Thurston Region Public Transportation System Architecture and Strategic Deployment Plan

Technical Memorandum #3

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Thurston Regional Planning Council

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. . . Putting Technology To Work

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BRW

Pacific Rim Resources

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Executive Summary

Introduction

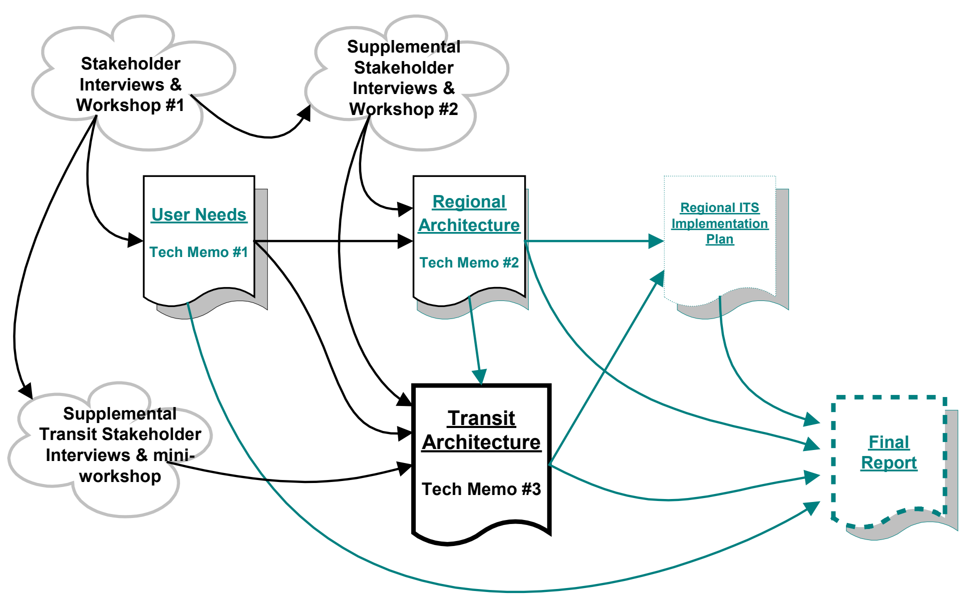
This document is the third in a series of five that present the sequential results of the Thurston Regional Planning Council (TRPC) – Regional Intelligent Transportation Systems (ITS) Planning Project.

This document presents an ITS Strategic Deployment Plan for Intercity Transit ("Intercity"), the general public transit provider for Thurston County. The plan identifies a specific, three phased set of investments estimated at $6.3M that will implement many of the Intercity related components contained in the broader, regional multi-modal transportation technology vision that has been articulated for the Thurston Region—this regional vision, or architecture, is presented and documented in Tech Memo #2. This vision is referred to as "system architecture", and identifies the various transportation technology areas to be implemented and the inter-relationships among those components.

The specific technology implementation strategy identified in this document for Intercity will be further linked to the regional vision, technology plan and strategies in the following documents:

- Regional ITS Implementation Plan, and a
- Final Report.

These products will be made available through the TRPC web site. The following figure illustrates the relationship of this document to the others, and the uses of these documents:



Organization

Section 1 describes the overall process that has been used to develop the Thurston Region System Architecture, the products of the Thurston Region System Architecture, and an overview of the Thurston Region.

Section 2 illustrates the inclusive regional architecture, then within that context, summarizes the portions of the Thurston Region System Architecture that are most relevant to Intercity Transit and which relate to the ITS investment strategy identified in this document.

Section 3 describes the process followed to develop the phased ITS Strategic Deployment Plan for Intercity, building upon the efforts that produced the Thurston Region System Architecture.

Section 4 presents the phased ITS investment strategy for Intercity, including a summary of the overall vision, project descriptions, estimated costs and the relationships between the investments and the Thurston Region System Architecture.

Section 5 summarizes the benefits of many of the Intercity ITS investments, as experienced by other organizations that have implemented the same technologies.

Section 6 discusses how ITS investments will be utilized within Intercity's overall, on-going process to continually monitor and enhance performance.

Section 7 presents some "lessons learned" and suggestions relative to ITS implementation.

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1.0 Introduction

1.1 Purpose of this Document

This document identifies a specific, phased set of technology investments for Intercity Transit ("Intercity"), the primary public transportation provider for Thurston County, Washington. The investment strategy will implement many of the major public transportation related components of the regional system architecture that is being developed for the Thurston Region. The system architecture identifies an overall regional concept for how technologies will be used to improve the efficiency and effectiveness of transportation systems. The architecture identifies an overall, future "end state", but does not prioritize or phase the various components of that end state system, nor group them into bundles that can be implemented sequentially, as individual investments. This document accomplishes that step for Intercity.

This document is the third in a series of five publications documenting the effort to develop the Thurston Region System Architecture. Figure 1-1 below illustrates the relationship between this document and the other four documents.

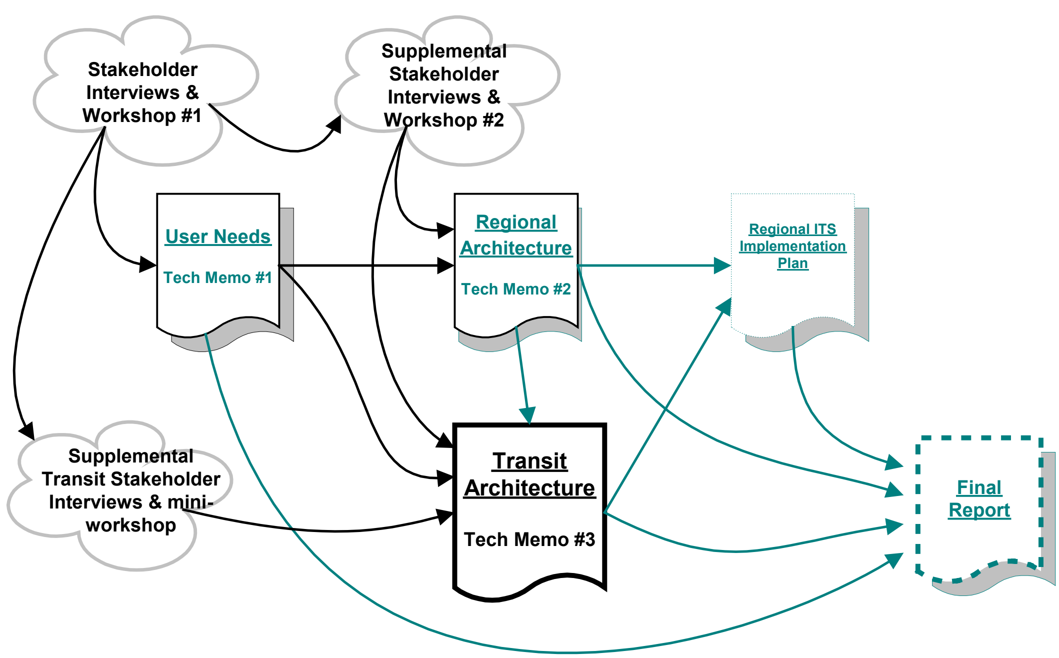

Figure 1-1 TRPC System Architecture Reports

Tech Memo #1, Users Needs, documented the transportation needs and issues of a wide range of organizations and their stakeholders in Thurston County, and associated each of those needs with groupings of technology related activities, or "user services".

Tech Memo #2, *Thurston Region System Architecture*, identified the overall concept and suggests the framework for how technologies will be applied in transportation in the region. This regional architecture was described using the concepts and terminology of the National ITS Architecture, which the United States Department of Transportation has developed to guide the development of regional architectures throughout the country. The next section within this introduction further explains the rationale behind the development of a system architecture.

This document, Tech Memo #3, identifies a specific program of investments to be made by Intercity Transit. These investments will implement many of the public transportation related components of the Thurston Region System Architecture. A separate document devoted specifically to Intercity has been developed partly in recognition of the fact that Intercity has obtained Federal ITS grants funds and requires a more detailed set of investment recommendations in order to guide the near-term uses of those funds.

The fourth document, the Regional ITS Implementation Plan, identifies how the regional system architecture, and specific ITS projects that will be developed, will be incorporated within the broader transportation planning and programming process utilized by the Metropolitan Planning Organization for Thurston County, the Thurston Regional Planning Council (TRPC). The Implementation Plan will also identify a set of activities for advancing some of the most important, initial components of the regional system architecture. Those activities will reflect the specific Intercity ITS investment strategy identified in this document.

The final document, the project Final Report, will synthesize and integrate the four previous documents into a single volume.

1.2 The System Architecture Concept

Ultimately, the goal of deploying intelligent transportation systems (ITS) in the Thurston region is to improve efficiency and safety of the transportation system in the area through deployment of advanced technologies and systems management techniques. ITS technologies offer benefits ranging from improved safety on the existing transportation infrastructure to better status information to users of the transportation facilities (travelers and transportation management professionals), allowing them to better plan their travel itineraries. ITS technologies also provide managers of the transportation systems the ability to "do more with less" by squeezing more out of existing infrastructure by using the information provided from ITS solutions.

To be successful, deployments of ITS technologies must involve more than just the transportation professionals (e.g., State DOT, city and county transportation engineers) in the Thurston region. All regional stakeholders, including emergency management, transit, traveler information providers, the media, etc. must be involved and integrated to gain the greatest benefit from an integrated regional deployment of ITS technologies. A blueprint is needed for the development of an integrated system because multiple interest stakeholders are involved --

all with different systems and technologies in place and planned for the future. Without such a blueprint, the transportation system in the Thurston region would simply be a collection of isolated systems, none interacting with each other or sharing information/data between them.

An ITS architecture describes how various systems are connected electronically, what data is shared, and functionally how this interconnected system is used to accomplish a particular goal (e.g., improve emergency response times to accidents/incidents). The creation of an ITS architecture is important because the cost of deploying technologies is expensive, and growing rapidly. Also, the decisions made in the early stages of procuring and deploying ITS technologies can have significant impacts on the costs and functionality of future deployments. Planning ahead for future regional needs and designing each system for future flexibility is the purpose of an ITS architecture.

The National ITS Architecture defines the functions (e.g., transit itinerary planning, emergency response routing) that must be performed to implement given requirements of the region, expressed as user services in the National ITS Architecture. The National ITS Architecture also details the physical systems or subsystems where these functions reside (e.g., the emergency vehicle or transit operations facility). The regional architecture under development for the Thurston region will translate local needs and issues into the terminology and system descriptions of the National ITS Architecture.

1.3 Architecture Development Process

The approach employed to develop a regional ITS architecture for the Thurston region is consistent with the National ITS Architecture and meets the needs and issues specific to the Thurston region. This process is summarized graphically in Figure 1-2 below:

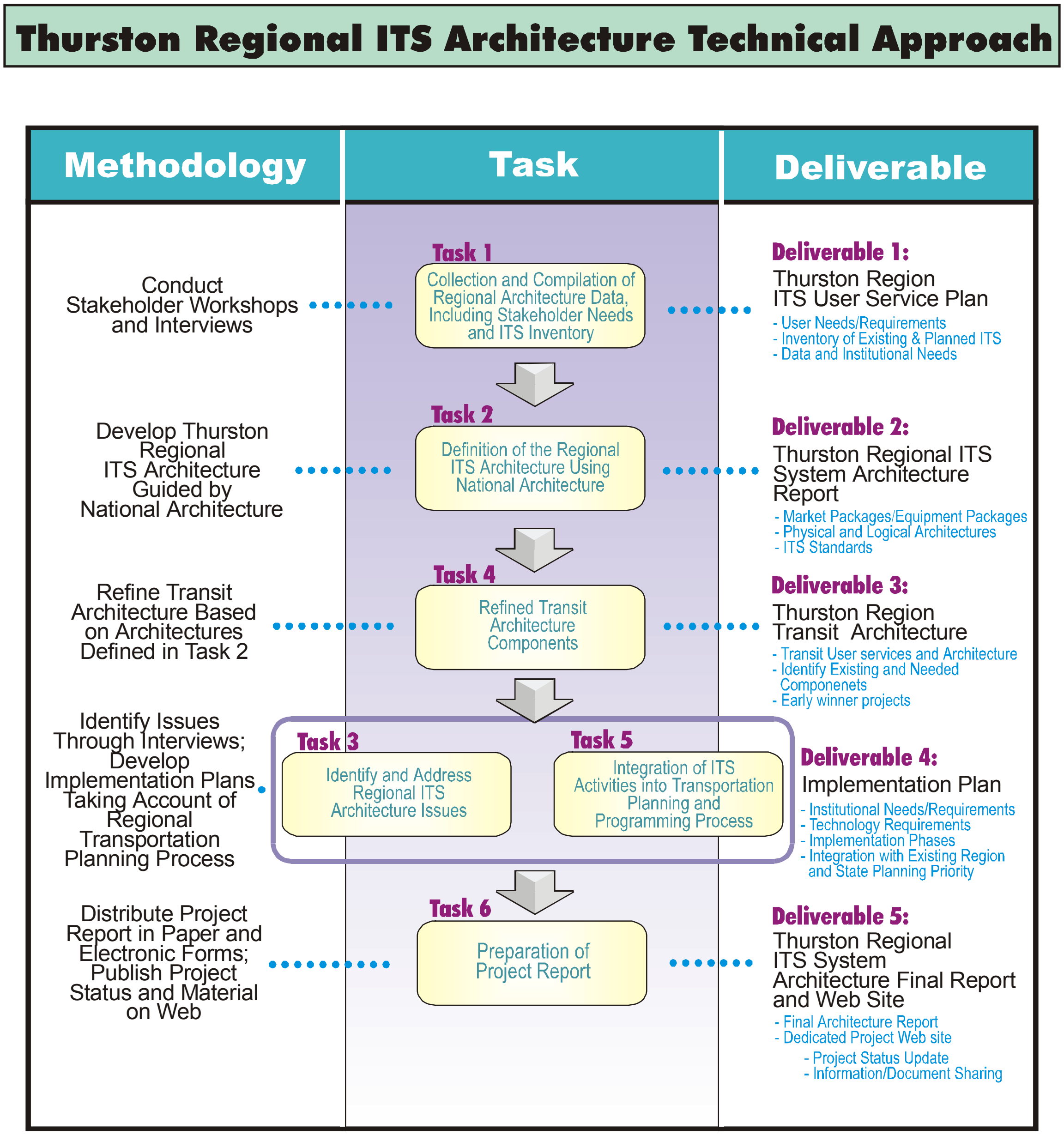

Figure 1-2 Thurston Region ITS System Architecture Approach

Technical Memorandum #1 (TM #1) has been drafted, then reviewed and revised once prior to finalization. The purpose of TM #1 was to describe and document the first steps undertaken in the development of the regional ITS architecture for the Thurston region. The report identified the stakeholders, summarized the needs of the various stakeholders, expressed those needs in National ITS Architecture terms as User Services, then mapped those user services to User Service Requirements and provided an inventory of existing and planned ITS deployments in the region.

