signals. Dispatchers also control the trains using the system. The CCF monitors/controls traffic for Metra and the Freight rail system. Within the next year, the Scada Electric Train System will be relocated from Randolph Street to the CCF. Data gathered from this system is stored online for 21 days. Desks are manned 24x7. The internal network at this location is Ethernet 10bT over CAT5. The primary servers are Compaq/DEC Alphas running Unix.

Metra’s Communication Network consists of fiber and over 28 T1 circuits. Video is being used to monitor vending machines at the Randolph Street Station (RSS). That data is being transmitted over the data circuit between RSS and Kensington Yard (KYD) Station. Figures 4.3.1 and 4.3.2 provide a graphical representation of the network architecture.

Metra has plans to purchase 250 new coaches. Each coach will be equipped with LED displays or some type of monitors. This feature could drive the need for video or other wireless communication in the future.
Figure 4.3.1

LEGEND:
- FIBER IN USE
- FIBER NOT IN USE
- T1
- ANALOG
- FUTURE 10GHZ
- GEO-FOCUS
- COMMUNICATION SWITCH
- SQL Server
- Penta switch monitor
- Matrix switch
- 10 GigHz
- 2 GHz Analog
- 15th Street & Canal
- 51st Street
- 51st & Wentworth
- 220th Gov. Pkway
- Downtown Joliet
- Randolph Street Station (RSS)
- Michigan & Randolph
- Geo-Focus
- Satellite Tracking
- Consolidated Control Facility
- 15th Street & Canal
- Jackson & Canal
- 547
- 10 GHz Digital
- T1 10 GHz Digital
- 2 GHz Analog
- Mokena
- 191st & Rt. 45
- 127 & INDIANA
- Kensington Yard (KYD)
- 127 & INDIANA
- Spare
- Video
-.jp2
- Figure 4.3.1
- SQL
- 3XT1 10 GHz Digital
- T1 10 GHz Digital
- 3XT1 10 GHz Digital
5   ILLINOIS TRANSIT HUB CONCEPTUAL NETWORK DESIGN

5.1   Introduction

The ITH concept is centered on the ability to communicate. Without enabling the communications facilities, high volumes, real-time information exchange would not be possible. The ITH will be a regional data repository that will collect and distribute information being generated by or provided to the transit agencies within Northeastern Illinois. It will also maintain the current on-time status of all participating transit services. Table 5.1.1 provides a summary of the type of data to be transmitted by each service board. These data types will be transmitted between the service boards and the ITH using a yet-to-be determined XML format. One potential source for this is the Traveler Information Markup Language (TIML). The Gateway is currently participating in a prototype study with Mitretek to test this emerging standard. For transmittal of data from the ITH to the Gateway/Illinois Hub, CORBA will be employed.

In addition to serving as a centralized information source for transit data, the ITH will provide a means to access the Internet. In doing so, ITH will be enabled to provide transit information data to the public. At present, it is anticipated that the ITH will host the Transfer Connection Protection (TCP) System and the Active Transit Station Sign (ATSS) Subsystem. The ITH will connect to the Illinois Hub/Gateway, which is connected to the GCM WAN.

<table>
<thead>
<tr>
<th>Node</th>
<th>Ingress</th>
<th>Egress</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA</td>
<td>Link travel times</td>
<td>Transit schedule and fare updates</td>
</tr>
<tr>
<td></td>
<td>Incidents that may affect CTA operations</td>
<td>Real time schedule adherence reports</td>
</tr>
<tr>
<td></td>
<td>Weather information</td>
<td>Delay causes and expected duration</td>
</tr>
<tr>
<td></td>
<td>Road or lane closures</td>
<td>Service disruption information</td>
</tr>
<tr>
<td></td>
<td>Messages/updates for CTA ATSS</td>
<td>Parking lot inventories from PMS</td>
</tr>
<tr>
<td></td>
<td>TCP system alerts/updates</td>
<td>Incidents affecting traffic or transit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Updated paratransit ETAs for TCP</td>
</tr>
<tr>
<td>Pace</td>
<td>Link travel times</td>
<td>Transit schedule and fare updates</td>
</tr>
<tr>
<td></td>
<td>Incidents that may affect Pace operations</td>
<td>Real time schedule adherence reports</td>
</tr>
<tr>
<td>Node</td>
<td>Ingress</td>
<td>Egress</td>
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<tr>
<td>--------------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Weather information</td>
<td>Delay causes and expected duration</td>
</tr>
<tr>
<td></td>
<td>Road or lane closures</td>
<td>Service disruption information</td>
</tr>
<tr>
<td></td>
<td>Messages/updates for Pace ATSS</td>
<td>Parking lot inventories from PMS</td>
</tr>
<tr>
<td></td>
<td>TCP system alerts(updates)</td>
<td>Incidents affecting traffic or transit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Updated paratransit ETAs for TCP</td>
</tr>
<tr>
<td>Metra</td>
<td>Incidents that may affect Metra operations</td>
<td>Transit schedule and fare updates</td>
</tr>
<tr>
<td></td>
<td>Weather information</td>
<td>Real time schedule adherence reports</td>
</tr>
<tr>
<td></td>
<td>HRI blockages</td>
<td>Delay causes and expected duration</td>
</tr>
<tr>
<td></td>
<td>Messages/updates for Metra ATSS</td>
<td>Service disruption information</td>
</tr>
<tr>
<td></td>
<td>TCP system alerts(updates)</td>
<td>Parking lot inventories from PMS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incidents affecting traffic or transit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HRI blockages</td>
</tr>
<tr>
<td>RTA</td>
<td>Transit schedule and fare updates</td>
<td>Internet WWW responses</td>
</tr>
<tr>
<td></td>
<td>Real time schedule adherence reports</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delay causes and expected duration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Service disruption information</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parking lot inventories</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internet WWW inquiries</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.1.1
5.2 Vision

Often times, when creating a conceptual network design, such as the ITH Communications Design, it is difficult for the users to understand or relate to the environment where the system will be located. For this reason, a vision has been established that lays the foundation for the operational expectations. This vision is derived from information received from the Service Boards, discussion amongst the Wilson Consulting Team, and previously released documents on the subject. The components of the vision described herein presume there will be continuous technology advances and new systems being deployed.

It is envisioned that the ITH networking environment will include:

- Main File and Print Server
- Database Server
- Web Server
- Application Servers
- Tape Backup System
- Domain Name Services (DNS) Server
- Network Management System
- Email Server
- Operator and Administrator Workstations
- Switches
- Routers
- Firewall
- Fault Tolerance and Redundancy

The uninterrupted provision of transit traveler information, especially during adverse weather or institutional circumstances, is essential. In order to support this, the platform is expected to have a 99.5% uptime/availability. To ensure continuous communications and operation, the LAN will employ two infrastructures—a primary and a secondary.

The ITH will incorporate a hybrid network design, which utilizes private, leased, and switched circuits. Switching is a fundamental technology positioned to be the core of both the LAN and WAN infrastructures. Both infrastructures are expected to transmit and receive data using the TCP/IP networking protocol. The network architecture will be developed using structured wiring standards.

It is envisioned that the primary LAN will be a collapsed backbone, converging to an ATM Switch. It will deploy fast Ethernet 100BaseT, an IEEE 802.3 standard. To support a distributed environment, all servers will be linked using a high-speed Gigabyte interface. The LAN will be isolated from the GCM WAN corridor using firewall technology. The internal servers and users will be secured by implementing a Demilitarized Zone (DMZ) scheme. As mentioned previously, the LAN will deploy a primary network infrastructure and a redundant secondary network infrastructure to ensure maximum availability. The secondary LAN infrastructure will be an optical OC-3/OC-12 fiber optic ATM network, which operates in parallel with the primary LAN. The primary purpose for this infrastructure, other than redundancy, will be to handle traffic for video and other high-bandwidth applications.
The WAN will be implemented using a Star topology with point-to-point connectivity to the Service Boards and the Illinois Hub/Gateway. The interfaces will be ATM over DS-1 leased lines, and OC-3/OC-12 fiber optics. Frame Relay or Digital Subscriber Line (DSL) Technology may be deployed pending the site requirements and the availability of DSL at location. The design supports voice, data and video transmissions from any service board hub to ITH and to Illinois Hub/Gateway. The bandwidth will support a minimum of four simultaneous video feeds using MPEG-II compression techniques. In addition, the design supports voice data from various agency telephone systems and PBX systems—a feature that is expected to be implemented in the future. A firewall will be installed at the service board hubs where Data Source Interface (DSI) is required to support legacy systems.

ITH will implement Open Standard Interface (OSI) Network Management, which is based on Fault, Configuration, Accounting, Performance, and Security (FCAPS). Fault management involves detecting, isolating, and correcting fault. Performance management involves closely monitoring the network elements for changes or patterns which may trigger a fault situation or imply that a fault is imminent; then, taking action to modify the network to avoid the fault. Configuration management involves designing and monitoring the physical and logical state of network and resources, making changes as required. Accounting management monitors the cost of the network and its resources. Security management includes, but is not limited to, monitoring the network and enforcing network security, policies, access control, use of data authorization, validation and encryption. In addition to the above, processes and procedures will be implemented to address disaster recovery, load balancing and corrective maintenance actions for managing the environment. For better security features and improved performance, the ITH conceptual design will support SNMP Version 2 or above. Appendix A provides additional information regarding the functionality and major components in a network management system.

The desired facility to house the ITH will have a computer room with the following features:

- Available space.
- Multiple power feeds from different sources.
- Security System with limited access.
- Dedicated HVAC with 24 hours by 7 days per week by 365 days per year humidity control and filtered air.
- Equipment racks with fans.
- Cable management system.
- Labeled cables using an approved labeling schematic.
- Sufficient lighting.
- Building Uninterrupted Power Supply (UPS) System complimented by a diesel generator.

In addition, physical space for the operator console and other workstations would be needed. Preference will be given to sites that provide opportunities for multi-modal cooperation and integration, and are managed by a 24x7x365 staff.
The ITH conceptual design will conform to Industry Standard Network Architecture based on scalability and upgradeability. The network capacity will be periodically managed to ensure that the available bandwidth capacity is in alignment and is sufficient for new applications, which may be installed in the environment.

5.3 Gap Analysis Results

This section will provide an assessment of the voids that exist in the Service Boards’ current network architecture, as compared to the one envisioned by the ITH Conceptual Communication Design. The assessment will be addressed from two perspectives—network design and facilities. Section 5.3.1 is the assessment of the network design, by Service Board, based on nine critical criteria. Section 5.3.2 is a complete assessment of the facilities/sites that have been evaluated to house the ITH.

5.3.1 Network Design

The network design for each Service Board has been evaluated based on its ability to support the following:

- The bandwidth requirements for ITH.
- Fiber interfaces/Sonet
- WAN Connectivity.
- Asynchronous Transfer Mode (ATM).
- TCP/IP Protocol.
- Centralized Network Management.
- Network Integration to ITH.
- Technical Staff Resources.
- Wireless.

The assessment for each of these criteria is provided in Table 5.3.1.1. In general, all three service boards lack sufficient network management, redundancy, and, to some degree, scalability. These shortfalls, as well as the ones identified in the table, will be addressed by the conceptual design.

<table>
<thead>
<tr>
<th>Service Board</th>
<th>Network Design Evaluation Criteria</th>
<th>Assessment Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA</td>
<td>Support for Bandwidth requirement for ITH</td>
<td>CTA has potential to support bandwidth requirement for data, video, and voice. The backbone design needs modification to incorporate redundancy and eliminate traffic bottleneck.</td>
</tr>
<tr>
<td>Service Board</td>
<td>Network Design Evaluation Criteria</td>
<td>Assessment Results</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>CTA</td>
<td>Support for fiber interface/SONET</td>
<td>CTA is capable of supporting fiber interface, trunking for high-speed optical communication. OC-12 interface is deployed between Cisco 1010 light stream using ATM switching.</td>
</tr>
<tr>
<td>CTA</td>
<td>Support for WAN connectivity</td>
<td>CTA wide area network is maintained by Unisys, Frame Relay technology is currently deployed to support remote sites. Design has Single point of failure.</td>
</tr>
<tr>
<td>CTA</td>
<td>Support for ATM</td>
<td>CTA supports ATM technology in a limited environment. More interfaces need to be installed; design changes are also needed to eliminate bottlenecks and single points of failure.</td>
</tr>
<tr>
<td>CTA</td>
<td>Support for TCP/IP</td>
<td>CTA supports TCP/IP protocol.</td>
</tr>
<tr>
<td>CTA</td>
<td>Support for centralized network management</td>
<td>CTA supports HP Openview platform at NCC location; needs additional tools to support FCAPS functionality.</td>
</tr>
<tr>
<td>CTA</td>
<td>Support for network integration to ITH</td>
<td>CTA network meets the basic requirement. However, DSI may be required to access the databases.</td>
</tr>
<tr>
<td>CTA</td>
<td>Technical staff</td>
<td>CTA has outsourced WAN and some MIS functions, management has to address the issue of how to fill the gap.</td>
</tr>
<tr>
<td>CTA</td>
<td>Support for wireless</td>
<td>CTA employs a wireless radio communication system by Motorola. There are issues related to limitation of channel frequencies. New technologies such Cellular Data packet data (CDPD) and GPS could boost present and future need.</td>
</tr>
<tr>
<td>Service Board</td>
<td>Network Design Evaluation Criteria</td>
<td>Assessment Results</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>METRA</td>
<td>Support for Bandwidth requirement for ITH</td>
<td>Metra communication network has fiber available to support multi-media requirement. The Network Design should be evaluated to support future technologies.</td>
</tr>
<tr>
<td>METRA</td>
<td>Support of fiber interface/SONET</td>
<td>Metra supports SONET interfaces; currently they are using SONET infrastructure for video and voice. The data traffic can be easily accommodated on existing fiber. Plans are under way to transition the data traffic to the fiber.</td>
</tr>
<tr>
<td>METRA</td>
<td>Support for WAN connectivity</td>
<td>Metra has mainframe centric environment; point to point links to remote sites mostly SNA traffic. Metra has limitation for any further expansion, the existing 3Com switches are absolute, and replacement by CISCO is being considered. The network design does not support ITH requirement.</td>
</tr>
<tr>
<td>METRA</td>
<td>Support for ATM</td>
<td>No support for ATM technology.</td>
</tr>
<tr>
<td>METRA</td>
<td>Support for TCP/IP</td>
<td>Metra supports TCP/IP in a very limited environment.</td>
</tr>
<tr>
<td>METRA</td>
<td>Support for centralized network management</td>
<td>Metra has no network management platform. Many options are under consideration.</td>
</tr>
<tr>
<td>METRA</td>
<td>Support for network integration to ITH</td>
<td>Metra existing network does not support ITH design.</td>
</tr>
<tr>
<td>METRA</td>
<td>Technical staff</td>
<td>Metra has limited technical resources to implement such project.</td>
</tr>
<tr>
<td>METRA</td>
<td>Support for wireless</td>
<td>Metra supports a wireless radio network. GeoFocus is being tested to support wireless train tracking system.</td>
</tr>
<tr>
<td>Service Board</td>
<td>Network Design Evaluation Criteria</td>
<td>Assessment Results</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>PACE</td>
<td>Support for Bandwidth requirement for ITH</td>
<td>Pace network currently does not have the bandwidth required to support IT. The network design would need extensive modifications to accommodate ITH.</td>
</tr>
<tr>
<td>PACE</td>
<td>Support of fiber interface/SONET</td>
<td>Pace does not have any fiber installed in their location. Therefore, there are no fiber interfaces.</td>
</tr>
<tr>
<td>PACE</td>
<td>Support for WAN connectivity</td>
<td>Pace supports WAN connectivity. However, the design indicates that there is a single point of failure in the router. There is minimal redundancy and scalability built into the backbone design.</td>
</tr>
<tr>
<td>PACE</td>
<td>Support for ATM</td>
<td>Does not support ATM.</td>
</tr>
<tr>
<td>PACE</td>
<td>Support for TCP/IP</td>
<td>Supports TCP/IP.</td>
</tr>
<tr>
<td>PACE</td>
<td>Support for centralized network management</td>
<td>Does not support.</td>
</tr>
<tr>
<td>PACE</td>
<td>Support for network integration to ITH</td>
<td>Existing design does not support integration, uses proprietary databases, RFI is out for major upgrade.</td>
</tr>
<tr>
<td>PACE</td>
<td>Technical staff</td>
<td>Pace has limited technical support staff available.</td>
</tr>
<tr>
<td>PACE</td>
<td>Support for wireless</td>
<td>Pace supports RF radio.</td>
</tr>
</tbody>
</table>

Table 5.3.1.1

5.3.2 Illinois Transit Hub Facility Assessment

The Wilson Consulting Team visited and assessed four potential sites for their suitability to host the ITH. These sites included the:

- CTA Control Center located at 120 N. Racine, Chicago.
- Metra Consolidated Control Facility (CCF) located at 15th and Canal, Chicago.
- Pace Headquarter Office, located at 550 W. Algonquin Road, Arlington Heights.
- RTA Travel Information Center (TIC) located in the RTA Headquarter at 181 W. Madison, Chicago.
Each of these sites currently houses the communications control, dispatch, and/or customer/traveler information functions.

Aside from the facility physical characteristics that have been described in Section 5.2, the ideal site would:

- Meet or exceed all technical, staffing and facility requirements for the ITH.
- Currently house an organization/function closely aligned with the goals of the ITH.
- Maximize opportunities for regional coordination in the provision of transportation services.

These additional measures are valuable for many reasons. For instance, the more closely the mission of the current occupants correlates with that of the ITH, the more likely that ITH will function smoothly in that location. In addition, with functional alignment, the more likely it is that synergies between the two uses will add value in both areas.

An imperative for the future development of transit ITS is that it take into account, and contribute to, regional ITS coordination and integration. One of the ways this has been accomplished throughout the United States is by co-locating traffic and transit management functions. Consequently, the same approach can be taken with respect to regional coordination between transit providers. Ideally, the site for the ITH would include present or future opportunities for such regional coordination and integration between transit providers, or between transit and traffic management functions and staff.

Subsequent sub-sections of this document will provide an analysis of each site considered, as well as convey a summarized version of the findings in the form of a table. Comparative costs for the various potential ITH sites are not included because of the difficulty of obtaining comparable information for all the sites within the timeframe available for this study. When the desired location is narrowed, detailed costing should then be performed as part of the final site analysis.

### 5.3.2.1 CTA Control Center

The CTA Control Center meets most of the additional facility and technical analysis criteria. Facility security includes a guard at the ground floor entrance to 120 N. Racine; elevator access with an authorized key card only; and key card entry to all sensitive facilities. With respect to space and growth potential for the ITH, the Control Center has 30% to 50% expansion spaces available in its computer room, as well as additional space for system operators. However, some of this space may be needed for future CTA requirements, limiting its availability for the ITH. Finally, the Control Center was designed for presentations, with a viewing area available for visitors to observe control personnel, and a large wall mounted status displays. There are also rooms suitable for demonstration of Control Center systems functionality.

The functional alignment of the Control Center with the ITH is low to moderate. The primary function of the Control Center is to manage the provision of CTA bus transit and rail transit services. On the other hand, the primary mission of the ITH is to support the provision of multi-modal traveler information, and service coordination. Another point is that the Control Center does not currently support the management of contracted transit...
services, although CTA as an organization does through Paratransit Operations and its Special Services program.

Finally, the opportunities for multi-modal coordination at the Control Center are moderate. While the CTA is not involved in any traffic management operations, it does provide both transit bus and rail transit. Thus, the Control Center is currently involved in multi-modal coordination and integration of its bus and rail services.

Overall, with the inclusion of the gap analysis results, CTA has a medium to high suitability for housing the ITH.

5.3.2.2 Metra Consolidated Control Facility (CCF)

The Metra Consolidated Control Facility (CCF) was primarily designed for secure control of Metra's operated and contracted regional commuter rail operations. In addition to housing Metra dispatch personnel, the CCF was designed to host representatives of Metra’s contract carriers for the purpose of coordination with Metra personnel managing Metra-owned lines. Finally, Metra has made space available to regional freight carriers in the CCF for the purpose of coordinating the regional freight railroads.

Facility security at Metra is medium to high. The primary control mechanism is a remote-controlled gate, restricting both automobile and pedestrian traffic from entering the facility. Within the building, the same guards who control the gate control facility access. With respect to space, room for additional computer and communications equipment at the facility is somewhat limited. In addition, there are few additional workspaces available for ITH-related staff. Finally, the facility does permit walk through viewing of some operations management personnel through large area windows into their work areas. Other workers are in cubicles, limiting the ability to visibility to their activities to only a few visitors. There is no viewing or presentation area in the facility.

The alignment of CCF functionality with the ITH mission is low to medium. Metra facilities are devoted to management of a single mode of transportation. In addition, Metra supports coordination with contractor operations staff.

Finally, the CCF opportunity for multi-modal integration is moderate. Since the CCF currently hosts freight rail carrier representatives (as part of the Chicago Transportation Control Office (CTCO) initiative of the rail industry Chicago project), there could be the potential for the CCF facilitating transit and traffic management coordination with the freight rail industry. However, there is no guarantee that the CTCO will remain in place permanently at the CCF.

Overall, the Metra CCF has a low suitability for hosting the ITH. The space is inadequate for the complex, and little infrastructure currently exists that could support the ITH.
5.3.2.3 PACE Headquarters Office

The computer facility at Pace headquarters in Arlington Heights currently serves all administrative, safety and mechanical systems requirements for the entire Pace operation. However, there is no operational control function or staff comparable to those at the CTA Control Center or the Metra CCF. Pace fixed route bus dispatchers are located at the garages associated with Pace’s operating divisions. Operations management staff at headquarters coordinate with the divisions for troubleshooting and resolving problems. Computer systems currently provide only limited support to dispatchers or line operations personnel.

The forthcoming IBS system will include the installation of a central IBS server at Pace headquarters. This server will support distributed dispatching, while providing some flexibility for dynamic modification of dispatch territories to assist in overnight coverage from a single location. However, it is not expected that there would be any centralized operations management function associated with this installation, at either Pace headquarters or another Pace location, in the near future.

Following from the above, potential Pace headquarters support for the ITH consists of a relatively small computer room with no line operations management function or staff at the location.

With respect to facility security, Pace headquarters are moderate. Pace has a key card entry system for building access, with three possible entry doors. The computer room facility itself requires a key card (same system) with appropriate access authorization. In terms of space, the Pace computer room has some, but not substantial, room for expansion. However, the building overall is significantly space constrained. It is unlikely that space could be freed up for support of ITH operations staff and their consoles. Finally, the Pace headquarters would offer no facilities for presentations where the visitors could view computer operations or ITH management staff at work.

Pace’s functional alignment with the ITH is low to medium. There is a limited customer information function in the Pace headquarters building, separate and distant from the computer room complex. However, most day-to-day service management takes place in the field through division dispatchers. Similarly, Pace’s alignment with inter-modal coordination is low. While major effort goes into coordinating Pace schedules with rail services, routine day-to-day inter-modal coordination takes place primarily at the field level. However, Pace does coordinate with contract operators of some Pace routes.

The overall suitability of the Pace headquarters, as a site for the ITH is low. Lack of space is the overwhelming factor in the analysis.

5.3.2.4 RTA Travel Information Center (TIC)

The RTA Travel Information Center (TIC) provides telephone and Internet based transit traveler information for Northeastern Illinois. The principal computer application supporting the TIC is the Itinerary Planning System (IPS). The TIC is strictly an
information provider—not involved in any service provision, management or coordination.

Security for the TIC is moderate. The RTA headquarters has key card entry for all its offices, with a receptionist at the principal entrance. TIC facilities are a floor below; access is controlled by the same key card system. Space for the current TIC has a small amount of space for additional staff, but little or no additional computer room space available with the current equipment and configuration. For purposes of presentations, the TIC includes a large training room that is fully equipped with functioning workstations.

The functional alignment of the TIC with the ITH is high. Both the TIC and ITH are primarily devoted to providing traveler information. In addition, the TIC’s planned improvements to its website would go a long way toward satisfying the needs of the ITH in that area. However, without any current operations coordination function, the TCP function of the ITH would represent a move to a substantially different functional area for the TIC. Also, the TIC is operated by a contract call center operator, so siting the ITH at the TIC would require personnel from a different organization to be collocated in the Center with contractor employees.

With respect to multi-modal coordination, the TIC is medium. It deals with traveler information for all modes, but again is not involved in service management coordination functions.

In its current facility, the overall suitability of the RTA TIC as an ITH site is low to medium. Computer room facilities have limited room for expansion, but there is probably adequate space for the people involved. The functional alignment is very strong.

### 5.3.2.5 Summary of Findings

The data gathered in the site analysis was combined with the information ascertained in the network design analysis to develop a comprehensive understanding of each site’s ability to host the ITH. The results of those findings are summarized in Table 5.3.2.5.1.

<table>
<thead>
<tr>
<th>Potential ITH Site</th>
<th>Site Evaluation Criteria</th>
<th>Analysis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA Control Center</td>
<td>Facility security</td>
<td>Good, secure facility with key cards controlling elevator and control center access.</td>
</tr>
<tr>
<td>CTA Control Center</td>
<td>Supports 24x7 Operations</td>
<td>High, CTA has a state of the art Network Control Center, providing 24x7x365 coverage.</td>
</tr>
<tr>
<td>CTA Control Center</td>
<td>Building UPS backed by a generator.</td>
<td>High, the building has a dedicated UPS which provides a minimal of 30 minutes backup power, independent of the generators which it is attached to that provides ongoing power provided there is fuel available.</td>
</tr>
<tr>
<td>Potential ITH Site</td>
<td>Site Evaluation Criteria</td>
<td>Analysis Results</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>CTA Control Center</td>
<td>Space for further expansion</td>
<td>Expansion space could be made available.</td>
</tr>
<tr>
<td>CTA Control Center</td>
<td>Presentability of facility</td>
<td>High. A showcase facility with viewing areas and a training/briefing room.</td>
</tr>
<tr>
<td>CTA Control Center</td>
<td>Functional alignment with ITH</td>
<td>Low to moderate – an operations management site, not a traveler information site.</td>
</tr>
<tr>
<td>CTA Control Center</td>
<td>Opportunities for multi-modal coordination</td>
<td>Moderate – bus and rail coordination can be done, but no systems in place to do so.</td>
</tr>
<tr>
<td>CTA Control Center</td>
<td>Overall evaluation</td>
<td>Medium to high suitability for ITH.</td>
</tr>
<tr>
<td>Metra CCF</td>
<td>Facility security</td>
<td>Medium to high. Remote control gate restricts any access to facility or parking lot.</td>
</tr>
<tr>
<td>Metra CCF</td>
<td>Supports 24x7 Operations</td>
<td>High, the CCF is currently providing 24x7 operations for rail services.</td>
</tr>
<tr>
<td>Metra CCF</td>
<td>Building UPS backed by a generator.</td>
<td>High, the building has a dedicated UPS which provides a minimal of 30 minutes backup power, independent of the generators which it is attached to that provides ongoing power provided there is fuel available.</td>
</tr>
<tr>
<td>Metra CCF</td>
<td>Space for further expansion</td>
<td>Low. A few workspaces available, but no room in the computer facility</td>
</tr>
<tr>
<td>Metra CCF</td>
<td>Presentability of facility</td>
<td>Medium. The facility allows operations to be viewed through windows into dispatcher spaces.</td>
</tr>
<tr>
<td>Metra CCF</td>
<td>Functional alignment with ITH</td>
<td>Low to medium. Operations center, not a traveler information center.</td>
</tr>
<tr>
<td>Metra CCF</td>
<td>Opportunities for multi-modal coordination</td>
<td>Moderate. No inter-modal transit coordination. Freight railroad representatives on site provide opportunity for coordination.</td>
</tr>
<tr>
<td>Metra CCF</td>
<td>Overall evaluation</td>
<td>Low suitability for ITH when above factors are combined with gap analysis.</td>
</tr>
<tr>
<td>Pace Headquarters</td>
<td>Facility security</td>
<td>Moderate. Key card access to building.</td>
</tr>
<tr>
<td>Potential ITH Site</td>
<td>Site Evaluation Criteria</td>
<td>Analysis Results</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pace Headquarters</td>
<td>Supports 24x7 Operations</td>
<td>Low, Pace currently provides coverage for normal business hours, with emergency contacts for after hour support.</td>
</tr>
<tr>
<td>Pace Headquarters</td>
<td>Building UPS backed by a generator.</td>
<td>Low, there is no building UPS. However, all critical systems are backed up by a stand alone UPS for protection in case of an outage.</td>
</tr>
<tr>
<td>Pace Headquarters</td>
<td>Space for further expansion</td>
<td>Low. Building is at capacity.</td>
</tr>
<tr>
<td>Pace Headquarters</td>
<td>Presentability of facility</td>
<td>Low to medium. Not enough room to create an appropriate viewing area.</td>
</tr>
<tr>
<td>Pace Headquarters</td>
<td>Functional alignment with ITH</td>
<td>Low to medium. Limited customer information staff at different location in the building.</td>
</tr>
<tr>
<td>Pace Headquarters</td>
<td>Opportunities for multi-modal coordination</td>
<td>Low. Little involvement in day to day multi-modal coordination at the headquarters level – takes place in the field.</td>
</tr>
<tr>
<td>Pace Headquarters</td>
<td>Overall evaluation</td>
<td>Low. Space is the most critical factor.</td>
</tr>
<tr>
<td>RTA TIC</td>
<td>Facility security</td>
<td>Moderate. Key card entry to RTA offices, including the ITC.</td>
</tr>
<tr>
<td>RTA TIC</td>
<td>Space for further expansion</td>
<td>Low to moderate. Room for people; equipment is questionable.</td>
</tr>
<tr>
<td>RTA TIC</td>
<td>Presentability of facility</td>
<td>Moderate. Large training area has full functionality and ability to view sessions.</td>
</tr>
<tr>
<td>RTA TIC</td>
<td>Functional alignment with ITH</td>
<td>High. The missions of the TIC and ITH are complementary and strongly linked.</td>
</tr>
<tr>
<td>RTA TIC</td>
<td>Opportunities for multi-modal coordination</td>
<td>Medium. The TIC is not currently involved in transit operations, but does provide multi-modal transit itineraries.</td>
</tr>
<tr>
<td>RTA TIC</td>
<td>Overall evaluation</td>
<td>Low to medium. With a more suitable site, the TIC would be the clear choice.</td>
</tr>
</tbody>
</table>

Table 5.3.2.5.1
5.4 **Network Architecture Design**

The ITH Conceptual Network Design has been developed using Unisource’s Net Composer™ Methodology together with the Enterprise Network Review™ and WAN Design Compositions™, which defines the steps and processes to be considered when assessing or designing a network. Throughout the process, Unisource also applied the guiding principles that are relevant to the creation of a conceptual network design, namely:

- Requirement Analysis
- Networking Direction
- Addressing Scheme
- Transmission Selection
- Hardware Selection
- Protocol Selection
- Network Management
- Capacity Planning

The requirements for this design are provided in Section 4 of this document, and are further expanded upon in Section 5.2. It is anticipated that the ITH architecture will be composed of five major components: Physical Media, Data Pipeline and Capacity, Communication Protocols, Addressing, and ATM hardware. A description of each component is provided below:

- **Physical Media** is type of cable that will be used in the environment. In the case of the ITH, the physical transmission media will be a combination of dedicated leased lines, privately owned fiber, microwave, and public switching. The LANs will operate at minimum of 100 MBPS and the WANs will use a minimum of 1.5 MBPS (DS-1) for data only facilities. Facilities with video requirements will use a minimum bandwidth of 45 MBPS (DS-3) with an optimum bandwidth link of 155 MBPS (OC-3).

