Prepared for

Minnesota Department of Transportation
Guidestar Program

August 1996

Final Report

Travlink Operational Test Evaluation Report

Prepared by

Cambridge Systematics, Inc.

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■ Background and Objectives

The Travlink Operational Test demonstrated the use of Automatic Vehicle Location (AVL), Computer-Aided Dispatch (CAD), and Automatic Vehicle Identification (AVI) systems on Metropolitan Council Transit Operations (MCTO) buses in Minneapolis and surrounding suburbs, and the distribution of real-time bus schedule information and traffic information to travelers using Advanced Traveler Information Systems (ATIS). The ATIS network consisted of a computer on-line service using videotext terminals and personal computers, "smart" kiosks, electronic signs, and display monitors. The objectives of the Travlink Operational Test were to improve transit fleet management, improve the timeliness and accuracy of travel information, and encourage transit ridership. The project's corridor was a newly reconstructed freeway that was designed to include a significant transit and ridesharing element.

Eighty buses were equipped with AVL transmitters. A workstation at MCTO's Transit Control Center provided two-way communication with these 80 buses, and sent real-time bus status information to a computer server at Mn/DOT's Traffic Management Center (TMC). From the TMC, bus status and other travel information, such as real-time traffic conditions, was reported to three travel information kiosks located in downtown Minneapolis, two video monitors, and four electronic signs located at park-and-ride lots in the I-394 corridor, as well as to 212 Travlink On-line users with videotext terminals or personal computers at home or work.

The Travlink Operational Test was the product of a public-private partnership. The public sector partners provided substantial investment, personnel resources, and the actual operating environment under which the APTS technologies were tested. The private partners provided both technical assistance and additional project funding.

■ Implementation Constraints

Several obstacles arose during the course of the implementation that affected the performance of the operational test. These were:

- **Limited funding did not allow full deployment and customization in the actual operating environment.** A total of only 80 buses (out of a fleet of 750) were equipped with AVL technology. Thus, real-time information was not available to the public for many bus trips, even within the single corridor where the AVL buses were operated. In addition, the lack of an automated interface with the MCTO's scheduling system resulted in disruptions to ATIS services when bus schedules changed.

- **Cutbacks in the transit operator's service and personnel.** Just as the Travlink technologies were coming on line, MCTO cut service by about one third in the test corridor due to budget constraints. Also, MCTO had originally planned to hire a staff person who would have operated the Travlink workstation in its control center, but was unable to do so due to budget constraints.

- **A three-week bus strike.** MCTO bus drivers were on strike for most of the month of October during the operational test. This resulted in the shut down of transit service, and, therefore, the Travlink system could not report on buses. The strike also had a negative impact on ridership for several months after its conclusion.

- **One-year time limit.** The Travlink Operational Test was funded for one year as a demonstration project. This time limit established an end date to the systems implemented. Since this was a test system, it was not configured with all of the features of a permanent system.

- **Service provided in only one corridor.** As an operational test, Travlink served only one corridor, thus limiting the variety of operating scenarios under which it was tested.

These obstacles to implementation prevented the Travlink project from demonstrating its full potential. However, in spite of these obstacles, Travlink did meet many of the project's objectives. The following section outlines these objectives and describes the extent to which they were met through the Travlink Operational Test.

■ Findings

Improved Customer Information

Travlink made strides toward improving customer information. Customers had three new sources of transit information: travel information kiosks, electronic signs and monitors, and the Travlink On-line computer service. To some extent, Travlink also improved the quality and timelines of transit information by providing real-time transit information. However, largely due to the obstacles mentioned above, usage indicators suggest that kiosks were used moderately, the electronic signs and monitors at park-and-ride lots were not referred to extensively, and Travlink On-line service use declined during the 12-month operational test.

Improved Safety and Security

The AVL system offers significant safety benefits to a transit system. Knowledge of the exact location of each vehicle at any time is extremely valuable in emergency situations, including vehicle breakdowns, medical emergencies, and crimes. When such incidents occur, the AVL system can prove indispensable in resolving the situation.

An incident occurred on an AVL-equipped bus which demonstrated the potential of this technology to improve safety and security. In this incident, the MCTO Transit Control Center (TCC) received a silent alarm from a bus indicating a problem. The TCC supervisors realized that this bus was an AVL-equipped bus and used the AVL map to locate the bus' actual location. This information was passed on to the MCTO police. The police responded and met the bus. A man on the bus was verbally threatening the driver. The police arrested the passenger before his threats escalated to an assault. If this situation had occurred on a non-AVL-equipped bus, the TCC would have had to direct the police to begin looking for the bus based on its scheduled, rather than actual, location. As a result, precious time would have been lost, and the outcome may not have been as favorable.

Expanded Advanced Public Transportation Systems (APTS) System Design and Integration

The Travlink project was the first operational test that combined the two Advanced Public Transportation Systems (APTS) technologies, AVL and ATIS, to provide real-time bus information to passengers and transit managers. The Travlink project clearly advanced the knowledge base of transportation professionals concerned with APTS innovations.

Improved Transit Operations

Based on their experience with Travlink, the transit managers recognize how service reliability could be improved if an AVL system were put in place and used to its fullest capabilities, allowing them to better monitor operator performance and to keep service moving. The Operational Test also demonstrated how Travlink could collect schedule adherence data in a much more efficient manner than does the current manual procedure.

Improved Management Information

Because this was an operational test funded only for one year and limited to a single service corridor, the customized development of a comprehensive and useful management information system using the AVL system was not feasible.

Observed APTS Technologies under Actual Operating Conditions

The Travlink Operational Test clearly demonstrated how two APTS technologies, AVL and ATIS, perform together under actual operating conditions. The AVL and ATIS technologies were linked to provide information to daily commuters about the location and status of the buses they planned to board, along with real-time traffic conditions and other static traveler information.

Increased HOV Utilization

It is not possible to say whether Travlink led to an increase in transit ridership in the I-394 corridor because other, stronger influences affected transit ridership. Due to cutbacks in bus service levels and the bus drivers' month-long strike during the operational test, no definitive statement can be made about Travlink's impact on I-394 corridor transit ridership or on HOV use there as a result of this project.

■ Recommendations

The Travlink Operational Test demonstrated some useful aspects of the combination of AVL and ATIS technology. However, the way in which the project was implemented imposed limitations on the ability of the system to achieve its full potential in terms of expected benefits. There was general agreement among the partners that if such a system were to be implemented on a permanent basis (rather than as a one-year operational test) these benefits would be realized. The evaluator recommends that the Travlink concept be deployed on an expanded basis (e.g., an entire operating division, garage, or service area, if not the entire MCTO system) under conditions that would allow full implementation. The following points outline the recommendations that should be met for any future implementation of a Travlink concept system.

- The transit operator ensures that all buses on routes for which ATIS provides information are AVL-equipped.

- The bus routes chosen are a diverse set of routes, including local service routes to all types of neighborhoods so that the AVL/ATIS system can demonstrate its capabilities in a variety of situations.

- The transfer of data between the transit authority's scheduling system and the AVL/ATIS system is streamlined so that data can be downloaded from one system to the other quickly, resulting in user interfaces, such as screens and printed reports, that are updated and meaningful to transit managers.

- Adequate funding is available for hiring and training the staff necessary for operating the system and for customizing user interfaces, so that the information is useful to transit managers.

- Transit schedules and real-time transit information is integrated into a multimodal ATIS service, as it was in the Travlink Operational Test. The advantage of any ATIS service is that travelers can make well-informed decisions on how to get from one place to another based on complete information about the full range of transportation options.

- To the extent possible, the traffic and transit information services are integrated with one of the many commercial on-line services, such as America On-line, etc. As indicated by the on-line users' responses to the conjoint survey, most users are willing to pay for traffic and transit information.

- In addition to the other menu choices, transit trip planning is a capability of the kiosks and computer on-line service. This capability would allow users to identify their current location and their desired location, and then the software would tell them what bus(es) to take to make the trip.

- Passenger information screen displays, such as those on the kiosks and the computer on-line service, include maps and other useful graphics.

1.0 Introduction

1.0 Introduction

■ 1.1 Background

Urban Transportation

The Twin Cities of Minneapolis and St. Paul, like many major urban centers in the U.S., face growing traffic congestion. Between 1972 and 1984, the number of miles of freeway with severe traffic congestion tripled from 24 miles to 72 miles. It is projected that without changes to the people-carrying capacity of the highway system, the number of severely congested miles will double between now and the year 2010.

A study sponsored by the Federal Highway Administration (FHWA) estimated that annual costs to residents due to roadway congestion approach $360 million in wasted time, wasted fuel, and increased vehicle insurance premiums. This cost translates to $160 per year for every resident of the Twin Cities. Severe congestion impedes personal mobility and economic development, as well as worsens air quality and increases the consumption of additional energy resources.

The region's transportation policy makers recognize that it is not possible for the region to build its way out of congestion. Funding is insufficient to build enough highways to meet future demand. The solution to avoiding further congestion is to increase the number of people the system can carry without greatly increasing the number of passenger vehicles.

Increasing the use of public transit can help reduce urban traffic congestion. A FHWA study estimated that freeway congestion delays in major U.S. cities could be reduced by 64 percent if improved public transit services could eliminate one in five vehicles during peak commuting hours.

Replacement of single-occupant auto travel with bus travel would also help reduce overall air pollutants emitted. The region is testing alternative-fuel transit vehicles that would further enhance air quality. Similarly, reduced dependence on the private auto would help slow the growth in the consumption of petroleum and help protect against fuel shortages.

Unfortunately, the Twin Cities, like many cities, have experienced declines in transit ridership in recent decades. From 1970 to 1990, home-to-work trips via public transit in the metropolitan area declined from six percent to four percent of all trips. Trips by carpoolers dropped from 28 percent to 10 percent.

ITS and APTS

Transit must become more user-friendly and more competitive with single-occupant vehicles by becoming faster, more convenient, and safer. In particular, potential users must become convinced of these qualities through more timely and useful information. Intelligent Transportation System (ITS) technologies, together with other Travel Demand Management (TDM) strategies, have the potential to make transit more attractive, increase ridership, and reduce roadway congestion.

The Federal Transit Administration (FTA) has developed the Advanced Public Transportation Systems (APTS) Program, which is an integral part of the overall U.S. Department of Transportation's ITS effort. A major aim of the APTS Program is to promote research and development of innovative applications of advanced navigation, information, and communication technologies. These technologies would be designed and tested to achieve APTS Program goals directed toward enhancing the ability of public transportation systems to satisfy customer needs and contribute to the achievement of broader community goals and local objectives.

The wide array of new technologies that are available provides a unique opportunity to discover innovative and useful applications in public transportation. These operational tests and evaluations will be the principal activities of the APTS Program. Real world testing will be done in urban and rural areas using those technologies which appear to offer promise and represent useful applications.

Major technologies include automated vehicle location systems, smart card systems, dynamic ridesharing systems, passenger information systems, high-occupancy vehicle systems, and vehicle component monitoring systems. Tests of these technologies will involve joint ventures with state and local governments, and when appropriate, universities and private vendors. These tests may require three to four years to complete: one to two years to develop implementation plans, one year to implement service, and one year to evaluate the APTS application and associated impacts.

Minnesota Guidestar and Travlink

With the introduction of new ITS technologies and with local needs growing, the Minnesota Department of Transportation (Mn/DOT) has made it a top priority to solve the problem of rapidly-growing congestion in the Twin Cities metropolitan region. In the early 1990s, a strategic plan was developed to address the region's congestion problem, providing for several demonstrations of new technologies and a management plan for the expanding freeway operations program. It included the expansion of existing traffic management technology and traveler information services. Based on this plan, and working with the University of Minnesota Center for Transportation Studies, Mn/DOT launched the Minnesota Guidestar program, which is aimed at implementing ITS technologies.

Under the umbrella of the Minnesota Guidestar program, a Transit Innovations Committee was established to develop the APTS for the region, including the project, Travlink. Travlink is part of Minnesota Guidestar's broader program to develop ITS in the state. The objective of Travlink was to operationally test and evaluate Automatic Vehicle Location (AVL), Computer-Aided Dispatch (CAD), and Automatic Vehicle Identification (AVI) Systems on Metropolitan Council Transit Operations (MCTO) buses in Minneapolis and surrounding suburbs, and distribute real-time transit and traffic information to travelers using Advanced Traveler Information Systems (ATIS). The purpose was to improve transit fleet management, improve the timeliness and accuracy of travel information, and encourage transit ridership.

■ 1.2 Other Guidestar Initiatives

In addition to Travlink, the Guidestar office of Mn/DOT is developing and implementing several other ITS projects to reduce congestion, enhance mobility, improve air quality, and make transportation systems in the state safer. The following sections describe these projects.

Genesis

Genesis is a traveler information project that provided real-time travel data via personal communications devices. In a pilot test, traffic accidents and incidents, road condition information, and construction and detour information were transmitted to a "test market" of 350 motorists equipped with alpha-numeric pagers, and 50 equipped with Apple Newtons with paging cards. This project has been completed and evaluation is proceeding. Transportation officials for the 1996 Olympics in Atlanta are using Genesis as a model for providing traffic information via pagers.

Trilogy

Trilogy will test in-vehicle devices for providing real time traffic and travel information to travelers. User devices, including screens with mapping of incidents, will provide route-specific advisories on highway conditions in the Twin Cities metropolitan area. User assessments will be conducted to ascertain the relevance and usability of the information provided.

St. Paul Advanced Parking Information System

This Parking Information System is designed to provide motorists with accurate real-time information about the availability of space in parking facilities, as well as directions to facilities with space by means of automated signs. The system became operational in early 1996.

Portable Traffic Management System (PTMS)

PTMS adapts to various locations to improve traffic to and from major events. The system uses machine vision and other detection technologies for traffic management, including portable changeable message signs for travelers. Tests have been conducted at the following Twin Cities sites: the National Blaine Sports Center, Bunker Hills Golf Course, Minnesota State Fair, and Rosedale Shopping Center. The PTMS project is now being tested for use in construction zones.

St. Paul Incident Management (DIVERT)

The St. Paul Incident Management program, DIVERT, provides traffic guidance and control during freeway incidents by coordinating traffic along designated city streets. Instead of entering the city's central business district randomly, diverted traffic is accommodated in a planned fashion.

Light Detection and Ranging (LIDAR)

LIDAR is a laser-based scanning system that monitors the migration of aerosol plumes. The objectives of this project are to assess the usefulness of LIDAR technology as an air quality monitoring tool, and to assess the impact of the Portable Traffic Management System (above) on air quality.

Integrated Corridor Traffic Management (ICTM)

ICTM will demonstrate more efficient corridor transportation movement. Objectives of the project are to implement a corridor-wide adaptive traffic control system, demonstrate an inter-jurisdictional approach to managing and operating the corridor, use advanced technologies, and provide comprehensive motorist information services. ICTM Modules I and II began operational testing in the fall of 1995.

Adaptive Urban Signal Control and Integration (AUSCI)

Adaptive Urban Signal Control and Integration seeks to implement an adaptive signal timing plan generation algorithm for an existing traffic control system in Minneapolis, while integrating with ramp meters on I-394 and I-94 in the downtown central business district.

SmartDARTS

SmartDARTS is a three-phase operational test designed to measure the benefits of a combination of advanced technologies within a paratransit environment provided by Dakota Area Resources and Transportation for Seniors (DARTS), a 25-vehicle, demand-responsive transit system that provides service to the elderly and people with disabilities in Dakota County. Application of these technologies focuses on improved responsiveness, enhanced customer-focused service, increased capacity, increased cost effectiveness, enhanced coordination with other providers, and an enhanced ability to satisfy ADA requirements.