The next step in the process was the development of the regional architecture document Technical Memorandum #2 (TM #2), which, as of the publication date of this document, has been drafted, then reviewed and revised once prior to finalization. This TM #2 architecture lays out the regional ITS system as it is today and as it is envisioned to be in the future. It identifies who will share information and how that information will be shared.

This Technical Memorandum #3 (TM #3) focuses on Intercity Transit, and identifies a specific, phased set of investments that implement many of the core, public transit related elements of the regional architecture. Future technical memoranda will focus on development of an implementation plan that provides a strategic roadmap for the implementation of ITS technologies in the region that is consistent with, and built upon, the regional architecture. That implementation strategy will reference and incorporate the specific strategy for Intercity that is presented in this document. The project will conclude with a final report that summarizes the activities undertaken as part of the project, provides a concise summary of the overall direction and objectives of ITS deployment in the Thurston region, and integrates the discussion and presentation of the several deliverables.

1.4 Thurston Area Background

Thurston County is located at the southern end of Puget Sound and the greater Seattle-Tacoma metropolitan region. Thurston is home to the City of Olympia-the capital of Washington. Other cities in the county include: Lacey, Tumwater, Yelm, Tenino, Bucoda, and Rainier. Figure 1-3 illustrates the Thurston Region and the adjoining counties and cities. The county is traversed by interstate route I-5, a heavily traveled and critical north-south corridor for the movement of commuters, travelers and commercial freight. The majority of the commercial traffic passes through the Thurston Region for destinations in southern Washington, Oregon, California, Mexico, or north to major port and transshipment facilities in Tacoma, Seattle, and into Canada. Another major highway, US 101, serves commercial and private vehicle traffic to and from the rural Olympic Peninsula and coastal Washington.

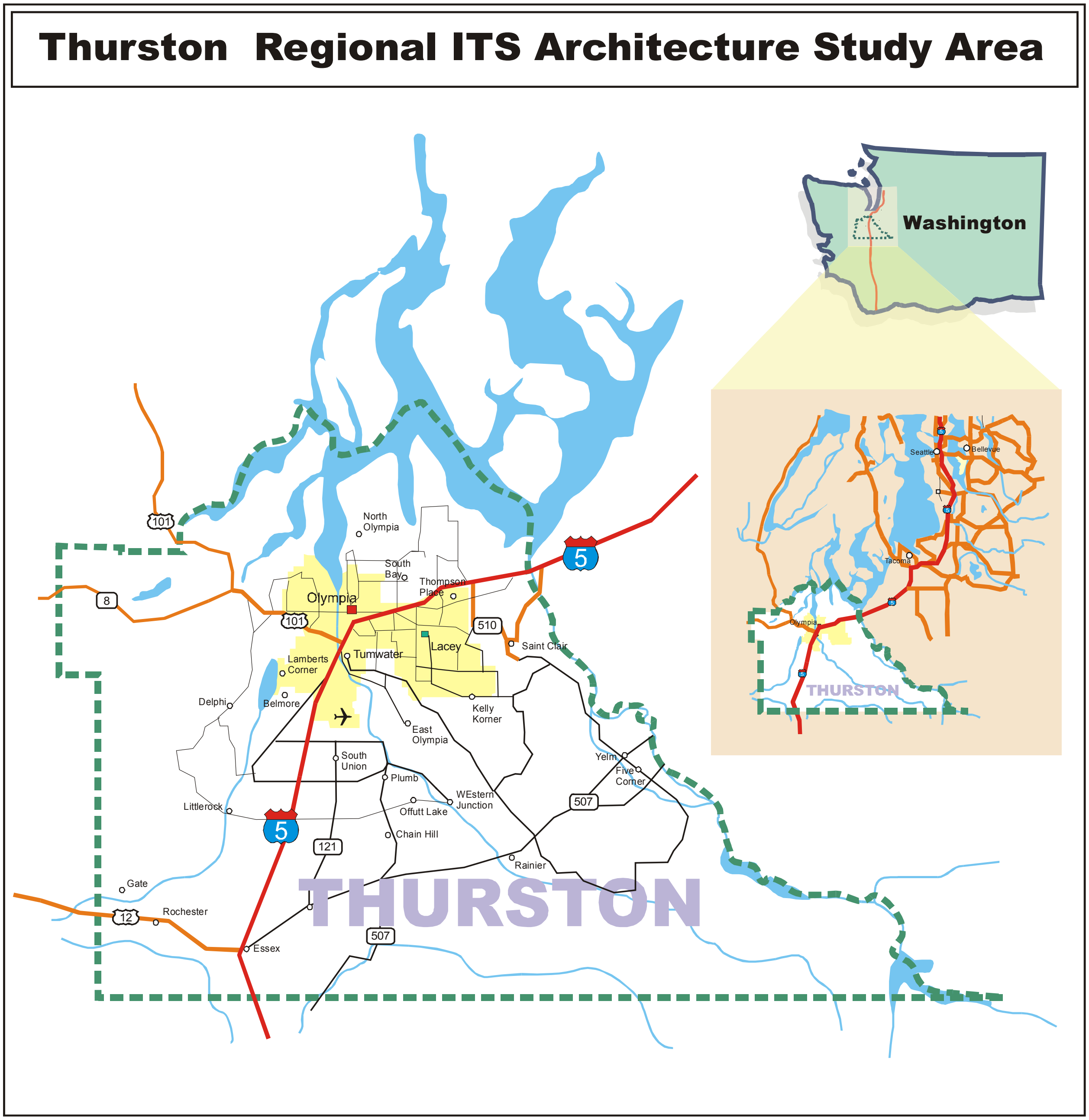

Figure 1-3 Thurston Region Background

The Port of Olympia is the southernmost port facility on Puget Sound and is accessible by rail and truck traffic. The port deals primarily in shipment of timber products originating in Thurston and adjoining counties. The Port also operates the Olympia Regional Airport. This facility provides private aviation and limited freight service--the airport has no regularly scheduled commercial passenger flights.

The region's economy is dominated by state government and its associated consumer business trade and service sectors. Other major influences include the regional retail and healthcare centers that draw consumers from other counties, agriculture, forestry and timber processing, colleges and local government, and an increasing variety of light manufacturing industries.

The southern reaches of Puget Sound have a moderating effect of the region's weather in that temperature extremes are not a major challenge. The region does experience significant rainfall (~51" annually in Olympia), and seasonal fog, snowfall and road icing conditions that must be considered in the conduct of transportation systems operations and maintenance activities. Additionally, the county area is approximately 13% incorporated urban and 87% unincorporated rural-with approximately 56% of the county population living in these rural areas (1999 estimate). Providing essential transportation services, incident and emergency response across this vast rural landscape is a major challenge for the state, county and city jurisdictions of the region.

1.4.1 Other Architectures in the Region

The Puget Sound Regional Council (PSRC) is the Metropolitan Planning Organization (MPO) for the Central Puget Sound region to the north of Thurston County. Beginning concurrently with the Smart Trek Metropolitan Model Deployment Initiative (MMDI), the PSRC has recently completed (June 2001) a regional ITS architecture for the Central Puget Sound. This PSRC architecture includes the ITS deployed and planned for three counties: Pierce, King and Snohomish counties to the north of Thurston; and the approximately 52 jurisdictions included therein. This adjoining architecture is dominated by the operational MMDI and WSDOT legacy ITS deployed along I-5/405 corridors in the major metropolitan areas of Seattle, Tacoma and Bellevue. In addition, several other regional cities are moving quickly with modernizing or first-time deployments of ITS. Likewise, WSDOT is extending their ITS coverage to include more than just interstate corridors.

To the south of Thurston, non-adjacent Clark County, the City of Vancouver, and the greater Portland (Oregon) metropolitan region are in the process of developing their own regional architecture. The MPO in that region is the Regional Transportation Council (RTC) for southwestern Washington, and METRO for greater Portland.

1.5 Overview of Intercity Transit

Intercity Transit is the public transit provider for Thurston County, Washington. Currently Intercity operates 34 fixed-route buses, 10-fixed route vans and 25 demand-responsive (Dial-A-Lift, Americans with Disabilities Act accessible) vans. Intercity is also the designated regional rideshare agency for the region and operates 69 vanpool vehicles. Intercity serves both the urban growth areas of Olympia, Tumwater, and Lacey, as well as rural areas of Thurston County. Intercity offers connections to the greater Puget Sound regional transit system, primarily via connections with Pierce Transit, the public transit provider in Pierce County.

Currently, Intercity utilizes a number of technologies. These include commercial computer software for scheduling and run-cutting for both fixed-route and demand-responsive services;

commercial vehicle maintenance system software; a geographic information system and a traditional two-way voice radio system, with three available frequencies (owned by Intercity).

Effective January 2000, Intercity's revenues were cut by approximately 42% through the elimination of funding received through the state Motor Vehicles Excise Tax. As a result of this revenue loss, Intercity has been forced to significantly cutback on service.

Technology system upgrades, replacements and additions are critical to the long-term viability of Intercity. Two core technology systems, fare boxes and the voice radio system, are old and have posed significant maintenance challenges. The significant loss of funding makes it imperative for Intercity to identify ways to operate more efficiently, to do as much as possible with their available resources. Investments in ITS are seen as an opportunity to upgrade aging systems, maximize efficiency and at the same time provide new conveniences to riders and thereby bolster the attractiveness of transit as an alternative transportation choice in the region.

2.0 Intercity Transit and the Thurston Region System Architecture

As explained in the Introduction, the ITS investment strategy for Intercity Transit that is described in this document implements many of the core public transportation related components of the Thurston Region System Architecture, the overall regional concept for transportation technology implementation and coordination. That regional system architecture is presented in detail in Tech Memo #2. This section summarizes the public transportation component of the regional architecture, which provides the broader context for the investments identified in Section 4.

The Thurston Region System Architecture has been documented in Tech Memo #2 at various levels of detail and articulated using several different concepts, each emphasizing a particular view of the architecture. Two architecture products that depict the architecture from a physical perspective, that is, emphasizing entities and physical components of the transportation system, are used in this section: the regional "sausage diagram" and the public transportation physical architecture. These products, respectively, identify the relative position and role of Intercity in the regional architecture, and identify the major public transportation related ITS strategies and associated relationships.

2.1 High-Level "Physical" Architecture for the Thurston Region

The highest level depiction of the Thurston Region System Architecture is presented in Figure 2-1 using a "Sausage Diagram"[1] that depicts the physical entities involved in the operations of a fully integrated regional ITS system. The subsystems or the physical entities are organized by their characteristics in four categories, namely: Center, Roadside, Vehicle, and Traveler subsystems. The Center Subsystems represent operational entities such as a traffic management system or transit management system in a central facility. The Roadside Subsystems represent devices or systems deployed on the transportation infrastructure such as surveillance assets, signal control systems, or dynamic message signs. The Vehicle Subsystems represent vehicles or mobile entities that utilize the ITS technology in support of their respective operations. The Traveler Subsystems represent traveler information services provided to the traveling public as well as the commercial operators to improve the safety and efficiency of their travel experiences.

1 The term Sausage Diagram is from the National ITS Architecture and typically refers to the highest-level depiction of an ITS Architecture where the "sausage" represents communication links.

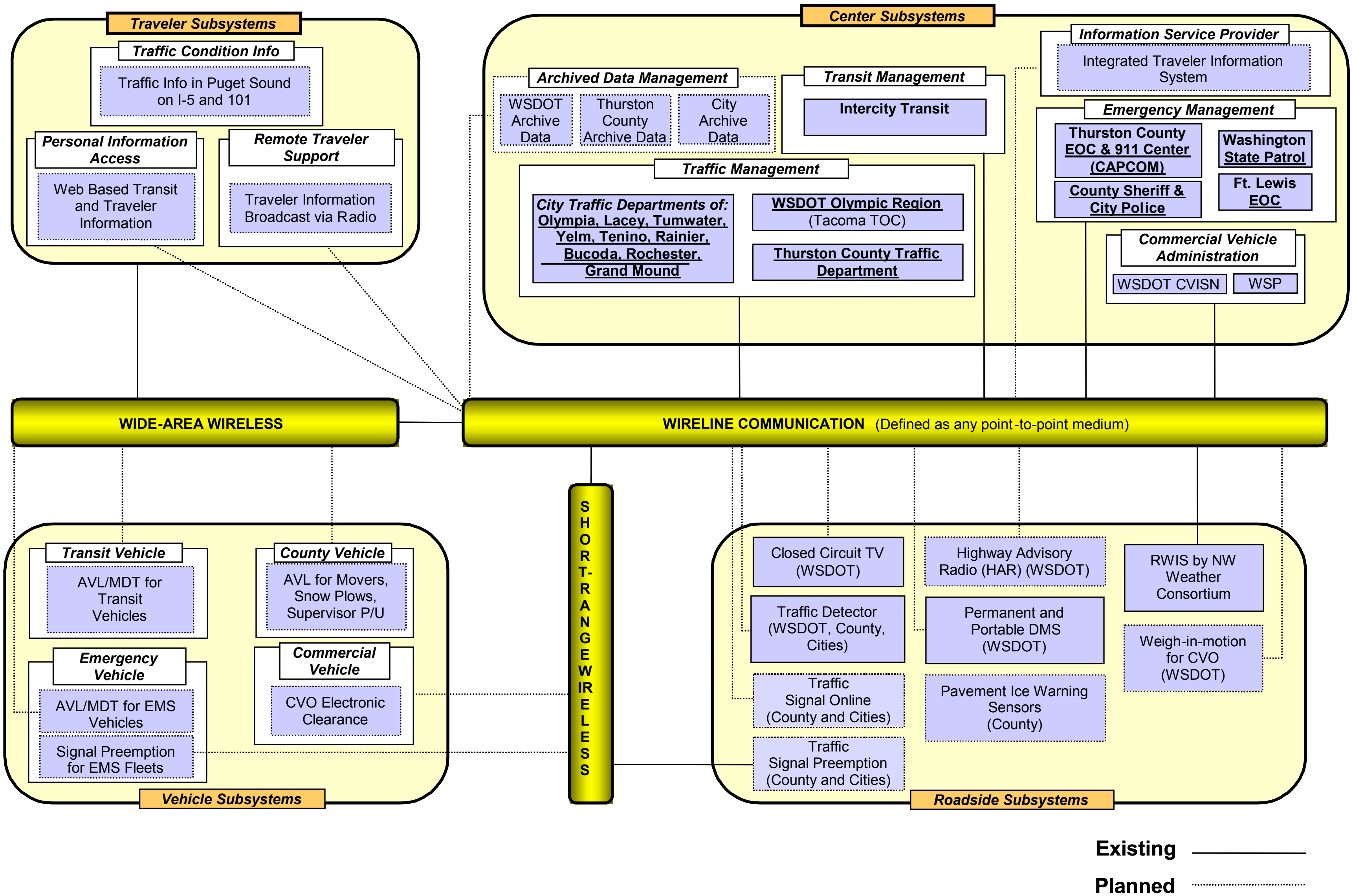

Figure 2-1 Thurston Region ITS Architecture "Sausage Diagram"

These subsystems are connected with each other via three general types of communications to facilitate data and information exchange, including Wire-line, Wide Area Wireless, and Short-Range Wireless communications. The wire-line communications include an array of known “wired" communication methods including telephone lines, copper cables, high-capacity fiber optics, and includes wireless point-to-point media (e.g., point-to-point microwave). The Wide-Area Wireless communications provide wireless data and voice communications over a long distance. The examples of Wide Area Communications include Mobile Radio, and commercially available wireless data services such as the Cellular Digital Packet Data (CDPD). The Short-Range Wireless is typically used to provide data exchange between a mobile unit (e.g., vehicle) and a roadside device. Examples of Short-Range Wireless communication include: emergency vehicle signal preemption, electronic tolling, and commercial vehicle electronic clearance such as at weigh stations. As shown in Figure 2-1, the solid lines indicate existing communications while dashed lines indicate planned communications based on the user needs stated by the stakeholders.