- **Data Pipeline and Capacity** is the available throughput or bandwidth that can be used in the environment. To reduce cost, the ITH will use DS-1/DS-3 dedicated ATM high-speed circuits, operating at 1.544 KBPS to OC-3 fiber optics circuits, operating at 45 KPBS. These circuits will be provisioned and provided by the local telephone company’s public network. The minimum bandwidth requirement for voice and data traffic is 56 KPBS. If voice, video and data are needed in the environment, the minimum bandwidth requirement is 768 KBPS. In each case, the bandwidth allocated to voice, video and data should not exceed 75% of the total capacity.

- **Communication Protocols** are the means by which network devices “talk” to each other. ITH will use TCP/IP for data transportation and OSPF for router convergence. Deploying standard base protocols, such as these, will allow faster convergence of data, and will prevent loss of connectivity and temporary routing loops. Open Shortest Path First (OSPF) is an industry standard based protocol that supports multi-vendor internetworking. Implementation of the routing protocol requires design considerations. However, it will create support for dependent networks by the designated area’s OSPF. PNNI is the standard protocol for communication between ATM switches. This protocol will be used to communicate between the ITH and Illinois Hub/Gateway.
• Addressing is the numbering scheme that is used with the Internet Protocol (IP). The ITH will require an IP addressing plan that encompasses pertinent information such as the subnet mask and default gateway. Dynamic allocation of IP addresses will be done using a Dynamic Host Control Protocol (DHCP) server.

• Communication Hardware comprises a server, switch, data storage devices, and workstations, at a minimum. Requirements for the ATM switch are provided in Appendix B.

As previously stated the ITH Conceptual Network Design is based on these components and takes into consideration the shortfalls identified in the gaps. Figure 5.4.1 depicts the design envisioned for the ITH.
6 RECOMMENDED NEXT STEPS

Based on the data collected from this exercise, it is recommended that the RTA consider the following in order to achieve the best return on investment:

- **Conduct a detailed network assessment at each service board.** This will serve to identify any security issues that may be masked due to the lack of monitoring and management tools.

- **Implement network management tools within each Service Board.** This will allow the System administrator to gather performance statistics and conduct capacity analyses. This type of data is critical for modeling the bandwidth requirements and ensuring proper capacity is installed at the onset of the project.

- **Conduct a detailed frequency/bandwidth analysis for Radio Frequency (RF) Bandwidth.** Both Metra and CTA are experiencing problems with Radio Frequency (RF) bandwidth. However, because capacity data is not available, it is not possible to accurately access the real need. It is recommended that a detailed frequency/bandwidth analysis be conducted to identify viable options for increasing throughput. In addition, this study should access the technologies being used today to determine if it is reasonable to continue investing in the technology or implement a more state-of-the-art solution. Appendix C provides a brief overview of wireless technologies in use today.

- **Reexamine the project “vision”**. Investing more time in a “visioning” exercise will help ensure that the business requirements and technology requirements are in alignment. In addition, an exercise of this type will ensure that components procured for the ITH are specified and designed accurately.

Networking is a rapidly evolving industry. Therefore, it is very important that a clearly outlined vision is established and there is buy-in from each of the stakeholders. In addition, it is crucial that everyone understands the critical success factors and the ramifications when tasks are not accomplished to expectation. From our observation, the most pressing issues in the Service Boards are the lack of network performance monitoring and management tools, and redundancy. A single, integrated, scalable network that demands 99.5 percent availability must be secured, have inherent fault tolerance, and be well managed. In addition, as new wireless applications are developed, existing infrastructures will become more challenged for bandwidth capacity and performance will be hindered. It is important that an assessment of future wireless needs be performed to better understand the appropriate technology to be deployed, as well as the bandwidth that will be required to support the systems.

As the RTA considers potential sites to host the ITH, the Wilson Consulting Team recommends that strong consideration be given to the CTA Control Center. This facility is clearly the leading site among those studied in terms of suitability for the ITH. Its strengths include security, available bandwidth, redundancy inherent in the network design, space for additional equipment and people, monitoring and operations, and an overall very good communications infrastructure. Its functional alignment and potential for fostering multi-modal communications were moderate.

The RTA TIC would be an ideal site if the facilities available were more adequate to house the ITH. There is a natural synergy between the TIC and ITH. However, the
facility limitations make it the second choice by a considerable margin. It should be noted that the RTA’s lease at 181 W. Madison is scheduled for renewal in Fall 2002. If, at that time, a move of the TIC were contemplated, the TIC facility could be designed to specifically accommodate the requirements of the ITH.

The other two sites, the Metra CCF and the Pace Headquarters computer room, are not good choices. The CCF lacks much of the systems and network infrastructure needed for the ITH Conceptual Design. Pace is primarily constrained by the lack of additional space available in the building.
APPENDIX A: NETWORK MANAGEMENT

The International Telecommunication Union (ITU) Telecommunication Management Network (TMN), M3100 architecture model for the network management, as adapted by the ITS, breaks down the complexity of management into following five layers:

- Network Element Layer
- Network Element Management Layer
- Network Management Layer
- Service Management Layer
- Business Layer

The Network Element layer is the location where all the network devices, which provide interconnections between various networks, reside. Integrated into each device are embedded Remote Network Monitoring (RMON) and Simple Network Management Protocol (SNMP) features. The network elements can be a host, gateway, router, or other type of network device. In the ITH design, the network management node will run the application that communicates with each network element to obtain the status of any ITH element. The information ascertained from the network elements will be maintained in a Management Information Base (MIB). Each element will have a MIB. The MIB’s structure will be defined by the Structure of Management Information (SMI) System.

The next layer, Network Element Management Layer, gives the network manager the ability to manage devices individually. Conversely, the Network Management Layer provides a system view of the network and its devices. The RMON collects a set of composite metrics, which it uses to continuously determine the overall health of the network.

The Service Management Layer has tools that facilitate the management of all network services, while the Business Management Layer proactively manages the deployment of services offered in the network.

The five management functions are key in order to maintain the ITH LAN and WAN. IBM's Tivoli or HP's Openview management platform could be considered for deployment. Figure A-1 depicts a typical network management flow and provides the critical steps that should be considered when evaluating network management systems.

Tivoli Management Architecture is structured using a three-tier approach. The framework that forms the basis for the solution is built on top of the CORBA communication platform. The Management Server acts as the management supervisor for the entire management environment. The Management Gateways provide communications between groups of management agents and the rest of the environment. Lastly, the Management Agents Managed Endpoints can be executed on the hosts, Unix workstation, and any desktop and network devices.

HP Openview distributed management platform has recently added CORBA-based application development, using CORBA 2.0-compliant ORB. It includes a set of object services supporting the implementation of management application (naming, event, lifecycle services, transaction services, notification services, and topology services).
Network Management flow chart

Figure A-1
APPENDIX B: ATM SWITCH REQUIREMENTS

Switches characteristics:
- Power - AC/DC.
- Minimum/maximum switch price/configuration - Minimum cost of entry for single port and max number of ports that can be used before additional switch is required.

Switch Architecture:
- Matrix - Crossbar the bus capacity in MBPS and GBPS, scaleable on both the backplane and swathing modules/cards.
- Maximum Sum of Ports speeds.
- Offer both LAN and WAN ports

Percent Blocking at Load per GR-1110:
- The essential attribute for a switch is degree to which it is virtually non-blocking with probability of non-blocking defined as 1*10-X.

Point to Multi-point capability:
- Provides support for multicast—spatial or logical. In spatial multicast, the leaves of point to multi-ports trees are physical ports, while in logical multicast, the leaves are Virtual Channel Connections (VCC).

Minimum switch transit delay:
- Total one-way delay through the switch should be few hundreds of microseconds.

VPI/VCI Bits on UNI/NNI:
- Support for number of virtual path identifier and virtual channel identifier address bits they support on UNI and NNI. Some support all VPI and VCI addressing bits 24 Bits.
- VPC and VCC support (max per card/switch)
- Support for PVC and VCC per card and per switch how many SVC support per card per switch. PVC and SVC compliant with ATM Forum and ITU-T Q.2931 specifications

Redundancy:
- Support for Node, card, module, and port level. M for N (M: N) M spares for set of N active components such as CPU port card ports power supplies and switching matrix. True redundancy is achieved when a module, card or processor can fail and the redundancy spare automatically assumes the role with no appreciable traffic or user service interruptions

Buffering:
- More buffering means better throughput for protocols such as TCP. Larger buffers can create more latency and delays during peak traffic conditions. In general, the belief is if the buffer is large; then, less traffic will be dropped. However, this thought does not take into consideration the impact on delays.

Congestion Control and available Bit rate:
- Three major modes of standard ABR congestion control
- Explicit forward congestion control identification EFCI
- Explicit rate ER
• Virtual Source/Virtual destination (VS/VD)

Policing and shaping:
• Support for policing performed at Peak cell rate PCR or for both PCR and sustainable Cell rate
• Support for Connection Admission Control (CAC)
• Support for Early Packet Discard/Partial packet discard
• Support for OAM (Operation administration and maintenance) performance measurement

Protocol and standard supported
• Support for Signaling ATM forum standards version 3.0 3.1 and 4.0 for UNI, point to point SVC and point to Multi-point SVC, latest ITU stand for UNI is Q9231 and NNI signaling is defined in the ITU-T B ISUP standards
• Support for Classical IP over ATM
• Support for Multi-protocol over ATM
• Support for Signaling as specified by ATM forum

Network management support:
• ATM Forum has defined the Integrated Local management interface ILMI and server other network management interfaces.
• Support for management protocol includes MIBs and OAM cell automatic configuration and restoration.
• Support for ATM FORUM ILMI version 3 3.1 and 4.0
• Support for RFC 1695 AToMMIB supported
• Support for ATM forum five-network management interfaces MI M2 M3 M4 M5
APPENDIX C: WIRELESS TECHNOLOGIES

TECHNOLOGY: Cellular Digital Packet Data (CDPD)
CDPD is very useful for short “bursty” type data application. The data is transmitted at the rate of 19.2 KBPS from a mobile data terminal. The main components to CDPD are:

- Mobile Database Station (MDS) - A wireless computing device that moves around the CDPD network, communicating with the Mobile Data Bus Station (MDBS).
- Mobile Data Bus Station (MDBS) - Resides in the cell site itself and can utilize cellular systems infrastructure for transmitting and receiving packet data. The function of the MDBS is interface between MDS and MDIS. The communication speed between MDBS and MDIS is 56Kps. One MDBS can control several physical channels depending on the site configuration and loading requirement:
- Mobile Data Interface Station (MDIS) – Performs the routing functions for CDPD. Several MDIS can be networked together to expand the cellular network. MDIS is connected to the router or gateway that is linked to fixed end system.
- Fixed End System (FES) - A communication system that reside over layer 4, a transport layer of OSI model performing all transport and higher layer functions.
- Intermediate System (IS)

There are two methods used to assign frequency channels for delivering data packet service. Method 1 uses specific cellular radio channels and Method 2 utilizes channel hopping/unused channels. There are advantages and disadvantages to using either method. For instance, in Method 1, dedicated channel assignment for CDPD has no interference issues from cellular system sharing the voice spectrum. However, there is no interaction between the packet data network and cellular voice network, thus it reduces the overall capacity of the networks. Method 2, which shares the voice channels and uses unassigned channels in the same spectrum, has the potential for interference. On the other hand, the system has a mechanism to detect the channel assignment and instruct the MDS to return to another channel before it interferes with the cellular channel.

CDPD address security issues by incorporating authentication and encryption technology in the air link standard. Typical applications used in this environment include: dispatch, remote monitoring, email, database access, LAN access, thin client browser, and Internet access.

Technology: General Packet Radio Service (GPRS)
GPRS is high speed, packet data technology used for data only. The core design is based on Time Division Multiple Access (TDMA). The technology is scalable and evolutionary in nature. GPRS is the migration path for GSM evolution toward an enhanced data rate; it will also incorporate interoperability between GSM and TDMA. GPRS supports a data rate of 100+ KBPS. In addition, IP and X.25 packet data, and domestic and international data standards for faster packet data rates are supported.
Technology: Personal Communication System (PCS):
PCS is the next-generation wireless communication. The applications and spectrum available for PCS are unique. PCS utilizes 30MHz of spectrum. Currently there is no standard for the PCS technology platform. The licensees have picked up few major standards. The selected standards are IS-136, IS-95, IS-661 and DCS1900.

Technology: Global System for Mobile (GSM):
GSM is the European standard for digital cellular systems operating in the 900 MHz. GSM has achieved worldwide success. GSM has many unique features and attributes.

Technology: Global Positioning Satellites (GPS):
GPS is based on a series of 24 satellites that orbit the earth providing position and time information. GPS system ensures that four satellites are visible anywhere in the world. GPS technology is used to pinpoint the location of an asset, such as a vehicle or a person. This technology then allows subscribers to access the location of the asset on a detailed street map display via the Internet. Additional features include address geocoding, automatic alarm generation, data management and tracking archives, and many different styles of reports. GPS is used in LMDS system for synchronization providing stable clock and primary reference source. GPS transmits on two frequencies using spread spectrum modulation, CDMA using BPSK.

Technology: Narrow Band Analog Mobile Phone Service (NAMPS)
NAMPS is used in parts of the United States. It is based on analog radio system technology, and is similar to AMPS, except that it utilizes 10 kHz wide voice channels. This technology has a capacity advantage, under ideal condition, three times greater than AMPS. NAMPS is able to achieve this small bandwidth through changing the format and methodology.

Technology: IS-136 (IS-54)
IS-136 is also known as IS-54. It is a digital cellular standard developed in United States using TDMA technology. The system operates in the same band as AMPS, and it is used in PCS spectrum. IS-136 allows multiple users to occupy the same channel with time division. Currently several cellular operators in the United States deploy this technology. IS-136 utilizes the same band of analog 30KHz per physical radio channel. However, it enables three to six more users to operate on the same physical radio channel. Some of the advantages in using IS-136 are:

- Increased capacity.
- Improve protection for channel interference.
- Authentication.
- Reduce infrastructure cost.
- Voice privacy.

Technology: Cellular Digital Multiple Access (CDMA)
CDMA is a spread spectrum technology platform that enables multiple users to occupy the same channel and frequency spectrum at the same time. It is utilized for microwave point to point communication and satellite communication. CDMA can be deployed into existing systems simply by deploying additional equipment. CDMA offer many unique features, some of which includes:

- Increased system capacity over analog and TDMA.
- Improve interference protection.
• No frequency planning required between CDMA channels.
• Fraud protection due to encryption and authentication.
• New wireless features.

**Technology:** Advance Mobile Phone Service (AMPS)
AMPS is a cellular standard system operates in 800 MHz frequency band uses 30KHz channels.

**Technology:** Total Access Communication System (TACS)
TACS is a cellular standard that is derived from AMPS technology. TACS operates in both 800 MHz and 900 MHz. It uses 25 kHz channels. This technology is mostly deployed in Europe and Middle East.

**Who is supporting what technologies?**

• AT&T Wireless – CDPD, GPRS, TDMA, W-CDMA
• Verizon – CDPD, CDMA, W-CDMA
• VoiceStream – GSM, GPRS, EDGE, W-CDMA
• Sprint PCS – CDMA, W-CDMA
REGIONAL TRANSPORTATION AUTHORITY
REGIONAL TRANSIT ITS PLAN PROJECT

FINAL TASK 5 REPORT
PUBLIC-PRIVATE PARTNERSHIP AND
INTERAGENCY AGREEMENT OPPORTUNITIES

Prepared by:
Wilson Consulting
TranSmart Technologies, Inc.
Multisystems, Inc.

August 27, 2001
# TABLE OF CONTENTS

1 INTRODUCTION ........................................................................................................... 1  
1.1 Background .................................................................................................................. 1  
1.2 Purpose of this document .......................................................................................... 1  
1.3 Glossary of Terms ....................................................................................................... 2  
1.4 Related Reports ......................................................................................................... 4  

2 PUBLIC-PRIVATE PARTNERSHIPS ........................................................................... 5  
2.1 Introduction .................................................................................................................. 5  
2.2 Existing Examples of Public-Private Partnership in the GCM Corridor ................. 5  
2.2.1 ADVANCE .............................................................................................................. 6  
2.2.2 FleetOnline™ Chicago ......................................................................................... 7  
2.3 Opportunities For Public-Private Partnership In RTIP ............................................. 7  
2.3.1 Regional Traveler Information Kiosks ................................................................. 8  
2.3.2 Active Transit Station Signs (ATSS) .................................................................... 8  
2.3.3 Parking Management Systems (PMS) ................................................................. 10  
2.4 Public And Private Sector Roles .............................................................................. 11  
2.5 Business Models in Public-Private Partnership ....................................................... 12  
2.6 Barriers to Public-Private Partnership ..................................................................... 15  
2.7 Guiding Principles In Building Public-Private Partnerships ................................ 16  
2.8 Lessons Learned In Public-Private Partnerships ..................................................... 18  

3 ESTABLISH INTERAGENCY AGREEMENTS ......................................................... 20  
3.1 Introduction .................................................................................................................. 20  
3.2 Existing ITS-related Interagency Agreements In the Region .................................... 21  
3.2.1 Memorandum of Understanding for GCM Corridor Initiative ........................... 21  
3.2.2 CTA - Pace Agreement on Automatic Fare Collection (AFC) ......................... 21  
3.2.3 Agreement between Pace and Metra for Computer Use ...................................... 22  
3.2.4 Agreement for joint use of transit terminals ....................................................... 22  
3.3 Potential Requirements for ITS-related Interagency Agreements in the RTA project area .................................................................................................................. 22  
3.3.1 Data sharing agreements for the Illinois Transit Hub (ITH) ................................. 23  
3.3.2 ATSS at jointly served stations, stops or terminals ............................................. 23  
3.3.3 ITH Hosting Agreement ....................................................................................... 23  
3.3.4 Metra – TMC Agreements for exchange of HRI information .............................. 24  
3.3.5 Integrated regional fare system & clearinghouse agreement ............................ 25  
3.3.6 Agreements for Transit Signal Priority Operations ........................................... 25  
3.3.7 Sharing of Variable Message Signs (VMS) ......................................................... 26  
3.3.8 Sharing of Fiber Optic Communications Facilities ............................................ 26  
3.3.9 Community Based Information Systems ............................................................ 27  
3.3.10 Project grant agreements ................................................................................... 27  
3.3.11 Agreements for interagency transfers of ITS funds ......................................... 28  

4 SUMMARY ..................................................................................................................... 29  

5 REFERENCES ............................................................................................................... 31
1 INTRODUCTION

1.1 Background

The Northeastern Illinois Regional Transportation Authority (RTA) is currently developing a Regional Transit Intelligent Transportation Systems Plan (RTIP). Its broad purpose is to present a vision and a template for planned deployment and integration of transit Intelligent Transportation Systems (ITS) in the RTA service area. Once complete, the RTIP will include:

- Descriptions of current and planned transit ITS installations throughout the region, along with cost/benefit information where available.
- A vision for a seamless public transportation system in northeastern Illinois, facilitated in part by ITS.
- The functional requirements for an Illinois Transit Hub (ITH), which will be a regional server for processing and distribution of static and real time transit data, and will maintain current transit status information for all active services in the region.
- A conceptual communications network design.
- An assessment of public-private partnership opportunities.
- Provisions for public involvement and comments.
- A deployment strategy for ITS installations.

The RTIP will contribute to the RTA’s stated goals of studying and developing new transportation technologies; ensuring regional coordination of service board programs; and developing regional standards and requirements to support the design of a seamless public transportation system. The RTIP will also enable the RTA service boards (CTA, Metra and Pace) to design, develop, and test promising ITS solutions in order to determine their applicability for full implementation.

1.2 Purpose of this document

This report presents the findings of the Wilson Consulting team’s investigation of requirements and opportunities for public-private partnerships and interagency agreements associated with the RTIP project.

In Section 2 of this report, various issues related to public-private partnerships are reviewed and addressed. Existing examples of public-private partnerships in the GCM Corridor are first reviewed. Then, opportunities for public-private partnership in RTIP are identified. Public and private sector roles are defined; business models in public-private partnership are also discussed. Next, the
barriers to public-private partnership in RTIP are addressed, and guiding principles in building public-private partnership are proposed. Finally, lessons learned in public-private partnerships are discussed.

Section 3 discusses potential requirements for interagency agreements associated with elements of the RTIP. Existing ITS-related interagency agreements in the region are identified. Then, a variety of areas are identified where interagency agreements may be needed.

The report concludes with a summary of findings in Section 4.

1.3 Glossary of Terms

The table below defines the acronyms and selected other terms used in this document.

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
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<tbody>
<tr>
<td>AAA</td>
<td>American Automobile Association, or “triple A”.</td>
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<tr>
<td>ADVANCE</td>
<td>Advanced Driver and Vehicle Advisory Navigation Concept. A public-private partnership begun in 1991. ADVANCE has demonstrated and evaluated the use of dynamic in vehicle route guidance and traveler information in the Chicago area.</td>
</tr>
<tr>
<td>ATIS</td>
<td>Advanced Traveler Information Systems. One of the major ITS program areas.</td>
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<tr>
<td>ATSS</td>
<td>Active Transit Station Signs. An RTA initiative for installation of multimodal transit traveler information signs at transit stops and stations.</td>
</tr>
<tr>
<td>AVL</td>
<td>Automatic Vehicle Location. A fleet management subsystem that allows a vehicle and/or a control center to know the precise location of that vehicle on a real time basis.</td>
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<tr>
<td>CAD</td>
<td>Computer Aided Dispatching. A software/hardware system that presents relevant information to a dispatcher in usable format that aids decision-making. CAD may also provide decision aids or recommended actions to a dispatcher.</td>
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<tr>
<td>CDOT</td>
<td>Chicago Department of Transportation.</td>
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<tr>
<td>CPP</td>
<td>Corridor Program Plan. When used in respect to GCM, refers to the GCM Priority Corridor Program Plan.</td>
</tr>
<tr>
<td>CTA</td>
<td>Chicago Transit Authority. An RTA service board providing transit bus, rail and paratransit services to Chicago and its collar suburbs.</td>
</tr>
<tr>
<td>CVO</td>
<td>Commercial Vehicle Operations. One of the principal ITS program areas.</td>
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<tr>
<td>FHWA</td>
<td>Federal Highway Administration.</td>
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<tr>
<td>GCM</td>
<td>Gary-Chicago-Milwaukee.</td>
</tr>
<tr>
<td>HRI</td>
<td>Highway-Rail Intersection. A new term for a railroad grade crossing.</td>
</tr>
<tr>
<td>IDOT</td>
<td>Illinois Department of Transportation.</td>
</tr>
<tr>
<td>INDOT</td>
<td>Indiana Department of Transportation.</td>
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<td>TERM</td>
<td>DEFINITION</td>
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<tr>
<td>Interagency Agreement</td>
<td>An agreement between two public sector agencies that may concern anything from a straightforward transfer of funds to a large-scale collaborative ITS-related effort.</td>
</tr>
<tr>
<td>ITH</td>
<td>Illinois Transit Hub. A proposed computer hub that will collect static and real time transit information and make it available to the Gateway and Internet web users, as well as hosting value added applications such as the Transfer Connection Protection System.</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation System.</td>
</tr>
<tr>
<td>Metra</td>
<td>An RTA service board providing commuter rail services to Northeastern Illinois.</td>
</tr>
<tr>
<td>MPO</td>
<td>Metropolitan Planning Organization. Metropolitan Planning Organizations develop long range and short range regional transportation plans for their jurisdictions as stipulated by Federal law. The MPO for RTA's service area is the Chicago Area Transportation Study (CATS).</td>
</tr>
<tr>
<td>Pace</td>
<td>Pace Suburban Bus Service. An RTA service board providing transit bus, paratransit, and transit-sponsored vanpool services to Northeastern Illinois.</td>
</tr>
<tr>
<td>PMS</td>
<td>Parking Management Systems. An RTA initiative for installation of parking management technology at Metra and CTA rail stations. PMS would measure parking lot occupancy and use the data to populate Variable Message Signs on tollways or freeways informing motorists of transit alternatives to their destinations.</td>
</tr>
<tr>
<td>Public-Private Partnership</td>
<td>An effort in which one or more public sector partners and one or more private sector partners collaborate to implement a new facility, technology, program and/or service. The partnership may be simply a collaboration, or could be a more formal joint venture.</td>
</tr>
<tr>
<td>RTA</td>
<td>Regional Transportation Authority. The agency with funding and oversight responsibilities for transit services in Northeastern Illinois.</td>
</tr>
<tr>
<td>RTIP</td>
<td>Regional Transit ITS Plan. The effort of which this report is part.</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition. A system that collects primarily status and fault information from widely distributed systems, such as power supply and remote fare collection systems.</td>
</tr>
<tr>
<td>SLA</td>
<td>Service Level Agreements. SLAs are often used when an organization outsources its information technology function or contracts with an Application Service Provider (ASP). The SLA identifies and codifies the levels of service the vendor will provide to the organization – e.g. availability, reliability, response time, backup and disaster recovery.</td>
</tr>
<tr>
<td>TMC</td>
<td>Traffic Management Center. A control center where multimedia information on current traffic conditions, incidents and emergency response is gathered for decision-making and sometimes dissemination to other agencies.</td>
</tr>
<tr>
<td>USDOT</td>
<td>United States Department of Transportation</td>
</tr>
<tr>
<td>VMS</td>
<td>Variable Message Sign. An electronic sign used to display messages for travelers based on the input of the sign operator.</td>
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### 1.4 Related Reports

This document is the fourth of a series of documents being produced as part of the RTIP. The reports, to date, are as follows:

- Draft Tasks 1-2 Report, which identifies RTIP stakeholders, transit information needs of travelers, service providers and information service providers, and existing and planned Transit ITS projects.
- Draft Task 3 Report, which encompasses the Illinois Transit Hub Functional Requirements.
- Draft Task 4 Report, which presents the conceptual network design for the ITH, as well as a site analysis for location of the ITH.

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
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<tr>
<td>WisDOT</td>
<td>Wisconsin Department of Transportation.</td>
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2 PUBLIC-PRIVATE PARTNERSHIPS

2.1 Introduction

One approach to fully pursuing the ITS projects envisioned by the RTA and its service boards is to simply select those projects and technologies that will deliver the greatest value for the least amount. Another is to leverage available funds along with public resources such as facilities and information in order to actually attract private capital.

As part of both these approaches, it will be beneficial to create opportunities for public-private partnerships and to attract qualified private sector firms to participate in them. Such partnerships can bring services and benefits to the public that might not otherwise be realized. A wide range of objectives may be involved: bringing a new technology to market; building and operating a traffic management center; making a new transportation information service available to the public. Resulting public benefits may include improved safety, cost, comfort, reliability and traveler information.

The public-private partnership approach has the following advantages:
• It encourages creativity and flexibility;
• It increases the opportunity for public sector and private sector firms to share information and resources;
• It enables the field testing of leading-edge technologies; and
• It increases the potential sources of funds.

A public-private partnership involves the sharing of costs, benefits and risks. For such partnerships to be successful, an institutional framework should be in place that is supportive of the public and private sectors working together.

Public sector and private sector participants have different expectations from public-private partnerships. The public sector expects that the partnership will allow them to explore new technologies while obtaining the maximum leverage against public funds. The private sector expects that the partnership process will allow them to explore the new technologies and bring them to a test market more quickly and with less risk than a traditional approach. Also, potential private sector participants will not commit unless there is 1) a clear potential opportunity to make a profit, and 2) an acceptable risk profile.

2.2 Existing Examples of Public-Private Partnership in the GCM Corridor
The consulting team has identified two ITS-related public-private partnership initiatives in the GCM Corridor region. One is the Advanced Driver and Vehicle Advisory Navigation Concept (ADVANCE) Project and the other one is the FleetOnline™ Chicago Project – An Advanced Traveler Information System for Commercial Vehicle Operations.