Advanced Rural Transportation Information Coordination (ARTIC)

ARTIC will test and evaluate communication systems of several public agencies (transportation, state patrol, and transit) through the establishment of a centralized dispatching site. Its goal is to improve response time for accident and road condition emergencies by providing real-time vehicle status and schedule information. Information will be provided to both the transportation agencies and the traveling public by means of coordinated customer information services.

Field Test of Non-intrusive Traffic Detection Technologies

This project will test alternative traffic detection technologies under challenging urban conditions. Planned activities have been completed, including the contracting process with private vendors, design and installation of a I-394/Penn Avenue test facility, Task I "technology identification," and a report. Task II field deployment review testing is ongoing.

Polaris

The goal of the Polaris project is to develop a Minnesota Statewide ITS Architecture as a tailored version of the National ITS Architecture. Significant research has been conducted to understand the need for ITS, its benefit to the traveling public and public agencies, and the best application for ITS technologies and services throughout the state, given the transportation systems already in place. Market research was carried out to develop a list of desired transportation services. The services that are the highest priority are as follows:

- Travel conditions information;
- Comprehensive public transit security;
- Integrated regional incident management;
- Integrated regional traffic management; and
- Integrated transit management.

Polaris will serve as a guideline for acquisition of all new transportation systems. This pioneering effort by the state of Minnesota assures that its model development program will proceed along the path laid out by the National ITS Architecture.

Commercial Vehicle Operations (CVO)

Guidestar's CVO project team is also currently involved in three ITS operational tests:

- A test of a one-stop electronic delivery system that will enable motor carriers to request, pay for, and receive multiple state credentials and permits from state agency locations, motor facilities, permitting services, and truck stops;
- An imaging technology test for automatic, real-time, out-of-service verification that will use license plate scanning technology and a real-time inspection database to verify correction of out-of-service conditions in a corridor along westbound I-90/94 through Wisconsin and Minnesota; and
- An automated mileage and stateline crossing operational test, in which Global Positioning System and on-board mileage recorder technology automatically collect jurisdiction and mileage information from commercial vehicles for apportioning fuel taxes and registration fees.

Other ITS-CVO initiatives with Minnesota participation include HELP, Inc. (Minnesota is an affiliate member), the Commercial Vehicle Information System project, and a test of automated brake testing equipment.

1.3 Evaluation Process and Methodology

The Federal Transit Administration (FTA), through the Volpe National Transportation System Center (Volpe Center), has established an evaluation process to be followed for all of the APTS evaluations. Generic guidelines for the evaluation process are established in the Volpe Center's report entitled "Advanced Public Transportation Systems; Evaluation Guidelines." The evaluation process involves the four following steps:

1. **Evaluation Frame of Reference.** The evaluation frame of reference consists of four elements: the operational test applications; APTS program objectives; external influences; and local issues, objectives and site characteristics. The Evaluation Frame of Reference for the Minnesota Guidestar Travlink project was prepared in July 1994.

2. **Evaluation Plan.** The evaluation plan includes the preparation of an Evaluation Strategy, which describes:

   - Information on the APTS operational test and site conditions;
   - APTS program objectives addressed by the operational test;
   - Relevant local, state, and/or national objectives;
   - Key issues to be resolved;
   - External influences to be addressed; and
   - Recommended scope and focus of the evaluation.

   The Evaluation Strategy, which was included as part of the Evaluation Frame of Reference referred to above, served as the basis for the more detailed Evaluation Plan that was prepared in July 1995. The Evaluation Plan includes measures of effectiveness to be used, data to be collected, and specific procedures for collecting and analyzing data relative to project objectives, issues, and the site.

3. **Evaluation Implementation.** The evaluation implementation phase is the period during which the Evaluation Plan is executed. Activities during this phase include: the collection and analysis of data relative to project objectives; the collection and analysis of data on site characteristics; the compilation of a chronology describing the implementa-

tion and operation of the test; and the recording of external factors which might influence operational test findings and results.

4. **Potential Evaluation Spin-offs.** This phase includes potential implementation and analytical spin-offs, such as comparison with other similar APTS applications, suggested modifications in applications for future use, and improving evaluation techniques.

This report presents the results of the final two stages of the evaluation process.

2.0 Site Description

2.0 Site Description

2.1 Characteristics of Twin Cities

The Minneapolis – St. Paul metropolitan area has a population of 2.6 million. The Metropolitan Council Transit Operations (MCTO) provides bus transit service to approximately 100,000 daily riders on 120 routes throughout the metropolitan area. About five percent of the area's residents ride the bus to and from work or school.

2.2 I-394 Corridor Description

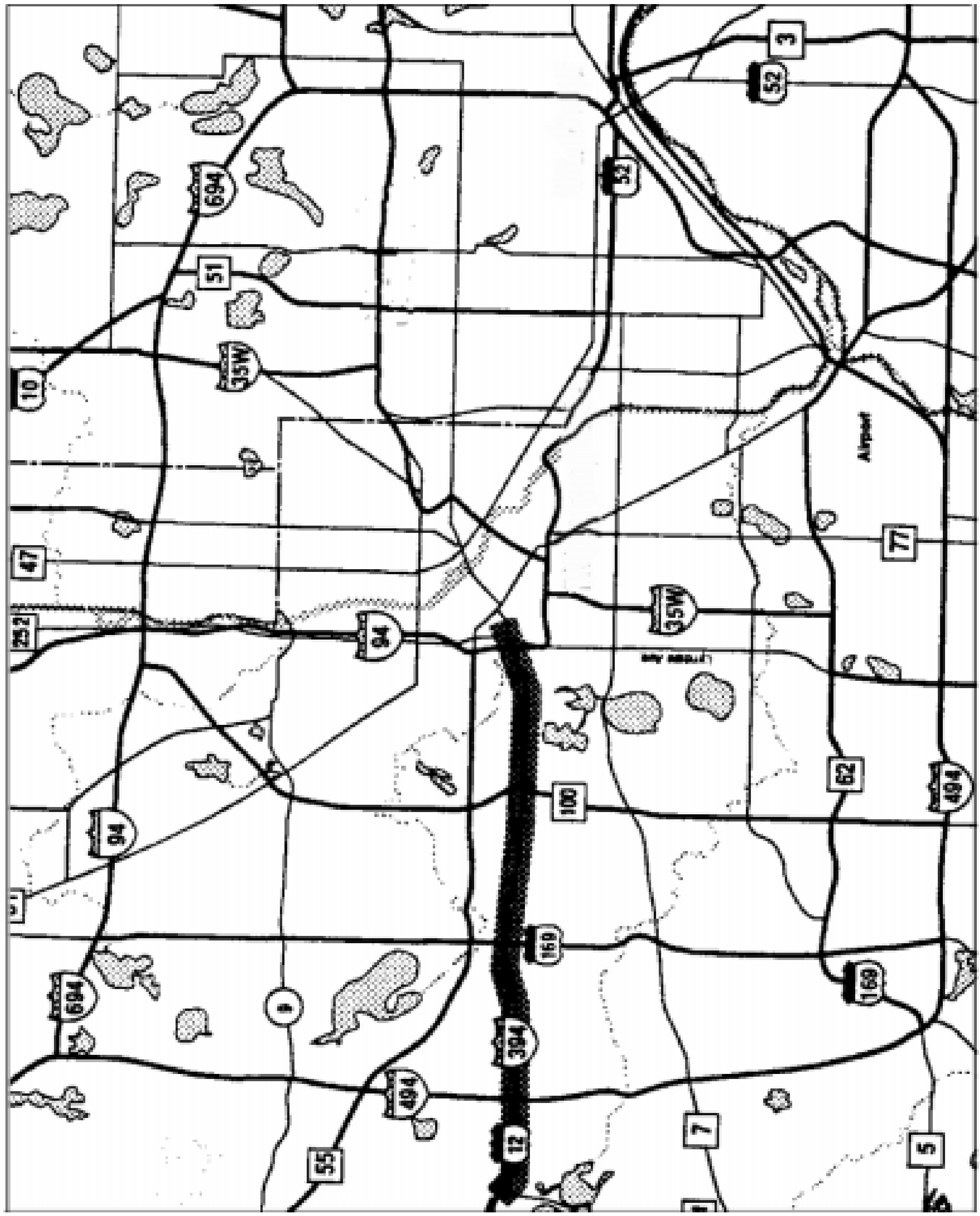
The location of the I-394 corridor is shown in Figure 2.1. In their August 1995 *I-394 HOV Lane Case Study Final Report*, SRF Consulting Group, Inc., described the facilities in the I-394 corridor as follows:

"Interstate 394 is an 11-mile, six-lane freeway that extends west from downtown Minneapolis. The three miles immediately west of downtown include two separated, reversible high-occupancy vehicle (HOV) lanes and two mixed use traffic lanes in each direction. The remaining eight miles include a concurrent HOV diamond lane and two mixed use traffic lanes in each direction. The HOV lanes are reserved for carpools and vanpools with two or more people, buses and motorcycles only during peak hours in the peak direction. The overall purpose of the I-394 transportation system is to maximize the number of people, rather than vehicles, the roadway can carry by encouraging carpooling and bus ridership. Incentives for transit and carpooling, including travel time savings in the HOV lanes, are key tools for achieving this goal."

There are a series of park-and-ride lots along the I-394 corridor. Each of these is served by some bus service to downtown Minneapolis. The locations of these lots are:

- General Mills P&R Lot at I-394 and General Mills Boulevard (112 parking spaces);
- Louisiana Transit Center at I-394 and Louisiana Avenue (88 parking spaces);

Figure 2.1 I-394 Corridor in the Twin Cities Metropolitan Area



- County Road 73 P&R Lot at I-394 and County Road 73 (285 parking spaces in the North lot, and 182 parking spaces in the South lot);

- Xenia P&R Lot at I-394 and Xenia Avenue/Park Place (60 parking spaces);

- Plymouth Road Transit Center at I-394 and Plymouth Road (111 parking spaces); and

- Wayzata Transit Center at I-394 and Wayzata Boulevard (98 parking spaces).

Three of these park-and-ride lots, the Louisiana Transit Center, the County Road 73 South lot, and the Plymouth Transit Center, were chosen to be the sites where passenger information devices (i.e., electronic signs and video monitors) were placed. These lots have a combined total capacity of 666 parking spaces. Nine MCTO routes currently serve these three (and most other) park-and-ride lots, providing primarily express commuter service to downtown Minneapolis. Service is fairly frequent (i.e., every 10 to 15 minutes) during the peak periods in the peak direction on several of the bus routes.

3.0 Operational Test Description

3.0 Operational Test Description

■ 3.1 Overview

The Travlink Operational Test was consistent with the Twin Cities' adopted transit development plans. The Regional Transit Facilities Plan (1992) identified four critical elements for solving the transportation problem:

- Strong transportation management of both supply and demand, particularly during rush hours, to reduce the need for additional freeway lanes;

- Incentives for high-occupancy vehicle use, including shorter and more reliable travel times, queue bypasses at congestion points, and parking and pricing incentives; and

- More efficient and "transit-friendly" land uses that are transit-, bicycle- and pedestrian-oriented.

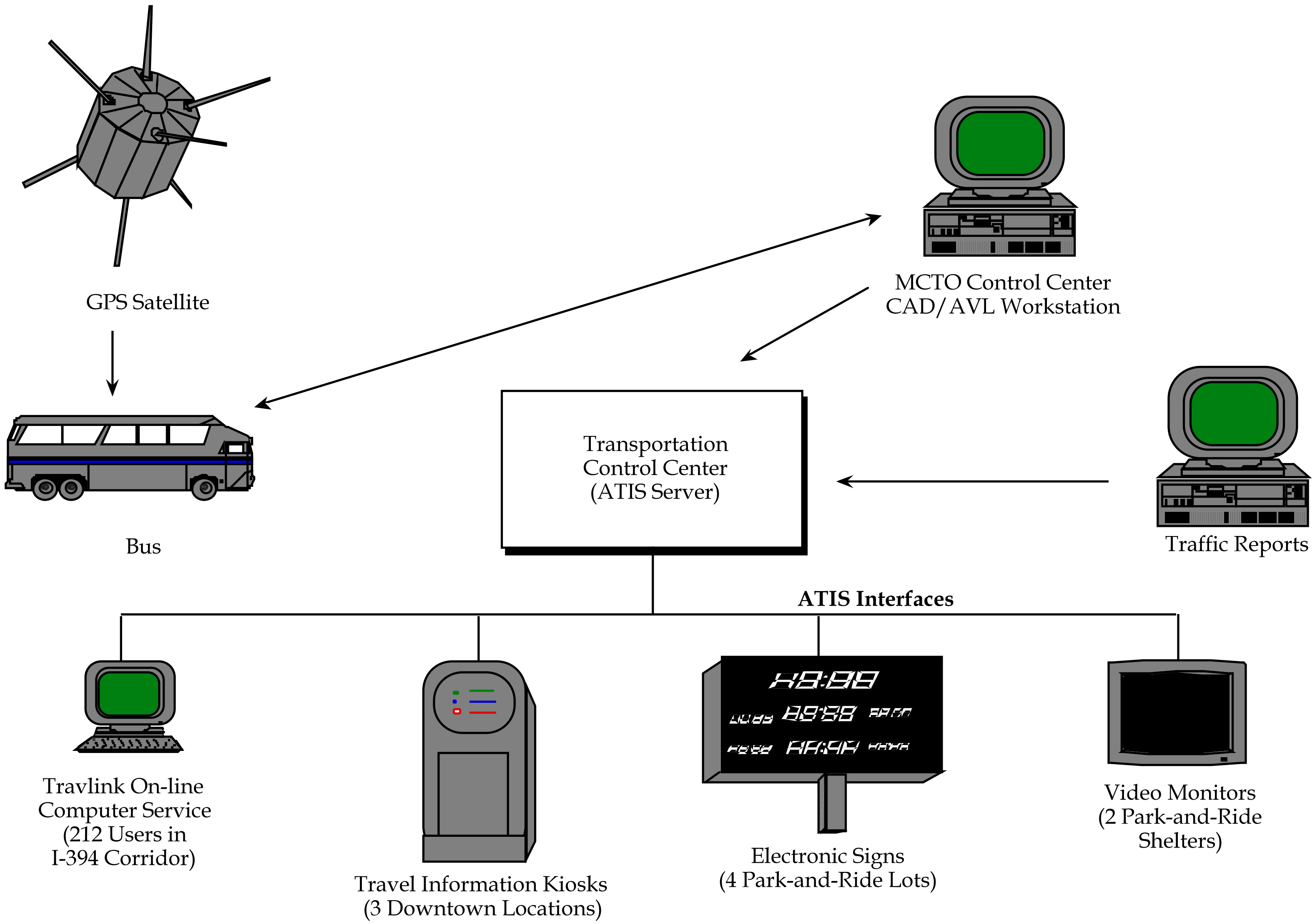
Specifically, Travlink was a U.S. Department of Transportation (DOT) APTS operational test which included the following (see Figure 3.1):

- The implementation of a system combining computer-aided dispatch and automatic vehicle location (CAD/AVL) on transit vehicles operating on I-394 from the western suburbs of Minneapolis to downtown. The transit operator used the location information to improve fleet management. Anticipated benefits included better on-time performance and more responsive incident management.

- The implementation of an advanced traveler information system (ATIS) network, which consisted of a computer on-line service using videotext terminals, "smart" kiosks, electronic signs, and display monitors. The ATIS presented real-time status information from the AVL system, other static transit data, as well as real-time information on traffic conditions including detours, construction, accidents, and other incidents.