The major subsystems depicted in the “Sausage Diagram” include:

- **Centers Subsystems**
    - Traffic Management Center Subsystems
        - WSDOT Tacoma Traffic Operation Center (TOC)
        - Thurston County
        - Regional Cities Traffic Departments (Olympia, Lacey, Yelm, etc.)
    - Transit Management Center Subsystems
        - Intercity Transit
        - Various special needs transportation services
        - School districts
    - Emergency Management Center Subsystems
        - Thurston County EOC
        - Thurston County 911 Call Center
        - Ft. Lewis Emergency Management
        - Washington State Patrol (WSP)
        - Local Police and Fire
    - Commercial Vehicle Center Subsystems
        - Various WSDOT commercial vehicle administration subsystems
    - Archived Data Management Center Subsystems
        - WSDOT regional ITS data archive subsystem
    - Regional (Integrated) Traveler Information

- **Roadside Subsystems**
  - Closed-Circuit Television (CCTV)
  - Real-time traffic counter
  - Traffic signal for signal coordination and emergency vehicle preemption
  - Dynamic Message Sign (DMS)
  - Highway Advisory Radio (HAR)
  - Weather, pavement and environmental sensors
  - Commercial vehicle operation implementations such as weigh-in-motion and electronic clearance

- **Vehicle Subsystems**
  - Transit vehicle Automatic Vehicle Location (AVL)
  - Emergency vehicle traffic signal preemption (vehicle instrumentation)
  - County vehicle AVL
  - Commercial vehicle electronic clearance (onboard device)

- **Traveler Subsystems**
  - Real-time en-route traffic information service on major freeway
  - Personal information access via Internet and personal communication devices
  - Remote traveler information broadcast via Television and Radio

The "Sausage Diagram" provides a high-level graphical representation of the ultimate integrated regional ITS system and the major operational entities involved.

2.2 ITS Physical Architecture for Public Transportation

The high-level "sausage diagram" identifies the major entities and generally describes the physical relationships among them in terms of their association with center, traveler, vehicle and roadside subsystems. Additionally, the Thurston Regional System Architecture includes a series of more detailed diagrams for seven major "functional areas" that compose the regional transportation system. These functional areas are: traffic and transportation management, public transportation management, electronic payment and fare collection, freight mobility, emergency response and management, traveler services, and information storage and management. The elements of the Thurston Region System Architecture that are directly relevant to Intercity are included in the public transportation functional area.

The public transportation functional area has been defined as including the following major service operators: Intercity Transit, special needs transportation providers (e.g., senior citizens, disabled, social service programs, including Medicaid and Head Start), and school bus operators.

The physical architecture diagrams developed for each functional area were based on a set of technology solutions that were developed with stakeholders, reflecting their needs, as identified through interviews and workshop discussions. The potential technology solutions for public transportation in Thurston region include:

2.2.1 Intercity Transit

- Electronic payment system, linked with other agencies
- Automated traveler information/trip planning system, linked with other agencies
- Automated passenger counters
- Automated enunciators
- Vehicle tracking and data communications system (w/mobile data terminals)
- Enhanced transfer coordination
- Traffic signal priority
- Enhanced communication/data exchange with traffic/emergency agencies
- Security monitoring
- Flex-route service
- Enhanced vehicle monitoring

2.2.2 Special Needs Transportation

- Integrated smart card system
- Coordination and resource sharing (reservation, dispatch, vehicles) strategies using scheduling and dispatch software, voice and data communications, and vehicle tracking

2.2.3 School Bus Service

- Agreements for resource sharing, supported as necessary by communications technologies, scheduling/dispatch systems, and inclusion in regional communications and information systems

These technology solutions are not intended to include specific solutions that organizations would implement. Rather, given the current perspectives of the stakeholders and the resources available to develop the architecture, these are the solutions that show the greatest promise for the foreseeable future.

Figure 2-2 presents a high-level public transportation ITS physical architecture for the Thurston region, incorporating the preceding technology solutions identified by the stakeholders.

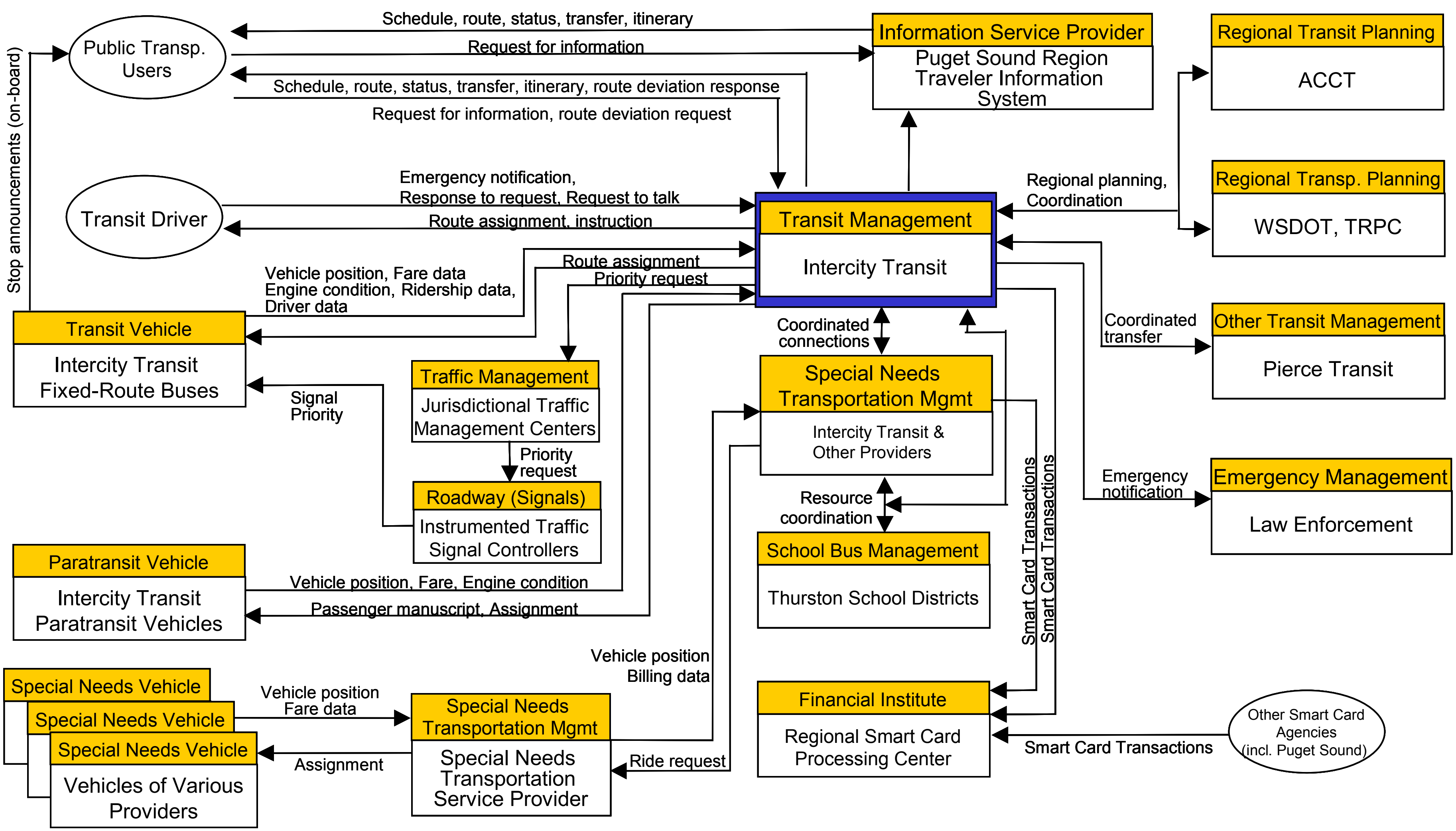

Figure 2-2 Public Transportation Management Architecture Diagram

3.0 Development of the Intercity Transit ITS Investment Strategy

This section describes how the phased, specific set of Intercity Transit ITS investments were identified and developed. These investments will implement many of the solutions portrayed in the Thurston Region ITS Architecture.

Overall, the process to develop the Intercity ITS Investment Strategy was very closely integrated with the effort to develop the regional architecture, with inputs and outputs shared between the two efforts. The investment strategy development effort focused on building upon and refining—in terms of the relative phasing of ITS strategies and their grouping into logical, separate investments—the "end state" picture represented in the architecture. Figure 3-1 graphically illustrates how the investment strategy development effort was linked with the regional architecture effort.

3.1 Identification of Intercity Transit Needs

Development of the investment strategy began with interviews with Intercity staff and representatives of the transit agencies of neighboring counties. From these interviews and follow-up meetings with IT, a list of needs was identified.

As shown in Figure 3-1, these needs were then added to the needs of other regional architecture stakeholders, including those of other Thurston County transportation providers (e.g., school bus and special needs), documented in Tech Memo #1, and used to identify the regional ITS user services.

The needs that were identified for Intercity cover most of the major areas of activity for the agency, including customer information, administration and planning, fare collection, communications and transfers. The long and comprehensive set of needs recognizes that nearly all areas of activity can be made more efficient and effective through the thoughtful application of technologies. As Intercity struggles to maintain quality service with significantly reduced funding levels, it is especially important to squeeze every bit of efficiency and value out of their resources—a process in which technologies can play a key role. Of course, the urgency of the needs vary, not all of the needs are critical or short-term in nature. However, some needs are critical, such as the need to replace radios and fare boxes that are out-dated and difficult to maintain.

3.2 Relationships to ITS Applications

For the purposes of the Intercity investment strategy, the identified needs were further discussed and loosely prioritized by Intercity staff, a process that included discussions and a needs ranking survey. After establishing some general priorities among the various needs, the needs were matched up against a list of potential ITS applications, identifying which applications can help address each need. The relationships between the needs and the ITS applications is shown in Table 3-1.

After identifying the general applications most responsive to the identified needs, the list of ITS applications was input into the regional system architecture process, where they formed the basis for the high-level architecture shown in Figure 2-1.