2.2.1 ADVANCE

The ADVANCE operational test that involved on-board route guidance and traveler information was a pioneer ITS public-private partnership in northeastern Illinois. Conceived in early 1990, ADVANCE initially included one private sector partner, two public agencies and a university consortium:

- Motorola, Inc. provided in-vehicle navigation systems, in-vehicle database development, and communications system design.

- Illinois Department of Transportation (IDOT) contributed project management services, acquired radio frequencies, and operated the traffic information center for ADVANCE.

- Federal Highway Administration (FHWA) provided coordination with other ITS projects and was responsible for project evaluation.

- The Illinois Universities Transportation Research Consortium designed the traffic information center and provided technical support for system operation and testing.

- The overall contracted funding shares were 68 percent federal, 20 percent state, and 12 percent private sector.

In addition, the American Automobile Association (AAA), in conjunction with the Chicago Motor Club, joined the project near the end of its design phase. More than 25 other private firms contributed to this project. DeLeuw, Cather & Company, now Parsons Transportation Group, served as the systems integration and project management consultant; Argonne National Laboratory as the evaluation manager.

The ADVANCE project stands as a textbook example of a public-private partnership. It has combined the capabilities and benefits of public agencies and private organizations in order to advance their jointly held and individual objectives. The blend of government, private sector, and university interests has provided a wide spectrum of talents to the project and an exceptional pool of resources to draw from. This wide range of interests has also proved to be a challenge in terms of blending cultures and operations of the participants. As a
public-private partnership, ADVANCE has challenged the normal contracting and operating procedures of all participants.

2.2.2 FleetOnline™ Chicago

The FleetOnline™ Chicago Project was the first public-private partnership initiative of the GCM Corridor Coalition. In May 1999, TranSmart Technologies formed a public-private partnership with the GCM Corridor Coalition and ITS Midwest to develop and deploy an Advanced Traveler Information System for Commercial Vehicle Operations (CVO). Another partner in this project was the American Trucking Associations (ATA) Foundation. The FleetOnline™ System provided commercial vehicle dispatchers and drivers with information on congestion, incidents, weather, and alternate routes – information that is necessary for safe, effective routing and dispatching.

The objectives of the FleetOnline™ Chicago project were to enhance the efficiency of motor carrier operations and to reduce traffic congestion by providing information that will improve carrier routing and dispatching. The system provided customized, route-specific, and point-to-point real-time traffic information and driving restriction information; and dynamic CVO routing based on real-time and predictive traffic data. More than ten motor carriers were recruited to participate in the operational test of the FleetOnline™ System.

The GCM FleetOnline™ Chicago project was a successful public-private partnership project. The public partners provided the seed money in order to help the private partner expedite the development and deployment of the system. The private partner provided substantial cost sharing. In this way, both private and public partners shared costs and risks in developing and implementing the advanced technologies. In addition, the technology was pushed into the market more quickly than it would have been under a traditional approach.

2.3 Opportunities For Public-Private Partnership In RTIP

Whenever an ITS project involves the implementation of new technologies and long-term operation and maintenance, an opportunity for a public-private partnership may exist. There are many such opportunities among the 20+ projects encompassed by the RTIP. In this section, the report highlights three technologies with significant short and medium-term potential for the application of public-private partnerships:

- Regional Traveler Information Kiosks
- Active Transit Station Signs (ATSS)
- Parking Management Systems (PMS)
The following sections examine each opportunity in more detail.

2.3.1 Regional Traveler Information Kiosks

During 2000, CTA and CDOT initiated the development of a project for a pilot implementation of interactive information kiosks. These Internet-based kiosks, which will be placed initially at tourist attractions in Chicago, will offer a web page to receive information about public transport and special event options. Ultimately, the information kiosks will provide static and real time information about public transport services, and tourist information such as hotel and restaurant locations. The Metropolitan Planning Council (MPC) will conduct the feasibility study and pilot demonstration with financial and technical assistance provided by the RTA beginning in fourth quarter 2001.

In a kiosk-related public-private partnership, the public sector would provide seed funds, oversight and direction on the design, content and ergonomics of the kiosks. This would help assure that public goals for which the public funds were designated were met. The private sector partner(s) would also contribute funds, as well as technology and expertise. They could also perform long term operation and maintenance of the kiosks.

The public sector interest in the kiosk project lies primarily in providing reliable and accurate multi-modal traveler information and services while utilizing the expertise of leading private sector firms. Potentially being able to outsource the operation and maintenance of such a system, rather than adding staff to service boards for that purpose, could also be beneficial to the public sector.

For private sector partners, the opportunity to profit from the project could potentially come through placement of advertising content on the kiosks. In addition, some potential private partners might be looking for a showcase installation that could be a springboard for additional business from other regions. Finally, the resultant organizational learning would enhance the partner or partners’ ability to compete in the future.

2.3.2 Active Transit Station Signs (ATSS)

The Active Transit Station Sign (ATSS) project involves the provision of fully accessible displays at transit stations or stops, providing real-time status information on transit service as well as important advisory messages. The key enabling technology for ATSS is the implementation of transit AVL/CAD systems. ATSS signs at intermodal transfer points will display information from multiple service boards.
Phase I of the project investigated the feasibility of an ATSS program for northeastern Illinois. In Phase II, detailed design specifications were developed. Phase III, awarded in mid-2001, involves a prototype installation of ATSS at four CTA rail sites. Depending on the results of the demonstration project, future phases would move the technology to full regional implementation as deployment of the information infrastructure permits.

A public-private partnership for ATSS could follow a similar model to that of kiosks. This would be particularly appropriate for those locations where the transit agency currently does no maintenance of the site except for occasional replacement of the route sign. However, at many locations where there are already power and communications available, such as at CTA rail stations, as well as agency systems such as fare collection or Supervisory Control and Data Acquisition (SCADA), the agency may wish to own and manage the signs. In the latter case, a more limited public-private partnership or a traditional procurement relationship, focusing on the provision of general interest information and commercial messages for the signs, might be appropriate. Under such an arrangement, the private partner could provide seed money and perhaps some technology, and participate in the design as it pertained to the general interest and commercial messages. The partner could also sell the time available for commercial messages.

From an ATSS public-private partnership, the public sector would be looking primarily for an attractive price based on the private partner’s ability to sell commercial message time. This could be guaranteed on the basis of a percentage of commercial revenue received. In addition, public sector partners would seek state of the art technical expertise, and possibly access to some of the private partner’s information infrastructure.

The private sector partner(s) for ATSS, in addition to seeking a profitable engagement, would expect the freedom within guidelines to control the non-ATSS content on displays, and to independently price the services based on market conditions. The partner(s) might also seek public sector data on usage of stops and stations to support their marketing efforts.

A practical example of public-private partnering for active signs is currently unfolding in Atlanta. MARTA and Mass Transit Network International, Inc. (MTNI) have partnered to test active displays at several MARTA rail stations. These displays provide travelers with next train information, CNN news in text, and advertising messages. The next train information has been provided in three different forms during the test: 1) identity of next train for each line (A or B train); 2) ETA for the next train on each line; and 3) real time countdown for the next train on each line.

Under the terms of the demonstration partnership agreement, MTNI has absorbed virtually all the costs associated with the acquisition, installation,
operation and maintenance of the displays. Also included is integration of the MTNI product with the agency’s existing information systems. The only exception is that MTNI does not cover electrical costs associated with the installation. The rail carrier also provides flaggers to control train movements and protect installation personnel.

MTNI generates its revenue from the sale of advertising messages. Therefore, the installation of these systems under this business model is limited to rail stations with enough traffic to be of interest to advertisers. MTNI also employs remote monitoring of the signs and a quality control staff whose visits to each sign on a regular basis are verified. This assures MARTA and the advertisers that any problems will be quickly dealt with.

MTNI also offers a train alert product that utilizes the real-time information used by the station displays. The train alert system provides subscribers with notification via a number of media when their train has been delayed.

In reference to RTA’s ATSS project and the possible sale of advertising on the signs, there are current agreements with advertising agencies for station, stop or terminal advertising that may need to be modified to enable this. This is because many of these contracts preclude advertising from other sources from being displayed at the stop.

2.3.3 Parking Management Systems (PMS)

The Parking Management System (PMS) project involves the use of real time inventory monitoring technologies at park-and-ride lots, along with variable message signs (VMS) to alert auto travelers to the availability of parking spaces and the schedules for public transportation services served by a given station. The system is primarily targeted at stations adjacent or near to freeway or tollway interchanges, where travelers could divert to avoid congestion.

Phase I of the PMS project was a feasibility study to determine the functional requirements and to identify locations for demonstration of a pilot system. A Phase II PMS demonstration for design and evaluation of the concept is planned to be initiated in 2001. Ultimately, the PMS installation could include ten or more stations on Metra or CTA.

A public-private partnership approach to PMS would most likely take the form of a joint development effort with both public and private sector funding, followed by private sector operations and maintenance. The PMS technology does not present the same kind of opportunities for commercial messages as ATSS, since the PMS signs are targeted toward attracting auto travelers to transit, rather than toward a captive audience at a stop or station. As a result, other profit sources
would need to be found for a private sector partner. One option for this could be sharing a portion of incremental increases in parking fees.

Another complicating factor for a PMS public-private partnership is the fact that many service board station parking lots are operated by municipalities. In such cases, the municipality involved might need to be included in the partnership. While the municipal role might not be substantial at first, the municipality’s participation would be critical in the future if the PMS were to evolve to include electronic collection of parking fees or premium reservations services.

Public sector expectations from a PMS public-private partnership would be a contribution of technology, expertise and partial funding by the private partner(s). The expectation would also include an efficient, well maintained operation, and a steady flow of accurate, timely and complete real time data to the ITH.

The private sector partner will expect the opportunity to make a profit from basic operations and maintenance. In addition, an opportunity to share in the upside potential of PMS, charges for collecting parking fees and/or fees from premium reservations services would be a major plus.

### 2.4 Public And Private Sector Roles

Participants in public-private partnerships each have very distinct roles. The public sector provides the public share of project funds, generally takes initial ownership of the concept prior to securing a private sector partner or partners, and often owns the facilities, systems or vehicles which may be involved in the ITS installation. The private sector, on the other hand, brings expertise, funds and usually an ongoing management or operating service provision capability to the partnership. As part of these basic roles, it is the public sector partner’s responsibility to create the opportunity for potential profitability, in order to attract private partners. Conversely, the private sector partner must come in with the expertise, products and services promised, and take ownership of the public sector project goals, working in a collaborative fashion.

Additional observations about the public sector role:

- The main rationale for public sector pursuit of public-private partnerships is to attract the private capital that would permit the delivery of ITS user services that could not be achieved with public funds alone. The agency will not want to pursue such a partnership unless the benefits to the public will be greater than without the partnership in place.
- The public sector should pursue proven strategies and explore creative means for reducing the risks of public-private partnerships. However, it must
be recognized that public-private partnerships inherently involve risk sharing, and that the entire risk cannot be transferred to the private sector.

- Public sector agencies are involved in many public-public partnerships with other related public agencies, including Federal, state, county and municipal agencies, as well as MPOs and other transportation authorities. Principles of successful public-public partnerships are in many cases directly transferable to public-private partnerships. In short, public-public partnerships can be viewed as the foundation for public-private partnerships.
- Public agencies need flexibility in procurement, legal and audit policies to successfully deploy a public-private partnership. If there are regulatory or statutory restrictions that limit their ability to do so, it may be necessary to seek relief from the regulator or the state legislature.

Major components of the public sector’s role in public-private partnerships can be summarized as follows:

- Provide assistance and guidance throughout the project, oversee the evaluation of the project, and provide the seed funding.
- Provide an integrated system so that there will be a single information source that the private sector can access.
- Provide coordination among public agencies.
- Provide strong leadership
- Arrange and supervise the project evaluation team.
- Coordinate the relationship with media.
- Support a public awareness and marketing campaign.

The private sector role in public-private partnerships is generally proscribed by the initial agreement. It usually includes the provision of specific expertise, technology and systems suited to the problem at hand. Frequently, ongoing operations and maintenance are the responsibility of private sector partners as well. Private sector roles are summarized as follows:

- Coordinate and integrate the various equipment, hardware and software associated with the project.
- In some cases, add value to the public sector’s raw data.
- Build a strong technical linkage between public partners and end users.
- Operate and maintain the system.
- Keep technical systems current as new releases and improved technologies are introduced – often known as “technology refreshment”.
- Coordinate revenue sharing with public partners.
- Contribute to the public awareness and marketing campaign.

\[2.5 \textit{Business Models in Public-Private Partnership}\]
There are a variety of ways in which public and private sector partners can work together to apply advanced transit ITS technologies. Each of these different ways of partnering may be thought of as a different business model – a particular way of doing business. A public-private partnership business model has different dimensions such as the nature of the partnership and the types of customers the business targets.

As background, the term “public-private partnership” does not necessarily refer to a separate legal entity formed to pursue a project. Rather, a public-private partnership may take a wide variety of forms, from a partnership or joint venture in the strictest legal sense, to projects in which the parties simply agree to pool specific resources and to share the profits and benefits arising from a particular project. In the most general terms, a public-private partnership is an activity in which the public and private sectors share the costs, benefits and risks. In addition, public-private partnerships typically give a private entity special rights in public property in return for a service or other benefit that it would otherwise be inefficient or too costly for the public sector to provide or obtain by other means.

There are several business models that have been used in ITS public-private partnerships. It is still too early to judge which business model is the most effective one. However, lessons learned from implementing those business models can be of great value. Several business models in ITS public-private partnerships are summarized as follows.

- One successful business model is the AZTech Advanced Traveler Information systems (ATIS) business model, which is based on a public-private partnership that will eventually allow for the private sector to operate a self-sustainable ATIS. The underlying principle is that the public sector contributes the public sector data collection and fusion. This data is made available at no cost to the private sector for dissemination to the traveling public. In return, all the value-added information that the private sector attaches to the data stream must be provided free of charge to the participating public sector partners. Also, there must be assurances from all partners as to the content, frequency and quality of information they provide.

  The public partners' primary risk is associated with the development of new technology and operating and maintaining that technology once it is completed. The public benefit is the contribution to a better-informed driving public, reducing congestion, preserving the environment, and developing safer traveling conditions. On the other hand, the private partners' risk is the possibility of losing money in providing services to the public, while the reward is the possibility of making a profit from providing a service to the public.

- Another business model for public-private partnerships has the private sector participant(s) funding the initial construction or implementation. Costs plus
profit are recovered through transaction fees. Many types of infrastructure and systems are financed this way -- for example, in the commercial vehicle operations (CVO) arena, various vehicle inspection and maintenance facilities, as well as the electronic clearance systems deployed by Lockheed Martin under Help, Inc.

Objections by many states to the transaction-based processing and monopoly business model of Lockheed Martin have resulted in an emerging competitive business model. Under the Norpass unit of TransCore Inc., the state builds the infrastructure, and Norpass provides technical and administrative services. Norpass charges an annual flat fee of $45 to enroll a truck (power unit) which can then bypass Norpass weigh stations for an unlimited number of times.

- Another public-private partnership business model relies on private partners such as manufacturers to finance key portions of the system. The private sector profits by capturing the willingness of the public to pay for the equipment. An example would be private sector financing of portions of the infrastructure necessary to provide in-vehicle real-time route guidance. A critical enabling factor in this example has been the development of communication infrastructure in the public rights of way to monitor speeds for vehicles and support delivery of real-time travel information to vehicles, which permits real-time route guidance. For manufacturers to finance ITS deployment, achieving significant economy of scale in manufacturing is essential. The lesson learned in Japan is that sufficient geographic coverage is essential, which in the United States requires a multi-state, large-scale, regional, or even national effort.

- Finally, another model for ITS implementations that involve a public-private partnership is the Trafficmaster System in the United Kingdom. The success of Trafficmaster has depended upon the company obtaining exclusive rights to deploy surveillance equipment on the motorways of the United Kingdom, based upon a pan-European patent, which other firms or countries must license. In effect, the United Kingdom, by licensing Trafficmaster and giving access to public rights-of-way, has granted this company an exclusive franchise. Trafficmaster is a profitable company, whose sole business is built around the provision of real time, reliable traffic information to its customers in the UK.

Successful ITS public-private partnership business models should be adaptable to rapidly changing technological and institutional environments, and should be based on sound business plans. A business plan should typically include market research and analysis, estimated market share and sales, design and development plans, and a financial plan including pro forma financial statements. One of the critical aspects of business plans is the preparation of realistic
estimates of costs and investment recovery. RFPs for public-private partnerships do not typically ask for business plans, but should; perhaps this is because a business plan requires information radically different from what engineering firms are accustomed to providing. If the public-private partnership is premised upon a business venture, then a business plan is essential to determining the viability of the venture.

### 2.6 Barriers to Public-Private Partnership

The attempt to develop a public-private partnership can face a number of legal and institutional barriers. These may include: Restrictions on how public property may be used, restrictions on how public funds may be spent, the authority of a public sector partner to enter into certain types of arrangements, and restrictions on the reinvestment of project revenues back into the project. In some cases, these issues can be dealt with by simply structuring the partnership in a particular way. Enabling legislation may also be required, either to change restrictive provisions, or to authorize specific projects on an individual basis.

There are additional barriers that may come to bear on specific projects. One of these is that in many states, legislation is lacking that would allow a barter relationship between a public sector agency and a private partner. Another is that the ability to transfer assets from public to private ownership may be limited.

Still another challenge in putting together a public-private partnership is the length and complexity of traditional public sector procurement processes. This puts public-private efforts at a disadvantage when competing for the attention and involvement of leading private sector firms. Any efforts to shorten and simplify the process, whether across the board or on a case by case basis, will improve the climate for private sector involvement.

Another major barrier is a mistrust of public-private partnerships, based on a lack of understanding of how they work. Lacking good information and past direct involvement in successful public-private partnerships, both partners are likely to fall back on historical expectations and stereotypes. Private sector partners will view joint public-private projects as slow, risky and with low profit potential. Further, they will view procurement practices as low-bid oriented. On the other hand, public partners may tend to look at private partners as primarily a source of capital, whose interest in profitability transcends their interest in quality. The stereotypes being perpetuated on both the public and private sides can be supplanted only with dialog, training and a body of successful public-private partnerships to serve as examples.

Other institutional barriers or challenges to ITS public-private partnerships are summarized as:
• The tendency of public sector participants to halt their participation or support 
  abruptly due to external considerations.
• Reluctance to alter traditional roles.
• Not enough value buying by public agencies.
• Insufficient overall project funding.
• An inequitable distribution of costs and risks.

In order to promote successful ITS public-private partnerships, public sector 
participants should:

• Use both open competition and sole source partnerships if possible.
• Try to measure benefits of partnership efforts.
• Encourage the private sector to propose ITS projects to the public agencies.
• Increase the public sector’s participation in industry activities.
• Create a “model deployment” to ensure that the legal foundations, contracting 
  procedures, and public sector’s management attitudes are supportive and 
  coordinated.
• Involve the private sector early on in project development.

2.7 Guiding Principles In Building Public-Private Partnerships

The following guiding principles should be followed in order to build an effective 
public-private partnership.

• An institutional framework is needed that puts in place all the necessary 
  institutional building blocks for an effective program of public-private 
  partnerships.

• Success in implementing public-private partnerships depends on senior 
  management leadership and commitment. It is important that top level 
  officials strongly support the partnerships through the establishment of 
  policies and an institutional framework, communicating the benefits to their 
  counterparts and to other stakeholders, facilitating the interaction between 
  public and private sector partners and making an appropriate and timely 
  commitment of funding and other resources.

• A public-private partnership must be based on a jointly developed and owned 
  business plan. This plan should encompass the services or products 
  involved, the enabling technologies and how they will be developed, the value 
  proposition for the investment, marketing plans and opportunities, financial 
  plans, a revenue model, and the team of key players who will get the project 
  going and continue its development. The business plan must be a dynamic 
  document, updated as elements of the partnership or underlying assumptions 
  change.
• For projects involving multiple private partners, it is essential for public sector participants to put a designated individual in charge of managing private partner performance. Without this, problems of slippage, overruns and finger pointing between private partners can ensue. If a consultant is used for this role, avoid selecting a direct competitor of any of the private partners, as concerns about confidentiality and proprietary information may render the situation unworkable.

• For station, terminal or stop-based ITS infrastructure, private sector partners should have input into the identification of best practices for station, terminal or stop development.

• Recognize the possibility that private partners sometimes drop out of partnerships for reasons external to the project – e.g. a corporate decision to get out of the business. While this risk can never be eliminated, it can be moderated by assuring that a full time project manager is assigned by the public sector partner(s), and by working hard at relationship building and honoring commitments. When there is a good relationship, attentive management and mutual buy-in, it can be harder for a partner to walk away.

• Involvement of a wide variety of stakeholders is critical. A plan for stakeholder involvement, including regular communications and specific outreach efforts is needed, and should be built around key milestones in the project.

• Special procurement and contracting procedures should be developed as necessary in order to support a broad range of business models for public-private partnerships, solicit creative ideas of the private sector, and attract private investment.

• Laws and policies may need to be amended to give the public sector agency the flexibility to allow the private sector the right to access publicly owned data and to adjust fees to use publicly owned data so as to make public-private partnerships as viable as possible.

• The public sector needs to rely on competition wherever possible to achieve the public's best interest. However, in some cases the public sector may need to protect its private partners from competition to ensure economic viability during the incubation and initial growth stages.

• All partners must agree to protect personal privacy and organization-proprietary information when it engages in public-private partnerships.
• The partnership agreement should include specific future review points where the structure of the partnership and the roles of participants can be reexamined. The agreement may also include provisions for one or more partners to buy out the interest of other partners, including the establishment of a fair price.

2.8 Lessons Learned In Public-Private Partnerships

There have been many lessons learned nationwide in the planning, implementation and operation of public-private partnerships. Those lessons learned are summarized in this section.

• It is important for the partners to establish a common vision for a project to help avoid misunderstanding and conflict.

• It is critical to clearly define public and private responsibilities.

• When there is more than one public entity in a partnership, there is a need to clearly define funding responsibilities before the start of a project.

• It is important to understand that a partnership means sharing risks, resources and benefits. To make the relationship with a private partner work, one needs mutual trust, the ability to accept and share risk, and the acceptance of uncertainties.

• Benefits received by each partner should be proportional to the resources expanded, especially in the areas of revenue sharing, assignment of intellectual property rights, and ownership of data.

• Multiphase contracts, in which the design phase is cost-plus-fixed-fee and the implementation phases are fixed price can significantly reduce risk and costs for all parties. This is particularly important when implementing new systems and technology where there is a great deal of uncertainty.

• For public partners, it is important to build a multi-agency, multidisciplinary coalition with a strong lead agency and top-level commitment from all agencies. Public partners should also realize that private partners by necessity will always be guided by business decisions even after the partnership is built.

• Public and private partners should work together in marketing and consumer awareness. Public partners should lead marketing and consumer awareness efforts. Better consumer awareness of the technologies will contribute to the success of a public-private partnership.
• It is important for public partners to realize that private partners need incentives to participate.

• It is crucial to get technical and procurement professionals from all participants (including subcontractors) together early. They should negotiate a scope that allows changes to take into account lessons learned during the project itself.

• Ownership rights and liability issues are two of the biggest stumbling blocks in negotiating a public-private partnership.

• System interfaces and compatibility can be a major issue. The partnership agreement will have to explicitly set responsibility for reaching an acceptable solution to these requirements. As standards efforts mature, their work will become more useful to agencies in addressing integration requirements.

• Public-private partnership arrangements require non-traditional procurement and contracting mechanisms. A process can be designed to generate both solicited and unsolicited proposals. A flexible, open solicitation process to achieve public objectives and to attract creative private sector ideas is highly desirable.

• Issues regarding intellectual property rights can be addressed by establishing clear policies. If federal funding is involved, one must observe federal policy regarding intellectual property rights. Ownership rights to software developed under a public-private partnership can remain with the private partners if no public money is used to develop the software.

• The failure to fully protect the privacy of business and individuals can quickly undermine a public-private partnership.
3 ESTABLISH INTERAGENCY AGREEMENTS

3.1 Introduction

It was mentioned earlier that for a public-private partnership to be successful, there needs to be an institutional framework in place that is supportive of the public and private sectors working together. A similar framework is often needed to support partnerships between public agencies (“public-public partnerships”). Such partnerships are codified by agreements between agencies, specifying the scope, terms and conditions of the public-public partnership.

Agreements may be required in a number of public-public partnership situations:

- When funding sources from multiple agencies are combined to finance an ITS project.
- When one agency makes facilities and/or people available to support a new ITS technology investment – for example, one agency hosting another’s ITS-related computer system.
- When existing ITS systems are being integrated, joint institutional and procedural arrangements may be required. For example, integrated regional fare payment systems may need to designate a neutral organization to be the clearinghouse for collection and disbursement of funds from the purchase and use of a common fare instrument.

There are at least two types of agreements between public sector agencies concerning ITS projects. An Interagency Agreement (IA) is a formal contract that establishes a relationship between the parties and describes the agreements around that relationship. For example, it may formally define responsibilities in the relationship and the contributions each will be required to make. An IA always used when there is a transfer of funds or assets from one agency to another. On the other hand, a Memorandum of Understanding (MOU) may outline the mutual understanding of parties about such things as shared goals, division of responsibilities, the identification of working committees, and a project oversight structure.

In general an interagency agreement is needed to cover any provision of goods or services, or any cooperative enterprise, undertaken by two or more public sector agencies. Often there is a statutory requirement for interagency agreements when funds are transferred from one agency to another for project use.
3.2 Existing ITS-related Interagency Agreements In the Region

Several existing ITS-related interagency agreements in the GCM region were identified during the course of this study. Each of these interagency agreements is summarized below.

3.2.1 Memorandum of Understanding for GCM Corridor Initiative

In August 1993, the Illinois, Indiana and Wisconsin DOTs and USDOT entered into a Memorandum of Understanding, which among other things provided for the development of a Corridor Program Plan (CPP) for the Gary-Chicago-Milwaukee (GCM) Corridor. The Memorandum of Understanding was executed by the Illinois Department of Transportation (IDOT), Indiana Department of Transportation (INDOT), Wisconsin Department of Transportation (WisDOT), and the United States Department of Transportation (USDOT).

The three State DOTs pursued the GCM agreement because of a commonly held interest in pursuing the development of multi-state ITS using a regional approach to transportation management. It was realized that such cooperation is important, given the wide range of technologies and systems being developed. The importance of a coordinated approach to provision of information and guidance to users of the transportation systems was also clear. Moreover, the three State DOTs were interested in obtaining federal funding through the ITS Priority Corridors Program; a coordinated planning effort and appropriate interagency agreement are prerequisites to obtaining such funds.

The CPP identified in the agreement has served as the guide for implementation of projects and technologies and as the basis for project negotiations with the USDOT. It is advisory to each partner. Also, in the Memorandum of Understanding, an Executive Committee and a Technical Committee (renamed Deployment Committee) were identified to organize and administer the Corridor initiative. The Executive Committee provides overall program direction and policy. The Deployment Committee provides guidance and direction on technical, institutional and operational policies and issues. The Deployment Committee also provides direction to technical working groups that oversee specific projects and programs conducted under the CPP.

3.2.2 CTA - Pace Agreement on Automatic Fare Collection (AFC)

CTA and Pace have an interagency agreement in place covering their use of a common fare medium that can be used on either carrier. Under the terms of the agreement, CTA programs and furnishes fare instruments for the use of Pace customers. CTA also transfers to Pace a fixed payment on a scheduled basis to
help address lost Pace revenue from passenger use of CTA-issued farecards on
Pace routes. Revenues for the sale of fare instruments are taken directly into the
accounts of the carrier who sold them (directly or through an authorized vendor).

3.2.3 Agreement between Pace and Metra for Computer Use

For a number of years, there was an interagency agreement between Pace and
Metra covering Pace's use of Metra computer facilities. Functionally, this
agreement originally included the hosting of computer systems for operations
support. Over time, however, Pace has migrated to its own computer systems to
cover its changing needs, so the agreement is no longer in force.

3.2.4 Agreement for joint use of transit terminals

There are numerous transit terminals in the region where interagency
agreements exist between service boards that govern their common use. CTA
and Pace have such an agreement covering their common use of the bus
turnaround located at 63rd Street and Archer Avenue, Summit, Illinois. This
agreement covers each agency's responsibilities around the use of the site.

While the 63rd and Archer turnaround agreement and others like it currently have
nothing to do with ITS, in the future it and other such agreements could be
expanded to incorporate responsibilities around the use of joint active transit
stations signs at stops, stations and terminals served by more than one service
board.

3.3 Potential Requirements for ITS-related Interagency Agreements in the
RTA project area

As ITS integration proceeds throughout the RTA service area, it is inevitable that
interagency agreements will be required as part of development, implementation
and ongoing operation of new ITS installations. These agreements will cover
such situations as facility or other resource sharing, pooling of funds and/or joint
project sponsorship, and reconciliation of pooled funds.

In this section, several situations are identified which may require the
development of new ITS-related interagency agreements. For each, there is a
discussion of the specific project, along with a discussion of why interagency
agreements may be needed and what they would cover.
3.3.1 Data sharing agreements for the Illinois Transit Hub (ITH)

The primary purpose of the ITH will be to gather information from the RTA service boards and to 1) further process it in order to add value for the service boards; 2) make it available to the public via the ITH web site; and 3) forward all or part of the data to the Gateway/Illinois Hub to support regional multimodal traveler information.