  The primary objective of the project was to test the extent to which improvements in the quality and availability of transit information can positively influence individuals to consider alternatives to single-occupant vehicle travel. In addition, the systems had the potential to

Figure 3.1 The Travlink System



improve service quality and safety, and provide commuters with valuable information that would make their trip more convenient and efficient. The intent was to consider full deployment of these APTS technologies throughout the metropolitan area.

The Travlink operational test included the following activities:

- Implement a computer on-line service for the distribution of market-based travel information.

- Provide real-time transit schedule and traffic information at homes, work places, transit stations, and other convenient locations in downtown Minneapolis.

- Use real-time transit vehicle location data to improve on-time performance and fleet management and to serve as input to the traveler information systems.

As stated in the operational test proposal submitted to FHWA, Travlink was distinguished by the following characteristics:

- The project corridor location was a newly-reconstructed freeway that was designed to include a significant transit and ridesharing element. The operational test would further strengthen the corridor's extensive services and facilities that include an HOV lane, timed-transfer transit service, transit centers and park-and-ride lots, ramp metering with HOV bypasses, reduced-rate downtown public parking for carpoolers, and transportation management organizations (TMOs) at both ends of the corridor.

- The combination of cost and convenience incentives resulting from the ATIS/AVL systems and the above features held real promise for successfully increasing transit and ridesharing use in this corridor.

- The project integrated AVL and ATIS technologies to extend real-time data to travelers, as well as to the transit control center. The integration of these "smart vehicle" and "smart traveler" elements would produce additional benefits compared to stand-alone applications. The scope of planned activities provided a comprehensive test of these systems.

- The videotext system would bring transit information to locations where it was needed: at home and at or near work. This technology allowed the user to interact with computer-based systems for pre-trip planning. Incorporating real-time status greatly enhanced the value of this information.

The project complemented other ongoing ITS activities conducted under Minnesota Guidestar. Travlink worked towards full integration of these technologies.

- Substantial private sector involvement and investment helped to share costs and provided technical expertise.

- The Travlink operational test also contributed to the national effort to implement APTS technologies. The lessons learned will be widely disseminated to provide guidance to others in selecting and implementing systems. The project will establish the requirements for success and identify problems that must be addressed during full deployment.

- The proposed project will directly contribute to the goals of the U.S. DOT's APTS program. The advanced technologies are expected to increase mobility and operational efficiency in the corridor, increase transit ridership and service efficiency, increase use of the high-occupancy facility, and contribute towards clean air and energy-efficiency goals.

The operational test included two phases. Phase 1 included implementation of AVL on one bus route to demonstrate the functionality and operability of the AVL components. Phase 2 included implementation of ATIS Videotext and other components, deployment of AVL on the remaining bus routes, and start of the full operational test.

■ 3.2 Functional Characteristics

Key Travlink activities included deployment of a CAD/AVL system, use of a commercial videotext service and installation of other traveler information devices including "smart" kiosks, display monitors, and electronic signs. While all of these technologies were essentially "off-the-shelf," the operational test provided a unique opportunity for integration into a single functional system using real-time information.

A CAD/AVL system was installed at the MTCO operations control center. For the operational test, the system operated in parallel to the existing communications and dispatching system. Eighty (80) buses that operate in the I-394 corridor were equipped with AVL capabilities using global positioning system (GPS) technology. The equipped vehicles operated primarily on peak-hour express bus routes providing service between the western suburbs and downtown Minneapolis.

The CAD/AVL system assisted in the traditional dispatch functions of communications, incident management, and fleet control. Additionally, the system allowed the control center supervisor to track vehicles continuously and to detect schedule and route deviations. The system could automatically inform drivers of schedule deviations via digital messages. Other functions of the CAD/AVL system were to help maintain or improve on-time performance and transit security by locating buses in emergencies.

ATIS consisted of kiosks, bus stop monitors and signs, and a computer on-line service. The ATIS system helped users plan bus trips (routes and schedules), find out if their bus was on time, be informed of traffic conditions (delays, congestion, road conditions, etc.), and provided a variety of other urban travel information.

The ATIS host computer server/terminal controller which collected, enhanced, and distributed information, was located at Mn/DOT's Traffic Management Center (TMC). ATIS collected real-time and static data from the CAD/AVL system and other databases. Traffic data was obtained through the companion operational test project, Genesis. The Travlink ATIS server distributed the transit, traffic, and related data to the videotext server and the various field devices via phone lines.

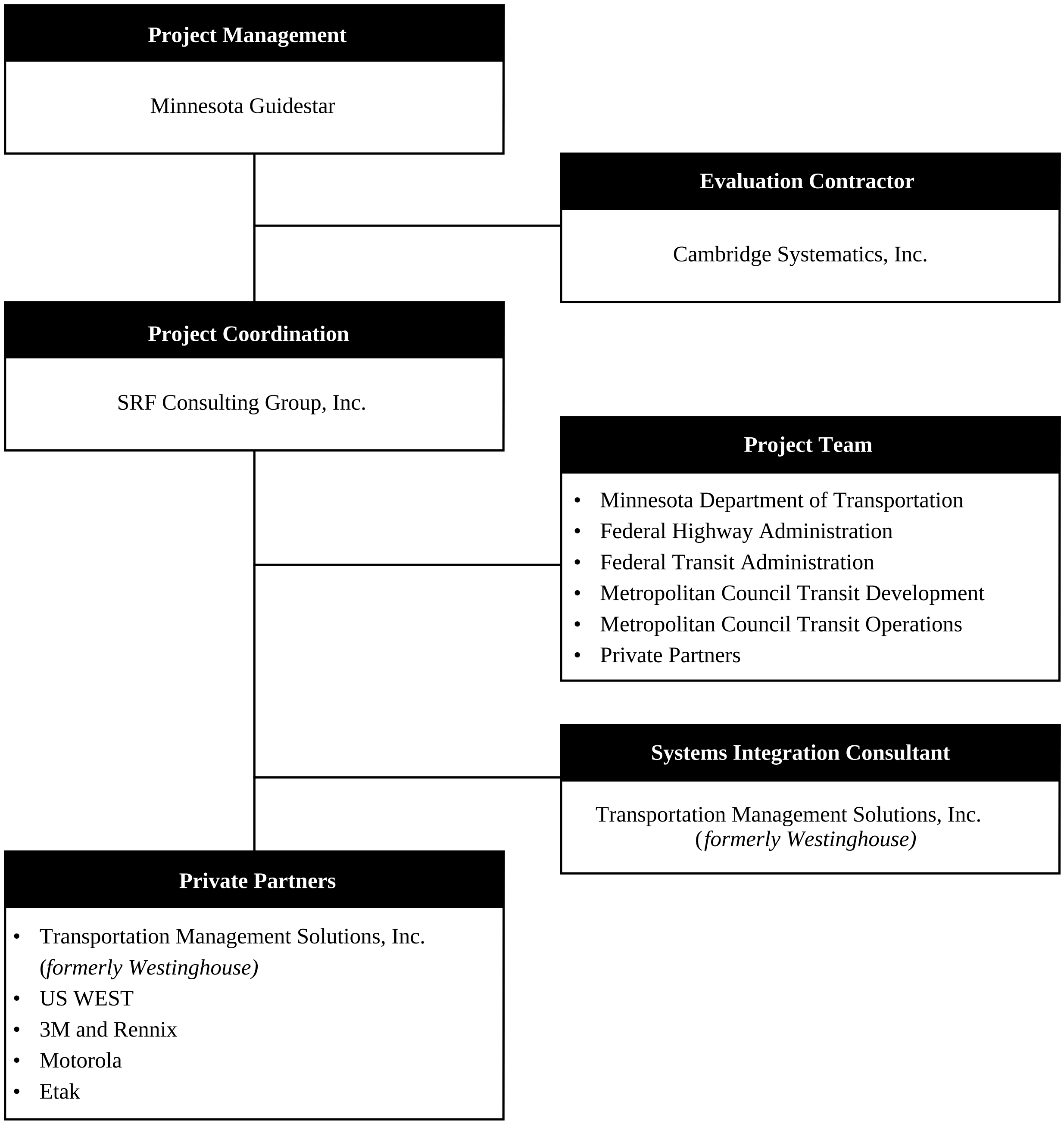
"Smart" kiosks with touch-screens provided information similar to that provided through the on-line service, including bus status and traffic conditions. Kiosk locations were in downtown Minneapolis and included the lobby of the Hennepin County Government Center, the MCTO Transit Store (a ticket outlet), and the Commuter Connection (a transportation information storefront operated by the downtown business council). Along the I-394 corridor, video display monitors were mounted inside bus passenger waiting shelters at two park-and-ride lots. Electronic signs were installed at four park-and-ride lots. The monitors and signs displayed the on-time status of next scheduled buses at those locations as well as other special messages for travelers. Multi-media for kiosks was dropped due to budget constraints.

The on-line service allows for interactive inquiries using small videotext terminals with keyboards and built-in modems, or, alternately, via personal computers with modems. Up to 212 commuters in the I-394 corridor were provided with videotext service.

■ 3.3 Organizational Roles

The Travlink Operational Test required the involvement of numerous public agencies as well as private firms. Travlink relied on innovative public-private partnerships for cost sharing and implementing the operational test. A discussion of the institutional issues affecting the public-private partnerships in this project was the topic of a separate report by the evaluator, and a synopsis of that report is included in the Appendix. The overall project organization is illustrated in Figure 3.2.

Figure 3.2 The Travlink Project Management Organization



Mn/DOT's Minnesota Guidestar managed the Travlink project with the assistance of a consultant Project Coordinator. An Evaluation Contractor provided a complete assessment of project impacts and performance. A Project Team, consisting of all project participants, reviewed all project activities. A Systems Integrator was responsible for integrating the designs and products of various subsystems into a single functioning system. The private partners are private firms that developed and provided the technologies. Following is a review of key participants.

Minnesota Guidestar

Minnesota Guidestar's responsibilities included project team coordination, securing funding, design review and approval, negotiating partnerships, issuance of contracts for equipment and services, contract management, budget control, oversight of technical activities, and project evaluation.

Contributions: Staff time, communication system enhancements, Traffic Management Center support, and marketing support:

- Provided project management for Travlink;
- Executed public-private agreements;
- Administered procurement of equipment and services;
- Provided technical design review and approval;
- Provided coordination with the Guidestar ITS projects;
- Conducted installation, developed software, and provided the signpost system computer;
- Provided the ATIS system administrator and space for the ATIS host computer;
- Provided arrangements for the communication system and supplied key components;
- Obtained all required licenses and permits, including an FCC-licensed radio spectrum; and
- Oversaw the activities of the project evaluation contractor.

Federal Highway Administration/Federal Transit Administration (FHWA/FTA)

The FHWA/FTA's role in the project was to provide a portion of the funding, provide technical assistance, review project activities, and monitor the evaluation process.

Contributions: Funding assistance and staff time:

- Provided review of technical activities;
- Assisted with development of public-private partnerships;
- Participated in defining evaluation activities; and
- Assisted in dissemination of information to and from other ITS activities nationwide.

Metropolitan Council Office of Transit Development

The Metropolitan Council's role in the project was to provide a portion of the funding, provide technical assistance, review project activities, and monitor the evaluation process.

Contributions: Funding assistance and staff time:

- Provided review of technical activities;
- Assisted with local agency coordination; and
- Participated in defining evaluation activities.

Metropolitan Council Transit Operations (MCTO)

The MCTO operated and maintained the CAD/AVL system and assisted with the implementation and operation of the ATIS system.

Contributions: Staff time, facility space and improvements:

- Provided all supporting data needed for CAD/AVL implementation;
- Operated and helped support the CAD/AVL system;
- Participated in the marketing program;

- Participated in system design; and
- Prepared facilities as needed and assisted with selected installation.

Project Coordinator

SRF Consulting Group, Inc. served as the Project Coordinator. Responsibilities included assisting the Systems Integrator in working with local agencies, facilitating the efforts of the project team, providing transit- and traffic-related input, reviewing designs, and developing the market research program.

Systems Integrator

Transportation Management Solutions (formerly Westinghouse Electric Corporation) served as the Systems Integrator. Responsibilities included overall system design, including requirements definition, preliminary and final engineering including interfaces, and technical schedule and cost monitoring. The Systems Integrator had no contract responsibility for ensuring the performance of other team partners.

Private Partners

Private partners are those firms that contributed to the project a portion of the cost of their equipment and services. These partners included Transportation Management Solutions, US West, 3M and Rennix, Motorola, and ETAK.

All the partners served on the Project Team. The partner responsibilities under partnership agreements are described below:

- TMS provided the CAD/AVL system, the ATIS system design, much of the ATIS system, and marketing support;
- US West provided the videotext user terminals, engineering services, and marketing support;
- 3M and Rennix was to provide the signpost system, engineering and installation services, and marketing support;
- Motorola provided mobile radios and other selected communications equipment and engineering services; and
- ETAK provided electronic mapping databases and updates.

Evaluation Contractor

Cambridge Systematics, Inc., is serving as the Evaluation Coordinator. Responsibilities include developing the evaluation plan, data collection, and analysis and evaluation of project results.

3.4 Project History

Travlink History

In 1992, the Minnesota Department of Transportation (Mn/DOT) completed the construction in the I-394 corridor of a completely grade-separated, reversible high-occupancy vehicle lane to complement the existing system of HOV lanes in the corridor. As a fully-managed corridor, I-394 became a testbed for ITS technology. Around that time, several agencies, including Mn/DOT, the Regional Transit Board (which later merged with the Metropolitan Council), and Metropolitan Council Transit Operations (MCTO) began discussing the possibility of enhancements to transit service in the corridor. They sought to implement an advanced passenger information and vehicle monitoring system. They wanted to maximize the people-carrying capacity of the HOV network in the corridor. This was the beginning of the concept for the Travlink project.

In August 1992, Mn/DOT hired the SRF Consulting Group as the project coordinator. In October of that year, Mn/DOT and the RTB submitted a proposal to the FHWA and the FTA for funding the Travlink Operational Test. At the end of the year, FHWA/FTA approved this ITS project along with ten others around the country, including another Minnesota Guidestar project, Genesis. The proposal included letters of commitment from two of the private partners in the project, US West and 3M.

Shortly after Travlink received approval from the FHWA/FTA, Mn/DOT brought Westinghouse on board as the systems integrator and the provider of the ATIS and AVL systems. The process of working out partnership agreements began in early 1993. As system design work continued, Mn/DOT and Westinghouse negotiated a partnership agreement for system equipment and related services. These negotiations took upwards of a year, primarily due to contracting issues on both sides related to liability, risk, and the nature of contributions.

Also in 1993, partnership agreements were executed with other partners, including US West, the Rennix Corporation (local distributor for 3M), and Motorola. A competitive selection process, as specified by an interpretation from the Minnesota Attorney General's office, complicated the negotiation process with Rennix. The final partnership agreement was executed with ETAK in the spring of 1994.

In early 1994, US West's Community Link on-line commercial videotext service was discontinued. US West maintained its commitment to providing the videotext terminals for the Travlink Operational Test, but Community Link could no longer perform the software development for integrating the ATIS information with the on-line service. Westinghouse took over responsibility for this software development, but this required Mn/DOT to come up with additional funds for this task.

Concept definition and preliminary system design of the Travlink project began in the spring of 1994. Detailed design work began in April 1994. In October, Westinghouse installed the CAD/AVL system. The Travlink Operational Test began in December 1994 with the inauguration of the CAD/AVL system, the installation of passenger information kiosks at three downtown locations, and the installation of the electronic signs and video monitors at the Louisiana Transit Center, the County Road 73 South park-and-ride lot, and the Plymouth Road Transit Center. The ATIS system became operational one month later, which meant that the kiosks, signs, and monitors could be turned on, and they could report the real-time status of AVL-equipped buses operating in the corridor.