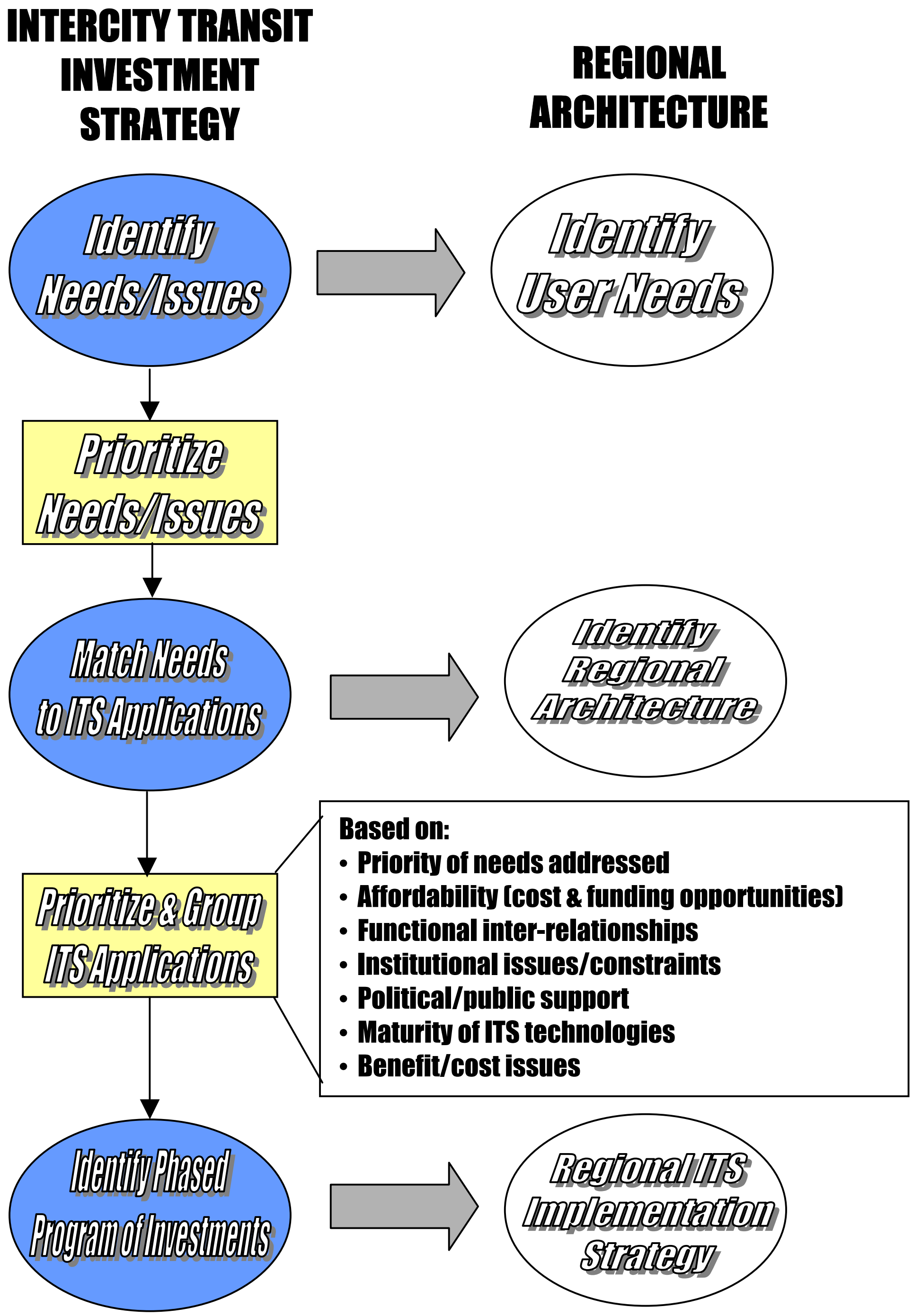

Figure 3-1 Relationship Between Transit and Regional Architecture Activities

Table 3-1 Relationship Between Intercity Transit Needs and ITS Applications

	ITS STRATEGIES																														
NEEDS (sorted loosely by general priority for fixed-route)	Transfer coordination system using automated real time vehicle location (requires data communications)	Computer scheduling/run-cutting software	Emergency vehicle location system using AVL (requires data communications)	Management information system	Traffic signal priority system	Real-time "next bus" arrival time information at bus stops	Mobile data terminals to compliment/reduce amount of radio comm.	Pre-trip real-time "next bus" arrival time information (e.g., phone, Internet)	Automated schedule adherence monitoring	Bus stop audio or video security monitoring	Real-time traffic congestion information	Real-time regional traffic advisory information (e.g., messages on VMS)	General public demand-responsive "smart shuttle" to provide same-day service	Automated on-board passenger counting	On-board audio or video security monitoring	Formal incident coordination procedures with law enforcement & traffic agencies	Real-time pavement condition and other weather information	Electronic fare payment (e.g., "smart card")	Automated electronic customer input/complaints system (e.g., internet)	Computerized vehicle maintenance software	Automated on-board voice annunciators and/or displays to announce stops and transfers	Automated route and schedule telephone information system	Interactive electronic trip planning (phone, kiosks, Internet)	Automated geographic referencing for passenger counting, e.g. AVL	Flex-route/route deviation service featuring AVL & mobile data terminals (requires data communications)	Integrate fare payment system with neighboring operators	Integrate traveler information system with neighboring operators	Computer-aided radio dispatch	Traveler information kiosks	Driver monitoring (computer log of accel/decel, etc.)	Vehicle monitoring (engine, brakes, etc.)
Need to reduce inefficiencies resulting from ride cancellations		X	X				X		X																			X			
Need to increase the efficiency of ride confirmation call back process		X																													
Need to improve ability to serve same day trip requests		X	X				X		X				X																		
Need to make fare payment more convenient for customers																		X								X					
Need to make schedule and route information more accessible to customers																						X	X				X		X		
Need to improve the reliability of fare collection equipment																		X													
Need to improve the effectiveness of radio communications (e.g., speed, comprehension, reliability and consistency)							X																					X			
Need to be able to update schedule and route information more quickly				X																		X	X						X		
Need to make trip planning more convenient for customers				X																		X	X				X		X		
Need to improve the efficiency of collecting ridership information														X				X						X							
Need to improve the accuracy of ridership information						X								X				X						X							
Need to improve detection and response to security or medical incidents at stops/stations			X		X					X		X				X	X														
Need to reduce the costs/increase the efficiency of fare collection and handling																		X													
Need to disseminate schedule and route information less expensively																						X	X				X		X		
Need to improve the efficiency of the customer service telephone information system																						X	X				X				
Need to reduce rider uncertainty regarding bus arrival times						X		X	X																				X		
Need to reduce rider confusion about stop announcements																					X										
Need to improve the convenience of making transfers	X				X	X			X									X			X	X	X						X		
Need to improve the convenience of making transfers to other services	X				X	X			X									X			X	X	X			X	X		X		
Need to improve ability to efficiently measure changes in ridership patterns																		X						X							
Need to improve ability to analyze operational data and develop and implement service changes																		X		X				X							
Need to improve ability to support more sophisticated fare schemes (e.g., distance-based)																		X								X					
Need to increase the amount of information collected via fare collection equipment																		X													
Need to improve effectiveness of communications with traffic and law enforcement agencies during incidents							X					X				X	X											X			
Need to improve the efficiency of scheduling/run-cutting		X																													
Need to increase the accuracy and efficiency of inventory functions				X																X											
Need to increase the efficiency of vehicle condition data collection																				X											X
Need to reduce travel delays caused by traffic congestion					X						X	X																			
Need to reduce travel delays associated with delays at traffic signals					X																										
Need to improve detection and response to security or medical incidents on vehicles			X		X		X				X	X			X	X	X											X			
Need to improve schedule adherence and on-time performance		X			X				X								X														
Need to increase the amount and detail of ridership information collected							X											X						X							
Need to reach more people through public meetings																			X												
Need to improve effectiveness and efficiency of data archiving				X																											
Need to provide more service to low density areas													X												X						
Need to reduce time required to collect fare collection data from individual vehicles, and to format for analysis																		X													
Need to improve the consistency of information given by customer service operators																							X								
Need to improve the efficiency of report generation and filing		X																		X				X							
Need to reduce the amount of radio "chatter"							X																					X			
Need to improve the ability to identify the need for preventative vehicle maintenance																				X										X	X
Need to improve ability to monitor and maintain vehicle headways/spacing									X		X	X					X														
Need to reduce travel delays caused by traffic incidents					X						X	X				X	X														
Need to reduce travel delays caused by road construction/maintenance					X						X	X																			
Need to reduce the costs associated with public meetings																			X												
Need to increase the speed and capabilities of computer workstations																															

3.2.1 Phasing and Grouping of ITS Applications

After identifying the general ITS strategies available to address IT's identified needs, a process was undertaken to convert these strategies into specific, phased investments, i.e., to prioritize and group the strategies into "implementable" pieces. As shown in Figure 2-2, this process considered a number of factors, including:

- costs, funding opportunities and benefit-cost issues,
- the functional inter-relationships among technology components (e.g., application X is needed to support application Y),
- opportunities to partner with other agencies,
- the maturity of the required technology, and
- public and agency support.

The product of this process is the ITS investment strategy presented in Section 5. As shown at the bottom of Figure 3-1, the Intercity ITS investment strategy will be reflected and will provide input to the more general, regional "implementation strategies" that will be developed as part of the regional architecture effort. These strategies will focus on near term activities needed to advance the implementation of the regional architecture.

4.0 Intercity Transit ITS Investment Strategy

This section presents the Intercity Transit ITS investment strategy, a phased set of specific investments that will provide the agency with critical management tools. These tools will allow Intercity to maximize the efficiency and effectiveness of their operation and at the same time will enable them to provide transit users with higher quality service and new, more convenient features.

The overall ITS vision and phasing of investments is summarized, followed by detailed descriptions for the individual investments and estimated costs. Finally the relationship between the ITS investments and the public transportation components of the regional ITS architecture are identified.

The rationale behind the ITS investments is noted throughout the vision and individual investment discussions. A more thorough discussion of the benefits of the investments is included in Section 6, including real world observed statistical improvements in efficiency.

4.1 Overall ITS Vision

Intercity Transit has identified an overall vision for enhancing the use of technologies within their operation. The objective of incorporating additional technologies into the operation is to maintain quality service in the face of increasingly scarce resources, and to maintain and attract new riders by making transit services more reliable, predictable and flexible.

The overall vision has been divided into three chronological phases:

- Near-Term (years 1-3)
- Mid-Term (years 4-6)
- Long-Term (years 7+)

The overall strategy is to start with investments that address the most significant, immediate needs, that is, those that are needed to replace existing systems that are failing or burdensome to maintain, as well as investments in “core” technologies that provide significant and fundamental management tools, and which are needed to support subsequent strategies. Over time, additional investments will be made that build upon the core systems implemented in near-term, and which provide additional tools and enhancements for users. Figure 4-1 summarizes the major components of the Intercity ITS investment strategy. The focus of each phase in that strategy is summarized in the sections below.

Specific years (e.g., years 1-3) have been associated with the three investment phases in order to provide some general structure. However, the actual pace of implementation will depend on many factors, factors that are constantly changing, most importantly resource availability. Therefore, the specific years associated with the investment phases should be seen as general guides. Given the constant change in institutional factors, such as resource availability, and the rapid pace of evolution in transit technology applications, the Intercity ITS investment strategy will be reevaluated on a periodic basis.

Figure 4-1 Intercity Transit ITS Investment Strategy

4.1.1 Near-Term Focus

The focus of Intercity ITS investments in the next three years will be on replacing outdated and increasingly unreliable voice radio and fare box systems; addressing one of the most significant sources of inefficiency in the demand-responsive service; adding “core” technologies; and providing some initial, high-visibility user conveniences.

The core technologies—a vehicle tracking system with automated passenger counters and automated stop enunciators—significantly enhance the ability to plan for and manage on-street operations and enable a number of later service strategies. These items have been grouped because both the counters and enunciators rely on vehicle location information, and therefore must be integrated with the vehicle location system. Implementing them at the same time as the overall vehicle tracking system reduces procurement and installation costs. These core ITS technologies should, to the extent possible, be implemented in conjunction with the radio system. Implementing these systems together will minimize procurement and installation costs and help insure that all components are designed and configured from the outset to work effectively together.

The passenger information and fare/billing management system for the demand-responsive service that will be implemented over the next three years will utilize an on-board card reader. This will address one of the most significant concerns in the demand-response service area: the difficulty in associating specific rides and trips with the appropriate billing or funding source. Improving this process should improve cost recovery and promote coordination with other regional special needs providers, including Paratransit Services, the regional Medicaid broker.

The vehicle tracking system that will be implemented makes it possible to estimate the arrival times of specific vehicles at specific locations. The final near-term project will provide this information for a few key routes and locations through Intercity’s customer service telephone system, and changeable electronic signs at key transfer locations, including the SR 512 Park and Ride lot where Intercity interfaces with Pierce Transit routes. This information is very useful and comforting to riders, and will allow key transfers to be very closely coordinated.

4.1.2 Mid-Term Focus

Years 4-6 of the Intercity ITS investment program will focus on adding capabilities that build upon the core infrastructure implemented in years 1-3. Estimated bus arrival time information will be expanded and made available for more routes and locations. Utilizing the fare boxes implemented in years 1-3 and building on the demand-response card reader investment, a card-based fare system will be implemented on fixed route vehicles. This system will be compatible with the integrated system being implemented in the Puget Sound region and will greatly facilitate trips involving transfers with Pierce Transit and continuation on to other Puget Sound area services.

A major new convenience will be provided to users in years 4-6 of the ITS investment program: the ability to obtain detailed travel itineraries automatically via the Internet, using only trip origin and destination information. This system will also facilitate connections with other services by including several Puget Sound area services in the trip planning system. As traffic and law enforcement agencies in the Thurston Region increase the level of coordination and information sharing—as outlined in the Thurston Region System Architecture—Intercity will make the communications and other investments necessary to remain an active partner in that enhanced, more closely coordinated regional transportation management process.

Also during years 4-6 of the Intercity ITS investment program, the “core” vehicle tracking and communications investments in the demand-responsive service will be employed to improve coordination with other regional special needs transportation providers.

Finally, at selected traffic signal locations where delays are known to chronically impact schedule adherence, systems will be installed to provide additional green time or shortened red time to buses that are running behind schedule.

4.1.3 Long-Term Focus

In the long-range component of the Intercity ITS investment strategy the focus will expand to include even more advanced technologies and strategies. Video security cameras will be installed on Intercity Transit vehicles and at major stops. Initially, it is expected that these cameras will be used to record conditions for future playback, in the event of an incident. Later, it is expected that the system will be upgraded to allow for real-time monitoring from the Intercity Transit offices. On-board monitoring of the major mechanical systems on buses will be implemented, providing the ability to fine-tune maintenance practices and reduce costs. The vehicle tracking and communications systems implemented earlier will be utilized to support new types of flexible service that combine features of fixed-route and demand-response service.

4.2 ITS investments

4.2.1 Near-Term Investments (Years 1-3)

N-1: Communications System Study

This investment will examine Intercity’s voice and data communications needs in light of their identified ITS and information technology investment strategy over the next five to ten years. The study will document the required communications functions associated with the various planned ITS technologies and investigate options for delivering those functions, including lease versus own, various data communications alternatives (e.g., radio, CDPD, etc.), and resource sharing arrangements. This study will explicitly consider possibilities for sharing communications resources with other agencies in Thurston County, including the planned County trunked radio system.

This study should also, to the extent possible given available resources, consider possibilities for sharing communication system resources and/or approaches with other major public transportation providers in Thurston County, including major special needs providers like Paratransit Services or the regional Medicaid broker. If possible, this communications study should also be coordinated with any other similar communications studies that may occur within the same time frame, as recommended in the Thurston Regional ITS Architecture implementation plan. The costs of this investment should be shared among agencies, based upon the scope of the effort. The cost estimate for this investment assumes an effort that would focus on IT, but would consider opportunities associated with the County's planned county-wide trunked radio system, and coordination with Paratransit Services.

Key issues to consider in evaluating shared radio system arrangements include:

- Distribution of infrastructure costs
- Deployment time frame
- Ownership of frequencies
- Priority for use of the system (i.e., transit typically secondary when law enforcement is a partner)
- Cost paid versus functions required (i.e., are you sharing costs for a system that is being "over-built" relative to transit needs, based on law enforcement or other users requirements)
- Differing data protocols that may necessitate separate data channels

The results of this study will be a set of specifications for the recommended voice and data communications system, suitable for use in a Request for Proposals procurement document.

N-2: CAD/AVL System with APCs and Enunciators

This investment replaces Intercity's existing voice radios, both base station and mobile units, and implements a new data communications ("computer-aided dispatch", or CAD) and automatic vehicle location (AVL) system on fixed route, demand-responsive, supervisory and maintenance vehicles. This technology constitutes the "core" of the Intercity ITS system, providing the basic communications and tracking capabilities that will allow the operation to be more efficiently managed, and which will enable a number of customer service strategies in the future.

In addition to the communications and vehicle tracking capabilities, this investment includes two additional features that depend upon vehicle location information: automated passenger counters (APCs) and automated stop enunciators. The passenger counters will provide Intercity with an extremely accurate and cost effective means to collect detailed ridership information, providing a wealth of data that can be utilized to identify service efficiency improvements and the need for schedule and route changes as well as assisting in the compilation and reporting of ridership numbers to the Federal Transit Administration. The enunciators, which automatically announce stops, facilitate compliance with the Americans with Disabilities Act, promote consistency in stop announcements and relieve drivers of a distraction.

The voice radio component of this investment replaces the aging voice radio system currently in place, a system composed of various brands and models of equipment, and which is at the end of its reliable life. The data communications system implemented in this investment is needed in order to relay vehicle locations to the Intercity dispatch center, and to relay text messages and signals to and from Intercity vehicles and Intercity dispatchers. The data communications system will include driver interface units, or "control heads" that will manage all communications. These will allow the drivers to initialize the on-board technology systems, including the automatic passenger counters (APCs) and enunciators, and will include user programmable "function keys" that can be used by drivers to record various information, such as wheelchair loadings. The driver interfaces will also provide for covert mayday signals and audio monitoring. Depending upon the specific technology utilized, a single driver interface unit may control both voice and data communications. The driver interfaces can also be configured to allow drivers to send and receive text messages, a capability that may be especially useful for dispatching demand-responsive vehicles.