It is expected that memoranda of understanding or interagency agreements between the service boards and the operator of the ITH will be needed. These agreements would cover all aspects of the proposed data exchange, but should be made flexible enough to easily incorporate the inevitable changes in the content being exchanged. These agreements would protect both the ITH owner (in terms of service board data timeliness, completeness and accuracy) and the service boards (stipulating how the ITH will use the data, what the ITH will provide in return, and how the ITH will guarantee the security of data reported by the service boards).

There will also be need to be an agreement between the ITH owner and IDOT, operator of the Illinois Gateway Hub, covering similar issues. This could be a distinct agreement, or the service board-ITH owner agreements could have IDOT added as a party and be expanded to include the additional issues.

3.3.2 ATSS at jointly served stations, stops or terminals

Ultimate plans for installation of active transit station signs (ATSS) will include a number of stops, stations or terminals served by more than one service board. For example, CTA and Pace both serve a number of rapid transit terminals/stations, including Howard St. (Purple and Red Lines), Rosemont (Blue Line) and 95th Street (Red Line). When ATSS are installed at these locations, a number of the signs may display information for both service boards/s services. Interagency agreements may be required to govern the supply of Pace data to these signs, especially if the ultimate design relies on CTA-Pace internetworking to get the data. If the ITH supplies the Pace data, then any interagency agreement governing the ITH should cover this requirement. Right-of-way agreements could also be a factor in the agreement process, as agency facilities become shared resources.

3.3.3 ITH Hosting Agreement

The RTIP Draft Task 4 report discusses potential sites for hosting of the ITH. The preferred site among existing locations was the CTA Control Center. If the ITH were to be hosted at this facility or any other not owned by the ITH owner
(most likely RTA), then an agreement would be needed between the two agencies. This agreement would address the facilities and services the host organization would provide in support of the ITH, and any consideration the host organization would receive.

Because the ITH will host and support critical applications for regional transit traveler information, it will require a high degree of service from the hosting agency in such basic areas as power supply and network availability. For these and other reasons, it is recommended that the interagency agreement between the ITH owner and host agency include most of the basic elements of a Service Level Agreement (SLA). An SLA would specify the level of service that the host agency/facility agrees to provide to the ITH and ITH owner. It would address any of the following areas that are applicable to the hosting of the ITH installation:

- Network availability, reliability and performance
- Host availability, reliability and performance
- Application availability, reliability and performance
- Customer service – applications help, technical support, and enhancements such as training or targeted help materials
- Security performance
- How any disagreements or disputes between the agencies will be resolved

3.3.4 Metra – TMC Agreements for exchange of HRI information

Railroad grade crossings (known as Highway-Rail Intersections or HRIs) can potentially disrupt both rail and highway traffic when blocked or out of service. As a result, it may be useful for railroads and traffic management centers (TMCs) to exchange information on planned and unplanned HRI closures or blockages. For TMCs, the information that a busy HRI will be blocked for 10 minutes by a slow moving freight can be used to help reroute traffic and to warn affected emergency management agencies so that reciprocal help can be requested if necessary. For railroads, knowledge that a highway incident has fouled an HRI can help dispatchers respond as necessary with rescheduling and by sending maintenance personnel.

A future interagency agreement between Metra and a TMC could cover the details of the information exchange related to Metra-owned HRIs in the agency’s jurisdiction. This would include what information would be exchanged, the formats for that information, and when and how it would be exchanged. It is expected that routine exchanges could take place through the ITH and Illinois Gateway Hub. Exchanges regarding urgent, immediate situations would require further study into how the information exchange should take place.
3.3.5 Integrated regional fare system & clearinghouse agreement

One of the features of a fully integrated regional fare system is expected to be a single fare medium usable on all RTA services and perhaps for other purchases as well. Because the fare medium can be used on more than one carrier, an interagency agreement will be needed to govern how funds from the sale of the fare medium are shared among the parties. This can be done in several ways:

1. carriers can keep the revenue from sales under their jurisdiction and agree to lump sum payments for compensation (current CTA-Pace situation);
2. the same as above, except that reimbursement would be based on measurements of actual fare medium use;
3. use of a neutral clearinghouse to disburse funds based on actual rides provided, or
4. outsourcing all or part of the fare payment system.

The neutral clearinghouse method (option 3 above) has been used for many integrated regional fare payment systems. It requires that revenues from the sale of fare media be forwarded to the clearinghouse or at least used to offset future credits due to the seller’s account. In this way, an agency’s receipts vary directly with actual service provided, not simply with the number and value of fare instruments they have sold or added value to.

Such a system may also need to account in some fashion for 1) a carrier’s initial investment in starting up the system and 2) any ongoing support the carrier may provide for the fare payment system (such as providing the physical fare media).

An interagency agreement would contain the exact formulas for transfers of funds between participants. These would include payment for each kind of fare transaction, as well as accounting for carrier expenditures on behalf of the system.

3.3.6 Agreements for Transit Signal Priority Operations

The installation of traffic signal priority request services inherently involves a relationship between the transit operator and the traffic signal operator. In many cases it can also involve emergency agencies, other transit operators, and heavy rail operators who also use preemption or priority request. A formal interagency agreement is usually needed to document the arrangements made by the parties about a number of issues. These include but are not limited to:

- What party will be responsible for acquisition, installation and maintenance costs?
• What will be the device’s relative priorities for regular traffic, pedestrians, bus transit, emergency vehicles and trains?
• What modifications from standard practice may be needed in order to best assure traffic and pedestrian safety?
• If the vehicle with priority fails to notify of clearing the intersection, how long will the signal controller wait until returning to the normal signal cycle?
• If any data is shared in the course of the exchange of vehicle and priority device, how will this data be handled?

One good example of how signal priority issues can be folded into a set of standard agency policies is the *Oregon Department of Transportation Traffic Signal Policy and Guidelines, November 19, 1999*. This document is currently available at:

http://www.odot.state.or.us/tstrafmgtpublic/public/SigPol99PDF.pdf

The Oregon policy and guidelines require the use of an interagency agreement between the transit agency and the road authority that covers, at minimum, cost responsibilities. They also allow deviation from some policies or guidelines when both parties agree and so indicate in their interagency agreement.

3.3.7 Sharing of Variable Message Signs (VMS)

Interagency agreements will be required to govern the display of transit-related messages on highway VMS. This is true whether there is actual collaborative control, or there is simply an arrangement that IDOT or other VMS operators will display transit-related content. Such an agreement could address elements such as parameters for receipt of information to be displayed, the duration and frequency of display, the delay between receipt and display, and cost sharing arrangements.

3.3.8 Sharing of Fiber Optic Communications Facilities

A growing area of interagency coordination is the shared use of fiber optic communications infrastructure. Common arrangements include:

• Two agencies agreeing to swap strands or otherwise share capacity in their own existing fiber optic communications infrastructure
• One agency piggybacking on another existing installation
• A number of agencies banding together to create a shared fiber optic network

Experience indicates that simple sharing or swapping of fiber optic capacity is often handled informally without a written agreement because there is no net
However, in many cases, a formal interagency agreement is necessary in order to address a number of key issues. A recent study at the Rudin Center for Transportation Policy and Management of New York University identified five such issues to be address in fiber-sharing interagency agreements:

- Sharing of physical facilities – i.e. the actual fiber sharing
- Sharing of software – this may range from simply agreeing on data exchange standards and guidelines, to actually installing specialized software capabilities to facilitate data exchange between agencies (e.g. CORBA).
- Sharing of expertise – software, networks, purchasing, sharing of individual strands using wavelength division multiplexing (WDM).
- Sharing of operations and maintenance responsibilities – a single agency may become the focal point for this, with all other participants subsidizing the operation.
- Sharing of costs for installation (if applicable)

Experiences in Portland and elsewhere with fiber sharing agreements have been that if formal interagency agreements are used, they should be as flexible as possible, recognizing that technological and organizational change are inevitable. The more individual specific arrangements are codified, the more overhead will be involved in modifying the agreement later when, for example, a new transit provider enters the mix.

3.3.9 Community Based Information Systems

Community-based information systems are intended to help strengthen a community and make it more attractive to residents by providing for exchange of ideas and access to services and information. One of the areas such sites often cover is transportation services. The ITH should be open to collaborating with such sites and their public and private partners. An interagency agreement would not be needed when the system was providing only a link to the ITH web site. However, if up-to-date data were provided directly to the site on a continuing basis, an agreement or memorandum of understanding might be required.

3.3.10 Project grant agreements

When grants are awarded to sponsors for ITS projects, a grant agreement is executed. This grant agreement incorporates the project scope, timeframe, and expected results, and may provide for final reports and project evaluations. It also includes all terms and conditions for use of the grant funds. These agreements will continue to be required for projects requiring funds from outside sources.
3.3.11 Agreements for interagency transfers of ITS funds

It is routine for there to be interagency agreements between a funding agency and a project-sponsoring agency governing the transfer of project funds from the former to the latter. These straightforward agreements specify the amounts of funds available, when the transfer can take place, and (by reference) all relevant terms and conditions for use of the funds. These agreements will continue to be required for ITS projects when the project sponsor is not providing all the funds.

Currently, memoranda of understanding are being executed for federal ITS earmarked funds provided under TEA-21. These MOUs could serve as a model for other funds transferring agreements.
4 SUMMARY

This report has presented the consulting team’s findings concerning potential opportunities for public-private partnerships in the pursuit of various elements of the RTA’s RTIP. In addition, a variety of areas where interagency agreements may be needed are identified. These findings are based in part on the review and analysis of existing public-private partnerships and interagency agreements in the region.

There are two current or former ITS-related public-private partnerships in the GCM Corridor. One is the ADVANCE project, the traveler information and route guidance project that evolved into the predecessor system for the Gateway. The other is the FleetOnline™ Chicago Project, providing real time traveler information and route guidance to commercial vehicle operators.

Three RTIP projects are initially identified as potential candidates for the pursuit of public-private partnerships:
- Interactive Information Kiosks
- Active Transit Station Signs (ATSS)
- Parking Management Systems (PMS)

In each case, there is the potential for private sector contributions to design and development, and for a lead private sector role in ongoing operations and maintenance. In the case of ATSS, the applicability of public-private partnerships may be strongly related to the current degree of service board systems and communications installations at its stops or stations, and the role of any private contractors already involved. For PMS, municipal management or ownership of parking facilities at Metra stations may complicate the partnership, but also could open up long term opportunities for expanding the PMS infrastructure to include parking fee collection.

There are clearly defined roles for public and private participants in public-private partnerships. The overall role of the public sector is to create the potential for profitability with reasonable risk in order to attract desirable private partners. On the other hand, the private sector’s roles are to implement the advanced technologies, add value to the public sector’s raw data, build strong technical linkages between public partners and consumers, and in some cases operate and maintain the system.

Successful ITS public-private partnership business models should be adaptable to rapidly changing technological and institutional environments and should be based on sound business plans. A business plan should typically include market research and analysis, estimated market share and sales, design and development plans, and a financial plan including pro forma financial statements.
One of the critical aspects of business plans is to prepare realistic estimates of costs and investment recovery.

Concluding the discussion of public-private partnerships, barriers to their use on RTIP projects, as well as guiding principles and lessons learned, are discussed.

The report goes on to identify a number of existing interagency agreements in the RTA region that currently or potentially relate to RTIP projects. They include the following:

- Memorandum of Understanding for GCM Corridor Initiative
- Fare Revenue Settlement Agreement between CTA and Pace
- Agreement between Pace and Metra for Computer Use
- Pace - Metra radio system sharing agreement
- Agreement for joint use of the 63rd and Archer bus turnaround

Finally, eleven situations where interagency agreements may be required are identified and discussed. These include:

- Data sharing at the Illinois Transit Hub (ITH)
- ATSS at jointly served stations, stops or terminals
- ITH Hosting Agreement
- Metra – TMC Agreements for exchange of HRI information
- Integrated regional fare system & clearinghouse agreement
- Transit signal priority operations
- Sharing of variable message signs (VMS)
- Sharing of fiber-optic installations
- Cooperation with community-based information systems
- Project grant agreements
- Agreements for interagency transfers of ITS funds
5 REFERENCES

Several references were consulted in preparation of this report. They are as follows:


REGIONAL TRANSPORTATION AUTHORITY
REGIONAL TRANSIT ITS PLAN PROJECT

FINAL TASKS 6-7 REPORT:
ITS DEPLOYMENT BENEFITS AND COSTS
ITS DEPLOYMENT STRATEGY

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# TABLE OF CONTENTS

1 INTRODUCTION ......................................................................................................................... 1  
1.1 Background – RTIP Overview ............................................................................................. 1  
1.2 Purpose of this document ..................................................................................................... 2  
1.3 Document Organization ......................................................................................................... 2  
1.4 Glossary of Terms .................................................................................................................. 2  
1.5 Related Reports ..................................................................................................................... 8  
2 COST BENEFIT ASSESSMENT APPROACH .......................................................................... 9  
2.1 Objective and Scope .............................................................................................................. 9  
2.2 Selection of Method .............................................................................................................. 9  
2.3 Cost and Benefit Impact Assessment Process ...................................................................... 10  
2.3.1 Selection of benefit areas ............................................................................................... 11  
2.3.2 Collection and processing of project cost information ..................................................... 12  
2.3.3 Benefit impacts collection ............................................................................................... 13  
2.4 Information collection .......................................................................................................... 14  
3 PROJECT COST AND BENEFIT ASSESSMENT .................................................................. 15  
3.1 Itinerary Planning System (IPS) .......................................................................................... 15  
3.2 Active Transit Station Signs (ATSS) .................................................................................... 16  
3.3 Parking Management System (PMS) .................................................................................... 18  
3.4 Illinois Transit Hub (ITH) ..................................................................................................... 19  
3.5 Traffic Signal Priority (TSP) ................................................................................................ 20  
3.6 Transfer Connection Protection (TCP) ................................................................................ 21  
3.7 BusWatch ............................................................................................................................ 23  
3.8 Rail Service Management System (RSMS) ........................................................................ 24  
3.9 Automatic Fare Collection (AFC) ....................................................................................... 26  
3.10 Intelligent Bus System (IBS) ............................................................................................. 27  
3.11 Train Information Management System (TIMS) ................................................................. 29  
3.12 Cost Summary: All Projects .............................................................................................. 30  
3.13 Summary Benefit Impact Assessment: All RTIP Projects .................................................. 31  
4 COST AND BENEFIT ANALYSIS SUMMARY ..................................................................... 33  
5 REGIONAL TRANSIT ITS DEPLOYMENT PLAN ................................................................ 35  
5.1 Objective .............................................................................................................................. 35  
5.2 A Hierarchy of RTIP Requirements ..................................................................................... 35  
5.3 Approach ............................................................................................................................. 37  
5.4 Deployment Plan Assumptions and Conventions ................................................................. 38  
5.5 Deployment Plan Summary Plans and Milestones ................................................................. 38  
5.5.1 Service Board infrastructure: CAD/AVL, network and staff ........................................... 41  
5.5.2 Service Board Data Integrity Initiatives .......................................................................... 41  
5.5.3 Provide ITH and networking connectivity ...................................................................... 43  
5.5.4 Provide regionwide integrated transit fare payment ......................................................... 44  
5.5.5 Provide Quality Transit Traveler Information Regionwide .............................................. 45  
5.5.6 Provide ITS-based transit service and efficiency improvements .................................... 46  
5.5.7 Provide improved traveler safety and security through ITS ....................................... 48
5.5.8 Equip TMCs with a full range of relevant transit information ..........48
5.5.9 RTIP Project Public Comment and Follow-up .................................49

6 RTIP PUBLIC AWARENESS STRATEGIES .............................................50
   6.1 Introduction ..................................................................................50
   6.2 The Message: Benefits of RTIP Projects .........................................50
   6.3 The Approach ................................................................................52
      6.3.1 Public Comment on the RTIP ....................................................52
      6.3.2 Finalize RTIP Report .................................................................54
      6.3.3 Board Adoption of the RTIP .......................................................54
      6.3.4 Ongoing Reporting .................................................................54

APPENDIX A: Detailed RTIP Gantt chart, project and task descriptions
1 INTRODUCTION

1.1 Background – RTIP Overview

During 2000, the RTA has initiated efforts to develop a Regional Transit Intelligent Transportation Systems Plan (RTIP). Its broad purpose is to present a vision and a template for planned deployment and integration of transit ITS. The RTIP will encompass:

- Current and planned transit ITS installations through the region, with analysis of associated costs and benefits
- A vision of a seamlessly integrated public transportation system in northeastern Illinois, facilitated in part by ITS
- An ITS hub as repository for current static and real time transit information, the Illinois Transit Hub (ITH)
- A conceptual communications network design
- An assessment of public-private partnership possibilities
- Provisions for public involvement and comment
- A deployment strategy for upcoming ITS installations

The RTIP will contribute to RTA’s stated goals of:
- Studying and developing new transportation technologies (such as ITS)
- Ensuring regional coordination of service board programs
- Developing regional standards and requirements to support design of an integrated, seamless, regional public transportation system

With the RTIP in place, the RTA service boards (CTA, Metra and Pace), will be able to design, develop, and test promising ITS technologies in order to determine their applicability for full implementation.

The ITS projects and installations encompassed by the RTIP are part of the overarching regional Gary-Chicago-Milwaukee (GCM) ITS Priority Corridor Architecture. The GCM Corridor is a 16 county corridor from Gary, Indiana, through Chicago, Illinois, to Milwaukee, Wisconsin. It was selected in the early 1990s by the United States Department of Transportation (USDOT) as an evaluation corridor for ITS applications.

The Multimodal Traveler Information System (MMTIS) is an essential element of the GCM Architecture. The MMTIS has at its core the Gateway Traveler Information System (Gateway TIS or Gateway), which collects information from the entire corridor and makes it available to participating agencies and the public. This is to be done through three regional hubs in Indiana, Illinois and Wisconsin,
along with a number of subregional and local hubs, including the Illinois Transit Hub. These hubs, in turn, are to be connected with all ITS installations in the region for purposes of data collection and dissemination.

1.2 Purpose of this document

This document reports the findings of the last two RTIP tasks. Task 6 involves the collection and analysis of cost and benefit information on 11 key transit ITS projects in the RTA service area. This information can assist in project evaluation, and can be useful to planners both in the region, and around the country.

Task 7 consists of the development of a deployment plan for transit ITS in the RTA service area, incorporating expected new ITS technologies. It also includes a recommended program for public awareness and input into the plan. The deployment plan is intended to serve as a blueprint for ongoing deployment of integrated transit ITS in the region.

1.3 Document Organization

Section 2 of this document describes the approach taken for the cost and benefit assessment of key transit ITS projects. Section 3 provides detail information about the assessment of each selected project. Section 4 summarizes the cost and benefit impact assessment findings. Section 5 describes the approach taken to developing the RTIP deployment plan, then summarizes its contents, identifying key activities and milestones. Section 6 concludes the report with a proposed public awareness plan for the RTIP. An appendix provides a complete Gantt chart for the RTIP deployment plan, along with brief descriptions of each project or task.

1.4 Glossary of Terms

This section defines the acronyms used in this document, as well as selected other terms or organizations.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADA</td>
<td>Americans with Disabilities Act</td>
</tr>
<tr>
<td>AFC</td>
<td>Automatic Fare Collection system</td>
</tr>
<tr>
<td>Amtrak</td>
<td>Amtrak is a Federally chartered for profit corporation charged with providing intercity passenger rail service. Generally, Amtrak operates its trains over trackage owned and managed by private railroad</td>
</tr>
</tbody>
</table>
companies. Amtrak also owns and operates Chicago Union Station.

**APC**
Automatic Passenger Counting system (or Automatic Passenger Counters). These devices use a variety of technologies to sense and record passenger boardings and alightings. If networked with an on-board processor, they can also provide real time information.

**ATSS**
Active Transit Station Signs. This identifies both an RTA project for uniform multi-carrier transit audio/visual signing throughout the region, and the signs themselves. ATSS will display expected arrival times for each route served by the stop, regardless of which service board is involved. It will also display advisory and emergency messages.

**AVL**
Automatic Vehicle Location. A system, usually using satellite based sensing such as Global Positioning Satellite (GPS), that allows a vehicle with the proper equipment to locate itself either in absolute latitude and longitude, or relative to known spatial objects such as a building or a road.

**BECS**
CTA’s Bus Emergency Communications System. Part of the BusWatch program. This system provides fundamental ITS infrastructure for CTA buses, including a silent alarm, an on-board processor with AVL, and wide area wireless communications.

**BSMS**
CTA’s Bus Service Management System. Part of CTA’s BusWatch program. An advanced set of “smart bus” capabilities that build upon basic on-board processors by adding signal priority capabilities, advanced on-board location tracking and schedule adherence calculation, and exception based schedule adherence reporting. All on-board ITS functions are connected by a “vehicle area network” – a vehicle based local area network.

**BTPU**
Bus Ticket Processing Unit. The unit, supplied by Cubic, that is attached on the side of CTA and Pace GFI fareboxes to read farecards and print transfers.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BusWatch</td>
<td>CTA's comprehensive program for advanced management of bus operations and service through application of a variety of ITS technologies. It includes the BSMS and BECS projects.</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer-Aided Dispatching. An ITS technology that receives reports on vehicle location and schedule adherence, then presents them to the assigned dispatcher along with a variety of decisionmaking tools. It also allows dispatchers to manage communications (voice and data) between with vehicles.</td>
</tr>
<tr>
<td>CTA</td>
<td>Chicago Transit Authority. The CTA operates or contracts for fixed route bus, rapid rail and ADA paratransit services in the City of Chicago and ring suburbs.</td>
</tr>
<tr>
<td>DOT</td>
<td>Department of Transportation</td>
</tr>
<tr>
<td>DSI</td>
<td>Data Source Interface. A subsystem that accepts data at its source in a native format and converts it to a standard format for data exchange.</td>
</tr>
<tr>
<td>DSRC</td>
<td>Dedicated Short Range Communications. This refers to the type of ITS communications used for vehicle to roadside data communications and other short range applications.</td>
</tr>
<tr>
<td>ETA</td>
<td>Estimated Time of Arrival</td>
</tr>
<tr>
<td>Exception reporting</td>
<td>A scheme by which a mobile vehicle does not report its schedule adherence unless it is early or late by more than the respective exception reporting threshold. This is done to conserve bandwidth.</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
</tr>
<tr>
<td>FTA</td>
<td>Federal Transit Administration</td>
</tr>
<tr>
<td>Gantt Chart</td>
<td>A horizontal bar chart for project management, showing individual tasks as bars with a specific start and end date.</td>
</tr>
<tr>
<td>GCM</td>
<td>Gary-Chicago-Milwaukee</td>
</tr>
<tr>
<td><strong>Greyhound</strong></td>
<td>Greyhound Lines, Inc. Initial contact has been made with Greyhound about participating in the ITH.</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>GUI</strong></td>
<td>Graphical User Interface. For example, the standard Windows 98 desktop.</td>
</tr>
<tr>
<td><strong>HRI</strong></td>
<td>Highway-Rail Interface. Also known as a railroad grade crossing.</td>
</tr>
<tr>
<td><strong>IBS</strong></td>
<td>Pace’s Intelligent Bus System. A comprehensive ITS system for managing Pace bus service, including on-board processors, vehicle area network, computer-aided dispatching, automatic vehicle location, wide area wireless communications, and management information functions.</td>
</tr>
<tr>
<td><strong>IDOT</strong></td>
<td>Illinois Department of Transportation</td>
</tr>
<tr>
<td><strong>IPS</strong></td>
<td>Itinerary Planning System. The software package installed by the Regional Transportation Authority’s Travel Information Center (TIC) to generate trip itineraries for callers inquiring about transit service.</td>
</tr>
<tr>
<td><strong>ISP</strong></td>
<td>Information Service Provider</td>
</tr>
<tr>
<td><strong>ISTHA</strong></td>
<td>Illinois State Toll Highway Authority, the organization that owns and operates the tollways in northern Illinois, with the exception of the Chicago Skyway.</td>
</tr>
<tr>
<td><strong>ITH</strong></td>
<td>Illinois Transit Hub</td>
</tr>
<tr>
<td><strong>ITH1</strong></td>
<td>The first phase of the ITH, which entails basic internetworking of the service boards, RTA and the Gateway/IH.</td>
</tr>
<tr>
<td><strong>ITH2</strong></td>
<td>The second phase of the ITH, in which service board data reporting is brought on line and information is forwarded to the Gateway/IH.</td>
</tr>
<tr>
<td><strong>ITH3</strong></td>
<td>The third phase of the ITH project, in which the ITH infrastructure and data will be leveraged to provide multimodal ATSS, TCP and other service improvements.</td>
</tr>
</tbody>
</table>
ITS  Intelligent Transportation Systems. Transportation technology systems enabled by computer processors and/or communications.

LAN  Local Area Network

Metra  The RTA Service Board charged with providing commuter rail services in northeastern Illinois.

MMTIS  The GCM Multi-Modal Traveler Information System, a broad designation that encompasses the Gateway, state hubs and the ITH.

Mobil Speedpass®  A small cylindrical passive transponder typically mounted on a key chain that returns its ID number when activated by a reader. Used by Mobil customers to activate Mobil pumps simply by waving the Speedpass in front of a reader in the pump.

NPV  Net Present Value – a way of expressing a stream of costs and benefits over time as a single number.

Pace  Pace Suburban Bus Service. Pace provides fixed route bus services, along with contracted community dial-a-ride, ADA paratransit services, and sponsored vanpool services.

PAHS  A platform passenger information system installed on the CTA Green Line.

PMS  Parking Management System

Positive Reporting  A system for reporting location and schedule adherence from vehicles to a CAD system. Under positive reporting, vehicles regularly report their location and schedule adherence regardless of whether they are on time or not, or whether they are on route or not. This method uses more bandwidth that exception reporting.

RFP  Request for Proposal

RSMS  Rail Service Management System. CTA’s control system for rapid transit trains.

RTA  Regional Transportation Authority
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTIP</td>
<td>Regional Transit ITS Plan</td>
</tr>
<tr>
<td>SEDP</td>
<td>Strategic Early Deployment Plan. A 1999 CATS report detailing plans for all ITS investments in the region over a 10 year + timeframe.</td>
</tr>
<tr>
<td>TCP</td>
<td>Transfer Connection Protection</td>
</tr>
<tr>
<td>TIC</td>
<td>RTA Travel Information Center</td>
</tr>
<tr>
<td>TIMS</td>
<td>Metra’s Train Information Management System. A system employing GPS AVL receivers on trains to provide frequent updates on location. This system will support better passenger information. It could also serve as Metra’s point of interface with the ITH.</td>
</tr>
<tr>
<td>TMA</td>
<td>Transportation Management Association</td>
</tr>
<tr>
<td>TMC</td>
<td>Traffic Management Center</td>
</tr>
<tr>
<td>TSP</td>
<td>Traffic Signal Priority – the system by which buses or light rail vehicles can request a green or an extension of a green at an upcoming signal. TSP can also take place on a center-to-center basis.</td>
</tr>
<tr>
<td>USDOT</td>
<td>United States Department of Transportation</td>
</tr>
<tr>
<td>Utility</td>
<td>A conceptual economic measurement of how much value individuals get out of things. Utility is normally used as the dependent variable in economic models describing consumer behavior.</td>
</tr>
<tr>
<td>VAN</td>
<td>Vehicle Area Network. A network connecting ITS and other devices on a vehicle.</td>
</tr>
<tr>
<td>VMS</td>
<td>Variable Message Sign</td>
</tr>
<tr>
<td>VPS</td>
<td>Visual Paging System. Metra’s system for displaying information at outlying train stations.</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide Area Network</td>
</tr>
<tr>
<td>Warmap</td>
<td>A GCM feature involving a large flat panel display that displays protected Gateway web pages summarizing the regional situation at a glance.</td>
</tr>
</tbody>
</table>
1.5 Related Reports

This is the penultimate document in the series of RTIP reports. The previous reports are as follows:

- Tasks 1-2 Report, which identifies RTIP stakeholders, transit information needs of travelers, service boards, traffic managers and information service providers, and existing and planned Transit ITS projects.
- Task 3 Report, which encompasses the Illinois Transit Hub Functional Requirements.
- Task 4 Report, which presents the conceptual network design for the ITH, as well as a site analysis for location of the ITH.
- Task 5 Report, which identifies potential opportunities and requirements for the use of public private partnerships and interagency agreements for deployment of future transit ITS projects in the region.

In addition, an Executive Summary of all RTIP deliverables is still forthcoming.
2 COST BENEFIT ASSESSMENT APPROACH

2.1 Objective and Scope

The primary objective of this RTIP cost and benefit assessment is to document and present the most complete cost and benefit information available for transit ITS projects included in the RTIP. This refers both to individual project findings, and to aggregate findings for the projects as a whole.

Eleven of the projects identified earlier in Tasks 1-3 were chosen for evaluation in Task 6. They are listed along with the responsible agency and project abbreviations in Table 2.1. These projects were chosen as key elements of the RTIP for which at least basic information was expected to be available.