In December 1994, Westinghouse sold off several of its divisions, one of them being the division that was working on the Travlink Operational Test. This division became Transportation Management Solutions, Inc. (TMS), a unit of E-Systems (later acquired by Raytheon). This sale had the effect of slowing down the project during this transition from Westinghouse to TMS.

The AVI signpost system of the Travlink Operational Test was installed on the buses and signposts along the I-394 corridor, but this technology never became a fully-operating travel time data collection and reporting system. There were two reasons that this system was never used. One of the problems was that the AVI transmitters on the buses were inadvertently triggering some of the traffic signals that had emergency vehicle pre-emption devices. This was a safety hazard, and so the AVI transmitters on the buses had to be turned off. The second reason was that several programming obstacles and staffing set-backs prevented Mn/DOT from developing the software to be used with the AVI system. To move forward with the remainder of the Travlink project, the AVI subsystems development was discontinued. (The MCTO is now working with area municipalities to use this system for transit vehicle prioritization at traffic signals.)

Participants for the on-line service portion of Travlink were recruited from the I-394 corridor. Recruitment was done via telephones, mailings, and presentations at downtown businesses. Criteria for participation included residing in the corridor and working or going to school in downtown

Minneapolis. Participants were also selected to equally represent the modes of travel, including driving alone, carpooling, and riding the bus. In June and July 1995, a total of 212 participants received an hour of training and terminals were distributed. The Travlink On-line information service became available to the test group of users in June 1995.

Two significant events in MCTO operations occurred during the life of the Travlink Operational Test. Beginning with the winter of 1994-1995 schedule, MCTO made significant cuts in service in the I-394 corridor routes due to budget cutbacks. (See Section 6.1 for details on the extent of these cuts.) The other significant event was the bus drivers' strike in October 1995. This effectively cut the operational test short by about two months since the buses did not operate for nearly a month, and then ridership was down during November as not all riders returned immediately to commuting by bus.

In December 1995, the video monitors, electronic signs, and the kiosks were turned off and the Travlink On-line service ceased according to the planned operational test schedule, with evaluation activities continuing. MCTO continues to use the AVL technology for tracking vehicle locations, but not for schedule adherence purposes.

■ 3.5 Objectives

Local Objectives

At the local level, the Travlink Operational Test pursued three levels of objectives: customer-oriented, transit operations-oriented, and technology-related. These objectives are described below.

Customer Objectives

Increase the number of transit users as a result of the following improvements to the transit system:

- Increase access of potential riders to information regarding transit services and facilities by providing information at home, in the workplace, at park-and-ride lots, and other public locations;
- Provide real-time transit and traffic information that emphasizes the time and dollar savings that can be achieved through the use of alternatives to single-occupant vehicles;

- Improve the quality of customer information by emphasizing timeliness, flexibility, and content that is based upon measured customer needs; and

- Determine customer response to the information provided by the APTS technologies and their response to how it is presented to them, including which information is useful, how easy it is to use kiosks, videotext terminals, etc.

Transit Operations Objectives

- Evaluate the impact of AVL on service efficiency and quality, including on-time performance, timed-transfers, incident management, and scheduling;

- Evaluate the functionality and integration of ATIS/AVL into the MCTO's bus operations, including service planning, dispatching, transit control and security, communications, and information systems; and

- Test the effectiveness of the traveler information system in terms of the physical location, content, and the ability to communicate the required information.

Technology Objectives

Determine the performance of the selected technologies in the real-world environment, including accuracy, timeliness, and reliability. These technology evaluations include:

- Videotext, personal computers with communications software, smart kiosks, and other customer access devices;

- Electronic signs and display monitors;

- AVL and computer-aided dispatching systems; and

- The data communications network required to support the project.

Other Objectives

- Develop cooperative agreements for partnerships among public sector agencies and with the private sector;

- Incorporate project findings into future policy related to transportation investments; and

- Disseminate the information to others involved with APTS technology.

The Travlink project activities were structured to fulfill these objectives. This evaluation of the Operational Test examines the extent to which the project objectives have been met.

National APTS Objectives

The FTA has defined the following four principal objectives of the national APTS program. Although the Travlink project addresses each of these objectives, not all of the elements under each objective is a part of the Travlink project. The APTS objectives and their elements are listed here to present the complete scope of national evaluation.

Objective 1 – Enhance Quality of On-street Service to Customers

- Improve the quality, timeliness and availability of customer information;
- Increase the convenience of fare payments within and between modes;
- Improve safety and security;
- Increase service reliability;
- Minimize passenger travel time; and
- Enhance opportunities for customer feedback.

Objective 2 – Improve System Productivity and Job Satisfaction

- Improve schedule adherence and incident response;
- Improve the timeliness and accuracy of operating data for service planning and scheduling;
- Improve the response to vehicle and facility failures;
- Provide integrated information management systems and develop improved management practices; and
- Reduce worker stress and increase job satisfaction.

Objective 3 – Enhance the Contribution of Public Transportation Systems to Overall Community Goals

- Facilitate the ability to provide discounted fares to special user groups (e.g., disabled or employees eligible for tax-free employer subsidies);

- Improve communication with users having disabilities (e.g., visual or hearing impairments);
- Improve the mobility of users with ambulatory disabilities;
- Increase the extent, scope, and effectiveness of Transportation Demand Management programs; and
- Increase the use of high-occupancy vehicles.

Objective 4 – Expand the Knowledge Base of Professionals Concerned with APTS Innovations

- Conduct thorough evaluations of operational tests;
- Develop an effective information dissemination process;
- Showcase successful APTS innovations in model operational tests; and
- Assist system design and integration.

These are overall objectives for the entire national APTS program. As such, they are not necessarily specific to the Travlink operational test.

By comparing the national APTS with local objectives, a correlation can be developed as shown in Table 3.1. This table shows that all of the local objectives are encompassed by national APTS objectives.

The remainder of this evaluation plan identifies the specific measures for evaluating the ATIS/AVL system in the context of both the goals and objectives. Table 3.2 identifies each measure of effectiveness based on the national APTS objectives and its place within the Volpe Center guidelines.

The specific Measures of Effectiveness that are listed in Table 3.2 are grouped into the categories identified in the Volpe Center Guidelines. This evaluation plan is organized by these categories. Therefore, each measure listed under a heading, such as cost, user acceptance, etc., can be found in a corresponding section of the evaluation plan. However, some of the Measures of Effectiveness listed in Table 3.2, such as change in park-and-ride lot use, change in VMT, and change in fuel consumption do not appear in this report because they were beyond the scope of this evaluation. They were included in this table to show the comprehensive nature of APTS evaluation.

Table 3.1 Comparison of National and Local Objectives

National APTS Program Objectives	Travlink Objectives
Enhance quality of on-street service to customers. • Improve the quality, timeliness and availability of customer information. **Enhance the contributions of public transportation systems to overall community goals.** • Increase the use of high occupancy vehicles.	**Customer Objectives** 1. Increase the number of transit users as a result of the following improvements to the transit system: a. Increase access of potential riders to information regarding transit services and facilities by providing information at home, in the workplace, at park-and-ride lots, and other public locations. b. Provide real-time and traffic information that emphasizes the time and dollar savings that can be achieved through the use of alternatives to single-occupant vehicles. c. Improve the quality of customer information by emphasizing timeliness, flexibility, and content that is based upon measured customer needs. d. Determine customer response to the technologies tested, including use and acceptance, changes in travel behavior, and changes in transit ridership.
Enhance quality of on-street service to customers. • Improve safety and security. • Increase service reliability. • Minimize passenger travel time. **Improve system productivity and job satisfaction.** • Improve schedule adherence and incident response. • Improve the timeliness and accuracy of operating data for service planning and scheduling. • Improve the response to vehicle and facility failures. • Provide integrated information management systems and develop improved management practices.	**Transit Operations Objectives** 1. Evaluate the impact of AVL on service efficiency and quality, including on-time performance, timed-transfers, incident management, and scheduling. 2. Evaluate the functionality and integration of ATIS/AVL into the Metropolitan Transit Commission's (MTC) bus operations, including service planning, dispatching, transit control and security, and communications and information systems. 3. Test the effectiveness of the traveler information system in terms of the physical location, content, and the ability to communicate the required information.

Table 3.1 Comparison of National and Local Objectives (continued)

National APTS Program Objectives	Travlink Objectives
Enhance quality of on-street service to customers. • Improve the quality, timeliness, and availability of customer information.	**Technology Objectives** 1. Determine the performance of the selected technologies in the real-world environment, including accuracy, timeliness, and reliability. These technology evaluations include: a. Videotext, smart kiosks and other customer access devices. b. Electronic signs and display monitors. c. AVL and computer-aided dispatching systems. d. The AVI signpost system. e. The data and voice communications network required to support the project.
	Other Objectives 1. Develop cooperative agreements for partnerships among public sector agencies and with the private sector.

Table 3.2 Measures of Effectiveness

Measure Category	National APTS Program Objectives		
	Enhance quality of on-street service to customer • Improve the quality, timeliness, and availability of customer information • Increase service reliability • Improve safety and security • Minimize passenger travel time	**Improve system productivity and job satisfaction** • Improve schedule adherence and incident response • Improve timeliness and accuracy of operating data for service planning and scheduling • Provide integrated information management systems and develop improved management practices • Improve response to vehicle and facility failures	**Enhance the contribution of public transportation to overall community goals** • Increase the use of high-occupancy vehicles
User Acceptance	• Change in transit ridership • Changes in travelers' attitudes towards transit system • Change in preferred source of travel information • Travlink use • User attitudes towards Travlink • Perceived benefits of Travlink by users • Willingness to pay	• Attitudes of MCTO employees towards Travlink • Perceived benefits of Travlink by MCTO employees	• Change in transit ridership • Former mode of new transit riders • Change in park-and-ride lot use
Functional Characteristics	• Accuracy of ATIS information • Effectiveness of user interface	• Equipment reliability • Communications reliability	
Financial Impacts		• Fixed costs • Ongoing costs	
Transit System Efficiency and Effectiveness	• Schedule adherence • Quality of information	• Changes in transit utilization • Passenger fare revenues • Operating cost per inquiry • Operating cost per transit rider	
Other Impacts	**Public-Private Partnership** • Procurement costs relative to standard RFP process • Staff time required to negotiate agreements • Calender time required to negotiate agreements		• Change in VMT • Change in fuel consumption • Change in vehicle emissions

4.0 User Acceptance

4.0 User Acceptance

The information provided by Travlink served a broad range of users, including bus riders who consulted the electronic signs and video monitors at the park-and-ride lots, downtown workers who obtained transit and traffic information at the kiosks, Travlink On-line users who accessed information at their videotext terminals or personal computers, MCTO bus drivers and control center staff who communicated via the CAD/AVL system, and MCTO administrators who used the information generated by Travlink to make management decisions. The response to Travlink by these various user groups was assessed by evaluating measures such as changes in transit ridership, changes in attitudes toward transit service, the extent to which Travlink was used, perceived benefits of Travlink, and, in the case of the Travlink On-line users, willingness to pay for the service.

The data needed to calculate these measures of user acceptance were collected through surveys administered to Travlink On-line users, passengers boarding buses at park-and-ride lots with Travlink devices, kiosk users, and bus drivers. The data collected from these surveys was supplemented with information gathered from two focus group sessions of Travlink On-line users, and from interviews with MCTO administrators. The Travlink systems also tracked use electronically and provided measures, such as the number of log-ons and the number of screens accessed for the kiosks and the on-line service. In addition, this evaluation relied on statistics collected routinely by MCTO on bus route performance, such as ridership and fare revenues.

The following discussion of user acceptance is divided into separate sections for each of Travlink's four types of user interfaces: Travlink On-line, kiosks, electronic signs and monitors, and the CAD/AVL system. The specific measures used to evaluate user acceptance of these four types of interfaces are discussed in each section.

■ 4.1 Travlink On-line

The Minnesota Department of Transportation provided a computer on-line travel information service called Travlink On-line via ATIS to a test group of 212 residents of the I-394 corridor who worked or went to school in Minneapolis. Members of this test group received training and were given special videotext terminals or used their own PC to access the on-line service. They also responded to two separate surveys: once prior to the Travlink Operational Test and again after they had used the service for four or five months. A control group that did not have access to Travlink On-line was also recruited and asked the same questions about travel behavior before and after the Travlink Operational Test. Twenty of the Travlink On-line users also participated in focus groups that were held to discuss the service.

User and Control Group Profiles

The purpose of including a control group as part of the experimental design for the evaluation was to isolate the effects of Travlink from other factors influencing travel behavior, attitudes, etc. The extent to which this can be accomplished depends on how similar the user and control groups are. For the purposes of this study, these groups were found to be fairly comparable. Table 4.1 provides a comparison of the profiles of these two groups. Sample sizes are not sufficient to make any statistically significant conclusions, but the results are indicative of the directionality of the impacts.

Mode Split and Commuting Patterns

During the recruitment of participants in the Travlink On-line study, an attempt was made to obtain equal numbers of participants from all three commuter groups: one-third drive-alone commuters, one-third carpoolers, and one-third bus riders. This does not reflect the mode split of the corridor, but rather was an attempt to get significant numbers from each group to participate in the study.

There was almost no change in the mode split of the Travlink On-line users from before to after the test. The mode split of respondents in the post-Travlink survey was identical to that obtained in the recruitment survey, with the exception that one percent said they now used some other mode (e.g., bicycling, walking, etc.), which reduced the bus riders by one percent (see Table 4.2).

The results of the survey suggest that participation in the Travlink On-line users group had a stabilizing effect on commuters' mode choice. Before the Travlink project, 22 percent of the Travlink On-line users stated that they had been commuting by their current mode for less than one year.

After Travlink, only 11 percent of the On-line users stated that they had been commuting by their current mode for less than one year.

This indicates that over the course of the Travlink Operational Test, only half as many On-line users changed commuting modes in the last year as before Travlink. This trend contrasts with the trend among the control group. Both before and after Travlink, 18 percent of the control group

Table 4.1 Comparison of Travlink On-line Users to Control Group

		Travlink On-line Users (Percent)	Control Group (Percent)
Sex	Men	52	48
	Women	48	52
Age	20 to 34	31	39
	35 to 44	38	34
	45 to 55	24	19
Income	$30,000 to $79,999	68	53
	$80,000 or more	25	38
Changed Residences			
	Moved outside study area	1	2
	Moved within study area	1	5
Work/School			
	In the city of Minneapolis	95	94
	Five days a week	88	81
Average Household Size		2.98	2.90
Sample Size Total		**212**	**349**

Table 4.2 Mode Split

Mode	Users Pre-Test (percent)	Users Post-Test (percent)	Control Pre-Test (percent)	Control Post-Test (percent)
Drive Alone	36	36	28	37
Carpool	31	31	41	39
Bus	33	32	31	24
Other	0	1	0	0

Table 4.3 Length of Time Commuting via Chosen Mode

Length of Time	Users Pre (1994)	Users Post (1995)	Control Pre (1994)	Control Post (1995)
Less than 3 months	5	5	5	6
3 to 12 months	17	6	13	12
1 to 5 years	41	49	50	45
Longer than 5 years	37	40	33	37

reported having changed commuting modes within the previous twelve months (see Table 4.3).

During the Travlink Operational Test, there was a slight increase in vehicle ownership among Travlink On-line users' households. Before Travlink, only one user (less than one percent) reported having no car, 23 percent reported having only one car, and 76 percent reported having two or more cars. In 1995 after they had used the Travlink On-line service, the number of households with two cars or more increased to 79 percent, while only 20 percent of the users reported having one car. One more household reported having no car available at the end of the Travlink project. The control group showed a similar trend in vehicle ownership.