The automatic vehicle location system, or AVL, determines the real-time location of vehicles using on-board technologies, with Global Positioning System (GPS) receivers being the most common and current "state of the practice" technique. The vehicle location information, latitude and longitude, is then relayed from the individual vehicles back to the Intercity dispatch center, where computer software and map displays allow the real-time, automatic tracking of all equipped vehicles, including automated monitoring of schedule adherence. Real-time vehicle tracking and schedule adherence allows for improved coordination of timed transfers.

The automated passenger counters implemented in this investment will utilize on-board sensors at the vehicle doors to automatically record passenger movements on and off of the buses. By rotating APC equipped vehicles around various routes, or by moving the APC equipment from vehicle-to-vehicle, accurate system-wide passenger counting can be performed using a fairly limited number of units, and therefore this investment will implement only enough passenger counters for about 10% of the Intercity operating vehicle fleet. Automated passenger counters rely on vehicle location information—passenger boardings are referenced against a specific stop location. Although alternative methods are possible, AVL is the most accurate method for identifying vehicle locations for passenger counting, and implementation of APCs in conjunction with AVL is cost effective.

The AVL system is critical to the operation of the automated stop enunciators. As the bus nears a particular stop location, the enunciator system triggers the appropriate pre-recorded announcement over the bus's public address system. Like automated passenger counters, automated enunciators require vehicle location information, and although other methods are possible, GPS-based AVL represents the most accurate approach and implementation of enunciators in conjunction with AVL is cost effective.

The technologies implemented in this investment, specifically the vehicle location/schedule adherence monitoring and automated passenger counters, will create a tremendous amount of data that can be extremely useful. However, the volume of data from these types of systems can be overwhelming, and without advance planning for how the data will be used, and how these efforts will be supported, the full potential of these systems is often not realized. For this reason, a data collection and analysis plan should be prepared as part of the planning and development of this investment.

By providing Intercity the ability to monitor vehicle locations in real-time and communicate text and other data to and from vehicles, this investment provides backbone capabilities that support regional agency integration. For example, real-time vehicle location output from the AVL system can be made available to traffic and incident response agencies. Vehicle location can provide information on traffic conditions, and allows emergency responders the ability to locate vehicles quickly during medical, security, natural disasters or other emergencies.

N-3: Registering Fare Boxes

This investment implements fare boxes on Intercity Transit's fixed-route vehicles. The boxes will be capable of collecting data, including the number of various types of fares paid. The fare boxes that are currently used cannot collect any data, and merely serve as a storage location for collected fares. The current fare boxes have reached the end of their reliable service life and have become difficult to maintain.

Efforts will be made in implementing the registering fare boxes to select hardware that will facilitate the ultimate migration to a smart card fare payment system that will be compatible with the one currently being procured in the Puget Sound region. It is expected that if the appropriate care is taken in selecting fare boxes, migration to a compatible smart card approach will require the addition of a smart card processing unit and associated software, but will not require replacement of the fare box units themselves. The selection of the new fixed-route fare boxes should also be coordinated to the extent possible with the implementation of the passenger information/fare system. This system is planned for roughly the same time period for the Intercity Transit demand-responsive vehicles and other special needs transportation providers in Thurston County (see investment N-4).

Currently, this investment is recommended to occur approximately concurrently with, but through a separate contract from, the communications and AVL investment. This recommendation is based on the fact that direct integration of fare boxes with AVL systems is now only an emerging capability, and therefore need not be done as part of the broader AVL. Keeping the fare box contract separate therefore is not expected to compromise any integration objectives, and may provide more flexibility and control. However, as the communications/AVL investment and the fare box investments develop, the benefits and disadvantages of linking these investments under a single contract should be reevaluated.

N-4: Demand-Responsive Passenger Information/Fare System

This investment implements a passenger information/fare system for the Intercity demand-response (i.e., paratransit) system, and for other interested Thurston County special needs providers, such as Paratransit Services (regional Medicaid broker) and Head Start. The specific features of this system will be defined through a coordinated, county-wide study (as recommended in the Thurston County Regional ITS Architecture implementation plan), and to the extent possible, should be implemented with consideration to the overall strategy for improving special needs transportation coordination in the region.

The system implemented in this investment will provide special needs transportation providers with an improved method for associating individual riders and trips with the various programs that will help pay for the trip, and an improved means for billing those programs. This system will greatly improve what is now an extremely complex, and therefore inherently resource-intensive and to some extent inefficient and imprecise process. Currently, there a number of different special needs transportation services providing demand-responsive, point-to-point service in Thurston County. Each service provides service to varying locations for varying client groups, and allows payment for the trips through various funding programs. In some cases, a single vehicle/provider may serve—simultaneously, or as is more often the case, sequentially over the course of a given day—a variety of trips/clients to a variety of different locations which may be paid for through a number of different programs. The provider of the trip, the rider, and the purpose and destination of the trip all impact how the cost of the trip is billed and paid for.

It is anticipated that this investment will include some sort of "card" that clients/riders will present when boarding a vehicle, providing the information needed for the service provider to accurately classify the trip and bill the appropriate program for the appropriate amount. Until the regional study is completed and a specific set of system objectives and functional requirements are identified it is not possible to specify the type of card system that will be needed. A range of options exist, providing a range of features through different types of cards, including magnetic stripe cards, credit cards and "smart cards". Cards may be "swiped" through a magnetic reader, or sensed remotely using a proximity reader. Regardless of the specific card technology, some sort of card reader device will be required on-board the vehicles. In the case of IT, the card reader functionality should be considered when procuring the CAD/AVL system, which will include a driver interface and vehicle logic unit, both of which may interface with the card reader.

In addition to the on-board and client/rider components of the passenger information/fare system, specialized software, and quite likely associated new or upgraded computer hardware will be implemented as part of this investment.

The cost estimate for this investment includes the development of a regional system concept and set of functional specifications, and the costs to implement required hardware and software at Intercity Transit. It is anticipated that other participating agencies will contribute toward the cost of the study/design portion of this investment, and will be responsible for their own implementation costs (not reflected here).

N-5: Initial Real-Time Bus Status Information System and Transfer Coordination

This investment implements the first part of a phased system that will provide transit users and potential users with estimated bus arrival times at specific locations. The information for this system will be obtained through the automatic vehicle location system implemented in investment N-2. Ultimately, it is envisioned that information will be available for many routes, vehicles and locations, and will be provided via a combination of: existing customer service operators, the Internet, and either kiosks, monitors or changeable electronic signs at transit centers and key transfer locations. This investment implements the first phase of the system, making the information available through the Intercity customer service operators, via the Internet and via a few signs at the most important transfer locations, including inter-county transfers with Pierce Transit at the SR 512 Park and Ride near Lakewood.

Uncertainty regarding actual vehicle schedule status and arrival time is generally cited as one of the reasons people don't use transit. This investment provides a very visible, tangible resource to riders and focuses directly on that uncertainty. Also, time spent waiting for transit vehicles is generally given more weight than time actually spent on-board vehicles. By providing riders with the information they need to arrive at the bus stop at the same time as the bus, this system will minimize unproductive wait times.

The real-time bus arrival estimates provided to riders transferring between Pierce Transit and Intercity Transit routes at the SR 512 Park and Ride will be part of an overall effort to improve inter-system transfers. In addition to providing the information needed to estimate bus arrival times, the communications and automatic vehicle location systems implemented in investment N-2 will allow timed-transfers to be more closely coordinated.

4.2.2 Mid-Term Investments (Years 4-6)

M-1: Expanded Real-Time Bus Status Information System

This investment expands upon the real-time bus information system implemented in investment N-5 by expanding the number of routes for which estimated bus arrival times will be available and by providing the information—via kiosks, monitors or changeable electronic signs—at more locations.

M-2: Automated Trip Planning System

This investment implements a system that will allow Intercity riders to plan trips and obtain specific travel itineraries via the Internet and from Intercity customer service operators. Users will be able to pick a trip origin and destination and travel time and the system will automatically identify the bus, stop location, time and fare required to complete the trip.

Currently, three Puget Sound area transit operators, Pierce Transit, Community Transit and King County Metro, are implementing this same capability at their respective organizations, and sharing their route and schedule information. As a result, users may request an itinerary for a trip with an origin and destination anywhere within the combined three-agency service area. The three agencies are sharing the cost of the system software. It is anticipated that Intercity will be able to participate in that cost-sharing arrangement. By participating in the regional system, Intercity riders will be able to plan itineraries across all four services. This ability will be most useful for Pierce Transit, which is the only one of the services that Intercity directly connects with.

This project will also be coordinated with the statewide "trip planner" project that is being developed by the Agency Council on Coordinated Transportation (ACCT). That effort is building on similar work done by the Oregon Department of Transportation, and is expected to ultimately provide the ability to plan transit trips throughout Washington. The Washington trip planner project is now in the conceptual stage.

This investment would include the following major components:

- system hardware and software
- customer service operator workstations and training
- internet development
- development and maintenance of schedule and route information and distribution to partnering agencies

M-3: Integrated Electronic Fare Payment System (E.g., Smart Card)

This investment expands upon the passenger information/fare system implemented on Intercity demand-response vehicles in investment N-4, in years 1-3. This project will implement a card-based electronic fare payment system that will include Intercity Transit's fixed-route vehicles. The system will improve the convenience of fare payment for riders and will reduce fare evasion, improve fare security and reduce fare-handling costs for Intercity.

The fare payment system implemented in this investment will be compatible with the system implemented on the Intercity demand-response vehicles, and on other regional special needs providers, as part of project N-4. Opportunities for making the system compatible with the regional integrated smart card fare payment system being deployed in the Puget Sound region will also be investigated.

This investment will include additional on-board hardware, including card readers, and system software which will work with the registering fare boxes and other system elements implemented on Intercity's fixed-route vehicles in project N-3.

M-4: Enhanced Communication and Coordination with Traffic and Incident Response Agencies

This investment supports activities to improve the level of communication and coordination between Intercity's dispatch center and local and regional traffic and incident response agencies. As the level of information sharing and coordination among traffic and incident response agencies increases in the coming years, supported by various technology systems, it will be important for Intercity to remain involved in discussions and to identify wherever appropriate their role in these processes. This investment will fund Intercity's on-going involvement in joint planning activities as well as implementation of communications, computing and other infrastructure needed to support Intercity's role in these processes. These investments could include computer hardware or software, or communications linkages (such as dedicated data phone lines, etc.).

M-5: Enhanced Demand-Responsive Service Coordination

This investment supports Intercity's participation in future coordinated service strategies to be pursued by Thurston County special needs transportation providers. Currently, there are planning efforts underway to identify specific strategies for improving efficiencies in the special needs transportation community and the regional ITS architecture will support continued planning and deployments. These deployments will focus on reducing redundant services, better matching desired trips with available providers, and overall improved utilization of cumulative resources. To date, specific strategies or needed investments have not been identified. It is anticipated that the communications and AVL capabilities, and possibly the passenger information/fare payment system, implemented in the Intercity paratransit fleet in an earlier investment will provide the foundation for any of a number of strategies that are likely to emerge from the special needs planning efforts. However, it is probable that additional resources will be required, including at a minimum, resources for continued planning. This investment reserves those resources.

M-6: Transit Traffic Signal Priority

This investment implements transit vehicle traffic signal priority at selected locations where heavy traffic congestion and/or delays at traffic signals significantly impact transit schedule adherence. Transit signal priority provides extended green time, or reduced red time, to transit vehicles that are running behind schedule (and to any other vehicles traveling in the same direction as the transit vehicle). The decision of when to provide signal priority for transit will be based on the current schedule status of the vehicle, as monitored through the AVL system implemented earlier—only transit vehicles running sufficiently behind schedule will be given the special treatment. It is also possible to incorporate vehicle loading into this determination, using data from the automated passenger counters implemented in an earlier investment. Under such a scenario, only vehicles that are behind schedule, and carrying a certain number of passengers would be provided the special treatment.

This decision to implement this investment does not lay solely with Intercity Transit. Traffic signal priority treatments are not possible without the explicit cooperation with the local traffic engineers who are responsible for traffic signal operations. In many cases, these individuals do not view transit signal priority favorably. In order to succeed, any transit signal priority implementation must be preceded by a planning and design effort. That effort must involve all of the parties, insure that signal priority is implemented in the right places and for the right reasons, and is part of an overall strategy to maintain transit schedule adherence.

4.2.3 Long-Term Investments (Year 7+)

L-1: On-Board and Station Security Recording

This investment implements video recording equipment for security purposes on-board Intercity vehicles, and controllable, closed-circuit television cameras for real-time monitoring at transit center locations. The on-board equipment records on looped videotape, so that when a security incident occurs, the recording can be stopped and the tape recovered before the desired footage is recorded over. This investment does not provide for real-time video security monitoring on board.

L-2: Enhanced Vehicle Monitoring

This investment implements systems that will provide Intercity the means to collect a range of vehicle performance data, including information that will allow maintenance to be scheduled in an optimum manner (e.g., to minimize costs). Permanently mounted, on-board probes will collect data on the performance of the major components of the transit vehicle, including engine, transmission and brakes. This information can either be accessed in the garage, or on a real-time basis, in which the information is transmitted from the vehicle to the Intercity garage using the data communications system implemented in an earlier investment.

L-3: Technology-Enhanced Flexible Service

This investment implements a flexible transit service using the real-time vehicle location and data communications capabilities implemented in earlier investments. There are a number of specific service strategies that are possible, all of which combine aspects of fixed-route and demand-responsive transit service. One example, route deviation, or “flex-route” service, consists of a fixed bus route that includes extra time in the schedule to accommodate a number of off-route trip pickups or drop offs, during certain times and within a certain distance of the route. Vehicle location, schedule adherence and mobile data terminals are an integral component of such service strategies. This investment provides funds to identify a specific service strategy and implement it. Although major infrastructure investments are not anticipated, this investment will also support whatever investments are required. Costs will vary depending on the extent of the service provided.

L-4: Real-Time On-Board Security Monitoring

This investment provides the ability to monitor, in real-time, conditions on board Intercity vehicles using closed-circuit television surveillance cameras. The cameras will be controlled and monitored remotely. Currently, due to limitations with mobile data communications, real-time monitoring on-board transit vehicles is uncommon. This investment is an upgrade of the on-board and station video security recording (with no real time monitoring capability) implemented in investment L-1.

4.3 Estimated Costs

This section presents estimated implementation costs for the Intercity Transit ITS investments described in the previous section, and discusses operations and maintenance cost issues.

4.3.1 Estimated Implementation Costs

Table 4-1 presents the estimated implementation costs for the Intercity ITS investments. Implementation costs include project development activities such as planning and design, procurement, installation of equipment and staff training. The total cost for the ITS investment program is approximately $6.3 million, with approximately $2.3 million programmed for the first three years.