Table 2.1: RTIP Projects Selected for Cost Benefit Analysis

<table>
<thead>
<tr>
<th>No.</th>
<th>Lead Agency</th>
<th>Project Name</th>
<th>Abbr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RTA</td>
<td>Itinerary Planning System</td>
<td>IPS</td>
</tr>
<tr>
<td>2</td>
<td>RTA</td>
<td>Active Transit Station Signs</td>
<td>ATSS</td>
</tr>
<tr>
<td>3</td>
<td>RTA</td>
<td>Parking Management System</td>
<td>PMS</td>
</tr>
<tr>
<td>4</td>
<td>RTA</td>
<td>Illinois Transit Hub</td>
<td>ITH</td>
</tr>
<tr>
<td>5</td>
<td>RTA</td>
<td>Transit Signal Priority</td>
<td>TSP</td>
</tr>
<tr>
<td>6</td>
<td>RTA</td>
<td>Transfer Connection Protection</td>
<td>TCP</td>
</tr>
<tr>
<td>7</td>
<td>CTA</td>
<td>Bus Watch</td>
<td>BW</td>
</tr>
<tr>
<td>8</td>
<td>CTA</td>
<td>Rail Service Management System</td>
<td>RSMS</td>
</tr>
<tr>
<td>9</td>
<td>CTA</td>
<td>Automatic Fare Collection</td>
<td>AFC</td>
</tr>
<tr>
<td>10</td>
<td>Pace</td>
<td>Intelligent Bus System</td>
<td>IBS</td>
</tr>
<tr>
<td>11</td>
<td>Metra</td>
<td>Train Information Management System</td>
<td>TIMS</td>
</tr>
</tbody>
</table>

2.2 Selection of Method

The project team considered five main approaches to assess RTIP costs and benefits. They were:

1. *Net present value analysis*, which involves calculating the difference between costs and benefits in each project year, then calculating a present value for the net cost or benefit, which can be used for project evaluation and selection.
2. *Marginal-benefit analysis*, which compares the ratio of the additional cost of a project to the additional benefit of a project.
3. *Break-even analysis*, which looks at degree of benefits required in order to offset the projected costs of the project.
4. *Utility-cost analysis*, which uses the ratio of utility to cost as the evaluative criterion; utilities are created from project, sponsor and stakeholder inputs.
5. **Benefit impact assessment**, which involves the separate assessment of costs on the one hand, and predicted distribution of benefits by project managers on the other hand.

The first three methods require that the costs and benefits be quantified as dollar values; each takes a somewhat different approach to project evaluation and selection from among a variety of alternatives. The last two require that costs be quantified, but rely on soft estimates of benefits distributions without requiring that the benefits be quantified.

The project team chose the benefit impacts assessment approach for this analysis. There was little quantified benefit information available, so the first three approaches could not be used. The utility cost assessment was not used because 1) it does not adapt well to comparisons of different projects (it is designed for evaluating alternatives for a single project where costs and benefits will be clustered around the true values), and 2) reaching consensus on how to weight the various benefit factors for use in the utility analysis was beyond the scope of this project.

### 2.3 Cost and Benefit Impact Assessment Process

Cost and benefit impact assessment involves collecting and processing cost data and perceived benefits information in order to characterize each project. Capital costs, operating and maintenance costs, and tangible, hard-dollar benefits are collected from project owners in a straightforward manner. The project owners are also asked to predict the distribution of total project benefits among a set of unique benefit impact areas. This information becomes the basis for analysis and presentation.

Cost and benefit impact assessment involves several steps:

1. Develop a comprehensive set of unique, non-overlapping benefit areas relevant to the universe of projects to be analyzed.

2. Collect project cost information and develop comparable present value cost figures for each project.

3. Have project managers characterize their expected project benefits by distributing a total of 100 points among the pre-defined benefit areas, with the number of points representing the mix of expected project benefits.

4. Aggregate the individual project cost information, summarize the benefit impact distributions, and analyze for trends and anomalies.

Steps 1 and 4 are done once. Steps 2 and 3 are repeated for each project.
The remainder of this section provides additional detail on each step.

2.3.1 Selection of benefit areas

The consulting team’s first step was to develop a unique, minimally-overlapping list of transit ITS benefit areas applicable to RTIP projects. This was done by adapting and consolidating the benefit typology used in the FTA’s “Benefits Assessment of Advanced Public Transportation System Technologies, Update 2000” and its “Transit-ITS Impacts Matrix”, illustrated in Table 2.2.

Table 2.2: Benefits Areas

<table>
<thead>
<tr>
<th>Transit ITS Project Categories</th>
<th>Potential Benefits</th>
</tr>
</thead>
</table>
| Fleet Management Systems (including Operational Software and Computer-Aided Dispatching Systems) | 1. Increased transit safety and security  
2. Improved operating efficiency  
3. Improved transit service and schedule adherence  
4. Improved customer convenience  
5. Improved transit information  
6. Increased compliance with transit ADA requirements  
7. Ridership increases |
| Electronic Fare Payment Systems | 1. Improved security of transit revenues  
2. Increased customer convenience  
3. Expanded base for transit revenue  
4. Reduced fare collection and processing costs  
5. Expanded and more flexible fare structures  
6. Ridership increases |
| Advanced Traveler Information Systems | 1. Increased transit ridership and revenues  
2. Improved transit service and visibility within the community  
3. Increased customer convenience  
4. Enhanced compliance with Americans with Disabilities Act |
| Traffic Management Systems for Transit | 1. Improved operating efficiency  
2. Improved transit service and schedule adherence  
3. Improved customer convenience |

A final list of 12 project benefit impact areas was developed from the material in Table 2.2 by weeding out duplicates and consolidating similar items. The list was designed to encompass all key benefit impact areas addressed by RTIP. The benefit impact areas are listed below:

1. Enhanced compliance with ADA
2. Improved customer satisfaction and convenience
3. Improved transit traveler information
4. Improved transit service reliability, such as schedule adherence
5. Improved visibility of transit within the community
6. Increased transit customer safety and security
7. More flexible fare structures
8. Improved security of transit revenues
9. Increased transit ridership and revenues
10. Reduced fare collection and processing costs
11. Improved operating efficiency and effectiveness
12. Improved vehicle operator utilization

2.3.2 Collection and processing of project cost information

Collection of costs was central to the objectives of this task. Project costs generally fall into two categories:

1) Capital and other one-time costs.
2) Annual operating costs and maintenance costs.

*Capital and other one-time costs* for projects are often the easiest numbers to obtain for an exercise such as this. For projects fully implemented or underway, fairly precise contract amounts or actual expenditures are generally available; for others, budget or planning costs can be used. Often, there are in-kind costs as well – these may not appear on project budget reports, but nonetheless should be collected and included if possible. For example, one service board might provide staff assistance on an RTA project. The estimated costs for this assistance should be identified and included to the greatest extent possible.

When costs are to be used to support competitive analysis, a decision is needed as to whether project costs will be expressed in current dollars (as of the year incurred) or constant dollars (corrected for inflation). The consulting team chose the first approach. We felt that any improvement in precision of the analysis from the use of constant dollars would be outweighed by the confusion associated with altering key numbers with which many stakeholders are already familiar. As a result, all cost figures provided in the report are unadjusted. The analysis narratives include the year upon which all actual or contract costs are based.

*Annual operating and maintenance costs* generally recur over time and are expressed on an annual basis. Operating costs include items such as staff salaries and benefits, rent and facility maintenance, communications user charges, and other overhead expenses. Maintenance costs may include annual repair, upgrade, and support costs for hardware, software, and operational facilities. Often operating and maintenance expenses are reported in a single annual figure for expenditures associated with a project.

In many cases, it is difficult to identify operating or maintenance cost impacts of a project, especially when new technology is introduced into established organizations. The consulting team, based on experience with previous projects,
established fallback rules of thumb for operating and maintenance costs, to be used when no actual figures are available. These were set at a fixed percentage of capital costs -- 10% for operating expenditures and 8% for maintenance.

When capital, operating and maintenance costs had been collected or computed for a specific project, the final step was to develop a single cost figure that could be used in subsequent stages of the analysis. This was accomplished by calculating a single Net Present Value (NPV) cost for each project. Net Present Value is calculated using this standard formula:

\[
NPV = \sum_{i=1}^{5} \frac{\text{annual flow}_i}{(1 + rate)^t}
\]

where

Annual flow$_i$ = total ongoing costs for the project for year $i$
Rate = the selected discount rate

The following assumptions were applied to all projects to provide for uniform analysis and comparability of the results:

- Project life and analysis period of five years
- Discount rate of 6%, consistent with federal standards for life cycle costing of federally-funded projects.$^1$
- Where actual or estimated ongoing operating and maintenance costs are not available, they are estimated as 10% and 8% of capital costs, respectively.

2.3.3 Benefit impacts collection

In a parallel effort to the collection of cost information, each project manager for one of the 11 selected RTIP projects was asked to estimate how the total benefits for their project(s) would be distributed among the standardized benefit impact areas described in Section 2.3.1. To accomplish this, the project manager was given 100 points and asked to distribute them among the benefit impact areas as described. This approach captured the project managers’ expectations as to the benefit impacts of their project(s). It results in an expected benefit profile for each project. However, it is important to note that the magnitude of hard dollar benefits is not estimated as part of this effort.

Table 2.3 shows a hypothetical example of a project's benefit profile, based on the project manager’s estimated benefits distribution.

Table 2.3: Hypothetical Project Benefit Profile

<table>
<thead>
<tr>
<th>Benefit Area</th>
<th>Project Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced compliance with ADA</td>
<td>5</td>
</tr>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>35</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>15</td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td>10</td>
</tr>
<tr>
<td>Improved visibility of transit within the community</td>
<td>5</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>5</td>
</tr>
<tr>
<td>More flexible fare structures</td>
<td>0</td>
</tr>
<tr>
<td>Improved security of transit revenues</td>
<td>0</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>20</td>
</tr>
<tr>
<td>Reduced fare collection and processing costs</td>
<td>0</td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td>10</td>
</tr>
<tr>
<td>Improved vehicle operator utilization</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

2.4 Information collection

Five different interviews were held with project owners at CTA, Metra and RTA. In cases where adequate information could not be obtained, supplementary cost information was developed from the Chicago Area Transportation Study (CATS) Strategic Early Deployment Plan (SEDP) or from feasibility studies that had already been completed.
3 PROJECT COST AND BENEFIT ASSESSMENT

This section includes the cost and benefit assessment for each of the 11 projects included in this task. Each assessment includes a brief project description, a summary of costs and benefits, and an explanation of the results of the utility-cost analyses.

3.1 Itinerary Planning System (IPS)

The RTA IPS was initially implemented in January 1999, and formally accepted in 2001. The IPS is a software system used by customer service representatives to automatically generate trip itineraries and travel information for transit customers. The itineraries are based primarily on static bus and train information from the RTA’s three Service Boards.

The IPS project features a new Web site that allows customers to plan their own itineraries from any computer connected to the Web. Customers enter desired origin and destination and other preferences for a trip, and receive a proposed trip plan. Although a standalone system at this time, the IPS will be integrated eventually with the ITH as its principal source of static and real-time transit data. It may also forward information requests to the ITH for other types of information. If the ITH is co-located with the IPS at the RTA Traveler Information Center (TIC), these information exchanges will take place across the ITH local area network (LAN).

Costs and Benefits Summary

The total estimated base and NPV costs for the IPS are shown in Table 3.1

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$871,000</td>
<td>Phillip Shayne, RTA</td>
</tr>
<tr>
<td>Annual Operating and Maintenance</td>
<td>$17,000</td>
<td>Phillip Shayne, RTA + standard assumptions</td>
</tr>
<tr>
<td>NPV Operating and Maintenance</td>
<td>$72,000</td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$943,000</td>
<td></td>
</tr>
</tbody>
</table>

The capital figure includes the development of data interfaces between the Service Boards’ scheduling systems and the IPS to provide automatic updates when schedules change. It incorporates development costs such as in-kind services associated with staffing provided by the Service Boards and indirect costs for internal RTA staffing.
Benefits for the IPS were estimated to be $150,000 annually. These savings are derived from reduced operator training costs. They were estimated to be $0.05 for each of the 3,000,000 annual calls to RTA. In terms of the project’s five-year life cycle, the benefits would be approximately $632,000 in present value.

**Benefit Impact Assessment**

The results of the Benefit Impact Assessment for the RTA TIC IPS are shown in Table 3.2. Those benefit areas to which the IPS project manager allocated no points have been eliminated from the table. We can infer from the points allocation that the majority of benefits are expected to come from improved customer satisfaction and transit traveler information. The IPS is also anticipated to have a modest impact on improving transit visibility.

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>50</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>40</td>
</tr>
<tr>
<td>Improved visibility of transit within the community</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

### 3.2 Active Transit Station Signs (ATSS)

The ATSS project is an RTA feasibility study and demonstration of active sign technology for displaying “next vehicle” information at transit bus stops and rail stations. The system will receive its transit status information from AVL/CAD systems operated by Service Boards, from the ITH, or by manual input.

The design developed in Phase I supports the display of real-time traveler information at various locations, including bus stops, rail platforms, and station entrances. The information will come from multiple Service Boards and will be displayed on active (variable message) signs. Each location will be equipped with a computer interface to receive information and for manually posting messages of local concern. Phase II, currently under development, will involve demonstration of the ATSS at 4 CTA rail stations: O'Hare and Cumberland on the Blue Line, Midway on the Orange Line, and Davis Street on the Purple Line. After proof of concept is completed, extensive implementation across all service boards is expected.

Under the planned ITH architecture, individual active signs will be associated with a particular Service Board. Signs at bus stops or rail stations served by only one Service Board will receive information directly from that Service Board’s AVL/CAD system. Intermodal signs will receive information for connecting
carrier service from the ITH. If desirable, provisions can be made for making all signs addressable from the ITH.

Costs and Benefits Summary

The total estimated base and NPV costs for the ATSS are shown in Table 3.3

Table 3.3: Estimated Costs for ATSS

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$22,395,000</td>
<td>Duana Love, RTA and SEDP</td>
</tr>
<tr>
<td>Annual Operating and</td>
<td>$4,413,000</td>
<td>Standard assumptions</td>
</tr>
<tr>
<td>Maintenance (Base)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV Operating and</td>
<td>$18,591,000</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$40,986,000</td>
<td></td>
</tr>
</tbody>
</table>

The capital figure consists of planning and design costs, and one-time hardware purchase and software development for three central processors, one each at CTA, Metra, and Pace. The major component of ATSS capital expenditures will be the costs to equip approximately 200 key locations among the three Service Boards.

No hard-dollar benefits have been quantified for ATSS. However, benefits are expected in ADA compliance, customer satisfaction, transit information, service reliability, transit visibility, customer safety, and transit ridership, as described below.

Benefit Impact Assessment

The benefit impact weightings in Table 3.4 suggest that in addition to traveler information, the stated purpose of the ATSS project, benefits will accrue in the areas of improved customer satisfaction and improved (perceived) service reliability.

Table 3.4: Benefit Impact Assessment for ATSS

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced compliance with ADA</td>
<td>10</td>
</tr>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>15</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>40</td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td>15</td>
</tr>
<tr>
<td>Improved visibility of transit within the community</td>
<td>10</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>5</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
3.3 Parking Management System (PMS)

PMS installations will alert travelers about the availability of parking spaces at park-and-ride lots adjacent to transit centers and inform them about the schedules of public transportation services that serve those lots. The PMS project will deploy real-time inventory (parking space) monitoring technologies at the park-and-ride lots. Variable message signs will be placed at key approach locations adjacent to or near freeways or tollways, where travelers could change their travel plans to avoid traffic congestion. It is expected that where existing IDOT or ISTHA VMS are conveniently located, they could be utilized as well.

RTA has completed Phase I, a feasibility study of PMS. Phase II will involve installing equipment at a Metra demonstration site to further evaluate the concept. This will require a conceptual layout, drawings, specifications, and costing, upon which the RFP specifications will be developed. Metra expects to start testing the pilot system in early 2002. Further development of the PMS will depend on those test results. Over time, the entire project is expected to include 8 to 12 Metra, CTA, and Pace sites.

Each Service Board responsible for a PMS site would eventually provide the ITH with parking occupancy information, which it would then forward to the Gateway. Once at the Gateway, the information could be used to populate PMS messages on IDOT or ISTHA VMS units. The local PMS systems should also be able to retrieve highway travel times for display on local or arterial VMS via the ITH.

Costs and Benefits Summary

The total estimated base and NPV costs for the PMS are shown in Table 3.5

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$3,974,000</td>
<td>Gerry Tumbali, RTA + RTA Feasibility studies</td>
</tr>
<tr>
<td>Annual Operating and</td>
<td>$594,000</td>
<td>Gerry Tumbali, RTA</td>
</tr>
<tr>
<td>Maintenance (Base)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV Operating and Maintenance</td>
<td>$2,501,000</td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$6,475,000</td>
<td></td>
</tr>
</tbody>
</table>

The capital figure includes planning costs for a feasibility study, and a design and specification study. A one-time hardware purchase and software development for two central processors, one at CTA and one at Metra, are also included. (Note that the CTA cost is the incremental amount required to allow the ATSS system...
to also manage PMS.) The majority of capital costs will be spent equipping an estimated 10 CTA and Metra park and ride locations.

No hard-dollar benefits have been quantified for PMS. However, it is expected that precise parking occupancy profiles by day of week and time of day will help service boards to plan parking investments with maximum effectiveness.

Benefit Impact Assessment

The benefit impact weightings in Table 3.6 show the expected importance of traveler information and transit visibility benefits resulting from PMS deployment. In addition, increased ridership is an expected outcome.

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>15</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>45</td>
</tr>
<tr>
<td>Improved visibility of transit within the community</td>
<td>30</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>10</td>
</tr>
<tr>
<td>Total:</td>
<td>100</td>
</tr>
</tbody>
</table>

### 3.4 Illinois Transit Hub (ITH)

The ITH will serve as a centralized source for regional transit information that will support the region’s Multi-Modal Traveler Information System (MMTIS). The ITH will collect information from the service boards and make it available to other service boards, the public, and the Gateway. For example, CTA’s BusWatch system will provide schedule and on-time status information to the ITH. The ITH will also serve the service boards as the source for regional traffic information retrieved from the Gateway.

Costs and Benefits Summary

The total estimated base and NPV costs for the ITH are shown in Table 3.7

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$3,000,000</td>
<td>SEDP</td>
</tr>
<tr>
<td>Annual Operating and</td>
<td>$450,000</td>
<td>Standard Assumptions</td>
</tr>
<tr>
<td>Maintenance (Base)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV Operating and</td>
<td>$2,123,000</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$5,123,000</td>
<td></td>
</tr>
</tbody>
</table>
The total amount for capital includes expenditures for planning and development, engineering, hardware, and software.

No hard-dollar benefits have been quantified for the ITH. It would be difficult to do so since benefits are likely to be realized primarily through other RTIP projects that are integrated with the ITH. The most visible element of the ITH will be its web site – it is expected to provide significant transit traveler information benefits.

Benefit Impact Assessment

Table 3.8 shows that the predominant benefit impact is expected in the area of traveler information. In addition, improvements in customer satisfaction and transit visibility are expected.

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>10</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>80</td>
</tr>
<tr>
<td>Improved visibility of transit within the community</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

### 3.5 Traffic Signal Priority (TSP)

The RTA’s comprehensive TSP project is developing regional standards and guidelines for design, procurement, testing, installation, operation, and maintenance of a multi-jurisdictional transit signal priority system.

A Signal Inventory and a Location study have already been completed. A simulation modeling project of the key intersections is scheduled to begin in late spring, 2001. The simulation study will explore the two main categories of transit signal priority requests. The first is vehicle-to-wayside, where the transit vehicle communicates with the signal controller itself via a wayside detector. The other method is center-to-center, where the priority request is passed from the control center to a traffic management center, which decides whether or not to grant a priority request.

Region-wide deployment will be based on the results of the modeling study. The preliminary Phase II study area includes: 70 bus routes; three major transfer points served by CTA, Metra, and Pace; and, over 600 miles of roadway controlled by more than 3,000 traffic signals.

Costs and Benefits Summary
The total estimated base and NPV costs for the TSP are shown in Table 3.9. They are calculated using 300 signals as an estimated number for deployment (10% of region-wide signals).

### Table 3.9: Estimated Costs for TSP

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$6,060,000</td>
<td>Duana Love, RTA</td>
</tr>
<tr>
<td>Annual Operating and Maintenance</td>
<td>$450,000</td>
<td>Standard Assumptions</td>
</tr>
<tr>
<td>(Base)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV Operating and Maintenance</td>
<td>$1,896,000</td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$7,956,000</td>
<td></td>
</tr>
</tbody>
</table>

The capital and one-time costs include expenditures for the on-board components, traffic center software updates, and field signal system upgrades. These were based on a rough estimate of $15,000 per signal. The costs also include the three engineering studies mentioned above. It was assumed that the costs of in-vehicle systems would be covered under the CTA BusWatch and Pace IBS projects.

No hard-dollar benefits have been quantified for TSP on a regionwide basis. However, similar installations in other regions have resulted in improved bus and light rail running times and schedule adherence. These may in turn lead to reduced fleet requirements and improved ridership/revenues.

**Benefit Impact Assessment**

Table 3.10 shows that service reliability is the area where greatest benefits are expected. However, improved running times and schedule adherence have secondary impacts in other areas; these are reflected in the overall benefit impact weightings below.

### Table 3.10: Benefit Impact Assessment for TSP

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>15</td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td>45</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>5</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>15</td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td>10</td>
</tr>
<tr>
<td>Improved vehicle operator utilization</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

### 3.6 Transfer Connection Protection (TCP)
The RTA TCP system is intended to improve customer service across intermodal connections between CTA, Metra, and Pace. The system will continuously examine endangered transfer connections using the real-time status of all service board operations. With this information, the system will determine whether the “to” or “from” vehicle needs to be held for a connection to be completed and whether there is sufficient time in the schedule to do so.

The TCP system is expected to be located with the ITH to facilitate the prompt exchange of information. After receiving schedule adherence data from a Service Board, the ITH will pass the information to the TCP system. The TCP system will then access the ITH database to check schedules and connecting services. If an endangered transfer connection is identified, it will forward a message to the carriers involved via the ITH.

A feasibility study of the TCP system was completed in summer 2000. Detailed design and deployment are not expected to take place until at least two Service Boards have made substantial progress toward system-wide deployment of their CAD/AVL systems.

Costs and Benefits Summary

The total estimated base and NPV costs for the TCP system are shown in Table 3.11.

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$332,000</td>
<td>RTA Feasibility Study</td>
</tr>
<tr>
<td>Annual Operating and</td>
<td>$87,000</td>
<td>RTA Feasibility Study</td>
</tr>
<tr>
<td>Maintenance (Base)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV Operating and</td>
<td>$368,000</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$700,000</td>
<td></td>
</tr>
</tbody>
</table>

Project capital costs cover the development of the custom TCP software engine, as well as hardware, systems software and incremental facilities costs. Operating costs represent a 25% increment to ITH staff resources.

No hard-dollar benefits have been quantified for TCP. Its principal benefit is that carriers can better coordinate service across intercarrier connections. Therefore, actual system benefits will depend on how service boards integrate TCP endangered connection alerts into their operations and respond to them. Assuming that improvements are seen, the customer will perceive (and there will actually be) reduced dwell times at transfer points. The resulting effect will be faster, more reliable intercarrier trips.

Benefit Impact Assessment
Table 3.12 shows that the preponderance of expected benefits will be from improved service reliability. It is also expected that there will be customer satisfaction, increased ridership and improved security impacts.

Table 3.12: Benefit Impact Assessment for TCP

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>15</td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td>55</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>10</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>10</td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td>5</td>
</tr>
<tr>
<td>Improved vehicle operator utilization</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

3.7 **BusWatch**

The BusWatch system is CTA’s comprehensive transit management system. It uses information and communications technology to improve operations management for dispatchers, supervisors, and operators. BusWatch is a new identity for CTA’s two bus ITS projects, the Bus Emergency Communications System (BECS), and the Bus Service Management System (BSMS). BSMS incorporates all of the BECS features but adds schedule adherence and bus tracking. The project will eventually equip the entire CTA bus fleet with the mobile equipment necessary for the BSMS system to operate, including full AVL capabilities and a new CAD system. In the near term, 1,200 buses are being equipped for BECS, and 250 for BSMS.

BusWatch is expected to result in improved service reliability, minimization of bus bunching, provision of real-time passenger information, and faster emergency response. In addition to providing the core infrastructure to improve customer service and operational efficiency, information from BusWatch will be fed to the ITH to support other projects, such as TSP, TCP, and ATSS.

Costs and Benefits Summary

The total estimated base and NPV costs for BusWatch are shown in Table 3.13.

Table 3.13: Estimated Costs for BusWatch

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$30,000,000</td>
<td>Daryl Lampkins &amp; Dave Kredow, CTA</td>
</tr>
<tr>
<td>Annual Operating and Maintenance (Base)</td>
<td>$5,400,000</td>
<td>Standard Assumptions</td>
</tr>
</tbody>
</table>
The total amount for capital consists of upgrading the CTA radio network and purchasing new mobile and base station radio equipment. It includes all of the on-board hardware to equip 1,200 buses with BECS and 250 buses with BSMS. The dispatch hardware and software at the various bus garages is also covered in this amount.

No hard-dollar quantified benefits for BusWatch were available. The principal objectives of BusWatch, however, have been improved reliability of service on the street, and improved traveler information.

**Benefit Impact Assessment**

The benefit impact weightings in Table 3.14 show that while the principal benefit area for BusWatch is expected to be service reliability, expected benefits are spread across nine benefits areas. Clearly CTA also expects to realize increased ridership and revenue based on the improvements due to the new system.

Table 3.14: Benefit Impact Assessment for BusWatch

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced compliance with ADA</td>
<td>5</td>
</tr>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>10</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>10</td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td>30</td>
</tr>
<tr>
<td>Improved visibility of transit within the community</td>
<td>5</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>5</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>20</td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td>10</td>
</tr>
<tr>
<td>Improved vehicle operator utilization</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

### 3.8 Rail Service Management System (RSMS)

The RSMS is an AVL and dispatching system for CTA’s rail operations. It provides vehicle tracking through track sensors linked with a control center and CAD system via wireline connections. RSMS is intended to improve both operating efficiency and traveler information.

In addition to CAD and AVL, RSMS includes schedule status monitoring and service restoration capabilities. Future plans not costed here include on-board
and en-route passenger information displays and announcements, and integration with BusWatch to provide transfer connection protection between CTA bus and rail services.

Costs and Benefits Summary

The total estimated base and NPV costs for the RSMS are shown in Table 3.15.

Table 3.15: Estimated Costs for RSMS

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$46,000,000</td>
<td>Daryl Lampkins &amp; James Washington, CTA</td>
</tr>
<tr>
<td>Annual Operating and Maintenance (Base)</td>
<td>$8,280,000</td>
<td>Standard Assumptions</td>
</tr>
<tr>
<td>NPV Operating and Maintenance</td>
<td>$34,878,000</td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$80,878,000</td>
<td></td>
</tr>
</tbody>
</table>

The total amount for capital consists of upgrading the CTA radio network and purchasing new mobile and base station radio equipment. It also includes all of the on-board hardware and the dispatch hardware and software.

No hard dollar benefits were available for RSMS. However, the system’s benefits have included improved operational efficiency, service reliability and traveler information.

Benefit Impact Assessment

Table 3.16 provides the expected distribution of benefits for RSMS. Improved traveler information is anticipated to account for over 30% of the benefits while improved service reliability will provide another 15%.

Table 3.16: Benefit Impact Assessment for RSMS

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced compliance with ADA</td>
<td>5</td>
</tr>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>10</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>30</td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td>15</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>10</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>10</td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td>10</td>
</tr>
<tr>
<td>Improved vehicle operator utilization</td>
<td>10</td>
</tr>
<tr>
<td>Total:</td>
<td>100</td>
</tr>
</tbody>
</table>
3.9 Automatic Fare Collection (AFC)

CTA has fully implemented an AFC system serving its entire rapid transit and fixed route bus network. Currently, the primarily fare medium is stored value magnetic stripe fare cards and transfers. However, CTA is beginning to shift some customers to contactless smart cards, which are fully supported as well.

Fare cards can be purchased and have value added at farecard vending machines installed at all rapid transit stations and a few other locations. Cards encoded with a preset value can also be purchased at area supermarkets and other retail outlets. Customers can purchase a variety of fare cards on the CTA’s Web site.

Smart cards are only available directly from the CTA, and are not yet in general distribution. As of March 2001, 3,500 smart cards had been distributed. Customers have to pay $5.00 to use the cards which cost CTA $8.00 each. CTA reports that smart cards facilitate faster fare payment and require less maintenance on readers than magnetic stripe cards do. Plans for the AFC system include expanding the network of sales locations to increase customer convenience, and increasing the market penetration of the smart card.

CTA’s AFC system is a standalone RTIP project. It will not be integrated, for example, with the ITH or other systems.

Costs and Benefits Summary

The total estimated base and NPV costs for the AFC system are shown in Table 3.17.

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$106,000,000</td>
<td>Luis Cantu, CTA</td>
</tr>
<tr>
<td>Annual Operating and Maintenance</td>
<td>$3,200,000</td>
<td>Luis Cantu, CTA</td>
</tr>
<tr>
<td>NPV Operating and Maintenance</td>
<td>$13,480,000</td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$119,480,000</td>
<td></td>
</tr>
</tbody>
</table>

The total amount to date for capital expenditures is $106 million. Of this amount, CTA paid $83 million to the AFC system vendor. The remaining $23 million was spent on CTA engineering costs, equipment installation for the rail system, and marketing.

CTA has identified four quantifiable benefit areas for the AFC system. They are:
1. Reduction in headcount after conversion of station agents to customer service positions.
2. Elimination of paper transfer production and distribution.
3. Elimination of tokens
4. Reduction in cash handling costs.

However, no actual quantified benefit information was available to the consulting team as of this writing.

Benefit Impact Assessment

Table 3.18 shows the expected distribution of benefits with AFC. CTA estimates the greatest benefits have been in increased transit revenues, more flexible fare structures, reduced fare-related costs, and improved security of revenues.