Reasons for Not Riding the Bus

The most common reasons given by auto users for not riding the bus are presented in Table 4.4. As shown, the top three reasons were "Bus schedule doesn't fit my schedule," "Need vehicle during work hours," and "Faster to drive."

Another common reason people do not ride the bus is because they have to drop off or pick up children at daycare or school. When car commuters were asked if they used their car for this purpose before Travlink, 26 percent reported doing so, and 25 percent reported doing so after Travlink. The control group also reported needing their cars for school or child-care purposes at about the same rate.

Travlink On-line users who either drive alone or carpool to work or school reported needing their own vehicle for work-related business at a lower rate than did the control group. Among the Travlink On-line users, about half of those who carpool or drive alone reported using their own vehicle during work hours both before (53 percent) and after (49 percent) Travlink (see Table 4.5). The control group showed an increase in the need for using their own car during work hours from 56 percent needing it before Travlink to 59 percent needing it after Travlink.

Those survey respondents who indicated that they use their own vehicle for work-related business were then asked "How often do you use your own vehicle for work-related business?" For Travlink On-line users, private vehicles became more necessary for work over the course of the project. Before Travlink, 38 percent indicated that they use their own vehicle for business at least several times a week. After Travlink, 46 percent said they need a vehicle for work that often (see Table 4.6).

The majority of those respondents who need a vehicle for work-related business have no company vehicle available to them that they could use instead of their own vehicle. Among Travlink On-line users, 76 percent before and 86 percent after Travlink had to use their own vehicle. A small

Table 4.4 Top 10 Reasons for Not Riding the Bus

Reason	Travlink On-line Users		Control Group	
	Pre-Travlink (percent)	Post-Travlink (percent)	Pre-Travlink (percent)	Post-Travlink (percent)
The bus schedule doesn't fit my schedule.	23	20	30	31
It's faster to drive.	20	20	17	16
I need my vehicle during work hours.	18	13	24	25
I need to drop off/pick up children along the way.	9	11	8	4
Buses don't run where I want to go.	6	11	6	10
I prefer to drive.	6	7	12	1
It is not cost-effective to take the bus.	8	6	5	5
I get free parking/My company provides parking.	5	4	4	1
I don't like confined hours of a bus schedule.	4	4	6	2
There's no bus service where I live.	4	4	2	2

Table 4.5 Automobile Commuters Requiring Car for Work

Percent of Commuters Needing their Own Vehicle for Work-Related Business

	Travlink On-line Users		Control Group	
	Pre-Travlink (percent)	Post-Travlink (percent)	Pre-Travlink (percent)	Post-Travlink (percent)
During work hours, do you use your own vehicle?				
Yes	53	49	56	59
No	47	51	42	41

Table 4.6 Use of Vehicle for Work-related Business

	Users		Control Group	
	Pre-Travlink Survey (percent)	Post-Travlink Survey (percent)	Pre-Travlink Survey (percent)	Post-Travlink Survey (percent)
How often do you use your own vehicle for work-related business?				
Daily	19	23	27	21
Several times a week	19	23	22	26
Occasionally	61	55	52	54
Is there a company vehicle available that you could use instead of your own?				
Yes	21	9	13	13
No	76	86	83	82
Vehicle is company-owned	3	5	4	5

Table 4.7 Recipients of Free or Discounted Parking

	Pre-Travlink Survey		Post-Travlink Survey	
	Control (percent)	Users (percent)	Control (percent)	Users (percent)
Where you park, do you receive free or discounted parking?				
Yes	76	73	76	76
No	24	27	24	23

percentage (three percent before and five percent after) were using a company vehicle to commute to and from work.

About three quarters of the commuters receive free or discounted parking at their workplace or school (see Table 4.7). Among the Travlink On-line users who drive alone or carpool to work or school, 73 percent reported receiving a full or partial parking subsidy before Travlink, and 76 percent reported a subsidy after Travlink.

Reasons for Riding the Bus

Of the 145 bus riders who responded to the post-Travlink survey, 61 percent boarded their bus at a park-and-ride lot, while 39 percent did not. These proportions were similar to those found in the recruiting survey when 58 percent of the respondents said they boarded their bus at a park-and-ride.

Among Travlink On-line users who board buses at park-and-ride lots, 85 percent said they drive to the lot, three percent take another bus to the lot, and 13 percent said they walk. However, with only 40 respondents fitting into this category, it is difficult to make inferences from these statistics.

Most bus commuters who board the bus at a park-and-ride lot do not make stops to pick up or drop off children at school or daycare when driving to or from the lot. About 19 percent of the Travlink On-line users reported doing so before using the on-line service, and about 24 percent reported doing so after Travlink.

The three most common reasons bus riders gave for riding the bus to and from work or school were: 1) they can save money; 2) they can relax and do not have to drive in traffic; and 3) they do not have to worry about finding parking downtown. Before Travlink, 49 percent of the bus riders who became Travlink On-line users mentioned saving money as their primary reason for riding the bus. The second most popular reason before Travlink for riding the bus was that bus riders can relax and do not have to drive in traffic, with 46 percent of the bus riders identifying this reason. After Travlink, these two reasons remained the most popular reasons among Travlink On-line users who are bus riders, but their rankings switched. After Travlink, relaxing and not driving in traffic became the most commonly-cited reason for riding the bus (see Table 4.8). The third most common reason for riding the bus was that bus riders did not have to worry about finding parking, with around 20 percent of the Travlink On-line users who were bus riders citing this reason.

Among bus riders, parking rates may be an unstated reason for choosing that mode. If they were to drive to work or school, most bus riders would not receive free or discounted parking. About 70 percent of the Travlink

On-line users who were bus riders said they would have to pay the full price for parking if they drove.

Impacts on Users

Drive-alone and carpool commuters were asked if they had taken the bus for their commuting trip one or more times in the last 12 months. Before Travlink On-line was available, 44 percent of the users had used the bus in the previous 12 months (see Table 4.9, and Figure 4.1). A year later, after they had used Travlink On-line, 51 percent of the users reported having ridden the bus in the previous 12 months. This seven percent increase in bus use among Travlink On-line users is comparable to the seven percent increase among the control group, suggesting that Travlink had no discernible impact on car commuters' occasional use of the bus.

Over the course of the Travlink On-line service test, drive alone and carpool users indicated that they would be less likely to ride the bus to work or school on a regular basis in the coming 12 months. Before Travlink, 14 percent of the users indicated that they probably or definitely would start taking the bus (see Table 4.10, and Figure 4.2). After Travlink, the number of users who indicated they would consider a change to bus commuting dropped to nine percent, and over half indicated that they would definitely not ride the bus on a regular basis. The control group showed a similar decrease in the likelihood of changing to bus commuting.

Utilization

Travlink On-line use declined since its inauguration in July, except that in October there was a slight increase in the number of users logging on, probably due to increased interest in the status of MCTO service during the bus strike. In the first month that the Travlink On-line service was available, 82 percent of the registered users logged on (see Table 4.11). In August, this number declined to 60 percent, and in September it dropped again to 35 percent. In October, 44 percent of the registered users logged on to Travlink On-line.

Other measures suggest that Travlink On-line use declined steadily during the operational test. For example, the number of log-ons per user declined each month. In August (log-on data was not available for July), each user who logged on to the service logged on an average of 5.2 times. By October, users were only logging on at an average of 3.6 times a month. In November, there were only 1.4 log-ons per user, but the service was only available for the first half of the month.

Table 4.8 Reasons for Riding the Bus

Reasons	Users: Pre-Travlink Survey (percent*)	Users: Post-Travlink Survey (percent*)	Control Group: Pre-Travlink Survey (percent*)	Control Group: Post-Travlink Survey (percent*)
Save money/Cheaper than driving	49	32	40	26
Can relax and do not have to drive in traffic	46	37	54	58
Do not have to worry about finding parking	19	21	25	14

* More than one reason was allowed, so total may equal more than 100%.

Table 4.9 Bus Use in Past 12 Months: Drive-alone and Carpool Commuters

	Percent of car commuters who have used the bus in the past 12 months: Before Travlink	After Travlink
Travlink On-line Users	44	51
Control Group	34	41

Table 4.10 Likelihood of Future Bus Use: Drive-alone and Carpool Commuters

Likelihood of deciding to ride the bus to work or school on a regular basis in the next 12 months

Percentages	Travlink On-line Users: Before Travlink	Travlink On-line Users: After Travlink	Control Group: Before Travlink	Control Group: After Travlink
Definitely	4	3	2	1
Probably	10	6	7	6
Probably Not	43	39	37	31
Definitely Not	43	52	54	62

Figure 4.1 Car Commuters Who Have Used the Bus in the Past 12 Months

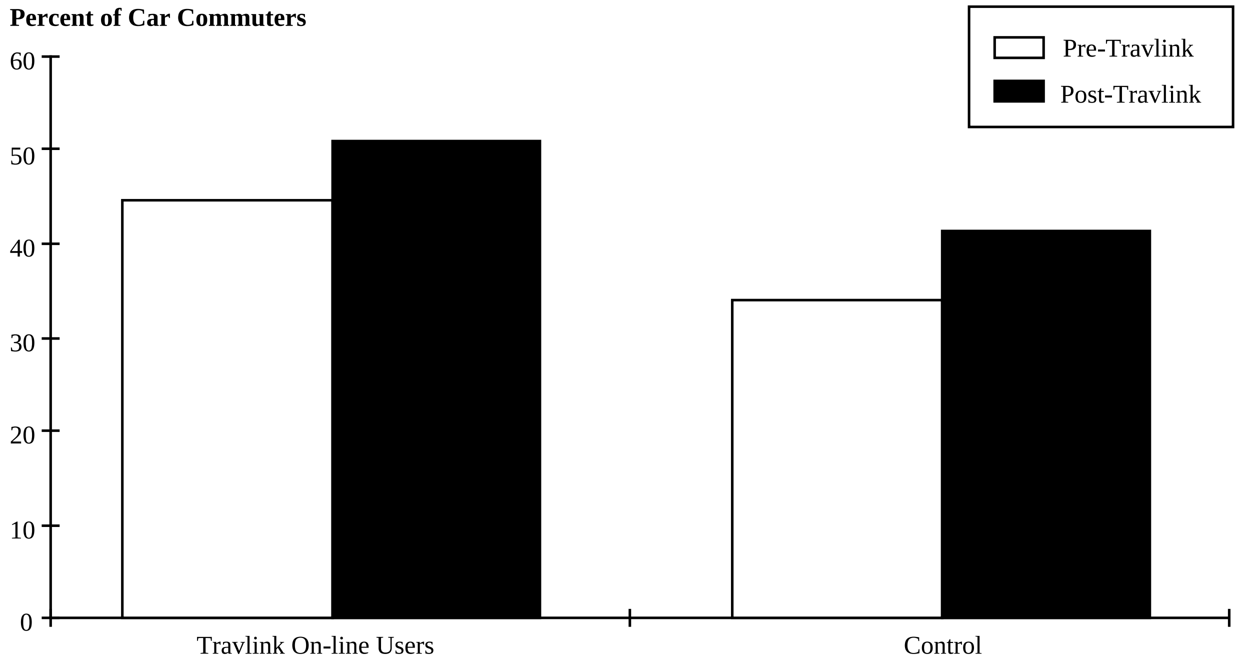


Figure 4.2 Car Commuters Who Will Probably Use the Bus in the Next 12 Months

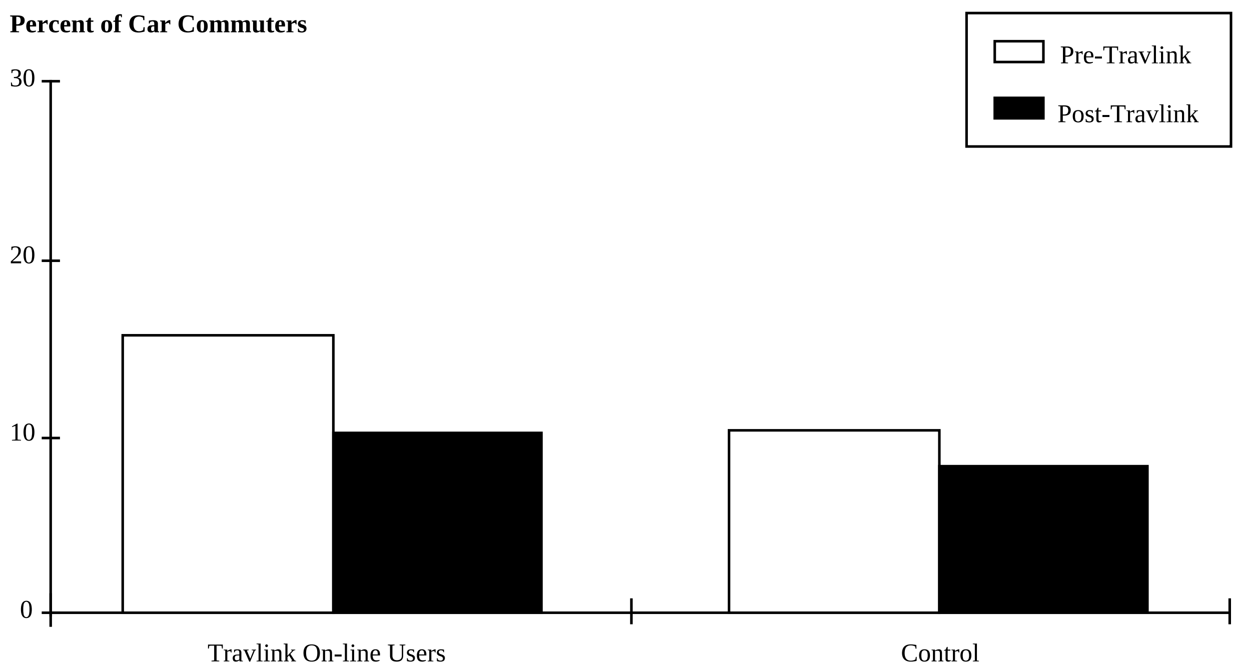


Table 4.11 Travlink On-line Use Summary

Month (1995)	No. of Users	Percent of Reg. Users	No. of Log-ons	Log-ons per User	No. of Screens	Screens per Log-on
July	174	82	N/A	N/A	7,748	N/A
August	126	60	654	5.2	4,568	7.0
September	75	35	299	4.0	1,883	6.3
October [1]	94	44	341	3.6	1,866	5.5
November [2]	26	12	37	1.4	237	6.4

1. Bus drivers' strike 10/9 – 10/29
2. On-line service was only available 11/1 – 11/15

Initially, Travlink On-line users accessed multiple screens, most likely to determine what types of information they could access on the service. As they became familiar with what was available, users began accessing fewer different screens. In August, the average number of screens accessed per log-on was seven. In September, that number dropped to 6.3, and in October, there were only 5.5 screens accessed per log-on. There was a slight increase in the number of screens accessed per log-on in November, up to 6.4.

The Travlink On-line service was more popular among bus riders than among carpoolers or drive-alone commuters. In July, 93 percent of the bus riders logged on at least once, while 81 percent of the drive-alone commuters and 75 percent of the carpoolers logged on. In August, there was a 20 percent or more drop off in log-ons among all three groups. During the last two months, at least 50 percent of the bus riders logged on, while only about a third of the other two groups logged on (see Table 4.12). It is interesting to note that the high level of use among bus riders during October coincided with the MCTO bus drivers' strike during that same month. The rise in the number of users logging on in October may have been due to bus riders using the on-line service to access information about the strike.

Most of the activity on the Travlink On-line system occurred during weekdays for the first three months of the service, but in October, users began accessing more screens during the weekends (see Table 4.13). With weekend access increasing, these figures suggest that fewer of the users were relying on Travlink On-line for real-time commuting information.