The cost estimates included in Table 4-1 are planning level estimates that should be updated as project concepts are further developed. Lack of detailed information on existing systems and the specific design and functionality of the planned investment is typical at the strategic planning level of analysis, i.e., the level of analysis in this document. This suggests however that as specific project concepts are further developed, the cost estimates must be revisited and updated with the more detailed information. Another reason for updating the cost estimates is that the cost of many technologies has dropped over time. In the future, the same level of functionality may be acquired at a reduced cost, or additional functionality may be obtained at the same cost.

4.3.1.1 Illustrative Cost Break-Down for CAD/AVL Project

The implementation cost estimate for project N-2 (AVL, etc.) is based on a total system cost that averages to approximately $25,000 per vehicle. This estimate is used by several of the major vendors to generate "ballpark" estimates when specific functional requirements and detailed information on existing systems are unknown. This value has held up over a variety of implementations, but can vary significantly based on a number of factors. For example, the extent of computer network upgrades required to support the new hardware and software, and the number of different vehicle types to be equipped can significantly impact the overall implementation costs.

One of the most significant sources of variation in implementation costs pertains to the specifics of the communications system solution being implemented to support the CAD/AVL system. For example, if the voice radio solution is sophisticated, i.e., digital trunked simulcast, two radios may be required per vehicle, rather than the single voice/data radio that can be used for simpler solutions (e.g., the current Intercity Transit radio system). Prior to a detailed communications study, one that identifies a specific voice and data solution, it is impossible to accurately identify the specific break down of costs for items directly related to communications. The $25,000 per vehicle overall cost has, in most cases, held up across a variety of "one radio" communications scenarios. If a very sophisticated solution is applied, such as one requiring two radios, the in-vehicle costs and total costs will increase.

Given these sources of uncertainty, it is impossible to provide a detailed and accurate breakdown of the costs for the CAD/AVL project (N-2). However, an illustrative breakdown can be provided, showing approximately how the total costs for the system may be spread over the various components. This illustrative breakdown is shown in Table 4-2.

Table 4-1 Estimated Implementation Costs

Phase & Investment	Estimated Implementation Cost	Comments
Near-Term (Years 1-3)		
N-1: Communications System Study	$75,000	Portion of cost may be shared with regional partners.
N-2: CAD/AVL System with APCs and Enunciators	$2,200,000	AVL for all vehicles, including supervisory and maintenance. APCs for approx. 6 fixed-route vehicles; enunciators for all fixed-route vehicles. See illustrative breakdown in Table 4-2.
N-3: Registering Fare Boxes	$500,000	"Mid- to high-level" fare box, upgradeable to full smart card. Approximately $8,000/vehicle, plus system software and vaults.
N-4: Demand-Responsive Passenger Information/Fare System	$250,000	Partnering agencies to contribute additional funding to support regional concept and specification development.
N-5: Initial Real-Time Bus Status Information System and Transfer Coordination	$200,000	Should be bundled with N-2, which will provide the design and integration. This cost is for hardware (signs) and install.
Near-Term Subtotal	**$3,225,000**	
Mid-Term (Years 4-6)		
M-1: Expanded Real-Time Bus Status Information System	$200,000	Additional signs/monitors.
M-2: Automated Trip Planning System	$300,000	Assume discounted cost for software through partnership with Pierce, Community and King County Metro.
M-3: Integrated Electronic Fare Payment System (E.g., Smart Card)	$350,000	Upgrades to fare boxes and additional system software.
M-4: Enhanced Communication and Coordination with Traffic and Incident Response Agencies	$100,000	Support communications/software enhancements as needed; also support participation in reg. development activities.
M-5: Enhanced Demand-Responsive Service Coordination	$250,000	Utilize systems implemented in N-2. This cost supports any required communications or software additions.
M-6: Transit Traffic Signal Priority	$300,000	At 5 or 6 locations, plus on-board equipment.
Mid-Term Subtotal	**$1,500,000**	
Long-Term (Years 7+)		
L-1: On-Board and Station Security Recording	$300,000	Selected routes/vehicles and key stops/centers.
L-2: Enhanced Vehicle Monitoring	$350,000	Cost dependent on specific approach.
L-3: Technology-Enhanced Flexible Service	$400,000	Utilizes equipment from N-2. Includes project development, trip reservation system.
L-4: Real-Time On-Board Security Monitoring	$500,000	
Long-Term Subtotal	**$1,550,000**	
Program Total	**$6,275,000**	

Table 4-2 Illustrative Breakdown of Implementation Costs for Investment N-2: CAD/AVL System w/APCs and Enunciators

Component	Estimated Cost	Comments
System computer hardware and software	$150,000	Workstations, servers, printers, network upgrades, third-party reporting software
Application software	$300,000	
Integration	$650,000	Project management, engineering, installation, training, documentation and 1-year warranty
In-Vehicle Equipment (per vehicle)		
AVL/communications	$10,000/vehicle	Includes driver interface/MDT, vehicle logic unit, GPS equipment
Automated Passenger Counters	$4,000/vehicle	$2,000 per door. Installed on +/- 10% of fixed-route fleet
Enunciators	$3,500/vehicle	Fixed-route vehicles only

4.3.2 Operation and Maintenance Cost Considerations

Funding for ITS investments must take into account on-going operating and maintenance costs. The major operating and maintenance components associated with ITS investments are:

- Planning and Operations Staff
- Maintenance – staff, equipment, vehicles, and spare parts
- Leased Communications

4.3.2.1 Planning and Operations Staff

Conceptually, there are three types of staff required to plan and operate ITS applications (excluding maintenance staff, which are addressed separately): 1. Project managers; 2. Planners and Analysts; and 3. Dispatchers and other office staff. Drivers have been excluded because none of the planned ITS investments are expected to increase total driver labor hours. Table 4-3 summarizes the general ITS responsibilities of these staff groups, and estimates the potential staffing requirements during each of the phases of the ITS investment program.

Table 4-3 Estimated ITS Planning and Operations Staff Requirements

Type of Staff	Major ITS-Related Responsibilities	Estimated Staff Requirements (# Full-Time Equivalent Positions)			Estimated Annual Salary
		Years 1-3	Years 4-6	Years 7+	
ITS Coordinator/Project Manager	• Oversee and coordinate development and implementation of ITS projects (planning, procurement, installation, testing, & training) • Continue coordination and information sharing with other regional ITS implementers • Oversee and coordinate the on-going evaluation and optimization of individual ITS systems	0.5	0.5	0.5	$80,000
Planner/analyst	• Assist in the development and implementation of ITS projects • "Shake-down" new ITS systems, fine-tuning and optimizing their application at Intercity Transit • Utilize ITS system-generated data in on-going planning and analysis	1.0	1.5	1.5	$55,000
Operations (dispatch, scheduling, accounting, etc.)	• Support expanded dispatch responsibilities associated with: transfer coordination, demand-responsive transit coordination, enhanced coordination with traffic and emergency response agencies and flexible service • Maintain/update electronic databases associated with trip planning system and enunciators	0.0	.75	1.5	$45,000
TOTAL		**1.5**	**2.75**	**3.5**	

Overall, the ITS investment program identified for Intercity Transit does include significant staff requirements, with the requirements increasing as the program expands. These requirements may be met by existing staff, or supported through the addition of new staff. Although existing staff participate in most of the activities identified in Table 4-3—clearly not all of the effort reflected in Table 4-3 will be "new", that is, above and beyond existing activities—the level of effort in these areas is expected to increase significantly. How much of the new ITS related activity can be accomplished by existing staff will depend in large part on how aggressive Intercity is in pursuing the ITS investments, and whether any surplus staff resources are available (i.e., is everybody completely busy as it is?). Assuming a relatively vigorous pursuit of the investment strategy, also assuming that existing staff is essentially fully engaged, it is reasonable to expect that additional staff support—at some level between zero and that reflected in Table 4-3—will be necessary at each stage in the phased program.

Training is a critical consideration for all staff that will be responsible for working with the new technology applications. Training is typically a standard deliverable included in the implementation package delivered by vendors, however, care must be taken to insure that the training is structured to meet Intercity's specific needs. Vendors should be provided with detailed information describing Intercity's training needs and expectations, and in turn should include a detailed training plan in their proposals.

4.3.2.2 Maintenance

ITS investments, like any capital investment, require routine maintenance. As a general planning level estimate, annual maintenance costs may be assumed to be approximately 5% of the initial total implementation cost, or closer to 10% of the initial capital cost (excludes installation and training, etc.). Table 4-4 presents illustrative annual maintenance costs for the Intercity ITS investment program, assuming a relatively conservative 5% of total implementation cost. The costs shown in Table 4-4 are not estimates, rather they provide an order-of-magnitude indication of possible costs. Actual implementation costs will vary, and like the implementation cost estimates, investment specific implementation costs should be developed as the investment concepts are further developed.

Not all of the cost shown in Table 4-4 are "new" costs, since some ITS investments are replacing existing systems, such as the radios and fare boxes. Although a net increase in total maintenance costs should be expected, this increase should be off-set at least in the near-term by a reduction in the costs to maintain the outdated fare boxes and radios.

It is typically the case that one-year of maintenance is included by the vendor in the initial procurement. After that first year, the decision must be made whether to perform maintenance in-house or to continue to contract for it. It is anticipated that Intercity will utilize a combination of in-house and contracted maintenance, with the specific breakdown varying by investment, and perhaps over time. It is anticipated that continued contract maintenance services will be used for, at a minimum, components of the CAD/AVL system.

Table 4-4 Illustrative Annual Maintenance Costs by Phase

Phase	Cumulative Total Implementation Costs	Potential Annual Maintenance Cost (@ 5%)
Years 1-3	$3,225,000	$160,000
Years 4-6	$4,725,000	$240,000
Years 7+	$6,275,000	$315,000

Vendors report that the expected life span for ITS investments typically varies from about 5 to 10 years. On-board equipment such as radios and passenger counters have shorter life spans, given the wear-and-tear experienced in the field, and the tendency of manufactures to discontinue replacement parts. Equipment located within the Intercity facility, such as computer servers, tend to have longer life spans. Of course, the 5-10 year life span estimates indicated by most vendors are quite conservative. As Intercity and many other agencies have demonstrated quite effectively, creativity and care can extend the life of many technology systems for many years beyond the conservative 5-10 year time frame. For example, willingness to operate “mismatched” components, independently “scrounge” replacement parts after they are no longer available through the original equipment manufacturer, and/or apply “tender loving care” has been shown to extend the life of radio and fare box systems to as long as 15 or 20 years.

4.4 Relationship Between Investments and System Architecture

The Intercity Transit ITS investment strategy presented in this document represents an extension and enhancement of the Thurston Regional System Architecture. The specific, phased ITS investments that are identified in this document directly implement many of the major public transportation related elements of the regional architecture. As the Intercity ITS investments are further developed, the architecture should be consulted to insure that the appropriate connections, stakeholders and functions are included in the project design and process.

Figure 4-2, Figure 4-3, and Figure 4-4 graphically associate the specific Intercity ITS investments, by investment phase, with the regional architecture, using the high-level public transit architecture discussed in Section 2 (Figure 2-2). These three figures focus on the major associations, rather than more tangential associations.