Table 3.18: Benefit Impact Assessment for CTA AFC

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>10</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>5</td>
</tr>
<tr>
<td>More flexible fare structures</td>
<td>20</td>
</tr>
<tr>
<td>Improved security of transit revenues</td>
<td>20</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>20</td>
</tr>
<tr>
<td>Reduced fare collection and processing costs</td>
<td>20</td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

3.10 Intelligent Bus System (IBS)

The Pace IBS is an integrated bus management system featuring AVL and CAD capabilities. It will be implemented in two phases. Phase 1 will include equipping 410 buses with an IBS on board processor, GPS, schedule adherence and full voice and data wireless communications. Also included will be the full radio infrastructure required to support operation throughout the Pace service area. Five divisions will also be equipped with the necessary terminals for local dispatch and maintenance monitoring. Some supervisory vehicles will also be equipped, and some buses will receive passenger counters.

Phase 2 will equip four divisions with dispatch and maintenance monitoring, and equip 152 additional buses as well as additional supervisory vehicles. It will also include the installation of signal priority transmitters.

Other features to be included in IBS include intra-Pace connection protection based on passenger request, management analysis capabilities, and emergency communications.
Regionally, IBS will provide schedule and on-time status information to Pace Passenger Services and to the RTA TIC. In the future, it may also receive TCP alerts and updates from the ITH, as well as roadway and weather information from the Gateway via the ITH.

An RFP for procurement of the IBS system was issued in September 2000. The Pace Board has approved the project and Phase I funds. Notice to proceed is scheduled for fall 2001.

Costs and Benefits Summary

The total estimated base and NPV costs for the IBS are shown in Table 3.19.

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$13,025,000</td>
<td>Pace contracted price + SEDP engineering cost</td>
</tr>
<tr>
<td>Annual Operating and</td>
<td>$2,156,000</td>
<td>Standard assumptions</td>
</tr>
<tr>
<td>Maintenance (Base)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPV Operating and</td>
<td>$9,080,000</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$22,105,000</td>
<td></td>
</tr>
</tbody>
</table>

The total amount for capital includes $1.05 million for engineering costs. It also includes all on-board and fixed location equipment and software.

Benefit Impact Assessment

IBS is expected to realize benefits in eight of the benefit impact areas identified. The most significant contributions will be in the areas of improved transit traveler information, improved transit service reliability, and enhanced compliance with the ADA. Other benefit areas include safety and security, ridership and revenues, operating efficiency and effectiveness, and operator utilization.

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced compliance with ADA</td>
<td>15</td>
</tr>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>5</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>20</td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td>20</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>10</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>10</td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td>10</td>
</tr>
<tr>
<td>Improved vehicle operator utilization</td>
<td>10</td>
</tr>
<tr>
<td>Total:</td>
<td>100</td>
</tr>
</tbody>
</table>
3.11 Train Information Management System (TIMS)

The purpose of Metra’s TIMS is to improve customer service. Metra will provide real-time train location information to riders, giving them better, faster, and more complete travel information. The information will be distributed via automated audio and visual stop announcements aboard equipped trains. In addition, it will enable two-way messaging between train crews and land-based operations personnel. TIMS uses GPS, spread spectrum radio, and GIS technology to capture and deliver the information.

The system will also greatly improve the tools available to dispatchers, schedule planners, and passenger services staff. Metra staff displays will allow detailed views of train operations status, location and ETA at next station. They will also enable full control of on board announcements from a central location. Historical information will allow review of operations, messages sent, and deadhead times.

The agency expects to complete Phase 1 of the project by November 2001, which will include basic installation on all Metra lines. Phase 2 will include equipping newly purchased cars with TIMS controllers (cab cars) and in-car displays (all cars). The new cars will also have improved PA systems for better quality audio announcements.

Regionally, TIMS is expected to provide schedule and on-time status information to the ITH, as well as receiving endangered connection alerts and updates from the ITH as part of the TCP project.

Costs and Benefits Summary

The total estimated base and NPV costs for TIMS are shown in Table 3.20

<table>
<thead>
<tr>
<th>Cost</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and One-Time</td>
<td>$2,806,000</td>
<td>Sharon Austin &amp; Bob Proper, Metra</td>
</tr>
<tr>
<td>Annual Operating and Maintenance (Base)</td>
<td>$1,300,000</td>
<td>Sharon Austin &amp; Bob Proper, Metra</td>
</tr>
<tr>
<td>NPV Operating and Maintenance</td>
<td>$6,132,000</td>
<td></td>
</tr>
<tr>
<td>Total Present Value Costs</td>
<td>$8,938,000</td>
<td></td>
</tr>
</tbody>
</table>

The capital figure for TIMS includes all of the in-vehicle and stationary hardware and software, training, warranties, telephone system upgrades, and overall
system integration for Phase 1. No hard-dollar benefits have been quantified for TIMS.

Benefit Impact Assessment

Table 3.21 shows the expected distribution of benefit impacts for TIMS. While half the benefits are expected in the area of improved traveler information, TIMS will also provide operational benefits and enable service improvements, hopefully leading to increased ridership.

Table 3.22: Benefit Impact Assessment for TIMS

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Benefit Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced compliance with ADA</td>
<td>5</td>
</tr>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>10</td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>50</td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td>10</td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>5</td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>10</td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td>10</td>
</tr>
<tr>
<td>Total:</td>
<td>100</td>
</tr>
</tbody>
</table>

3.12 Cost Summary: All Projects

Table 3.23 provides a summary of all project costs included in this document, sorted in descending order by total present value costs. This data indicates that the total estimated capital costs associated with the eleven projects studied are $234 million. The total estimated present value costs for all eleven projects are $349 million.

One important caveat to this table is that with many of the operating and maintenance costs based on rules of thumb rather than detailed analysis, present value costs may be overstated for some projects. Nonetheless, the numbers are useful when trying to associate a magnitude with the current and projected investment associated with RTIP.

Table 3.23: RTIP Project Cost Summary
(1,000s of Dollars)

<table>
<thead>
<tr>
<th>Project</th>
<th>Capital Costs</th>
<th>Annual Baseline O&amp;M Costs</th>
<th>NPV O&amp;M Costs</th>
<th>Total Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA AFC</td>
<td>$106,000</td>
<td>$3,200</td>
<td>$13,480</td>
<td>$119,480</td>
</tr>
</tbody>
</table>
### 3.13 Summary Benefit Impact Assessment: All RTIP Projects

Table 3.24 provides a summary of the benefit impact weightings for the RTIP projects assessed earlier in this section. This table shows the trends in where the project managers for RTIP projects feel that project benefits will be realized. The right-hand column shows the number of projects claiming some benefit in that benefit area. A review of this frequency distribution shows that only one benefit area was selected for all projects: Improved Customer Satisfaction and Convenience. Areas selected by seven or eight project managers include Improved Transit Traveler Information, Improved Transit Service Reliability, Increased Transit Ridership and Revenues, Increased Transit Customer Safety and Security, and Improved Operating Efficiency and Effectiveness.

The three fare related benefit areas were each selected for only one project – understandable in that only one fare collection project was included in the 11 projects analyzed.

<table>
<thead>
<tr>
<th></th>
<th>RSMS</th>
<th>BusWatch</th>
<th>ATSS</th>
<th>IBS</th>
<th>TIMS</th>
<th>TSP</th>
<th>PMS</th>
<th>ITH</th>
<th>IPS</th>
<th>TCP</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>$46,000</td>
<td>$30,000</td>
<td>$22,395</td>
<td>$13,025</td>
<td>$2,806</td>
<td>$6,060</td>
<td>$3,974</td>
<td>$3,000</td>
<td>$871</td>
<td>$332</td>
<td>$234,463</td>
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<tr>
<td>$</td>
<td>$8,280</td>
<td>$5,400</td>
<td>$4,413</td>
<td>$2,156</td>
<td>$1,300</td>
<td>$450</td>
<td>$594</td>
<td>$450</td>
<td>$17</td>
<td>$87</td>
<td>$26,347</td>
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<tr>
<td>$</td>
<td>$34,878</td>
<td>$25,472</td>
<td>$18,591</td>
<td>$9,080</td>
<td>$6,132</td>
<td>$1,896</td>
<td>$2,501</td>
<td>$2,123</td>
<td>$72</td>
<td>$368</td>
<td>$114,593</td>
</tr>
<tr>
<td>$</td>
<td>$80,878</td>
<td>$55,472</td>
<td>$40,986</td>
<td>$22,105</td>
<td>$8,938</td>
<td>$7,956</td>
<td>$6,475</td>
<td>$5,123</td>
<td>$943</td>
<td>$700</td>
<td>$349,056</td>
</tr>
</tbody>
</table>

3.13 Summary Benefit Impact Assessment: All RTIP Projects

Table 3.24 provides a summary of the benefit impact weightings for the RTIP projects assessed earlier in this section. This table shows the trends in where the project managers for RTIP projects feel that project benefits will be realized. The right-hand column shows the number of projects claiming some benefit in that benefit area. A review of this frequency distribution shows that only one benefit area was selected for all projects: Improved Customer Satisfaction and Convenience. Areas selected by seven or eight project managers include Improved Transit Traveler Information, Improved Transit Service Reliability, Increased Transit Ridership and Revenues, Increased Transit Customer Safety and Security, and Improved Operating Efficiency and Effectiveness.

The three fare related benefit areas were each selected for only one project – understandable in that only one fare collection project was included in the 11 projects analyzed.
Table 3.24: Summary of RTIP Project Benefit Impact Distributions

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>IPS</th>
<th>ATSS</th>
<th>PMS</th>
<th>ITH</th>
<th>TSP</th>
<th>TCP</th>
<th>Bus Watch</th>
<th>RSMS</th>
<th>AFC</th>
<th>IBS</th>
<th>TIMS</th>
<th>Number of projects claiming benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced compliance with ADA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved customer satisfaction and convenience</td>
<td>50</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Improved transit traveler information</td>
<td>40</td>
<td>40</td>
<td>45</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>30</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Improved transit service reliability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved visibility of transit within the community</td>
<td>10</td>
<td>10</td>
<td>30</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased transit customer safety and security</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>More flexible fare structures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved security of transit revenues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased transit ridership and revenues</td>
<td>5</td>
<td>10</td>
<td></td>
<td>15</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Reduced fare collection and processing costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved operating efficiency and effectiveness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Improved vehicle operator utilization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
4 COST AND BENEFIT ANALYSIS SUMMARY

The cost analysis and benefit impact assessment presented in this report have provided some useful information. This section highlights the findings, and suggests how to improve information in the future.

Methods used: Costs were collected in a straightforward fashion, and summarized into project cost figures for each RTIP project analyzed. Some concrete benefit information was also collected. In addition, a benefit impact assessment was performed in order to capture the perceived contribution of the 11 projects to 12 unique transit ITS benefit areas.

Cost findings: The four projects with the highest capital and present value costs – CTA AFC, CTA RSMS, CTA BusWatch, and RTA ATSS – have combined capital costs of $204 million, representing 87% of capital costs for the 11 projects analyzed. In present value terms, their combined costs are $297 million – 85% of the total. If CTA AFC, a largely standalone project, is removed, the concentration at the top is slightly reduced, with the remaining top three representing 77% of both capital and present value costs for the remaining ten projects.

These findings tell us that:

- Costs for the CTA AFC system represent nearly half the total for the eleven projects analyzed. These are due to factors such as market conditions, extensive field installation and maintenance requirements, the requirement for secure garage-based systems, and the need for secure networking of all turnstiles and fare vending machines to monitor status.
- AVL and CAD systems, the key infrastructure for service management and traveler information, represent the lion’s share of transit ITS investments outside of AFC -- $92 million or 40% of non AFC costs. AVL/CAD system costs vary substantially depending on the number of vehicles in the fleet and the features desired.
- Metra’s unfolding experience with its TIMS system suggests that if there are acceptable legacy dispatch systems and procedures in place, standalone AVL (no CAD) may be an attractive and relatively inexpensive option.

Benefit findings: In addition to the benefit impact assessment exercise, the interview team requested more specific quantified benefit information wherever possible. Specific information was available for two projects:

- The RTA Travel Information Center (TIC) Itinerary Planning System (IPS) has yielded tangible benefits in reduced training costs. These are estimated at $150,000 annually.
• The CTA AFC system has yielded tangible benefits in these four areas, although no quantified values were available to the consulting team:
  - Reduction in headcount after conversion of station agents to customer service positions.
  - Elimination of paper transfer production and distribution.
  - Elimination of tokens.
  - Reduction in cash handling costs.

Benefit impact assessment: The project team also performed a benefit impact assessment based on input from project managers. Each project manager was given a list of twelve unique benefit impact areas associated with transit ITS, along with 100 "points" to assign to the various benefit impact areas. The goal was for the project manager to distribute the points so as to best approximate the expected distribution of total project benefits among the twelve benefit impact areas.

A review of the impact distribution data from the project managers showed that only one benefit area, Improved Customer Satisfaction and Convenience, was selected by all eleven project managers. Five areas were selected by seven or eight project managers:

• Improved Transit Traveler Information (8)
• Improved Transit Service Reliability (8)
• Increased Transit Ridership and Revenues (8)
• Increased Transit Customer Safety and Security (7)
• Improved Operating Efficiency and Effectiveness (7)

The three fare related benefit areas were each selected by only one project – understandable in that only one fare collection project was included in the 11 projects analyzed.

Future needs: The results of this project suggest several changes for future project planning:

1) Better planning costs would be helpful in a regional analysis such as this. Locating or developing cost information from other regions on the various types of transit ITS projects could be a valuable resource.
2) Quality benefits analysis needs to be done for every ITS project. This will become more and more important in the future in order to compete for the limited funds available for transportation infrastructure investments.
3) The RTA may wish to consider formalizing cost and benefit analysis requirements for transit ITS projects in which it is involved.
5 REGIONAL TRANSIT ITS DEPLOYMENT PLAN

5.1 Objective

The objective of Task 7 is to develop a deployment plan covering all current and planned transit ITS projects in the region, as well as selected projects not yet being formally planned. This plan takes the form of a critical path plan, with dependencies between tasks explicitly identified. In addition to formal projects, the plan also addresses institutional tasks upon which any transit ITS projects are dependent. Finally, the plan is to address a public comment strategy for the RTIP project findings.

5.2 A Hierarchy of RTIP Requirements

The most desired benefits from RTIP — including service reliability and traveler information improvements, are the end product of numerous project tasks, including ITS infrastructure development, process changes, institutional shifts and successful integration of many disparate systems. A successful deployment strategy will assure that the lower level infrastructure tasks are successfully completed and fine tuned before detailed design is completed for the next higher level deployment.

The diagram in Figure 5-1 illustrates a hierarchy of requirements for RTIP project deployments. Current Institutions, Staff and Technology, including skilled technical staff and specialized software such as automated scheduling systems, provide baseline support for further transit ITS deployment. Core ITS Service management includes service board investments in location, dispatch and communications systems; examples are CTA BusWatch, CTA RSMS, Metra TIMS, and Pace IBS. These integrate with existing systems to provide enhanced capabilities to dispatch personnel.

A critical layer in this hierarchy is Institutional Shifts/Data Integrity. With the installation of core service management systems, a number of shifts need to take place. These include modifying procedures, policies and job responsibilities to take advantage of the new technology. One example of this would be a gradual shift in operational control from street supervisors (who historically have had the best information) to the dispatch center (now receiving real time information from a CAD/AVL system). Another would be establishing comparable service board priorities for service delivery and information delivery.
Data integrity is another essential shift whenever basic on-time status data is to be used directly for traveler information purposes. Even if no human intervention is involved, errors in traveler information can occur due to program bugs, equipment failure, isolated radio coverage problems, or a missed data report. In order to assure delivery of high-quality information to customers, service boards will need to establish or expand data integrity functions. Through monitoring software, error reports and customer complaints, the data integrity function’s mission is to identify and correct sources of error as quickly as possible. This, in turn, assures the best possible traveler information timeliness, accuracy and completeness. Data integrity measures can also be used to develop indicators of expected accuracy that could be included in traveler information (e.g. “The vehicle is expected in 3 minutes with a *high* degree of accuracy”).

As part of this layer, the service boards will also need to prepare their service management systems to provide transit data to the ITH. This effort includes the conversion of transit data to standard formats for transmission.

The *Illinois Transit Hub* is the point where information from the service boards is collected, validated, processed and distributed. It also includes the use of this

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**Figure 5-1: Hierarchy of RTIP Requirements**

<table>
<thead>
<tr>
<th>GCM GATEWAY: MULTIMODAL INFO</th>
<th>ALL MODES TRAVELER INFORMATION</th>
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<tr>
<td>RTA TRANSIT TRAVELER INFORMATION</td>
<td>WEB SITE; KIOSKS, TIC, PMS, MULTIMODAL ATSS</td>
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<td>GATHER/PROVIDE TRANSIT DATA</td>
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<td>INSTITUTIONAL SHIFTS/ DATA INTEGRITY</td>
<td>LEVERAGE ITS</td>
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<tr>
<td>CORE ITS SERVICE MANAGEMENT</td>
<td>MANAGE INFORMATION</td>
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<td>CURRENT INSTITUTIONS, STAFF AND TECHNOLOGY</td>
<td>BUSWATCH; IBS; METRA TIMS</td>
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<td></td>
<td>BASELINE SUPPORT</td>
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</table>
information for improvement of service management through the installation of the Transfer Connection Protection (TCP) system.

It is not until the fifth layer that RTA Transit Traveler Information can be implemented. The ITH, once it is receiving service board data, will support a public traveler information Web site, the RTA Travel Information Center and its Itinerary Planning System (IPS), Parking Management Guidance Systems and multimodal ATSS.

Finally, when the ITH has fine-tuned transit traveler information, it can provide GCM Gateway Multimodal Information. In addition, it can receive traffic information from the Gateway on a subscription basis.

While regional transit ITS deployment can take place at a number of levels simultaneously, this general hierarchy should be followed in order to assure that the overall goals of RTIP are achieved.

5.3 Approach

The project team developed a critical path plan for RTIP project deployment that is consistent with the above hierarchy of needs. The approach began with a brainstorming exercise in which desired outcomes associated with successful transit ITS deployment in the region were identified. Nearly 100 such outcomes were initially identified. They ranged from the very broad (“fully seamless fare payment throughout the region”) to the very specific (“service board Data Source Interfaces (DSIs) fully developed and tested”). No outcome, regardless of its level of specificity, was excluded.

The remaining steps in plan development were as follows:

- Create a task or tasks associated with each outcome.
- Organized the tasks into a high level project critical path diagram.
- Fill in the gaps with additional tasks as needed, particularly institutional steps.
- Identify the dependencies between tasks.
- Enter the information into project management software and add summary (“roll-up”) tasks, dates and durations.

The result of this work, version 1.1 of the plan, was distributed to RTIP stakeholders in at a meeting in May 2001. The principal feedback received was that key milestones for the ITH needed to occur considerably sooner than the first draft had envisioned. As a result of this feedback, along with some task-specific comments, that preliminary plan has been modified to bring benefits to implementation more quickly. The results of that modification – RTIP Deployment Plan Version 1.2 – are presented here.
5.4 Deployment Plan Assumptions and Conventions

The consulting team made several key assumptions and established certain conventions in the development of the plan. They are as follows:

- The plan was not constrained in any way due to funding. Because the plan is a blueprint, the expectation is that the RTA will work with other agencies to prioritize projects and work them into the regional planning process in order to secure funding at an early date.
- In general, phasing, prototypes and pilot projects were only included for projects when they were already planned or underway. For future projects, it is assumed that specific decisions about phasing will take place later as the projects enter the initial planning stage. The only other exception to this assumption was when it was necessary to break a project up because of dependencies. For example, implementation of Active Transit Station Signs (ATSS) can begin as soon as an AVL/CAD system is implemented and stable. However, intermodal ATSS (or the intermodal portions of signs as shared facilities) cannot be implemented until later, when the ITH is in place and stable.
- Similarly, for institutional tasks, no approval process was accounted for in the plan. It was assumed that either approval had been secured before the projected start date, or that it would be secured as soon as possible after the start date.
- Plans for projects beginning in 2007 and beyond were generally included as recommended actions for future consideration. They are based on the consultant’s view of potential developments in technology during the plan period.
- For future tasks involving all of the service boards, a single task was entered into the plan for the purpose of simplification. In actuality, each service board would have to pursue a separate task for their own organization.
- In some cases, projects or tasks were inserted into this draft version of the plan although there is no agreement at this time to pursue them. This was done either because they are necessary for fulfilling the RTIP vision, or because it was felt that technological advances or outside influences would require that they be addressed during the plan period.

5.5 Deployment Plan Summary Plans and Milestones

The RTIP Deployment Plan has been summarized in terms of nine summary plan elements, each corresponding to a portion of the RTIP vision. Figure 5-2 displays the summary timelines and milestones for these high level categories.

The remainder of this section describes each summary element of the Plan: the “mission thread” represented by the element; a summary of the key tasks or
projects involved, including key dependencies, a list of milestones for this summary Plan element, and key new initiatives included.

For reference purposes, Appendix A to this report holds:

- The detailed Gantt chart for the entire RTIP Deployment Plan, including task names, start and end dates (year and month), and dependencies
- A brief description of every task in the plan
<table>
<thead>
<tr>
<th>ID</th>
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<th>Start</th>
<th>End</th>
<th>2001</th>
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<tr>
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<tr>
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<td>Equip TMCs with full range of transit data to aid in traffic management efforts</td>
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<td>12/31/2007</td>
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5.5.1 Service Board infrastructure: CAD/AVL, network and staff

This summary plan element covers all the key service board infrastructure investments necessary to support the RTIP vision. Encompassed are such infrastructure components as the following:

- Complete implementation of AVL or CAD/AVL systems on bus, rail and paratransit services, for information capture and presentation.
- Equipping new vehicles with CAD/AVL components prior to delivery.
- Performing service board communications network studies and performing any necessary upgrades to assure high-reliability operation.
- Undertaking technical and project management staff recruitment and retention efforts in areas supporting ITS, such as engineering, technical services, and information technology.
- Staying abreast of bus manufacturer trends in providing buses with open architecture vehicle area networks.

Proposed milestones for this summary plan element are as follows:

1) Fixed route CAD/AVL Complete: Second quarter, 2003
2) Paratransit CAD/AVL Complete: Fourth quarter, 2004

The principal new initiative involved in this summary plan element is an intentional effort to fund new technical and project management positions as necessary for service boards to fully support the required infrastructure. Experience in this region and elsewhere indicates that dedicated project management is key for major technical infrastructure projects such as those above. This applies to all service boards and the RTA, but especially for those organizations with a serious shortfall in resources today.

5.5.2 Service Board Data Integrity Initiatives

This summary plan element includes both institutional and technical initiatives designed to assure high data quality: i.e. completeness, accuracy, timeliness, availability, and logical consistency. Such programs are an essential element of any effort to provide consistently high quality traveler information. A data integrity function combines data monitoring tools, training, procedures, technology and relentless follow-up to discover and correct sources of errors. This assures that when errors occur, as they inevitably will, that the agency will discover and address them proactively, rather than being forced into a reactive posture after learning from a customer or from the news media.
A parallel concern to data integrity is that for at least some of the service boards, constraints on wireless capacity will limit the location and schedule adherence data that can actually be collected from the vehicle. In order to support AVL and CAD systems, service boards AVL systems as they are currently designed will be forced to use the exception reporting method of collecting location and status from vehicles. To do this, thresholds are established for lateness (and earliness if desired). If the vehicle is on time or within the threshold value, it does not report in with location and schedule adherence. In this way the dispatcher(s) can focus on only the latest vehicles. Of course, the dispatcher can change the threshold at any time to adjust for conditions. In addition, the dispatcher is able to increase the frequency of reporting on a specific vehicle or group of vehicles.

The difficulty with this arrangement is that while exception reporting may be fully adequate for dispatch support, it will not support widespread use of active transit station signs with arrival countdowns, and it may significantly limit the effectiveness of centrally controlled connection protection. Further, it limits the precision with which vehicles that are late by less than the threshold can be reported. If the threshold is 5 minutes, then traveler information applications will report it as 0-5 minutes late. If the threshold is 10 minutes, then it will be 0-10 minutes late. As the threshold number is increased, the reduced precision of the information can become troublesome.

The appropriate medium-term goal for support of a good traveler information system should be positive reporting. In this case, each vehicle regularly reports its location and schedule adherence on a frequent basis. This helps deliver more precise countdown information, support connection protection and generally deliver more precise information.

A long term goal for accurate traveler information and connection protection is the calculation of smart ETAs by the CAD system. In standard dispatch systems, ETAs are calculated by added scheduled running times to the current position. In some cases there may be variable running times depending on time of day, demand spikes, etc. In contrast, smart ETA’s will use currently measured highway travel times along with historical information in order to calculate even more accurate ETAs.

Here are some of the specific data integrity initiatives included in the RTIP deployment plan:

- Updates to policies, procedures and training to emphasize the importance of providing not only high quality transportation service, but high quality transportation information as well.
- Establishment of formal data integrity functions at each service board, focusing on the quality of traveler information.
- Modification of emergency procedures as necessary to assure that the flow of traveler information continues for at least a backbone service network.
• Feasibility studies on modifying service board CAD/AVL/mobile communications systems to support positive reporting, or the installation of supplemental systems to accomplish the same objective.
• Implementation of positive reporting or supplementary systems as a prerequisite to countdown-type traveler information systems displaying the projected arrival of the next vehicle.

Proposed milestones for this summary plan element are as follows:

1) Service board data integrity functions in place – December, 2002
2) Service boards meet all data quality requirements – December, 2003

For the most part, all the tasks under this summary plan element represent new initiatives. This is because the data flows they address are not currently in existence. It is possible that in some cases existing data integrity functions for revenue or other data could be expanded to meet this requirement.

5.5.3 Provide ITH and networking connectivity

Provision of the ITH and associated communications network is the critical plan component for accomplishing regional integration of ITS systems and information. The plan envisions a three phase implementation of the ITH and communication networks. ITH1 represents basic internetworking of the service boards, RTA and the Gateway. Legacy data flows among these entities will be migrated to ITH1 and the associated network. It is also envisioned that under ITS1 the GCM Warmap will be brought to any service board desiring it. ITH2 involves the upgrade of the ITH to receive, process, store and distribute a full range of transit information, including current on-time status. ITH2 also includes provision of a public web site with transit information and decision tools – this project appears in the traveler information component of the plan, below. ITH3 represents a series of projects that leverage the IT information to provide additional value to both transit travelers and transit dispatchers. These projects are detailed separately under the various summary plan elements they pertain to.

Here are the key projects/tasks included in this summary plan element:

• Selection and preparation of a permanent site for the ITH
• Design and implement ITH1
• Development, test and acceptance of ITH2
• Implementing transit schedule and on-time status reports transmission
• Implementing the flow of information from the Gateway to service boards via the ITH.

Four milestones are proposed under this summary plan element:
1) ITH1 in place: September, 2002  
2) ITH2 in place: December, 2003  
3) ITH receiving all service board information: September, 2004  
4) Gateway receiving transit data: March 2005

The ITH represents a new initiative growing out of early GCM planning and the RTIP project.

5.5.4 Provide regionwide integrated transit fare payment

Integrated regional transit fare payment is one of the three legs (service, payment, information) that will be needed to support truly seamless regional transit service. Integrated regional transit fare payment means that a common cashless fare medium needs to be supported by all three service boards: CTA, Metra and Pace. Since today, CTA and Pace both share a common fare medium, an integrated regional fare medium will require either 1) that Metra adopt the CTA/Pace standard, or 2) that an alternative standard be adopted to which all service boards would conform. Such a common fare medium would also require institutional changes, with fare revenues or analogous credits pooled at a neutral clearinghouse institution which would process fare system data and disburse funds or credits based on actual ridership.

Here are the key projects/tasks involved in this summary plan element:

- A study and institutional process through which the three service boards would agree on a course of action for supporting regional fare payment, along with the most desirable technical approach.
- Identifying and bringing to market a compliant solution for Metra.
- Identifying and bringing to market a compliant solution for paratransit use (small footprint, no farebox, installable in sedans).
- Contracting with a neutral clearinghouse; bringing the network and systems into place for secure data transmission to the clearinghouse.
- Implementing the new systems on Metra and on CTA and Pace contract paratransit operators.
- Implementing the regional fare medium and clearinghouse.
- Expanding the network of fare sales, vending and (particularly) addfare capabilities.
- At the end of the plan period (or sooner if external influences so dictate), begin examining a regional transportation or general use fare medium that could be used for tolls, parking, auto expenses and transit. This trend should actually be monitored throughout the period to assure that transit’s interests are accounted for in any initiatives originating from outside the transit industry.

The proposed milestones for this plan element are as follows:
1) Service board agreement on an approach and standard: June, 2003
2) Technology solutions for Metra and paratransit available in the marketplace: June, 2005
3) Fully integrated system in place: December, 2007

The initiatives discussed here are not new, nor is there a regional consensus on how, or even if, they should proceed. However, they are arguably central to the goal and legislative imperative for seamless transit service and regional coordination.

5.5.5 Provide Quality Transit Traveler Information Regionwide

This plan element represents the most visible aspect of RTIP: Regionwide transit traveler information that is:

- Available and fully accessible to all
- Provided through a wide variety of media
- High quality: Accurate, complete, logically consistent

This information should ultimately encompass most or all items shown by studies to be important to travelers, including but not limited to: carriers, routes, station/stop locations, fares, connections, transfer instructions, current on-time status, delays & causes, and walking, bicycling or driving directions to the initial stop/station and the ultimate destination.

Also included in the regional transit traveler information concept is the provision of traveler planning and decision-making aids, such as the RTA Travel Information Center’s Itinerary Planning System (IPS). Such traveler aids should be made available before the trip, en route and at the end of the trip. When used before the trip, they will help travelers select a route and schedule, and ascertain the current on time status. During the trip, they will allow travelers to react to delays by determining their current ETA at destination, and the characteristics and status of alternative paths – for example, directions and distance to the stop or station, on time status of the alternate vehicle, and ETA using the alternate path.