Over 50 percent of Travlink On-line use during weekdays occurred between 3:00 p.m. and midnight (see Table 4.14 and Figure 4.3). Both the morning and evening peak-commuting periods were popular times for accessing the Travlink On-line service, with 19 percent and 26 percent of the screens accessed during those periods respectively. On weekends, the most popular times to access Travlink On-line screens were between 9:00 a.m. and 11:00 a.m. and between 3:00 p.m. and midnight.

The most frequently accessed screens of the Travlink On-line service were the Bus Schedules screen, the Bus Status screen, and the Traffic Incidents and Delays screen (see Table 4.15). The popularity of these screens indicates that on-line users perceived the service as a source of information about transit options and roadway conditions. In October, during the MCTO bus drivers' strike, the Service Changes screen became very popular, ranking as the fourth most commonly-accessed screen for that month. Previously, that screen had been one of the lesser-accessed screens.

Those screens providing information on traffic incidents and highway construction were both accessed at fairly high rates by drive-alone commuters, carpoolers, and bus riders alike. Bus route schedule information was also accessed by all three groups at fairly high rates, and was the most commonly-accessed type of information among bus riders. Bus schedule

Table 4.12 Travlink On-line Log-ons by Mode

	Number of Users Logging On			
	Bus Riders	Drive Alone	Carpoolers	Total
July	93	81	75	249
August	71	56	54	181
September	50	27	32	109
October	62	38	35	135
November	11	7	8	26
Average	**57.4**	**41.8**	**40.8**	

Table 4.13 Travlink On-line Use: Weekday vs. Weekend Average Number of Screens Accessed by All Users per Day

	Weekday	Weekend Day
July	317.6	107.8
August	171.7	77.5
September	71.8	41.8
October	58.1	65.3
November	10.9	18.5
Average	**154.1**	**73.9**

Table 4.14 Travlink On-line Use by Time of Day: Annual Totals

	Weekday		Weekend	
	Screens Accessed	Percent	Screens Accessed	Percent
Midnight – 6 a.m.	353	3%	104	4%
6 a.m. – 9 a.m.	2,657	20%	161	6%
9 a.m. – 11 a.m.	882	7%	653	24%
11 a.m. – 1 p.m.	889	7%	187	7%
1 p.m. – 3 p.m.	1,026	8%	367	13%
3 p.m. – 6 p.m.	3,522	26%	553	20%
6 p.m. – Midnight	4,237	31%	711	26%
Total	**13,566**	**100%**	**2,736**	**100%**

Figure 4.3 Travlink On-line Screens Accessed on Weekdays by Time of Day

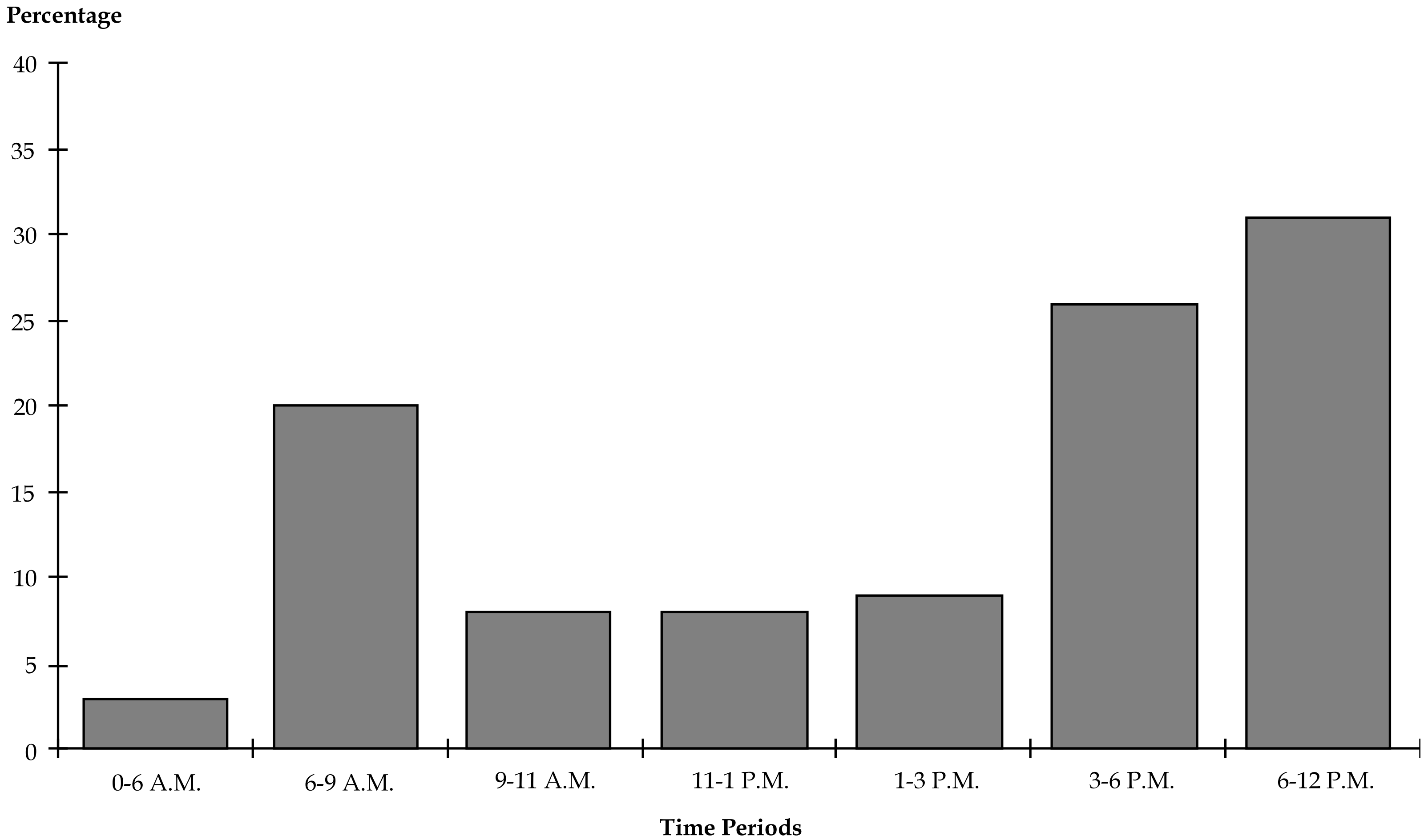


Table 4.15 Travlink On-line Screens Accessed by Mode of User

Screen Category	Total Screens	Drive Alone	Car Pool	Bus Riders
Bus schedules and maps	5,253	929	1,314	3,010
Is my bus on time (status)?	4,320	540	366	3,414
Construction and maintenance	2,384	791	586	1,007
How do I get there (by bus)?	1,607	450	357	800
Traffic incidents and delays	1,420	529	446	445
Park-and-ride locations	352	48	141	163
Bus service changes	307	44	39	224
I-394 commuter services	185	48	35	102
Customer service	163	23	33	107
Special events	161	33	33	95
Bus fares	115	42	16	57
Elderly/disabled services	35	15	4	16

adherence ("Is my bus on time?"), how to get to a destination by bus, and bus service changes were also types of information that bus riders sought from Travlink On-line. These three types of information were also popular among drive-alone commuters and carpoolers, but to a lesser extent.

Those users who indicated that they accessed a specific type of information via Travlink On-line were asked how well the information they got met their needs. Of the 169 users who indicated that they had accessed information about traffic accidents and delays, 14 percent indicated that the information provided had met their needs fully, while nine percent said that it had not met their needs at all. The remaining users fell between these two extremes, with the largest number indicating that the information provided more or less met their needs.

Of the 157 users who accessed highway construction and maintenance activity information via Travlink On-line, most found that the information met their needs. Thirty-seven (37) percent indicated that it met their needs and 24 percent said that it fully met their needs. Most of the others indicated that it met their needs to some extent, with only five percent saying that it did not meet their needs at all.

Of the 100 users who accessed bus trip planning information via Travlink On-line, most thought that it met their needs (59 percent). Eleven (11) percent indicated that it did not meet their needs at all, and another 14 percent indicated that it did not meet their needs in some respect. Bus riders found this information on Travlink On-line to be a little more useful. Seventy-four (74) percent found that it met their needs, while only eight percent said it did not meet their needs at all.

Bus route schedule information met the needs of Travlink On-line users at rates similar to those of the bus trip planning information. Sixty-seven (67) percent of the 131 users who accessed this type of information said that it either met their needs or fully met their needs. Nine percent indicated that it did not meet their needs in some way, and the same number of respondents did not think it met their needs at all. Among regular bus riders, the reaction to this information was more positive. Of the 54 bus riders using Travlink On-line to access bus route schedule information, 80 percent indicated that it met their needs, while 11 percent said that it did not meet their needs at all.

The reaction to information about bus schedule adherence ("Is my bus on time?") was mixed. Although 28 percent indicated that it met their needs to some extent and 21 percent said that it met their needs fully, for 17 percent it did not meet their needs at all. Bus riders had an even more negative reaction. For 31 percent of the 45 bus riders who accessed bus schedule adherence information via Travlink On-line, it met their needs to some extent, while for only 13 percent it did meet their needs fully. Twenty-two (22) percent did not think it met their needs at all.

Other types of information were accessed by fewer than 50 Travlink On-line users, and so the degree to which they met those users' needs will not be discussed in detail here.

Travel Information Sources

As a part of the Travlink On-line service design process, potential users were asked about what were their sources of travel information. They were not asked a corresponding set of questions during the post-implementation survey.

Before Travlink, almost all the Travlink On-line users who commute to work or school by car (either driving alone or carpooling) said that they got traffic information from the radio. Ninety-four (94) percent of these users said they listened to the radio for information about traffic. Other popular sources of traffic information included television and electronic freeway signs (51 percent of the car commuting users cited television as a source of traffic information, and 22 percent cited electronic freeway signs). Car commuters in the control group cited the same three sources of information at similar rates. Ninety-eight (98) percent of the control group car commuters said that radio was a source of traffic information for them, 48 percent cited television, and 15 percent cited the electronic freeway signs.

Before Travlink, Travlink On-line users who commuted by bus relied on information provided by the MCTO's telephone information line for information about riding the bus. Eighty-four (84) percent of the bus riders cited the telephone line as a source of transit information for them. Other sources of information cited were the Transit Store (31 percent), the respondent's employer (29 percent), radio (24 percent), and bus schedules (20 percent).

The Importance of Information

At the end of the Travlink Operational Test, the respondents in the test group were asked to rate the importance of various types of travel information. Table 4.16 lists the types of information that they were asked about and the number of respondents rating that type of information as either important or very important (4 or 5 on a scale of 1 to 5).

The type of information receiving the highest rating from the test group respondents was weather information, which also included road conditions. Seventy-four (74) percent of the 212 test group members rated this type of information as either very important or important. Since this information was not available on Travlink On-line, it should be considered as an enhancement in future on-line information services. The second most popular type of information was information about traffic accidents and delays, with 65 percent of test group respondents rating it as

Table 4.16 Importance of Different Types of Information

How Important is Information About:	Percent of People Responding "Important" or "Very Important"			
	Drive Alone	Carpoolers	Bus Riders	Total
Traffic accidents and delays	87	69	37	65
Highway construction and maintenance	84	54	41	61
How to get somewhere by bus	17	29	49	31
Bus route schedules	26	37	71	44
Bus schedule adherence	27	42	66	44
Park-and-ride lot locations	27	29	46	33
Bus fare information	18	17	40	25
I-394 commuter services	31	52	28	37
Bus service for special events	38	25	31	32
Elderly or disabled services	14	8	9	10
Customer service phone numbers	27	42	50	39
Bus service changes (detours, schedule change)	27	43	85	51
Weather information, including road conditions	87	80	54	74
How to get somewhere by car	69	54	40	54

important or very important. Highway construction and maintenance information was third, with 61 percent of the respondents rating it as important or very important. The type of information that was cited least often (by only 10 percent of test group respondents) as very important or important was the elderly or disabled services information. This may be due to the fact that only 10 out of the 210 households (about five percent) in the test group had a household member 65 or older.

The importance of each type of information varied considerably depending on the mode of transportation respondents used to get to work or school. Among those who drove alone to work or school, the types of information that were most often cited as important were the traffic accidents and delays (by 87 percent) and weather information (also by 87 percent). A large proportion also rated highway construction and maintenance activity information, and directions on how to get to a destination by car as important or very important (84 percent and 69 percent, respectively).

Those respondents who carpooled to work or school cited the same four types of information as important, but cited them at slightly different frequencies. Like drive-alone commuters, the largest proportion of carpoolers cited weather information as important (80 percent). The second largest proportion of carpoolers cited traffic accidents and delays as important or very important (69 percent). Highway construction and maintenance activity information, and directions on how to get to a destination by car were identified as being important by 54 percent of carpoolers. It is interesting to note that the type of information cited as important or very important by the fourth largest proportion of carpoolers (52 percent) was information about I-394 commuter services, such as carpool lane information, downtown parking, etc.

Bus riders placed importance on a much different set of information. Eighty-five (85) percent of the bus riders gave bus service change information a rating of very important or important. A relatively large proportion of bus riders also indicated bus route schedules (71 percent) and bus schedule adherence information (66 percent) as important.

User Ratings of Travlink On-line

Most of the Travlink On-line users found the training, support, and format for the service to be adequate. Seventy-three (73) percent agreed or strongly agreed that the training provided for the service was useful, and 68 percent thought the Travlink staff was responsive to their questions and complaints. Sixty-one (61) percent considered the format used to access specific information logical and easy to use.

Travlink On-line users were somewhat less satisfied with the information they received from the service. While 57 percent agreed or strongly agreed that the information provided by Travlink On-line was accurate and reliable, 34 percent were neutral on this aspect of the service. When asked if they thought the information was complete and comprehensive, 39 percent did think so, but 33 percent neither agreed nor disagreed, and 28 percent did not think so. On-line users also gave somewhat mixed reactions when asked if they thought the information provided by the service was timely and up-to-date: 35 percent of the users indicated that they neither agreed nor disagreed, 28 percent thought so, and 17 percent thought so strongly. Twenty (20) percent of the users did not think the information was timely and up-to-date.

Travlink On-line users did not think that the information provided by the service was more useful than that provided by the radio and television traffic reports. Forty-one (41) percent of the users rated radio and television as better sources of traffic information than the Travlink On-line service. Thirty-one (31) percent gave it a higher rating, including 11 percent who felt strongly that Travlink On-line provided better traffic information. As far as bus information is concerned, Travlink On-line users considered it better than that provided by the bus company's customer information telephone line. Over half (53 percent) of the users rated Travlink On-line as a more useful source of information than MCTO's route information telephone line, while 29 percent were indifferent.

Travlink On-line was used predominantly at home. Seventy-three (73) percent of users said they used the service at home, while 18 percent used it at home and at work, and nine percent used it at work only. Most of the users accessed Travlink information at home using a Travlink (videotext) terminal (77 percent), while 18 percent used their own personal computer. About five percent indicated that they used both types of terminals. In 57 percent of the cases, Travlink On-line was used by just one person in the household. In 35 percent of the households with access to Travlink On-line, two people used the service, and in eight percent of the households, three people made use of the service.

Among those who accessed the Travlink On-line service at work, 60 percent used a Travlink terminal, and 40 percent used a personal computer. (Note: Some people could not use their computers at work for Travlink On-line due to computer and telephone network configurations.) In most cases (54 percent) only the person involved in the operational test used the computer at the workplace. However, users were encouraged to let other people try the Travlink On-line service. At 39 percent of the workplaces, from two to six people used Travlink On-line; and at one workplace as many as 12 people used the service.