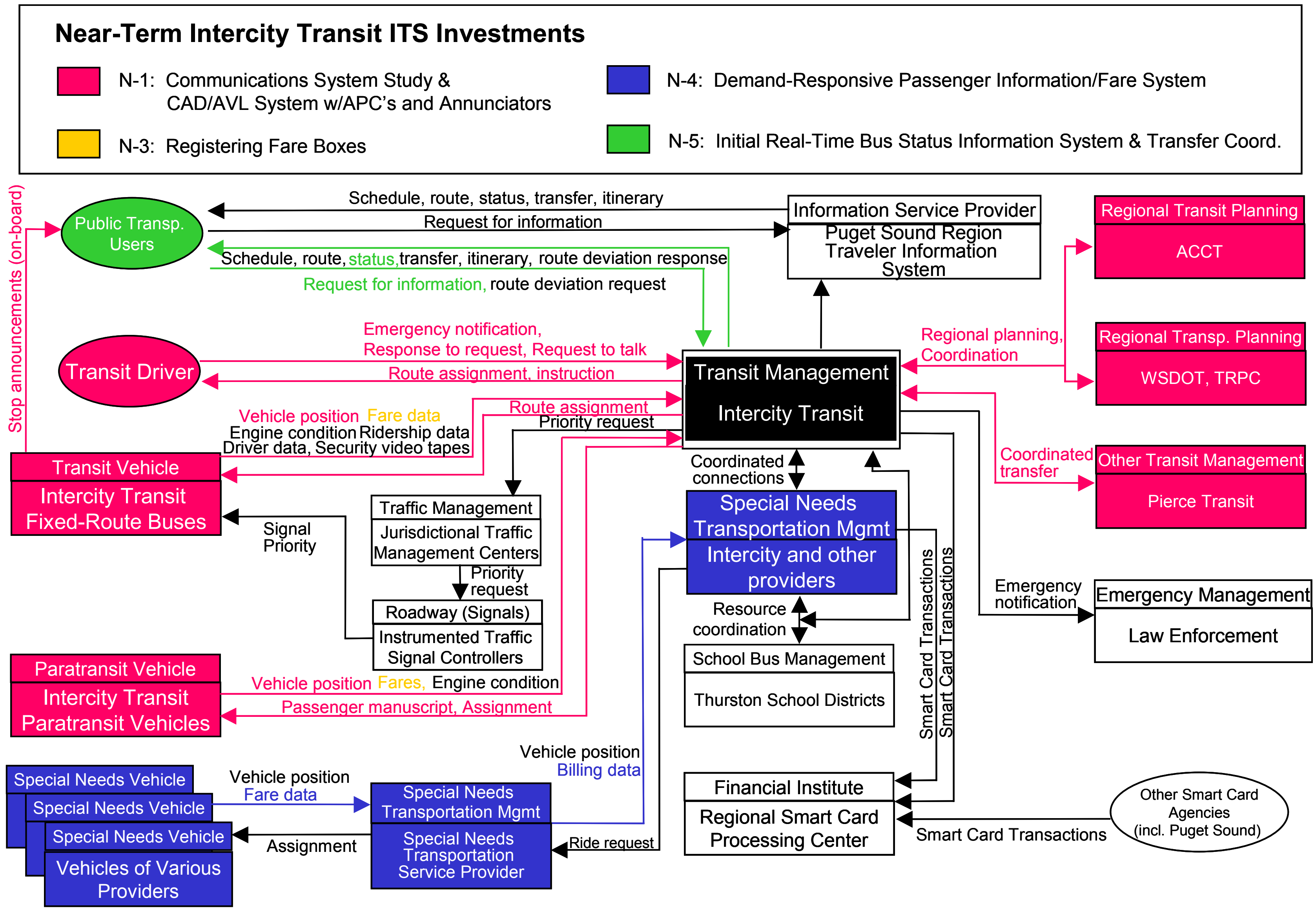

Figure 4-2 Relationships Between Near-Term ITS Investments

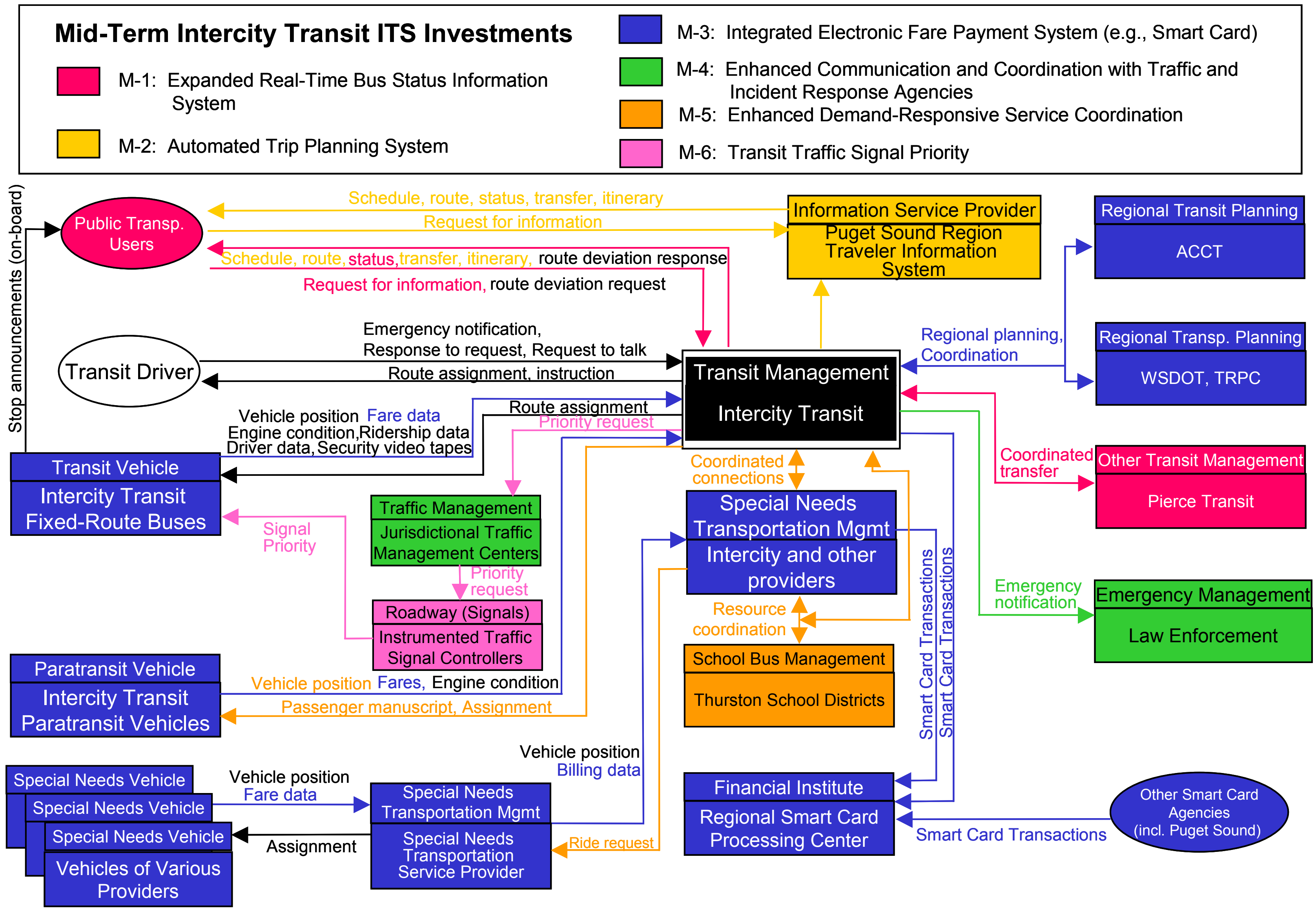

Figure 4-3 Relationship Between Mid-Term Investments and the Regional Public Transportation System Architecture

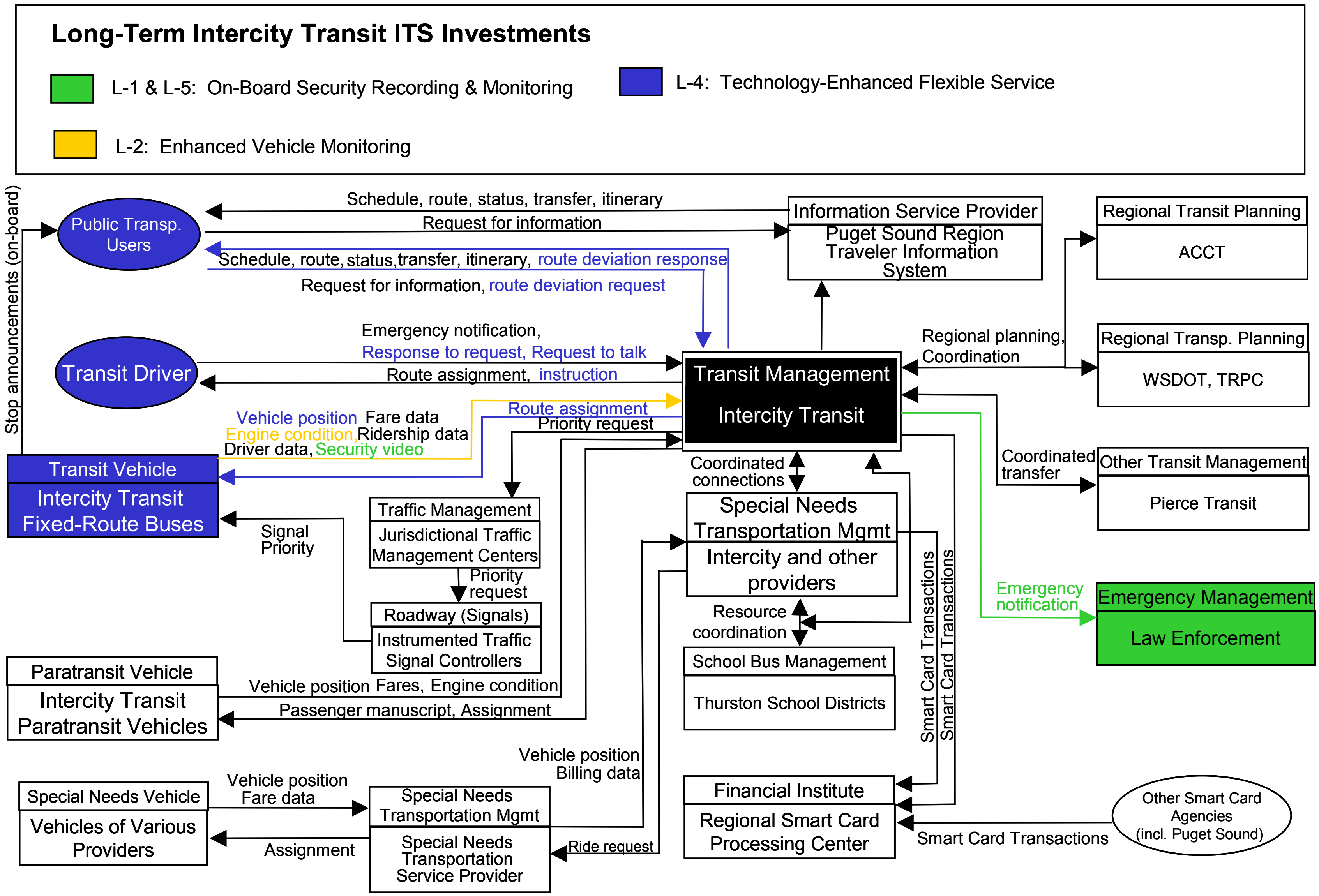

Figure 4-4 Relationship Between Long-Term ITS Investments and the Regional Public Transportation System Architecture

5.0 Typical Benefits of ITS Investments

The ITS investments included in Intercity Transit's program have, in nearly all cases, been implemented by many other agencies around the world and have been shown to produce significant benefits and to be cost-effective. This section provides an overview of the general benefits and rationale for implementing the identified Intercity ITS investments and reports some of the specific benefits that have been observed in real-world implementations.

5.1 Overall Benefits of Recommended Investments

In summary, the recommended ITS improvements will:

- ***promote ridership*** by improving customer's access to timely and accurate information, including estimated arrival times for specific buses and stops based on actual bus locations and customized schedule and route information for specific trips;
- ***promote ridership*** by reducing the uncertainty and variability perceived by customers relative to bus arrival times and by better maintaining schedules even through congested signalized intersections;
- ***promote ridership*** by offering more flexible and convenient services that can help expand cost-effective service to areas without service, provide customers with more options, and reduce waiting and missed transfers;
- ***promote ridership*** by making fare payment more flexible and convenient;
- improve Intercity's ability to ***manage*** their operation, and ***improve efficiency***, by providing them with more accurate, more comprehensive and more economically collected data for service planning, and by providing them with more powerful and effective computerized analysis and reporting tools;
- improve Intercity's ability to ***manage*** on-street operations, and to ***improve efficiency*** and ***service quality***, by providing them with a means to monitor bus locations, headways, spacing and on-time performance, and to more efficiently communicate with drivers and field supervisors;
- ***Improve safety and security*** for drivers and passengers by providing Intercity with the ability to almost instantaneously identify the exact location of vehicles during medical emergencies, accidents or other incidents, and to communicate silently (text messages) with drivers;
- ***Improve the efficiency, effectiveness, and safety*** of transit operations during special events, major traffic incidents and severe weather by facilitating coordination between Intercity dispatch operations and the regional traffic and emergency response agencies;

- Continue and enhance Intercity's ***partnership*** with other transportation organizations in the region and the Intercity's overall ***commitment to area mobility***.

Table 5-1 highlights some of the major benefits Intercity could expect to derive from specific ITS investments.

5.2 Demonstrated Real-World Benefits of Recommended Investments

- The benefits of the planned Intercity ITS investments have been proven through real-world experience. Some of the highlights of the benefits that have been documented include (*Benefits Assessment of Advanced Public Transportation Systems*, USDOT, July 30, 1996, *Intelligent Transportation System Benefits*: 2001 Update, USDOT, FHWA, ITS Joint Program Office, June 2001, and *Intelligent Transportation Systems Benefits: 1999 Update*, USDOT, FHWA, ITS Joint Program Office, May 1999):

- Implementation of ***automatic vehicle location (AVL)*** and communications enhancements (Intercity project N-2) have produced reductions in vehicle response times to transit emergencies of up to 40%.

- Implementation of ***AVL*** (Intercity project N-2) has improved schedule adherence by as much as 23%, has allowed vehicle fleet sizes to be reduced by as much as 5 percent, and has reduced the average coefficient of variability in run times by 18%.

- Implementation of ***electronic fare payment systems*** (Intercity project M-3) has reduced fare evasion rates by as much as 50 percent.

- Implementation of *traffic signal priority systems* (Intercity project M-6) have reduced travel times up to 8%.

- The following document some of the specific success stories associated with some of the ITS investments to be made by Intercity:

Computer-Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) Systems (Intercity Project N-2):

- Portland Oregon's Tri-Met System achieved a 9.4% improvement in on-time performance after implementing a CAD/AVL system. The variability in the headways between buses decreased by 5%. The average coefficient of variability of run times improved by 18%.

Table 5-1 Summary of Major Benefits of Intercity Transit ITS Investments

Near-Term (Years -13) ***Core Management Tools and Initial Enhancements***	**N-1 & N-2: Communications System Study and CAD/AVL System with APC's and Annunciators**	Locate vehicles quickly during emergencies
		Monitor and enhance on-time performance
		Reduce bunching
		Efficiently collect accurate passenger information
		Provide accurate, detailed data for schedule and route planning
		Required for technology-enhanced flexible service (L-3)
		Enhances timed-transfers
		Reduces volume of amount of voice radio communications and frees-up dispatcher
		Provides real-time data that can be given to customers
		Promotes compliance with Americans with Disabilities Act
		consistent and reliable
		Improved schedule adherence
		Improves safety by eliminating need for drivers to announce stops
	N-3: Registering Fare Boxes	Improve reliability
		Reduce fare evasion
		Provide data for planning and analysis
		Needed to support smart card or other electronic fare payment strategies
	N-4: Demand-Response Passenger Information/Fare System	Improve billing efficiency
		Provide data for planning and analysis
		Facilitate coordination with other services which will reduce inefficiencies
	N-5: Initial Real-Time Bus Status Information System and Transfer Coordination	Enhance customer convenience
		Promote ridership
Mid-Term: (Years 4-6) ***Building on Successes***	**M-1: Expanded Real-Time Bus Status Information System and Transf**	Enhance customer convenience
		Promote ridership
	M-2: Automated Trip Planning System	Improve customer convenience
		Enhance customer confidence
		Promote ridership
		Allow operators to handle more calls
	M-3: Integrated Electronic Fare Payment System	Improve customer convenience
		Reduced fare handling costs
		Improved security of fare revenues
		Promote ridership
		Permits expanded and more flexible fare structures
		Reduced fare evasion
	M-4: Enhanced Communication and Coordination with Traffic and Incident Response Agencies	Identify opportunities to share costs
		Improve regional traffic management by passing on IT driver reports
		Improve dispatchers ability to manage fleet, using real-time traffic information
	M-5: Enhanced Demand-Responsive Service Coordination	Improve customer convenience
		Improve service efficiency
	M-6: Transit Traffic Signal Priority	Reduced travel times
		Promote ridership
Long-Term (Years 7+) ***Next Generation Service Strategies***	**L-1: On-Board and Station Security Recording**	Promote rider confidence
		Promote ridership
		Improve ability to respond to legal challenges
	L-2: Enhanced Vehicle Monitoring	Reduce repair costs
		Postpone vehicle purchases
	L-3: Technology-Enhanced Flexible Service	Improved customer convenience
		Improved ridership
		Improved service efficiency
		Reduced travel times
	L-4: Real-Time On-Board Security Monitoring	Promote rider confidence
		Reduce response time to incidents
		Promote ridership
		Improve ability to respond to legal challenges

- In Sweetwater County, Wyoming, the bus system has doubled its monthly ridership using a computer-aided dispatch (CAD) system. Five years after its installation, operating costs have been reduced by 50 percent. The transit center now provides dispatching services for approximately 20 agencies in the region.

- Baltimore, Maryland, buses equipped with automatic vehicle identification have a 23 percent better record of on-time performance.