Here are the key components of this plan element:

- The Phase III Demonstration of the Active Transit Station Signs (ATSS) at four CTA Rail stations. ATSS will display “next vehicle” times in a countdown fashion. They will also display delay and other advisories related to service disruptions. They also may ultimately display commercial messages.
- After other service board CAD/AVL systems are installed and stable, implementation of ATSS for all service boards, covering their routes only.
Later, intermodal ATSS can be implemented when the ITH is available to supply information for other service boards covering the stop. If desired, limited ATSS type messages might also be delivered via legacy service board display systems such as Metra’s Visual Paging System (VPS) and CTA’s green line PAHS displays.

- Development and rollout of an ITH Web Site, providing a full range of transit traveler information to anyone with Internet access. Most likely, this will be an extension or enhancement of the existing RTA TIC web site, where current and potential transit travelers can enter trip information and preferences, then receive several alternate transit itineraries for their trips.
- Establishing electronic flows of current on-time status, delay and service disruption information to the RTA TIC so that its customer service staff can provide this information to callers.
- Implementing Parking Management Systems (PMS) at up to a dozen recommended sites where there is the potential for automobile travelers to be diverted to nearby transit stations with available parking. The PMS installations will include parking occupancy monitoring systems connected with variable message signs on tollways, expressways, and key arterials. Initially, the variable message signs will display parking occupancy and next transit vehicle information, but static transit and highway travel time data. Later, when the ITH is available along with improved predictive capabilities, PMS VMS displays may be upgraded to show comparative highway and transit times to major destinations.
- Develop new software (or enhance existing software) to provide travelers with full information and decision support before, during and at the end of trips.
- Design and implement on-board terminals for traveler information and decision support on service board vehicles.
- Develop and implement wireless delivery of transit traveler information and decision support tools.

Five milestones have been proposed for this plan element:

1) Completion of ATSS Phase III: November, 2002
2) Beginning of permanent ATSS field installation: January, 2004
3) Completion of PMS installations: June, 2005
4) ATSS field installations complete: December, 2007
5) Intermodal ATSS complete: December, 2008

Among the many initiatives included in this plan component, the new ones are those dealing with full traveler information and decision support, including the delivery of that support via wireless devices and on-board terminals.

5.5.6 Provide ITS-based transit service and efficiency improvements
This plan element encompasses all the service enhancements and operational efficiencies made possible by the implementation of the basic service board CAD/AVL/communications infrastructure, as well as by connection to the ITH and the Gateway. In general, these improvements are made possible by better real time information along with the tools to utilize it for problem diagnosis and service restoration, as well as by interfacing bus operations and various traffic signal systems.

Here are the key components of this plan element:

- Implementation of tools allowing operations analysts and planners to use CAD/AVL and other on board data to better tailor schedules to actual demand, stop/station dwell times and running times.
- Potential replacement of bus vehicle automatic passenger counting systems and networking of these systems with the on-board processor so that boardings and alightings can be recorded along with time and location stamps, and door opening and closing data.
- Via connection of the ITH with the Gateway/Illinois Hub, providing real time highway conditions, incidents and travel times, along with weather, road closings and lane reductions to CTA and Pace dispatchers. This will allow them to utilize this information in their service management efforts.
- Installation of the GCM Warmap – a flat panel display of protected Gateway web pages summarizing the regional traffic situation – at service boards.
- Implementing the Transfer Connection Protection (TCP) system for pre-defined connections between service board fixed route services. This system will continuously review on-time status information from service boards and identify pre-defined connections that may be in danger of being missed. Later, the TCP system will be extended to cover connections between paratransit and fixed route services.
- Implementing vehicle to roadway Transit Signal Priority (TSP) request capabilities. In these systems, a vehicle determines that it is behind schedule, or that it will be if it is delayed at an upcoming intersection. It then uses dedicated short range communication (DSRC) to communicate its request to custom equipment in the traffic signal controller. The controller then determines whether to grant the request. TSP can improve running times and service reliability by reducing en route delays at traffic signals.
- Developing the ability for Metra and regional traffic management centers (TMCs) to electronically share planned and unplanned closing information for HRIs (grade crossings). (Closings refer to both short term blockages due to train movements, and full closings for repair or accident investigation purposes.) In the future (beyond the plan period), possibly freight rail carriers in the region might share similar information. However, such an undertaking would require a sizable institutional effort and may face a limited likelihood of success.

Here are the five milestones proposed for this plan element:
1) Begin TSP implementation: January, 2003  
2) GCM Warmaps installed at service boards: March, 2003  
3) Operations analysis/planning tools for ITS data installed: December, 2003  
4) Fixed route TCP system implemented: June, 2007  
5) Paratransit TCP system implemented: June, 2008  

The only new unplanned initiative included in this plan element is the exchange of HRI blockage information between Metra and regional TMCs.  

5.5.7 Provide improved traveler safety and security through ITS  

This plan element involves two distinct ITS-enabled methods of improving traveler safety and security. They are listed below as key components of this plan element:  

- The use of video cameras on board vehicles to deter incidents, reduce accident claims, and document actual incidents for use in court. While current technology for the most part limits this approach to digital stored image cameras, future bandwidth improvements will eventually allow transmission of full motion video.  
- The deployment of advanced collision avoidance instrumentation to minimize the chance of collisions and pedestrian accidents. This includes potential obstructions in the front, rear and side of the vehicles.  

There is a proposed milestone associated with each of these components:  


Installation of collision avoidance systems is a new initiative in this plan component.  

5.5.8 Equip TMCs with a full range of relevant transit information  

The whole basis for this plan element is the provision of transit data to traffic management centers to help them do their jobs better. There are two components to this plan element, listed below:  

- Sending service board incident reports to the Gateway, where it will be distributed to the appropriate TMC(s)
• Implementing the use of transit buses as probes for travel time estimation. This may have application for arterial routes not instrumented for travel time estimation.

There is one milestone proposed for this plan element:

1) Service board incident reports available to TMCs: March, 2005

Both of these plan components have been discussed in previous plan documents.

5.5.9 RTIP Project Public Comment and Follow-up

This plan element concerns public comment, revisions and adoption of the RTIP itself. Public review and feedback from the full range of RTA stakeholder groups is important if the final plan is to have broad based support across the region.

The following are the key projects/tasks included in this plan element:

• Completion of the RTIP project – current scope
• Development and revision of an RTIP Executive Summary
• Review of the Executive Summary by all stakeholder groups during a public comment period, ending with a public meeting for the receipt of comments.
• Finalization of the RTIP
• RTA, then other agencies adopt RTIP
• Annual (or more frequent) ongoing reporting to the RTA board on RTIP progress against schedule.

There have been three milestones proposed for this plan component:

1) RTIP public comment complete: October, 2001
2) RTA and service boards adopt the RTIP: January, 2002
3) First annual report to the RTA Board: January, 2003

All the initiatives included in this plan element are part of the recommendations of the RTIP itself.
6 RTIP PUBLIC AWARENESS STRATEGIES

6.1 Introduction

The RTIP can be thought of as a “blueprint” for transit-related ITS activities in the Chicago region. It encompasses the core infrastructure and delivery mechanisms designed to provide information that will enhance the transit traveler’s trip. The projects encompass the RTA and its three service boards, CTA, Pace and Metra. While many of the projects are either visionary or only in the planning stage, there are a number in design, under development or in service today. For these latter projects, the RTIP also encompasses more detailed technical information on how they are to be deployed.

The GCM Corridor Architecture represents the broad architectural framework under which the RTIP is being developed. When viewed from this direction, the RTIP’s objective is to more fully flesh out the transit related elements of the GCM architecture, particularly those which allow the sharing of information and integration of systems among the service boards, the RTA, and the Gateway Traveler Information System.

As a significant element in the ITS infrastructure for northeastern Illinois, the ITH and associated RTIP components will be part of multiple regional ITS architectures. The ITH was first conceived as part of the CGM Corridor Architecture, as a means for collecting and distributing transit related information, supporting traveler information functions, and giving the service boards a conduit to traffic related information from the GCM Gateway. The ITH will also be part of the ITS Regional Architecture required for northeastern Illinois, mandated by the recently-issued FTA Final Policy on ITS Architecture Consistency. In addition, the ITH and other components of RTIP are likely to be included in multiple ITS project architectures in the region. One of these is the ITS project architecture developed as part of this project.

While the nuts-and-bolts details on how to share information between different sources and users are critical, they create limited interest beyond the engineers and planners involved in the individual projects. At the same time, the traveling public retains a great deal of interest in the larger issue of access to information to assist in planning and managing transit trips. Therefore, as the RTA seeks input and buy-in to the RTIP, the focus of the communication must first and foremost be on the benefits of implementation – rather than on the RTIP itself.

6.2 The Message: Benefits of RTIP Projects
Simply stated, the message that needs to be delivered in the public comment period is the benefits associated with RTIP. The RTIP vision outlined in the RTIP Task 3 report seeks to clearly state these benefits in plain English. Here is a sampling of the key benefit areas of RTIP that should be presented:

- **All RTA services will appear to function as a unified entity**, with consistent information presentation and a single shared payment medium that may also be usable for other purchases – transportation and otherwise.

- **There will be full information and decision aids for transit travelers**, before, during and at the end of their journeys. These will allow travelers to check the status of their current, planned or alternate services. The information will include not only fares, routes, schedules and itinerary planning – it will also include current on-time status for all scheduled services, ETAs at specific stations or stops, and alternative routes in case of delays. It will be delivered electronically to active signs at stations and stops, to the Internet, to terminals and audio visual displays on board vehicles, to cell phones and PDAs, subscribing media, kiosks, and via the RTA Travel Information Center.

- **All information will be fully accessible to all individuals**, including those with disabilities.

- **A single fare instrument will be good across all RTA services.** At minimum, travelers will enjoy a single fare medium good on all RTA services, with transfers and zone fares handled automatically. Future improvements may include an integrated transportation payment medium that could be used for transit, tolls, parking and other transportation related expenses. This medium could take the form of a commercial smart card, portable I-Pass, a key ring device like Mobil Speedpass®, or cell phone/PDA activation.

- **Auto travelers will get transit information** via display signs when traveling near key transit stations or stops. The signs will display parking availability, next transit vehicle time, and comparative travel times. This will allow automobile travelers whose destinations are served by transit to make an intelligent choice on whether to continue driving or divert to transit.

- **Transit service reliability and running times will improve** due to several tools available to drivers and managers. These include better management information, current location of vehicles, computer aids for service adjustment, the ability for buses to request green lights to stay on schedule, and updated real time information on traffic congestion and incidents.

- **Transit connections will be faster and more reliable.** Not only will active signs at stops or stations indicate when the next vehicle is coming, but management tools will allow CTA, Metra and Pace to coordinate services on a moment-to-moment basis so that more connections are made, with shorter waiting times.

- **Transit trips will be safer**, with security cameras on board able to broadcast full motion video, deterring criminal acts, and vehicles able to sense people or other vehicles all around them, reducing the possibility of accidents.
A transit web site will provide a full range of information about all RTA services. In addition, the Gateway web site will provide travelers with a means of comparing transit and automobile times between any two locations, taking into account both current traffic conditions, and current on-time status of transit services and connections.

Public awareness activities should also stress that coordinated implementation of the various components of the vision is essential if all the benefits are to be realized. This is the rationale for RTA involvement and the RTIP itself. In addition, it should also recognize the fact that there are many institutional and process issues that must be addressed to make the RTIP vision a reality. These will require both service board efforts and RTA oversight to assure success.

6.3 The Approach

The consulting team recommends the following steps for developing public awareness of the RTIP, soliciting and incorporating public comment, and fostering implementation of the deployment plan:

- Public Comment on the RTIP
- Finalizing the RTIP
- Formal adoption of the RTIP
- Ongoing Reporting

Each of these items is discussed in greater detail below.

6.3.1 Public Comment on the RTIP

Early in the RTIP project, a tiered group of stakeholders was identified. Stakeholders were defined as those who had interest in the outcome of the RTIP process. Three stakeholder groups were identified and characterized by the level and nature of their involvement. They are described below:

- The core providers group consists of CTA, Metra, Pace, Amtrak, Greyhound, RTA, and the IDOT ITS Program Office (owner of the GTIS). All these organizations are users and/or providers of traveler information.
- The core advisory group consists of agencies that do not have direct responsibility for implementation of transit ITS projects, but are involved as ITS architects, infrastructure owners, funding sources, agency overseers, regional ITS associations, municipalities in the region, private transportation operators, and private providers of transit traveler information. Since there is overlap between some of the groups, certain individuals may contribute on behalf of more than one organization.
The public advisory group includes a variety of organizations that may wish to provide input to the plan. These may include associations of municipalities, Lake-Cook TMA, chambers of commerce, planning organizations, civic associations, and other associations or commissions.

Table 6.1 gives the proposed composition of the groups outlined above:

<table>
<thead>
<tr>
<th>Core Providers Group</th>
<th>Core Advisory Group</th>
<th>Public Advisory Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA</td>
<td>CATS Advanced Technology Task Force and CATS Policy Committee</td>
<td>Business Leaders for Transportation</td>
</tr>
<tr>
<td>Metra</td>
<td>Chicago DOT</td>
<td>CATS Council of Mayors</td>
</tr>
<tr>
<td>Pace</td>
<td>Chicago OEC/911 Center</td>
<td>Chicagoland Transportation and Air Quality Commission</td>
</tr>
<tr>
<td>RTA</td>
<td>County DOTs</td>
<td>Metropolitan Mayors Caucus</td>
</tr>
<tr>
<td>Amtrak*</td>
<td>DuPage Mayors and Managers</td>
<td>Metropolitan Planning Council</td>
</tr>
<tr>
<td>Greyhound*</td>
<td>FHWA</td>
<td>Metropolitan Transportation Association</td>
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<tr>
<td>IDOT/ITS</td>
<td>FTA</td>
<td>Northeastern Illinois Planning Commission</td>
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<td>GCM ITS Deployment Committee</td>
<td>Transportation Management Association of Lake-Cook</td>
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<td></td>
<td>IDOT/DPT</td>
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<td>ISTHA</td>
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<td></td>
<td>Private ISP representative</td>
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<td></td>
<td>Private operator representative</td>
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</tbody>
</table>

* Assuming mutual interest, these organizations could be added in the future

Table 6.1: Composition of Stakeholder Groups

The consulting team recommends that public comment be proactively sought on the RTIP. The RTIP stakeholder groups, particularly the Public Advisory Group, should be afforded full opportunity to contribute in this fashion.

Following presentation of the RTIP to the RTA Planning Committee, the team recommends that a presentation of the key elements of the RTIP be made at a meeting to which all stakeholder groups are invited. Prior to the meeting, all stakeholder groups should be provided copies of the Executive Summary. A 4-week period to receive written and oral comments is recommended.

RTA may also wish to consider including public comments from Regional Transit Coordination Plan stakeholders who are not already involved in the RTIP. The RTIP recommendations and RTCP process share some areas of commonality; the viewpoints of RTCP stakeholders in these areas may be valuable in finalizing the RTIP.
6.3.2 Finalize RTIP Report

After the public comment period has ended and all comments have been received, the comments should be fully considered by RTA and changes made to the RTIP wherever appropriate. The RTIP Final Report should not be finalized until all such comments have been considered and all reasonable requests for changes accommodated.

6.3.3 Board Adoption of the RTIP

Upon completion of the final report, the consulting team recommends that the RTIP be formally adopted by the RTA Board. This action would be preceded by a final presentation of public comment findings and how they have been incorporated into the RTIP. Further, it is suggested that the service boards also formally acknowledge the RTIP by having their boards formally adopt it, by incorporating relevant RTIP elements into their own internal technical plans, or by any other methods that seem appropriate.

One of the benefits of RTA Board adoption of the RTIP is that it formalizes the role that RTA will play in RTIP implementation. Another is the creation of an opportunity for media exposure to the plan and the benefits that can be derived from implementing it.

6.3.4 Ongoing Reporting

The RTIP is complex, involving both technical projects and institutional issues. Further, the degree of interrelationship among the projects and initiatives is high. As a result, the consulting team recommends that RTIP public awareness activities include an ongoing reporting component. It is envisioned that an annual report on the status of the RTIP Deployment Plan will be provided to the RTA Board or Planning Committee. This report would include items such as accomplishments of the past year, progress against schedule and budget, and review of key institutional and technical issues. In this way, attention can be focused on progress and benefits in key areas.
APPENDIX A

RTIP PROJECT AND TASK DESCRIPTIONS
Introduction

This appendix presents the detailed RTIP diagram, along with a brief description of each project or task included.

Legend for plan diagram

For each project or task listed:

**Task**: A brief descriptive title for the project or task.

**Start**: Calendar date for projected start of the project or task.

**End**: Calendar date for projected end of the project or task.

**Various years**: This plan is constructed at a quarterly level: the “Q1” through “Q4” represent calendar quarters of the above year.

**Task bars**: Visually indicate the project duration.

**Thin vertical lines**: Represent task dependencies. NOTE: In the Milestones Professional software package, when a plan is printed on multiple pages, a dependency line is not printed on a page unless it either begins or ends on that page. As a result, to find the end of a dependency, it is necessary to identify the horizontal position of the dependency line, the page through the plan until finding a page where a dependency line appears at the top of the page at the same horizontal position.

**Shaded rows**: These represent the summary project elements described in Section 5.3.

**Stars**: These represent key project milestones, with a description and a projected date.

Project /Task Descriptions

Table A.1, below, contains project or task names from the plan diagram, along with a brief description of each.
RTA Regional Transit ITS Plan Project  Page A-3
Tasks 6-7 Pre-Final Report  August 27, 2001

Wilson Consulting

### Tasks and Timeline

**ID** | **Task** | **Start** | **End** | **Description**
--- | --- | --- | --- | ---
1 | Service Board infrastructure: CAD/AVL, network and staff | 1/1/1999 | 6/30/2012 | Deploy CTASMS for initial 250 buses & paratransit AVL
1.1 | | 12/31/2001 | 6/30/2002 | Deploy Pace IBS full bus fleet & contractors
1.2 | | 11/1/1999 | 6/30/2003 | Install and network connect CTA paratransit AVL/MDT
1.3 | | 11/1/2002 | 12/31/2004 | Buildout CTA BSMS for remaining fleet & garages
1.4 | | 11/13/1999 | 12/31/2005 | Implement Metra TIMS on all service routes
1.5 | | 1/1/2003 | 12/31/2006 | Metra Rail Centralized Control System Assessment
1.6 | | 6/1/2001 | 12/31/2002 | Metra Rail receives new cab cars - TIMS-equipped
1.7 | | 7/1/1999 | 12/31/2003 | Install and network connect CTA paratransit AVL/MDT

Fixed Route AVL complete
Paratransit AVL completed
Feasibility studies begin on next-generation AVL/CAD
### RTA RTIP Deployment Plan

**Version 1.4 -- August 24, 2001**

#### Page 2 of 12

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<tr>
<th>ID</th>
<th>Task</th>
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<tr>
<td>1.8</td>
<td>Install and network connect Pace paratransit AVL/MDT</td>
<td>6/1/2001</td>
<td>12/31/2004</td>
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<td>1.9</td>
<td>DuPage County Paratransit Coordination - next steps TBD</td>
<td>7/15/2000</td>
<td>6/30/2003</td>
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<td>1.10</td>
<td>Develop service board &quot;hubs&quot; to communicate with ITH; develop DSlis</td>
<td>1/1/2003</td>
<td>12/31/2003</td>
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<td>1.11</td>
<td>Perform service board network analyses</td>
<td>8/1/2002</td>
<td>3/31/2003</td>
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<td>1.12</td>
<td>Upgrade service board communications networks</td>
<td>4/1/2003</td>
<td>12/31/2003</td>
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<td>1.13</td>
<td>SB technical staff recruitment and retention actions</td>
<td>7/3/2001</td>
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<td>1.14</td>
<td>SB feasibility studies for next generation AVL/control systems</td>
<td>1/1/2011</td>
<td>6/30/2012</td>
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<td>1.15</td>
<td>SB potential bus purchases with integrated networks and processor</td>
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<td>12/30/2011</td>
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### RTA RTIP Deployment Plan

**Version 1.4 -- August 24, 2001**

#### Page 3 of 12

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<td>2</td>
<td>Service Board Data Integrity Initiatives</td>
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<td>12/31/2003</td>
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<td>2.1</td>
<td>SBs update policies, training &amp; procedures to reflect importance of both service &amp; e-information</td>
<td>1/1/2002</td>
<td>12/31/2003</td>
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<td>2.2</td>
<td>SBs implement data integrity functions and tools</td>
<td>1/1/2002</td>
<td>12/31/2002</td>
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<td>2.3</td>
<td>SBs implement procedures for protecting information flow during disruptions</td>
<td>1/1/2003</td>
<td>12/31/2003</td>
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<td>2.4</td>
<td>Perform feasibility study analysis on positive reporting from SB AVL systems</td>
<td>1/1/2002</td>
<td>7/31/2002</td>
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<td>Design and implement positive reporting solutions for SB AVL systems</td>
<td>7/31/2002</td>
<td>12/31/2003</td>
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<td>3</td>
<td>Provide ITH and networking connectivity</td>
<td>10/1/2001</td>
<td>3/31/2005</td>
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#### Notes:
- SB Data Integrity functions in place
- SBs meet all ITH quality requirements
- Gateway receives transit data
### RTA RTIP Deployment Plan

**Version 1.4 -- August 24, 2001**

#### Page 4 of 12

<table>
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<tr>
<th>ID</th>
<th>Task Description</th>
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<td>3.1</td>
<td>Identify and prepare ITH site</td>
<td>10/1/2001</td>
<td>9/30/2002</td>
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<td>3.2</td>
<td>Perform detailed design and engineering - ITH and wide area network</td>
<td>1/1/2002</td>
<td>9/30/2002</td>
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<td>3.3</td>
<td>Identify ITH network administration resource</td>
<td>4/1/2002</td>
<td>9/30/2002</td>
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<td>3.4</td>
<td>Develop and deploy ITH1 -- basic SB, RTA and Gateway internetworking</td>
<td>4/1/2002</td>
<td>9/30/2002</td>
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<td>3.5</td>
<td>Migrate legacy data flows to ITH1: route, schedule, ADA cert file</td>
<td>10/1/2002</td>
<td>3/31/2003</td>
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<td>3.6</td>
<td>Development, test and acceptance of ITH2 and communications architecture</td>
<td>1/1/2003</td>
<td>12/31/2003</td>
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<td>3.7</td>
<td>Implement SB schedule, fare and on-time status data flows to ITH</td>
<td>1/1/2004</td>
<td>9/30/2004</td>
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<td>3.8</td>
<td>Implement incident data flows to ITH -- all SBs</td>
<td>1/1/2004</td>
<td>6/30/2004</td>
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<td>3.9</td>
<td>Implement transit schedule, fare and on-time status data transfer to Gateway</td>
<td>7/1/2004</td>
<td>3/31/2005</td>
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<td>4</td>
<td>Provide regionwide integrated transit fare payment</td>
<td>1/1/2002</td>
<td>6/30/2010</td>
<td>SBs agree on a regional solution and standard</td>
<td>Technology solutions available in marketplace</td>
<td>Fully integrated regional system in place</td>
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<td>4.1</td>
<td>SBs and RTA adopt a plan &amp; standard for deploying an integrated regional fare medium</td>
<td>1/1/2002</td>
<td>6/30/2003</td>
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<td>4.2</td>
<td>Identify and bring to market if necessary a paratransit bus/sedan fare technology solution</td>
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<td>12/31/2004</td>
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<td>4.3</td>
<td>Identify and bring to market if necessary a Metra fare technology solution</td>
<td>7/1/2003</td>
<td>6/30/2005</td>
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<td>4.4</td>
<td>Develop and ready fare revenue clearinghouse and enabling agreements for SBs</td>
<td>7/1/2003</td>
<td>6/30/2004</td>
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<td>4.5</td>
<td>Develop and ready a common fare medium systemwide on Metra</td>
<td>7/1/2005</td>
<td>12/31/2006</td>
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Technology solutions available in marketplace
### RTA RTIP Deployment Plan

**Version 1.4 -- August 24, 2001**

#### Page 6 of 12

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<th>Task</th>
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<td>4.6</td>
<td>Develop and ready a common fare medium on SB paratransit, vanpool &amp; contracted fixed</td>
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<td>4.7</td>
<td>Implement fully integrated regional fare medium</td>
<td>1/1/2006</td>
<td>12/31/2007</td>
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<td>4.8</td>
<td>Fully implement AFC expansion plans for farecard vending and addfare services</td>
<td>7/1/2003</td>
<td>12/31/2008</td>
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<td>4.9</td>
<td>Feasibility study -- regional transportation fare medium</td>
<td>1/1/2009</td>
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<td>5</td>
<td>Provide Quality Transit Traveler Information Regionwide</td>
<td>5/10/2001</td>
<td>12/31/2011</td>
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<td>5.1</td>
<td>Install uniform signage, maps, graphics, color schemes, placement, &amp; annunciator voices across region</td>
<td>11/15/2001</td>
<td>12/31/2011</td>
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<td>5.2</td>
<td>RTA/CTA ATSS Phase III Demonstration</td>
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<td>11/10/2002</td>
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### RTA RTIP Deployment Plan

Version 1.4 -- August 24, 2001

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<td>5.3</td>
<td>Implement single-carrier ATSS for all SBs</td>
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<td>12/31/2007</td>
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<td>If desired, implement ATSS for legacy SB display systems</td>
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<td>Fully implement multi-carrier ATSS throughout region</td>
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<td>12/31/2008</td>
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<td>5.6</td>
<td>Design and implement ITH web site</td>
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<td>3/31/2005</td>
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<tr>
<td>5.7</td>
<td>Implement flow of private carrier data to ITH (e.g. Amtrak, Continental)</td>
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<td>12/31/2008</td>
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<td>5.8</td>
<td>Develop and implement electronic flow of static and real time data from ITH to RTA TIC</td>
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<td>5.9</td>
<td>Enhance RTA TIC IPS system to include real time data</td>
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<td>5.10</td>
<td>PMS Phase II demonstration</td>
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### RTA RTIP Deployment Plan

#### Version 1.4 -- August 24, 2001

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<tr>
<td>5.11</td>
<td>Fully implement PMS for all SBs - static VMS travel times</td>
<td>1/2/2003</td>
<td>6/30/2004</td>
</tr>
<tr>
<td>5.12</td>
<td>Upgrade PMS to display real time transit and highway travel times</td>
<td>9/30/2004</td>
<td>9/30/2005</td>
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<tr>
<td>5.13</td>
<td>Implement ITH media feeds if desired</td>
<td>9/30/2004</td>
<td>9/30/2005</td>
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<tr>
<td>5.14</td>
<td>Develop ITH software (or enhance IPS) for traveler decision support</td>
<td>9/30/2004</td>
<td>12/31/2005</td>
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<tr>
<td>5.15</td>
<td>Deploy wireless solution for ITH mobile decision support</td>
<td>9/30/2004</td>
<td>12/31/2005</td>
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<td>5.16</td>
<td>Develop and install terminals on transit vehicles for traveler decision</td>
<td>9/30/2004</td>
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<tr>
<td>5.17</td>
<td>Implement ITH support for wireless traveler decision support</td>
<td>1/1/2006</td>
<td>6/30/2007</td>
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## RTA RTIP Deployment Plan

### Version 1.4 -- August 24, 2001

#### Page 9 of 12

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<tr>
<td>5.18</td>
<td>Implement SB/ITH support for on-board decision support terminals</td>
<td>1/1/2006</td>
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<td>6.1</td>
<td>SBs implement tools for operations analysis &amp; planning use of ITS data</td>
<td>6/30/2002</td>
<td>12/31/2003</td>
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<td>6.2</td>
<td>CTA APC replacement -- potential</td>
<td>1/1/2002</td>
<td>12/31/2002</td>
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<tr>
<td>6.3</td>
<td>Implement traffic, incident weather and video feeds from IH to service boards</td>
<td>1/1/2004</td>
<td>12/31/2006</td>
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<tr>
<td>6.5</td>
<td>Develop and adopt pre-defined inter-SB connections</td>
<td>6/30/2005</td>
<td>6/30/2006</td>
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<tr>
<td>6.6</td>
<td>Detailed design and development of TCP fixed route system</td>
<td>6/30/2005</td>
<td>6/30/2006</td>
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<tr>
<td>6.7</td>
<td>Implementation of fixed-route TCP system</td>
<td>7/1/2006</td>
<td>6/30/2007</td>
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<tr>
<td>6.8</td>
<td>Upgrade TCP system to include SB paratransit services</td>
<td>7/1/2007</td>
<td>6/30/2008</td>
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<tr>
<td>6.10</td>
<td>Fully implement vehicle to roadside signal priority request across region</td>
<td>1/1/2003</td>
<td>12/31/2007</td>
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<tr>
<td>6.11</td>
<td>Fully implement center to center signal priority request where needed</td>
<td>1/1/2006</td>
<td>12/31/2009</td>
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<tr>
<td>6.12</td>
<td>SBs modify bus schedules to reflect faster running times under signal priority request</td>
<td>7/1/2003</td>
<td>6/30/2010</td>
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<tr>
<td>6.13</td>
<td>Develop Metra ability to send &amp; receive incident &amp; HRI closure reports electronically</td>
<td>1/1/2005</td>
<td>12/31/2005</td>
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### RTA RTIP Deployment Plan