Among those who used the service both at work and at home (39 people), more found Travlink On-line more useful at work than at home. Twenty (20) people (51 percent) indicated it was most useful at work, eleven (28 percent) said it was most useful at home, and eight people (20 percent) said it was equally useful at work and home.

The frequency of Travlink On-line use declined over time. When asked how many times in the first month that Travlink was on-line they had used the service, 70 percent said they had used it four or more times, and about 13 percent indicated they had used it on average once a day or more. When asked how many times in the last month they had used the service, almost half of the users said they had not used it at all. Another 33 percent said they had used it three or fewer times. Only 18 percent had used it more than three times in the last month. This is a significant decline compared to the first month's rate of use. It is important to note that the post-implementation survey of Travlink On-line users was carried out in November, shortly after the MCTO bus drivers' strike. The decline in use suggests that participants did not consult Travlink On-line during the strike.

The statistics on the number of screens accessed by on-line users corroborates these survey results (see Utilization section above). In July, almost 8,000 screens were accessed. In August, this number dropped to about 4,000, and for September and October, use was around 1,900.

Most focus group participants also said they accessed Travlink On-line more frequently at the beginning of the trial than they did at the time of the focus groups. Again, it is important to point out that the focus groups were conducted during the bus drivers' strike.

User Interface Characteristics

Travlink On-line users were asked about the frequency of problems they might have encountered when using the service. The responses to these questions provide an indication of how users experienced the On-line service and how user-friendly it was. The problems asked about included:

- Not being able to log-on;
- Being disconnected unexpectedly;
- Experiencing very slow response time;
- Garbled text;
- The terminal not functioning; and
- Information not available.

As shown in Table 4.17, none of these problems was cited as occurring very often by more than five percent of the users. However, 16 percent of the users often found (and 25 percent sometimes found) that the information they requested was not available on Travlink On-line. The other two problems that users indicated as occurring fairly frequently were slow

Table 4.17 Frequency of Travlink On-line Problems

How Often Did You Find:	Percent of People Responding: Very Often (5)	(4)	Sometimes (3)	(2)	Not Very Often (1)
You could not log-on when you wanted?	5	8	13	17	57
You were disconnected?	1	4	7	16	72
You experienced a very slow response time?	5	6	17	26	47
The text on your screen was garbled?	2	2	3	13	81
The terminal was not functioning properly?	3	4	6	10	79
The information you requested was not available?	5	16	25	17	37

response time (six percent often, 17 percent sometimes) and not being able to log-on (eight percent often, 13 percent sometimes). The problem that seemed to occur the least was garbled text. Eighty-one (81) percent of the users indicated that this problem did not occur very often.

Willingness to Pay for Enhanced Services

To determine what other information and enhanced services users would like to see added to Travlink, a stated preference survey was administered. In this survey, Travlink users were presented with a series of choice exercises. Each of these choice exercises provided the Travlink user with two hypothetical Travlink options offering different on-line attributes. The Travlink user had three choices: choose one of the two options presented or choose neither option. A discrete choice model representing the Travlink user's choice among these options was developed.

By comparing the relative importance of cost and the presence of these additional enhanced services as indicated by the model parameters, it is possible to estimate the users' willingness to pay for these additional services.

Figure 4.4 displays the willingness of people to pay for the various Travlink On-line attributes. The value of traffic delay information to people who drive to work, as implied by the relative magnitude of these coefficients, is $6.82. The value of weather information to people who drive to work is $4.30. People who take the bus to work would be willing to pay the most for bus on-time status: $3.34. The value of traffic delay information and bus trip planning is $2.87 and $1.20, respectively.

Change in Attitudes Towards Transit

Travlink On-line users and the control group were asked to rate the reliability, convenience, and overall quality of bus service to downtown Minneapolis before and after the Travlink Operational Test. Table 4.18 presents the results of these ratings.

Among all three commuting mode groups, improvements in ratings of reliability among Travlink On-line users were similar to improvements in ratings of reliability among the control group. Therefore, the on-line service does not seem to have had a measurable effect (see Figure 4.5).

Travlink On-line made bus service more convenient for bus riders. The number of Travlink On-line bus riders who said that bus service to downtown Minneapolis was either convenient or very convenient increased from 63 percent before Travlink to 76 percent after Travlink. There was no change among bus riders in the control group, suggesting

Figure 4.4 Value of Travlink Attributes

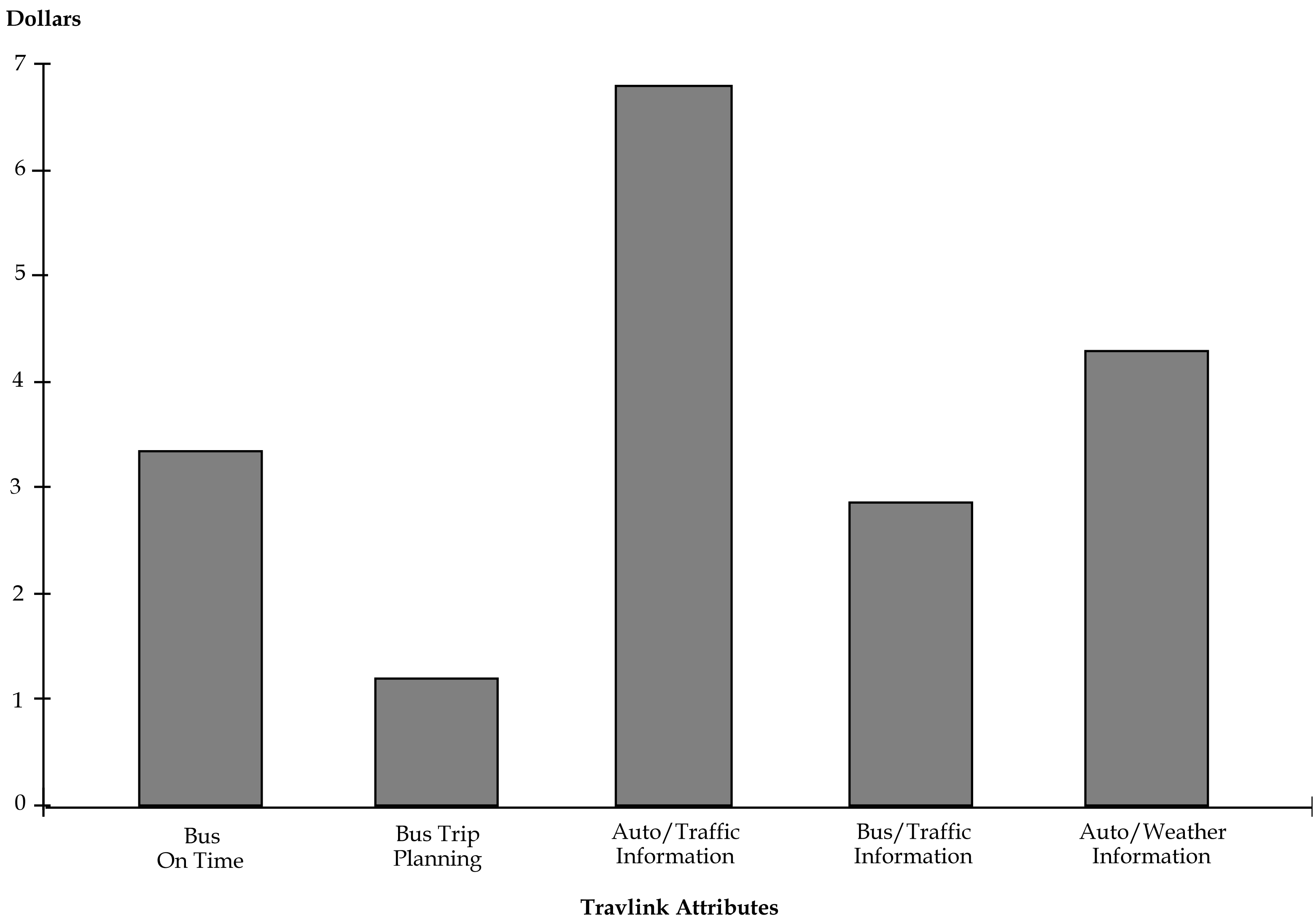


Table 4.18 Bus Service to Minneapolis Rated

	Travlink On-line Users			Control Group		
	Drive Alone	**Car Pool**	**Bus Riders**	**Drive Alone**	**Car Pool**	**Bus Riders**
Reliability						
Percent of respondents rating bus service as reliable or very reliable						
Before Travlink	66	72	87	62	66	86
After Travlink	79	75	94	76	75	92
Change	13	3	7	14	9	6
Convenience						
Percent of respondents rating bus service as convenient or very convenient						
Before Travlink	25	31	63	22	24	84
After Travlink	35	35	76	34	33	84
Change	10	4	13	12	9	0
Overall Quality						
Percent of respondents rating the overall quality of bus service as high or very high						
Before Travlink	40	46	71	36	50	80
After Travlink	58	58	71	48	50	83
Change	18	12	0	12	0	3

Figure 4.5 Bus Service Reliability

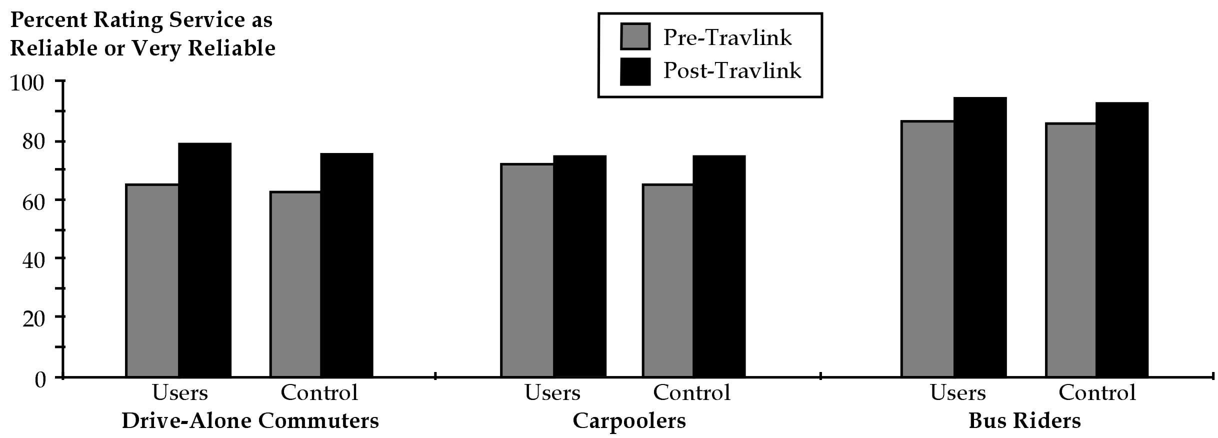


Figure 4.6 Bus Service Convenience

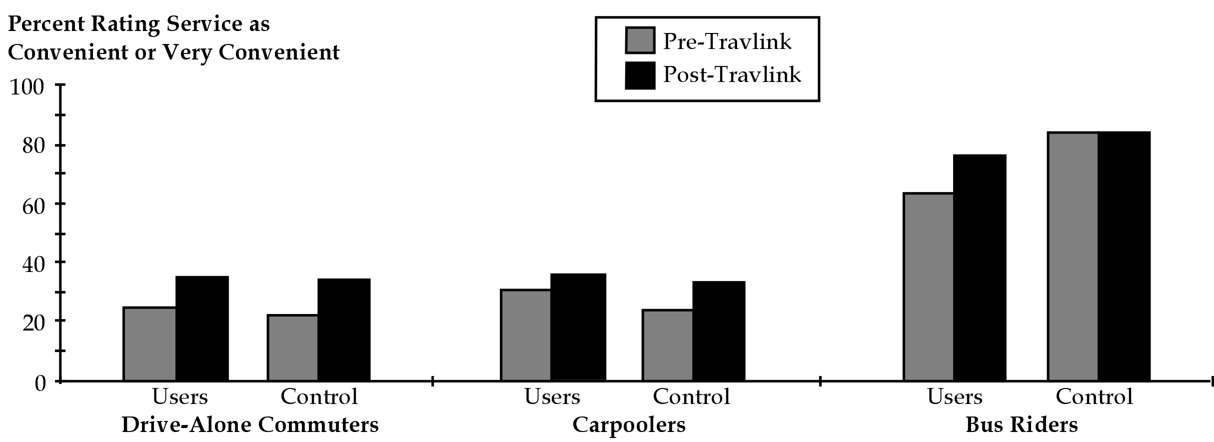
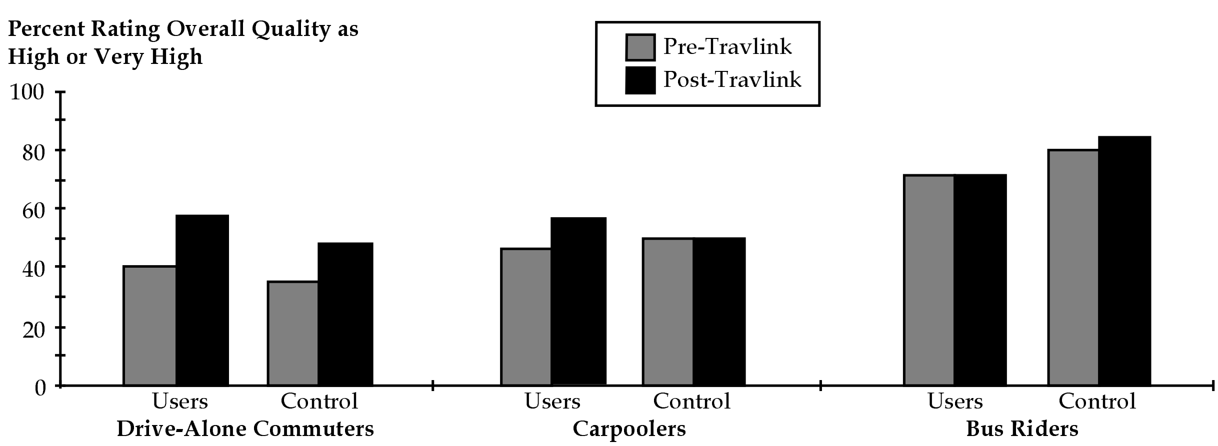


Figure 4.7 Bus Service Overall Quality



that the on-line service had a positive effect on bus riders in terms of their perceptions of the convenience of bus service to downtown Minneapolis (see Figure 4.6).

Travlink On-line improved carpoolers' and drive-alone commuters' perceptions of the overall quality of bus service to downtown Minneapolis. The number of Travlink On-line carpoolers who said that bus service to downtown Minneapolis was either high quality or very high quality increased from 46 percent before Travlink to 58 percent after Travlink. This percentage decreased by one percent among carpoolers in the control group. Drive-alone Travlink On-line users also improved their rating of the quality of bus service: from 40 percent rating bus service as high quality or very high quality before Travlink to 58 percent giving the same ratings after Travlink. However, the drive-alone commuters in the control group also gave the overall quality of bus service improved ratings, suggesting that not all of the improvement in the perceptions of the overall quality of bus service is attributable to Travlink On-line (see Figure 4.7).

Change in Awareness and Use of I-394 Services

The surveys administered to the user and control groups before Travlink On-line was implemented included a series of questions about their awareness and use of a variety of facilities and services available to I-394 commuters. These services and facilities included the express carpool and bus lane, park-and-ride lots, express bus service, reduced parking rates for carpoolers, the guaranteed ride home program, rideshare assistance, and bypasses for buses and carpoolers at metered ramps. In the post-Travlink survey that was carried out in November and December 1995, users and a control group (who did not have access to Travlink On-line) were asked the same series of questions. Some shifts in awareness and use did take place.