- In Kansas City, Missouri, the Kansas City Area Transit Authority's AVL system has improved its on-time performance by 12% in the first year of operations, at the same time, they have eliminated 7 of their 200 buses. The Authority estimates that they can save $400,000 per year in maintenance and operator costs. Average response time to bus operator assistance calls have been reduced from eleven to three minutes. The Authority achieved significant supervisor labor cost savings because the AVL system made it more acceptable to permit short-term reductions in the number of field supervisors due to absences or temporary reassignment.

- Hamilton (Ontario, Canada) Street Railway Company's AVL system increased schedule adherence from 82% to 89%.

- Milwaukee County Transportation Division's (MCTD) AVL system, not yet fully operational, increased on-time performance from 90% to 94%.

- London (Ontario, Canada) Transit Authority saved between $40,000 and $50,000 on each schedule adherence survey by using data generated from the AVL system.

- A large transit authority estimated that the authority can save $1.5 million per year by using schedule adherence data generated from the AVL system.

- Denver Regional Transportation District's (RTD's) AVL/CAD system login feature was used to verify a bus operator's claim that she was not initially paid for a day that she worked. The system was used to identify the bus that a robber used as his getaway vehicle, in addition, the bus control head's message display was used to confirm the suspect's presence on the bus. The system was also used to notify emergency service personnel that a bus passenger suffered a seizure. By being able to give emergency personnel the exact location of the bus, an ambulance arrived at the scene in eight minutes.

- Since implementing and AVL system, the Denver RTD has decreased the number of vehicles that arrived at stops early by 12% between 1992 and 1997. Customer complaints decreased 26% per 100,000 boardings, in part due to improved schedule adherence. Provision of a silent alarm feature with the AVL system has helped improve the safety of the transit system. Passenger assaults per 100,000 passengers decreased by 33% between 1992 and 1997.

AVL-Enhanced Demand-Responsive Service (Intercity projects N-2, N-4, M-5 and L-3):

- In Winston Salem, North Carolina, AVL/computer-aided dispatch system allows riders to make same-day reservations and dispatchers to maneuver the fleet to maximize utilization and minimize wait-time. The system's client list grew from 1,000 to 2,000 in the first six months and wait time dropped by 50 percent, while the operating expenditures fell by 2 percent. Paratransit ridership increased by 17.5% while operating expenses decreased by 8.5% per vehicle mile and 2.4% per passenger trip.

- The Potomac and Rappahannock Transportation Commission operates demand-responsive transit to serve transit needs and commuter rail stations in the suburban fringe of the Washington, DC metropolitan area. Compared to a fixed route service and complementary paratransit service, the demand-responsive system is estimated to produce a 40% reduction in total cost. Use of coordinated paratransit with a dispatch system including AVL, which can coordinate trips among up to five agencies, has the potential to reduce fraud in Medicaid transportation by $11 million annually in the State of Florida.

- A European study investigating Travel Dispatch Centers for coordinating and managing paratransit services demonstrated significant cost savings over previous implementations. Accounting for implementation costs, the system resulted in a 2% to 3% annual decrease in costs to provide paratransit services.

Traffic Signal Priority Systems (Intercity project M-6):

- In Portland, Oregon, the city has integrated its bus system with the traffic signal system by using signal prioritization to keep buses on schedule. By extending the green lights along the bus routes by a few seconds, the buses have cut their travel times by 5 to 8 percent.

Electronic Fare Payment Systems (Intercity project N-4 and M-3):

- Faretrans (Ventura County, California) estimated that their Smart Card system can save $9.5 million per year in reduced fare-evasion, $5 million per year in reduced data collection costs, and $990,000 annually by eliminating transfer slips.

- Metropolitan Atlanta Rapid Transit Authority (MARTA) estimated that their Visa Smart Card system, a stored value card, can significantly reduce the authority's cash handling costs.

- Maricopa County (Phoenix, Arizona) implemented the Bus Card Plus magnetic card payment system. Employers participating in the program are billed monthly for transit use by their employees. As of 1996, 190 companies participate in the Arizona system with a total of 35,000 cards in use. Express routes report that 90% of fares are paid by bus pass cards. Since employers are billed only for transit usage rather than purchasing monthly passes, costs to them are decreasing by up to one third. Starting in May of 1995, VISA and MasterCard have also been accepted. During the four months between May and September 1995, processing fees totaled under 7% of revenue generated and there were no major problems.

- New Jersey Transit Corporation (NJ Transit) estimated that their automated fare collection system can save $2.7 million in fare media handling costs.

- New York City Transit (NYCT) estimated that their Metro Card system, a magnetic stripe card, can save $70 million per year in fare evasion.

Automated Information Systems (Intercity project M-2):

- Rochester-Genesee (New York) Regional Transportation Authority's automated transit information system answers 70% of information request calls and allowed the authority to reassign four part-time information agents to other tasks. Due to higher system efficiency, calls have also increased by 80%.

- The California Department of Transportation reported that over 85% of Smart Traveler kiosk users in Los Angeles said that they will continue using the kiosks to obtain travel information.

On-Board and Station Security Recording/Monitoring (Intercity projects L-1 and L-4):

- A 1998 survey of transit riders in Ann Arbor, Michigan, assessed the impact of several transit safety and security enhancements including on-board video surveillance, emergency phones, video cameras at transit centers, enhanced lighting at transfer centers, and increased police presence. The surveillance systems were the safety enhancement most often cited by respondents. The on-board cameras were noticed by 70% of the respondents and the transit center cameras by 63%.

Vehicle/Maintenance Monitoring Systems (Intercity project L-2):

- A demonstration system in Valencia, Spain incorporating a remote maintenance monitoring system enabled a 20% to 30% reduction in the time required to detect and correct vehicle faults.

6.0 Commitment to Continuous Improvement

Intercity Transit practices a policy of continuous quality improvement, a process that includes on-going refinements based on periodic reexamination of performance, strategic direction, goals and objectives and specific tools, techniques and practices. The implementation of ITS will be subject to this same process of continuous assessment and refinement. In implementations around the world, it has been observed that the on-going process of evaluation and refinement is especially critical for ITS investments; the tools won't generate the benefits, rather, they must be purposefully wielded within an overall strategy, and that strategy is one that must be refined based on experience. Figure 6-1 graphically summarizes how the concept of continuous quality improvement will be used by Intercity in implementing and operating ITS applications.

As shown in Figure 6-1 the first step in the process to identify and implement ITS improvements is to identify the overall objectives to be accomplished and the strategies that are appropriate. As noted in previous sections, linkage of ITS investments with specific problems and needs has been a cornerstone in the development of the Intercity Transit ITS investment strategy.

The second step in the process includes implementation of the ITS technologies, as well as any necessary accompanying adjustments in organizational structure and processes, i.e., the way services are provided. This second component recognizes that the technology itself does not solve problems, but rather must be employed within the context of an explicit operating strategy in order to generate its maximum benefits. Although many ITS improvements do not require significant operational changes, some may. More precisely, implementation of the ITS equipment represents only one part of a broader set of adjustments associated with a new or modified service. For example, in addition to the implementation of automatic vehicle location and other technologies, establishment of flex-route bus service will require changes in dispatching.

The third step in the process consists of "fine-tuning", where various alternatives are tested and adjustments are made. Realization of the full benefits of many ITS elements requires the specification of the right combination of variables, which necessarily requires a period of testing and refinement. For example, sophisticated computer scheduling and run-cutting software are capable of generating highly efficient schedules. However, these software contain a number of user defined variables, and some time and experimentation is required in order to produce the most efficient schedules possible within the parameters of the existing labor agreement. It is critical that the "fine-tuning" portion of the implementation process be recognized as critical to long-term success. Sufficient time and staff commitment for this process needs to be built into schedules and budgets, and more importantly, expectations for immediate and dramatic successes need to be tempered by the understanding that the greatest benefits of ITS implementation are realized only after a period of fine-tuning—as is the case with "traditional" improvement strategies.

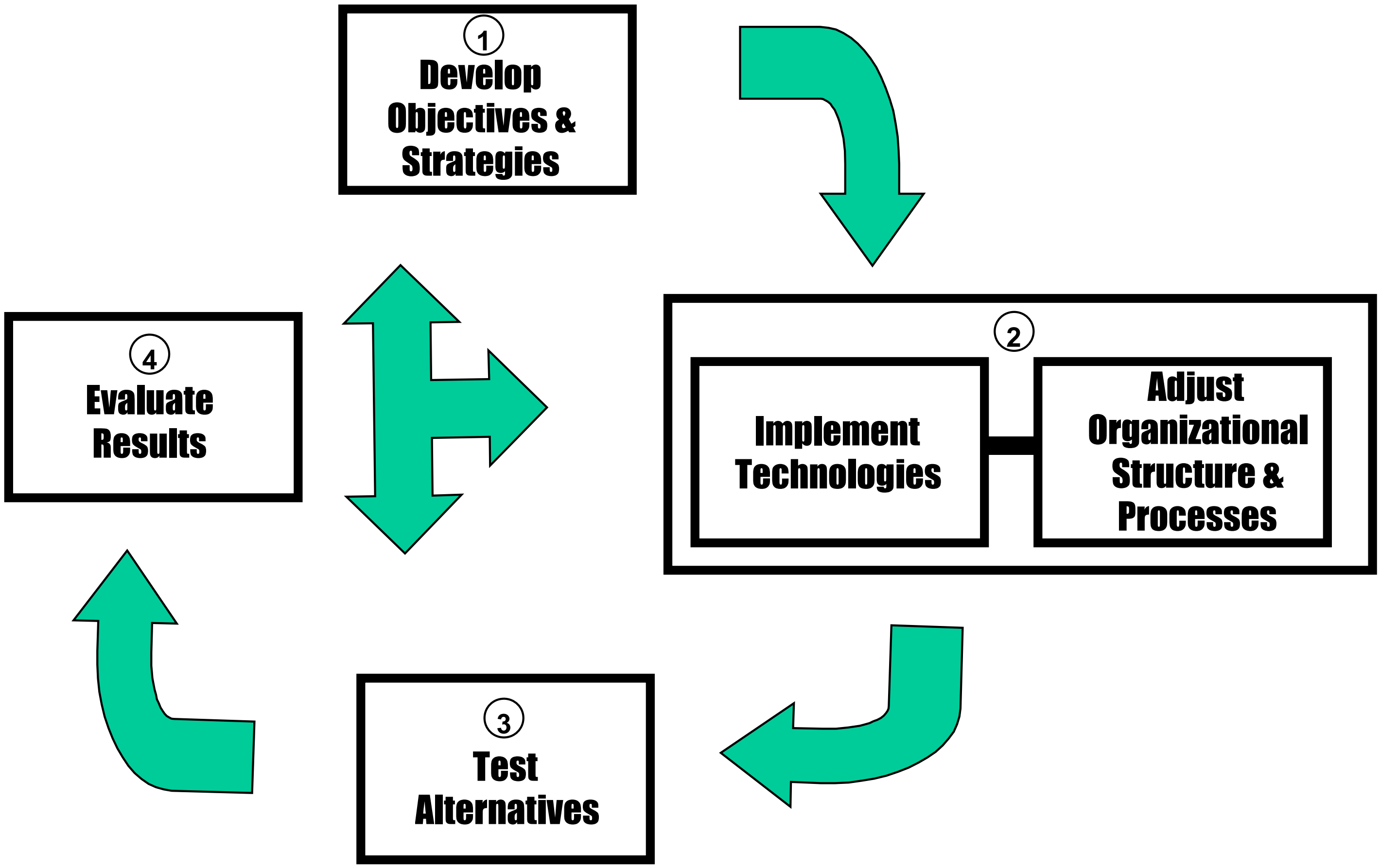

Figure 6-1 ITS Implementation and the Continuous Quality Improvement Program

7.0 Lessons Learned in Implementing Transit ITS Investments

As Intercity Transit moves from the strategic planning to the implementation stage of their ITS investment program, the following advice is offered, based on real-world experience of the consultant team and vendors (Orbital Sciences Corporation):

<u>Consider operations and maintenance costs carefully</u> – The costs to operate and maintain some ITS investments are "new" costs. Failure to adequately plan for these responsibilities can lead to under-utilization of the systems. The work is not completed when the system goes on-line!

<u>Develop specific operating concepts and objectives</u> – ITS investments are tools. In order to realize the significant benefits that they can provide they must be wielded purposefully. Identifying exactly how an ITS investment will be used, what is to be accomplished, and what constitutes a successful outcome will establish proper expectations, facilitate the design and implementation process and produce more successful results.

<u>Make on-site visits to other agencies that have implemented projects</u> – Prior to implementing a major ITS investment, such as a CAD/AVL system, make at least one personal visit to an agency that has implemented an equivalent system, and bring staff from throughout the organization. Talk to the agency about their experiences, including their experience with their specific vendor. Remember that no vendor or project will be perfect. Look for vendors who reacted well to adversity, who make a commitment and stick with it until the customer is satisfied. When you've found a location to visit that has been successful in their implementation, consider making a visit with one of your board members or political figures.

<u>Balance economies of scale against "implementability"</u> – In many cases implementing a number of different ITS components through a single procurement and installation process can reduce costs associated with procurement and integration, and can help insure that all system components work together as intended. However, large, multi-faceted, complicated projects are harder to implement. Don't bite off more than you can chew within a given period of time. ITS procurements and installations are resource intensive, not necessarily because the processes are complex, but because in most cases the implementation will be the first of its kind for your agency.

<u>Aim for "standard solutions" whenever possible</u> – If vendors can provide their standard product with minimal customization, everyone benefits through shorter implementation schedules, reduced risk and better long-term vendor support (because your system will be one of several similar systems the vendor is supporting simultaneously).

<u>Be flexible</u> – Willingness to compromise on some minor details can save a lot of time and money. When planning and designing the project, and developing an operating concept, think about which features are required and which are desired.

Be prepared for the procurement process to take longer than anticipated – No matter how thorough you think you are in writing the specification, vendors always have more questions and it takes awhile to answer them. Plan for at least one extension.

Set page limits on vendor proposals – If you don't, you'll get massive proposals. Setting page limits forces the vendor to be concise and cuts down on the marketing fluff.

Identify a single responsible vendor during implementation – Don't be surprised that for the more complicated implementations a "team" of vendors will be utilized. In such cases, however, make sure that there is a single lead vendor contractually responsible for making all of the components work correctly.

Take training seriously – Allow adequate time and money for training. Evaluate your training needs in advance, and expect vendors to provide detailed training as part of the implementation. Allowing staff to begin using the systems without appropriate, up-front training can cause significant confusion and result in negative feedback from staff and a general reluctance to use/ accept the system.

Build support internally – Include representatives from throughout the organization in the planning and implementation process. When those who will be impacted by the new systems are not allowed to participate in their planning and design, distrust and resistance can result. The people who will use the systems are a critical source of information, and by gaining their support early, the benefits of the investment can be more quickly and fully realized.