**Version 1.4 -- August 24, 2001**

#### Page 11 of 12

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<tr>
<td>7</td>
<td>Provide improved traveler safety and security through ITS</td>
<td>7/1/2001</td>
<td>12/31/2010</td>
<td>Local capture video monitoring of vehicles</td>
<td>Video monitoring of transit vehicles</td>
<td>Collision avoidance on transit buses</td>
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<td>7.1</td>
<td>Implement local storage video monitoring of transit vehicles</td>
<td>7/1/2001</td>
<td>6/30/2005</td>
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<td>7.2</td>
<td>Implement full motion video monitoring of SB vehicles</td>
<td>1/1/2007</td>
<td>12/31/2009</td>
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<td>7.3</td>
<td>Study, design and implement collision avoidance systems on SB vehicles as desired</td>
<td>1/1/2005</td>
<td>12/31/2010</td>
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<td>8</td>
<td>Equip TMCs with full range of transit data to aid in traffic management efforts</td>
<td>7/1/2004</td>
<td>12/31/2007</td>
<td>TMCs get SB incident reports</td>
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<td>8.1</td>
<td>Implement flow of SB incident data to Gateway</td>
<td>7/1/2004</td>
<td>3/31/2005</td>
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<td>8.2</td>
<td>Implement TMC uses of SB buses as probes</td>
<td>1/1/2005</td>
<td>12/31/2007</td>
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<td>RTA RTIP project public comment and follow-up</td>
<td>6/11/2000</td>
<td>12/31/2011</td>
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<td>9.1</td>
<td>RTIP project - current scope</td>
<td>6/11/2000</td>
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<td>9.2</td>
<td>Develop and revise Executive Summary</td>
<td>6/15/2001</td>
<td>7/18/2001</td>
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<td>RTIP Public Comment period</td>
<td>9/7/2001</td>
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<td>9.5</td>
<td>RTA, then other agencies adopt RTIP</td>
<td>11/18/2001</td>
<td>1/31/2002</td>
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<td>9.6</td>
<td>On-going reports to the RTA Board</td>
<td>1/31/2002</td>
<td>12/31/2011</td>
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<tr>
<td>1</td>
<td>Service Board/local CAD/AVL, network and staff infrastructure</td>
<td>Summary plan element concerning the deployment of basic service board ITS infrastructure for collection of current transportation status information.</td>
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<tr>
<td>1.1</td>
<td>Deploy CTA BSMS for initial 250 buses &amp; one garage</td>
<td>The BSMS system is the advanced component of CTA BusWatch. It builds on the BECS system's AVL and data communications infrastructure to provide on-board schedule adherence capabilities and central dispatching support.</td>
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<tr>
<td>1.2</td>
<td>Buildout CTA BSMS for remaining fleet &amp; garages</td>
<td>Once the project is proven via the initial garage installation, this component brings BSMS capabilities to all garages and all buses not slated for near term retirement.</td>
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<tr>
<td>1.3</td>
<td>Implement Metra TIMS on all service routes</td>
<td>The first phase of Metra TIMS provides AVL coverage for all Metra trains, for the purpose of improved customer service and traveler information.</td>
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<tr>
<td>1.4</td>
<td>Metra receives new cab cars TIMS-equipped</td>
<td>The second phase of TIMS includes newly-delivered passenger coaches being TIMS equipped. In addition, in this stage, there will be passenger information displays driven by TIMS inside the coaches.</td>
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<tr>
<td>1.5</td>
<td>Metra Rail Centralized Control System Assessment</td>
<td>This future Metra project would involve an assessment of current signaling systems – identifying upgrades and reconfigurations required, as well as assessment of staffed towers on Metra territory. Integrated Metra and freight operations would be considered where this was an issue. An assessment of dispatch system upgrade or replacement would also be included.</td>
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<tr>
<td>1.6</td>
<td>Deploy Pace IBS full bus fleet &amp; contractors</td>
<td>The Pace IBS is an integrated bus management system featuring AVL and CAD capabilities. It will also include on-board schedule adherence monitoring, traffic signal priority request, automatic passenger counting, and connection protection capabilities, as well as management analysis capabilities. There are also future options for adding on-board interior displays for passenger information.</td>
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**Table A.1: RTIP Project and Task Descriptions**

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<tr>
<th>ID</th>
<th>Project or Task</th>
<th>Description</th>
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<tr>
<td>1.7</td>
<td>Install and network connect CTA paratransit AVL/MDT</td>
<td>This task contains two distinct activities. The first is the equipping of CTA paratransit contract operators with full CAD/AVL systems at their facilities and on their vehicles, and connecting them with the CTA Special Services computer systems at the CTA offices. The CTA is contractually obligated to complete this portion. The second is the networking of the contract paratransit operators with the CTA Hub and the ITH. While this is scheduled sequentially after the first activity, it does not have to occur unless and until paratransit TCP is desired by the CTA paratransit contract operators.</td>
</tr>
<tr>
<td>1.8</td>
<td>Install and network connect Pace paratransit AVL/MDT</td>
<td>In this project, Pace will be undertaking two distinct initiatives with its paratransit contract operators. The first is upgrading the existing paratransit scheduling system and moving it to a central server, then networking each contract operator garage to Pace headquarters. The second is providing (or requiring contractors to install) AVL/CAD systems. As with CTA, this activity is relevant to the ITH only when/if it is desired to install paratransit TCP.</td>
</tr>
<tr>
<td>1.9</td>
<td>DuPage County Paratransit Coordination - next steps TBD</td>
<td>The DuPage County Department of Human Services has recently undertaken a study on the feasibility of implementing centralized coordination of over 40 local paratransit services in order to improve service and utilization. As of this writing no clear decision has been announced on what the next steps will be.</td>
</tr>
<tr>
<td>1.10</td>
<td>Develop service board &quot;hubs&quot; to communicate with ITH; develop DSIs</td>
<td>This project involves, for each service board, 1) establishing a hub server which will be responsible for managing information exchange with the ITH, and 2) developing data source interfaces (DSIs) for each hub which will take service board data formats and translate them into common ITH/GCM data formats.</td>
</tr>
<tr>
<td>1.11</td>
<td>Perform service board network analyses</td>
<td>The RTIP Task 4 report documented existing communications networks at each of the three service boards. It also presented an initial “gap analysis” pointing to potential improvement areas for network capacity, reliability and management. This task, for each service board, would perform a more thorough technical analysis of the existing network, and recommend specific detailed improvements that will support the degree of capacity, reliability, availability, security and network management required to satisfy the RTIP vision.</td>
</tr>
<tr>
<td>1.12</td>
<td>Upgrade service board communications networks</td>
<td>In this task, for each service board, network infrastructure improvements will be implemented according to the specifications from the previous task.</td>
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<tr>
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<td>Project or Task</td>
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<tr>
<td>1.13</td>
<td>SB technical staff recruitment and retention actions</td>
<td>The RTIP Task 3 report identified additional technical and project management staff positions, along with improved recruitment and retention, as important success factors in satisfying the RTIP vision. This task represents a multiyear effort to secure funding and implement the institutional changes necessary to accomplish significant improvements in this area.</td>
</tr>
<tr>
<td>1.14</td>
<td>SB feasibility studies for next generation AVL/control systems</td>
<td>This visionary task represents feasibility studies for the next generation of CAD/AVL systems for service board fixed route and paratransit systems. In 2011, existing systems will be 8-10 years old. The consulting team believes that at that time two major trends in transit CAD/AVL will have evolved to the point where one or both reach market. The first is the move to a distributed control architecture on board vehicles. This means that all intelligence is in the individual devices, with no central processor; all devices can examine every message and take action according to their particular functions. The second, more speculative, is the possibility that CAD/AVL systems that are fully vehicle based may appear. In these systems, the role of the dispatcher is diminished. Faster on board processors and broadband wireless communications would allow vehicles to receive and process information on their leaders and followers, and on connecting vehicles, and optimize their own positions on that basis.</td>
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<tr>
<td>1.15</td>
<td>SB potential bus purchases with integrated networks and processor</td>
<td>As of 2001, a number of bus manufacturers are delivering their vehicles with full wiring compliant with the J1708/1587/1939 family of vehicle area network standards. But at least one new line of buses – New Flyer Invero, is now delivering buses with an open architecture network using a distributed control architecture. Such networks can be used to access all vehicle electronics and diagnostics. They can also be used to internetwork other devices, including AVL systems, passenger counters, destination signs, internal audio visual displays, etc. The consulting team projects that by 2007, service boards may decide to acquire buses with factory installed open architecture vehicle area networks with distributed control architectures.</td>
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<tr>
<td>2</td>
<td>Service board institutional actions to support info quality and availability</td>
<td>This summary plan element includes technical and institutional initiatives designed to improve, monitor and maintain a high degree of quality for information forwarded to the ITH. The measures would also improve the quality of data for internal service board use.</td>
</tr>
<tr>
<td>2.1</td>
<td>SBs update policies, training &amp; procedures to reflect importance of both service &amp; e-information</td>
<td>This task represents service board activities to elevate the priority of information creation and quality in the operating functions of vehicle operation, supervision, dispatching and maintenance. This may be done by establishing or strengthening policies concerning event reporting or other information creation, adding content to line and supervisor training programs, and modifying procedures as necessary.</td>
</tr>
<tr>
<td>2.2</td>
<td>SBs implement data integrity functions and tools</td>
<td>This task for each service board involves the creation of a formal function with responsibility for the overall quality and integrity of data provided electronically by the service board. This function would develop and run data quality monitoring programs to detect and track patterns in data reporting errors. These sources could range from failure to report a cancellation or annulment, a faulty on board processor or radio, program errors, and a variety of other causes. The function would also be responsible for following up on patterns of errors and take action to assure they are corrected. It would also be responsible for overseeing changes to policies and procedures as required.</td>
</tr>
<tr>
<td>2.3</td>
<td>SBs implement procedures for protecting information flow during disruptions</td>
<td>With good systems and procedures in place, data creation and transmission normally occur with relatively few problems. However, in periods where service is disrupted by weather, collective bargaining disputes, reroutes or emergency closures, the routine flow of data can be easily disrupted if the parties involved do not continue to afford event reporting a high priority. Under this task, the service boards would modify procedures and develop or enhance training programs to reinforce the priority of event reporting and information provision during periods of disruptions or emergencies.</td>
</tr>
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<tr>
<td>2.4</td>
<td>Perform feasibility study analysis on positive reporting from SB AVL systems</td>
<td>The consulting team feels that the principal impediment to quality real time transit traveler information is the use of exception reporting from bus transit vehicles, which is necessitated by limited bandwidth availability in the licensed radio frequencies used by CTA and Pace. Exception reporting introduces error into schedule adherence reports and calculation of countdowns at stops and stations, as well as limiting the effectiveness of intercarrier connection protection. This task involves a feasibility study for eliminating exception reporting and moving to positive reporting. Positive reporting means that all event reports and frequent location updates are sent regardless of the on time status of the vehicle. This could be accomplished by adding on systems specifically designed to report countdown information, or by developing a regional wireless communications solution and modifying service board systems to take advantage of it.</td>
</tr>
<tr>
<td>2.5</td>
<td>Design and implement positive reporting solutions for SB AVL systems</td>
<td>The task follows after the feasibility study to design, specify, procure and implement solutions that will enable positive reporting of vehicle location and on-time status.</td>
</tr>
<tr>
<td>3</td>
<td>Provide ITH and networking connectivity</td>
<td>This summary plan element encompasses the design and implementation of the ITH and the communications network that will connect it with the service boards, RTA, and the Gateway.</td>
</tr>
<tr>
<td>3.1</td>
<td>Identify and prepare ITH site</td>
<td>The RTIP Task 4 report reviewed four potential sites for the ITH, and indicated that the CTA Control Center was currently the most suitable, but that the RTA TIC would be an excellent fit if current site limitations were corrected. This task involves more detailed analysis of the situation, selection of a site, and completion of all site preparation – electrical, structured wiring, facility modifications, etc.</td>
</tr>
<tr>
<td>3.2</td>
<td>Perform detailed design and engineering - ITH and wide area network</td>
<td>This task is the next step after the RTIP project Task 3, which performed a feasibility study and functional design for the ITH.</td>
</tr>
<tr>
<td>3.3</td>
<td>Identify ITH network administration resource</td>
<td>This step involves determining who will perform network management responsibilities for the ITH communications network (LAN and WAN). This could be an ITH staff resource, or an existing resource at RTA or a service board.</td>
</tr>
<tr>
<td>3.4</td>
<td>Develop and deploy ITH1 -- basic SB, RTA and Gateway internetworking</td>
<td>ITH1 is the first phase of ITH development and implementation. It involves internetworking the service boards, RTA and the Illinois Hub/Gateway.</td>
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<tr>
<td>3.5</td>
<td>Migrate legacy data flows to ITH1: route, schedule, ADA certification file</td>
<td>Coming after ITH1 is functional, this task encompasses the identification and migration to ITH1 of legacy data flows among the service boards and the RTA. Known legacy data flows include ADA certification files from RTA to the service boards, and route, schedule and fare information from service boards to the RTA.</td>
</tr>
<tr>
<td>3.6</td>
<td>Development, test and acceptance of ITH2 and full communications architecture</td>
<td>This task encompasses development, test and implementation of ITH2 and its full communications architecture. This is expected to build on the groundwork of ITH1. ITH2 will include the necessary software and services to process service board schedule, fare, route, on time status and incident reportings and to forward them to the Gateway/IH.</td>
</tr>
<tr>
<td>3.7</td>
<td>Implement SB schedule, fare and on-time status data flows to ITH</td>
<td>This task involves testing and implementing the flow of static and real time data on service board services to the ITH.</td>
</tr>
<tr>
<td>3.8</td>
<td>Implement incident data flows to ITH – all SBs</td>
<td>In this task, necessary system modifications are made, and the reporting of incident data to the ITH by service boards is instituted.</td>
</tr>
<tr>
<td>3.9</td>
<td>Implement transit schedule, fare and on-time status data transfer to Gateway</td>
<td>This task encompasses the testing and implementation of data flows from the ITH to the Gateway/IH using the Publisher function.</td>
</tr>
<tr>
<td>4</td>
<td>Provide fully seamless transit fare payment regionwide</td>
<td>This summary plan element encompasses all steps required to establish and implement a fully integrated regional fare medium for transit.</td>
</tr>
<tr>
<td>4.1</td>
<td>SBs and RTA adopt a plan and standard for deploying an integrated regional fare medium</td>
<td>This task represents the first and most crucial step for this plan element: the coming together of all service boards with technical support to review alternatives, share positions, and ultimately agree on an approach and a technical standard for regional fare integration.</td>
</tr>
<tr>
<td>4.2</td>
<td>Identify and bring to market if necessary a paratransit bus/sedan fare technology solution</td>
<td>One of the impediments to achieving an integrated fare collection system using the current Cubic mag stripe and “GO Card” standards is the lack of a version of the on-board card reader and transfer printer (BTPU) that can be installed in paratransit sedans. This step involves efforts, such as a public private partnership, to develop the necessary technology should the Cubic standard be selected as the basis for regional fare integration.</td>
</tr>
<tr>
<td>4.3</td>
<td>Identify and bring to market if necessary a Metra fare technology solution</td>
<td>Similar to the above task, this one involves the development of appropriate technology for implementing the Cubic standard for Metra’s barrier and non-barrier entry operations.</td>
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<tr>
<td>4.4</td>
<td>Develop and ready fare revenue clearinghouse and enabling agreements for SBs</td>
<td>This task includes all efforts necessary to study, define, specify and put in place an organization to serve as a neutral clearinghouse as part of the implementation of a fully integrated regional fare medium. The clearinghouse function is to maintain accounts for each of the participants, receive (or apply credits for) the receipts from sale of fare instruments, and distribute funds based on actual farecard usage.</td>
</tr>
<tr>
<td>4.5</td>
<td>Develop and ready a common fare medium systemwide on Metra</td>
<td>In this task, the actual design and preparation for implementation of the common regional fare medium is accomplished across all Metra services. Also included are policy agreements on Metra-Pace and Metra-CTA transfer charges, and updates to CTA and Pace turnstiles and fareboxes to accommodate Metra fares and transfers.</td>
</tr>
<tr>
<td>4.6</td>
<td>Develop and ready a common fare medium on SB paratransit, vanpool &amp; contracted fixed route vehicles</td>
<td>Similar to the previous task, here design and preparation for implementation of the common regional fare medium takes place for all Pace and CTA contract paratransit operations. This includes all policy and fare structure agreements, including transfers, between the participants.</td>
</tr>
<tr>
<td>4.7</td>
<td>Implement fully integrated regional fare medium</td>
<td>In this task, with all preparations in place, the regional fare medium is implemented across all service boards’ fixed route and paratransit services.</td>
</tr>
<tr>
<td>4.8</td>
<td>Fully implement AFC expansion plans for farecard vending and addfare services</td>
<td>This task represents current and future ongoing efforts to increase the number of locations where farecards can be bought and where value can be added to farecards, particularly for bus travelers who do not regularly visit CTA rapid transit stations.</td>
</tr>
<tr>
<td>4.9</td>
<td>Feasibility study – regional transportation fare medium</td>
<td>This visionary task anticipates that by late in the plan period there will be other efforts external to the transit community to develop transportation e-commerce instruments that can be used for parking, tolls, auto related expenses, and transit. In this task, the service boards and RTA would look at how to position themselves in light of emerging technologies such as Speedpass®, toll transponders such as I-Pass, commercial smart cards issued by credit card companies, and cell phone or PDA activated payment services.</td>
</tr>
<tr>
<td>5</td>
<td>Provide seamless, quality, available, robust, accessible transit information regionwide</td>
<td>This summary plan element includes all tasks that relate to delivering transit traveler information and decision support based on the infrastructure developed in the previous summary tasks.</td>
</tr>
<tr>
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<tr>
<td>5.1</td>
<td>Install uniform signage, maps, graphics, color schemes, placement, &amp; annunciator voices across region</td>
<td>While not primarily a technology task, this is included as an ongoing activity to encompass efforts to standardize both static and variable audio and visual displays that convey information to travelers. The standard color scheme for CTA rapid transit lines was a good step in this direction. Outcomes of this task could include things like a common annunciator voice across all audio displays in the region, consistent font and layout of computer based information displays and decision tools, and consistent maps at stops and stations showing the immediate environs of the station and identifying key destinations (to assist riders walking to their destinations).</td>
</tr>
<tr>
<td>5.2</td>
<td>RTA/CTA ATSS Phase III Demonstration</td>
<td>This project, currently underway, involves the development and implementation of active signs at four CTA rail stations (O'Hare, Midway, Cumberland and Davis Street - Evanston). The demonstration will help determine whether reliable countdowns can be generated from existing rail control information with the addition of station proximity sensors.</td>
</tr>
<tr>
<td>5.3</td>
<td>Implement single-carrier ATSS for all SBs</td>
<td>This task, dependent for each service board on the completion of its AVL or CAD/AVL deployment, involves the installation over time of active signs at a large number of transit stops and stations across the region. “Single Carrier ATSS” means that the signs initially will only display information for the operations of the owning service board, generated directly from its AVL or CAD/AVL system. If other service boards also serve the stop or station, their services can be added after the ITH is fully implemented.</td>
</tr>
<tr>
<td>5.4</td>
<td>If desired, implement ATSS for legacy SB display systems</td>
<td>This task involves the use of legacy service board display systems such as Metra’s Visual Paging System (VPS) and CTA’s green line PAHS displays to display ATSS information.</td>
</tr>
<tr>
<td>5.5</td>
<td>Fully implement multi-carrier ATSS throughout region</td>
<td>This task, dependent on full implementation of the ITH, involves the addition of information on other service boards’ services to the ATSS at jointly served locations.</td>
</tr>
<tr>
<td>5.6</td>
<td>Design and implement ITH web site</td>
<td>In this task, a web site is developed and deployed to provide static and real time transit traveler information and decision support tools for the public. It is likely that this web site will be an extension of the existing RTA TIC itinerary web site.</td>
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<tr>
<td>5.7</td>
<td>Implement flow of private carrier data to ITH (e.g. Amtrak, Continental)</td>
<td>During the RTIP project, preliminary contacts were made with Amtrak and Greyhound about including their schedule, fare and on time status information in the IT. This task represents the effort necessary to establish connections and begin information sharing with interested private carriers.</td>
</tr>
<tr>
<td>5.8</td>
<td>Develop and implement electronic flow of real time data from ITH to RTA TIC</td>
<td>This task includes all efforts and any hardware and software necessary to institute a flow of real time transit information to the RTA TIC IPS.</td>
</tr>
<tr>
<td>5.9</td>
<td>Enhance RTA TIC IPS system to include real time data</td>
<td>In this task, all necessary modifications or updates are made to the RTA TIC IPS so that it can accept and integrate dynamic information in its itinerary development. For example, reroutes currently underway would be received electronically by the ITH, and would be taken into account by the IPS in its development of travel itineraries for callers and web visitors.</td>
</tr>
<tr>
<td>5.10</td>
<td>PMS Phase II Demonstration</td>
<td>In this task, the Parking Management Systems (PMS) concept developed in RTA feasibility studies will be evaluated in a field demonstration. PMS are parking occupancy tracking systems coupled with variable message signs and the ATSS system to provide auto information on nearby transit alternatives for completing their trips.</td>
</tr>
<tr>
<td>5.11</td>
<td>Fully implement PMS for all service boards - static VMS travel times</td>
<td>This task encompasses full development and implementation of the PMS concept after successful proof of concept in the previous demonstration project. Installations during this task would not include real time transit times or highway travel times on variable message displays.</td>
</tr>
<tr>
<td>5.12</td>
<td>Upgrade PMS to display real time transit and highway travel times</td>
<td>In this task, comparative real time auto and transit travel times would be added to the VMS serving the various PMS installations.</td>
</tr>
<tr>
<td>5.13</td>
<td>Implement ITH media feeds if desired</td>
<td>A policy issue will need to be decided: whether direct media feeds will be provided from the ITH to regional media and ISPs, or whether transit traveler information will be provided to the media only via the Gateway – Illinois Hub. This task encompasses resolution of the policy question, and deployment if needed of the ability for the ITH to provide real time information feeds to media and ISPs.</td>
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<tr>
<td>5.14</td>
<td>Develop ITH software (or enhance IPS) for traveler decision support – entire trip</td>
<td>This task covers a major effort: the development of multi-platform software for traveler decision support. The functionality will need to encompass pre-trip planning, at-stop/station information, en-route information, en-route decision support in case of delays or changes in plans, and pedestrian navigation at the end of the trip.</td>
</tr>
<tr>
<td>5.15</td>
<td>Deploy wireless solution for ITH mobile decision support</td>
<td>This task encompasses the effort to select the technology(ies) through which mobile traveler information and decision support will be provided in the region.</td>
</tr>
<tr>
<td>5.16</td>
<td>Develop and install terminals on transit vehicles for traveler decision support</td>
<td>In this task, customer terminals will be specified, procured and implemented in a coordinated fashion across the various service boards. They will support basic information queries and decision support requests.</td>
</tr>
<tr>
<td>5.17</td>
<td>Implement ITH support for wireless traveler decision support</td>
<td>In this task, wireless decision support is implemented for mobile transit users with PDAs or web-enabled cell phones.</td>
</tr>
<tr>
<td>5.18</td>
<td>Implement SB/ITH support for on-board decision support terminals</td>
<td>This task involves the production implementation of vehicle on board terminals for traveler information and decision support.</td>
</tr>
<tr>
<td>6</td>
<td>Provide ITS-based transit service and efficiency improvements</td>
<td>This summary plan element encompasses all the service board operational improvements enabled by RTIP projects.</td>
</tr>
<tr>
<td>6.1</td>
<td>SBs implement tools for operations analysis and planning use of ITS data</td>
<td>This project encompasses the preparation, installation and refinement of analysis tools that will allow operations analysts and service planners to review, manipulate and create reports about ITS data generated by CAD/AVL systems and peripheral systems. In some cases software may already be in place or part of a procurement, reducing the time commitment necessary. However, as familiarity with the data and its patterns develops, additional refinements will be desired.</td>
</tr>
<tr>
<td>6.2</td>
<td>CTA APC replacement – potential</td>
<td>This project covers the procurement by CTA of replacement automatic passenger counting (APC) units for buses that will be networked with the BSMS on-board processor. Networking APCs in this way will allow their boarding and alighting information to be integrated with location and time information from the AVL system.</td>
</tr>
<tr>
<td>6.3</td>
<td>Implement traffic, incident weather and video feeds from IH to service boards</td>
<td>This task covers the implementation of all of these information flows from the Gateway/IH via the ITH to service boards, according to their needs.</td>
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<tr>
<td>6.4</td>
<td>Implement GCM Warmap at service boards in need of it</td>
<td>In this task, which can be undertaken with ITH1 in place, the GCM Warmap flat panel display can be installed at those service boards desiring it. The Warmap provides access to protected Gateway web pages summarizing traffic, delay, incident, roadway and lane closure information.</td>
</tr>
<tr>
<td>6.5</td>
<td>Develop and adopt pre-defined inter-SB connections</td>
<td>In preparation for the implementation of the TCP system, this task brings the service boards together to agree on which intercarrier connections will be selected for protection under the TCP system.</td>
</tr>
<tr>
<td>6.6</td>
<td>Detailed design and development of TCP fixed route system</td>
<td>Building on the TCP functional design completed in 2000, this task involves the detailed design and development of the Phase 1 TCP system, which covers intercarrier connections between service board fixed route services.</td>
</tr>
<tr>
<td>6.7</td>
<td>Implementation of fixed-route TCP system</td>
<td>In this task, the Phase I TCP system is implemented.</td>
</tr>
<tr>
<td>6.8</td>
<td>Upgrade TCP system to include SB paratransit services</td>
<td>This task includes the enhancement of the TCP system to incorporate connections between paratransit and fixed route systems.</td>
</tr>
<tr>
<td>6.9</td>
<td>Feasibility study – TCP across Indiana – Illinois border</td>
<td>Pace buses connect with transit agencies in northwest Indiana. This task is a visionary proposal for extending the TCP system to cover intercarrier connections across the Indiana-Illinois border.</td>
</tr>
<tr>
<td>6.10</td>
<td>Fully implement vehicle to roadside signal priority request across region</td>
<td>This project encompasses regionwide implementation of transit signal priority request capabilities by CTA and Pace in cooperation with IDOT, municipal and county DOTs</td>
</tr>
<tr>
<td>6.11</td>
<td>Fully implement center to center signal priority request where needed</td>
<td>As computer control of traffic signals across an area is implemented, it will be necessary to implement TSP for these signals by establishing center to center links between the service boards and the traffic management centers, and making requests on a center to center basis. This task covers implementation of TSP for such signals.</td>
</tr>
<tr>
<td>6.12</td>
<td>SBs modify bus schedules to reflect faster running times under signal priority request</td>
<td>This task covers the institutional action of service boards adjusting schedules to take into account the improved running times enabled by TSP.</td>
</tr>
<tr>
<td>6.13</td>
<td>Develop Metra ability to send &amp; receive incident &amp; HRI closure reports electronically</td>
<td>Traffic management can be improved if traffic management centers can be apprised of planned or unplanned HRI (grade crossing) blockages. This task involves equipping Metra to send and receive planned and unplanned HRI blockage reports via the ITH.</td>
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<tr>
<td>7</td>
<td>Provide maximum ITS-enabled safety and security for transit travelers</td>
<td>This summary plan element encompasses all safety and security related elements of the RTIP.</td>
</tr>
<tr>
<td>7.1</td>
<td>Implement full motion video monitoring of SB vehicles</td>
<td>Currently, transit agencies are finding success in reducing incidents and claims by installing on board cameras which digitally record still frame shots of the bus interior. This task involves the upgrade and networking of on board cameras and the transmission of full motion video of the bus interior. This video can be archived and or reviewed by monitoring software or security personnel.</td>
</tr>
<tr>
<td>7.2</td>
<td>Study, design and implement collision avoidance systems on SB vehicles as desired</td>
<td>Basic collision avoidance systems for buses are now beginning to come to market, particularly for school buses. This project provides for the assessment, specification, procurement and delivery of collision avoidance systems on service board transit buses.</td>
</tr>
<tr>
<td>8</td>
<td>Provide TMCs in the region with a full range of relevant transit information</td>
<td>This summary plan element includes all uses of transit data to improve traffic management.</td>
</tr>
<tr>
<td>8.1</td>
<td>Implement flow of SB incident data to Gateway</td>
<td>This project, contingent on the implementation of ITH2, will provide for the forwarding of SB incident information electronically to the Gateway/IH via the ITH.</td>
</tr>
<tr>
<td>8.2</td>
<td>Implement TMC uses of SB buses as probes</td>
<td>This task encompasses a feasibility study, design, development and implementation of the use of transit location and time information to estimate arterial travel times.</td>
</tr>
<tr>
<td>9</td>
<td>RTA RTIP project public comment and follow-up</td>
<td>This final summary plan element covers all the public comment activities recommended for the RTIP.</td>
</tr>
<tr>
<td>9.1</td>
<td>RTIP project - current scope</td>
<td>This task represents the remainder of the RTIP project; this report is the last RTIP task report.</td>
</tr>
<tr>
<td>9.2</td>
<td>Develop and revise Executive Summary</td>
<td>This task covers the development of an RTIP Executive Summary and its revision after the receipt of comments.</td>
</tr>
<tr>
<td>9.3</td>
<td>RTIP Public Comment period</td>
<td>This task includes distribution of the Executive Summary to public stakeholders, and the revision of the plan where appropriate.</td>
</tr>
<tr>
<td>9.4</td>
<td>Finalize RTIP</td>
<td>After public comment has been received, in this task the RTIP Final Report is finalized.</td>
</tr>
<tr>
<td>9.5</td>
<td>RTA, then other agencies adopt RTIP</td>
<td>This task covers the adoption of the RTIP by the RTA and all the service boards.</td>
</tr>
<tr>
<td>9.6</td>
<td>On-going reports to the RTA Board</td>
<td>This task represents the ongoing reporting to the RTA Board on the progress made against schedule and budget in the various components of the RTIP.</td>
</tr>
</tbody>
</table>