The most dramatic increase in awareness of I-394 facilities and services was that more people became aware of the guaranteed ride home program. This is a program that guarantees carpoolers and bus riders a ride home by offering discounted taxi service in emergency situations or at times when bus service is not available. After they had had an opportunity to use the Travlink On-line service, 23 percent more drive-alone commuters, 22 percent more carpool commuters, and 17 percent more bus riders said they had heard of this program (see Table 4.19). This increase is partly attributable to information available on Travlink On-line since the control group showed smaller increases in awareness of this program among carpoolers and bus riders. Among the control group, after the Travlink Operational test, 22 percent more drive-alone commuters, 12 percent more carpool commuters, and five percent more bus riders said they

Table 4.19 Awareness and Use of I-394 Facilities and Services

Travlink On-line Users	Drive Alone		Car Poolers		Bus Riders	
	Pre-Travlink (percent)	Post-Travlink (percent)	Pre-Travlink (percent)	Post-Travlink (percent)	Pre-Travlink (percent)	Post-Travlink (percent)
Heard of:						
Carpool and bus lanes on I-394	99	100	100	100	100	100
Park-and-ride lots along I-394	99	100	98	100	100	100
Express bus service along I-394	83	84	92	94	100	99
Reduced parking rates for carpoolers	84	88	89	94	86	90
Guaranteed ride home program	56	79	69	91	70	87
Rideshare assistance programs	94	95	94	95	94	93
Bypasses for buses and carpools	87	97	85	89	84	90
Have used:						
Carpool and bus lanes on I-394	84	87	97	98	93	100
Park-and-ride lots along I-394	29	35	40	45	67	79
Express bus service along I-394	32	32	43	57	94	96
Reduced parking rates for carpoolers	12	14	66	63	21	28
Guaranteed ride home program	0	3	3	6	6	9
Rideshare assistance programs	8	13	26	22	13	19
Bypasses for buses and carpools	47	62	78	85	77	84
None of the listed	14	9	3	0	0	0

had heard of the guaranteed ride home program than before the operational test. In spite of this increased awareness of the program, the number of respondents reporting that they had used this service increased only by three percent among Travlink On-line users who commute by each of the three modes. No change was observed for the control group.

Awareness of the bypasses for buses and carpools at metered ramps also increased. Prior to the operational test, around 85 percent of the Travlink On-line users in all three commuting mode groups had heard of the privilege that allows buses and carpoolers to bypass metered ramps (see Table 4.19). Among users who drive alone, awareness of this privilege had increased to 97 percent, while carpoolers' and bus riders' awareness had increased to 89 and 90 percent, respectively. Awareness increased among the control group as well, but at lower rates. Drive-alone commuters indicated almost no increase in awareness of the metered ramp bypass, while carpoolers reported an eight-percent increase in awareness, and bus riders reported a 13-percent increase. These results suggest that the Travlink On-line service was responsible for some increased awareness of the metered ramp bypass program, especially among drive-alone commuters. Unlike the guaranteed ride home program, increased awareness of the metered ramp bypass program did translate into increased use. Among the drive-alone commuters who presumably took advantage of this program when they had additional passengers in their vehicle, use increased from 47 percent before Travlink to 62 percent after Travlink. Both the carpoolers and bus riders increased their use of this program by seven percent. The control group also experienced similar increases in use. There was a slight reduction in the number of Travlink On-line users who had not made use of any of the I-394 facilities or services. Before the operational test, 14 percent of the drive-alone respondents and three percent of the carpoolers said that they had not used any of the facilities or services. After the test, only nine percent of the drive-alone Travlink On-line users and none of the carpoolers reported that they had not used any of the facilities or services.

These results suggest that there is some value to a service such as Travlink On-line in that it increases people's awareness and use of commuting options.

Comments from Travlink On-line User Focus Groups

Two focus groups were conducted in Minneapolis, MN on October 23 and 24, 1995. (Coincidentally, the timing of these groups corresponded to the dates of the MCTO bus drivers' strike.)

All participants were residents of the I-394 western suburbs and were commuters to Minneapolis. Each had volunteered to participate in the Travlink test, had received training and had been given special terminals or PC software to operate the on-line service. One focus group was comprised of individuals who ride the bus to work or school as their primary mode of transportation. The other group consisted of commuters who usually drive or carpool.

During each session, respondents discussed their experiences with the Travlink system, including how often they log on to the system, what information they find most useful and how they would like to see the system improved.

Some users in the focus groups reported that "information such as status of accidents, locations of road construction, and areas of congestion and traffic delays were not always available." A few users assumed that road conditions, as they relate to weather, also would be displayed. More information, such as estimated travel times and bus strike updates, was also expected by a few users.

The traffic information was thought to be most useful in helping individuals who drive to various locations throughout the day avoid traffic tie-ups. A few participants used the service to check the status of road construction projects. Others mentioned that it can be used to inform drivers of serious accidents or obstructions that are not likely to be cleared quickly.

Most focus group participants, however, remarked that even if they took the time to access the information before leaving, traffic could have been flowing easily by the time they had reached the troubled area and new slow-downs might have developed elsewhere. Another reason for the lack of interest in the system was that, regardless of any bulletins, most carpoolers are not able to change their routes to avoid traffic problems, since they need to pick up riders at specified locations.

Many of the respondents in the focus groups said they had expected Travlink to provide more information, and in greater detail. Some bus riders commented that they thought the terminal would tell them "how to get from point A to point B." Several group members were expecting the screen to display a map that indicated current bus routes and schedules. They complained that the user must enter a specific bus number, rather than a destination, to access information. Travlink On-line did have some trip planning capabilities, but due to budget constraints they were limited to the I-394 corridor and major points of interest.

The focus group participants' impressions of the value of Travlink's transit information is somewhat diminished by the perceived lack of information available. The data on bus schedules is thought to be severely limited. Since not all the buses are equipped with automatic vehicle location devices, many group members simply received a "no status" message when requesting information. One user noticed inaccuracies in the bus information, such as stops being listed that did not exist on a particular line. Some participants did not think the Travlink service allowed them to obtain route or schedule information unless they knew the bus number.

Since the buses run frequently during the peak periods and are rarely late, and those were the periods during which most respondents used the buses, some of them said that they would not bother to dial up the Travlink service to check on the status. Also, participants pointed out that bus status is only important once a rider arrives at the bus stop and wants to know how long the bus will be delayed.

In terms of other sources of information, the focus group participants did not mention being dissatisfied by the quantity or quality of information they received prior to Travlink On-line. Most said that they listen to the news on television or radio before leaving for work. Since they can listen passively while getting ready, this is seen as an easy alternative to logging on to a terminal. Many also mentioned listening to traffic reports on the radio on the way to work, and references were made to radio station KBEM-FM's frequent reports. Commuters who ride the bus said that if they needed route or schedule information, they would call the bus company directly or get a schedule from one of the transit stores or a bus driver.

Logging on two to three times per week during the first month of having the terminal was a fairly common pattern among focus group participants. Only a few of the participants, however, said that they continued to access Travlink on a regular basis. The time required to access the system was frequently mentioned as an obstacle to its use. Those with terminals at home said that it simply was not practical to take the time to log-on in the morning before work. A few dissatisfied users said that the system never worked properly, and was fraught with garbled text and system errors.

The most frequently-experienced difficulty among focus group participants was that the terminal was slow. It was said to be too cumbersome to use in a hurry. Users were surprised that the system was not on-line, such as being a part of an Internet-type service, and that it had to be read, rather than viewed graphically. One respondent pointed out that it was the videotext terminals that were slow, rather than the system, and that using a personal computer to access Travlink was a more efficient method.

Although the menu structure of the Travlink system was said to be adequate, it received some mild criticism in the focus groups. The problem cited was the many steps and/or screens to go through before the desired information was accessed. The lack of flexibility in moving back and forth between the screens or selecting specific screens was also considered a drawback. The group members would prefer not to have to scroll though other texts to jump ahead or to repeat information.

4.2 Kiosks

As part of the Travlink Operational Test, three "smart" kiosks provided real-time and static transit and traffic information. They were located at the MCTO Transit Store, the Commuter Connection office, and in the lobby of the Government Center complex.

The kiosks were used moderately over the course of the operational test. Use data for the year and user interviews in December suggest that people did use them to access information, and that they found them easy to use and the information helpful. However, many users wanted additional features, such as the ability to plan trips ("How do I get from here to there?"), or thought they should be placed in more strategic locations (e.g., at downtown bus stops).

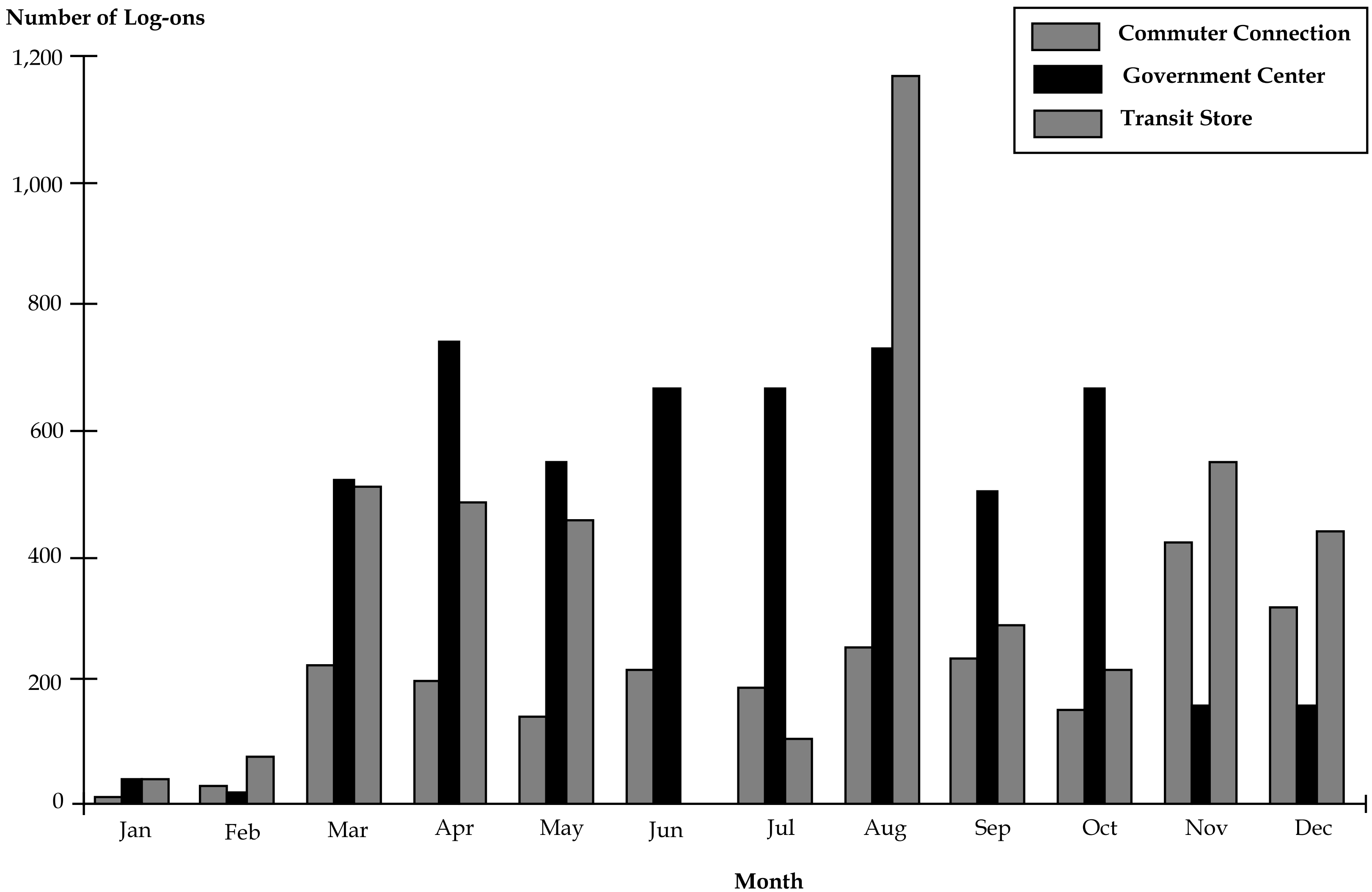
Utilization

Initially, kiosk use was light, but as more people became aware of their presence, use increased. In January and February of 1995, people logged on to the three kiosks fewer than 250 times. In March, log-ons jumped to 1,246 and remained above 1,000 for most months, until the kiosks were shut off in December. In June and July, the kiosk at the Transit Store was used only for a small part of each month because that facility was under renovation. The total number of log-ons during those months dropped below 1,000.

The Government Center kiosk had the highest use of the three kiosks. After an initial start-up period of two months, people logged on to the Government Center kiosk 500 or more times a month (see Figure 4.8). In April and August, that kiosk showed more than 700 entries. The other two kiosks had somewhat lighter and more sporadic use. Use of the kiosk at the Transit Store fluctuated between around 200 to as high as 1,167 log-ons between March and December, with almost no use during June and July, because the Transit Store was under renovation during most of those months. The monthly average number of log-ons for the eight months that the kiosk was available (excluding the first two start-up months) was 511 log-ons per month, or approximately 17 log-ons per day. Use of the kiosk at the Commuter Connection office was between 137 and 419 log-ons per month, with an average of 231, or an average of 7.7 log-ons per day.

The kiosks were used most frequently between the hours of 11:00 a.m. and 6:00 p.m. During the one-year Travlink Operational Test, the kiosk at the Commuter Connection outlet experienced its highest use during the lunch hour (i.e., 11:00 a.m. to 1:00 p.m.), but was also heavily used between 1:00 p.m. and 6:00 p.m. The other two kiosks showed no well-defined

Figure 4.8 Total Number of Log-ons for Each Month



peak in use, but in general were used primarily in the afternoon (see Figures 4.9, 4.10, and 4.11).

The most frequently accessed screens on the kiosks were the Schedules and Maps screen, the "How do I get there?" screen, and the Incidents and Delays screen. From August to October, they were the three most frequently-accessed screens (see Table 4.20). Two other popular screens were the Bus Fares screen and the Construction and Maintenance screen. The least frequently-accessed screen was the Elderly and Disabled Services screen.

Survey Results

People who used the three kiosks on December 12, 13, or 14 between the hours of 11:00 a.m. and 5:00 p.m. were asked a few short questions about their use and impressions of the kiosk. The interviewers spoke with 57 kiosk users at the three kiosk locations. Although this sample size is not large enough to make any definitive statements about kiosk users overall, the results of these interviews suggests who was using the kiosks and why.

Men used the kiosks more often than women. Seventy (70) percent of the people who accessed travel information at the kiosks were men. Kiosk users were mostly 21-40-year-olds. Fifty-eight (58) percent of the users fell in this age range, while 41-65-year-olds made up 35 percent of the users. About seven percent of the users were either over 65 or under 20. Ninety-four (94) percent of the users were residents of the Twin Cities. Most people who used the kiosks on December 12, 13, or 14 spent less than five minutes at the kiosk. However, four people did spend more than 10 minutes at the kiosks. Nineteen (19) percent had used the kiosk at least once before the day they were interviewed.

When asked why they had used the kiosk, 70 percent indicated that they were seeking bus schedule or route information, 49 percent said they were using it out of curiosity (multiple responses were accepted). Sixty-six (66) percent were satisfied or very satisfied with the information they received; 34 percent were not satisfied.

Sixty-five (65) percent indicated that they found the kiosk easy to use, 30.6 percent said that it was somewhat easy to use, and only four percent said they did not find it easy to use.

Figure 4.9 Annual Weekday Kiosk Use: Commuter Connection

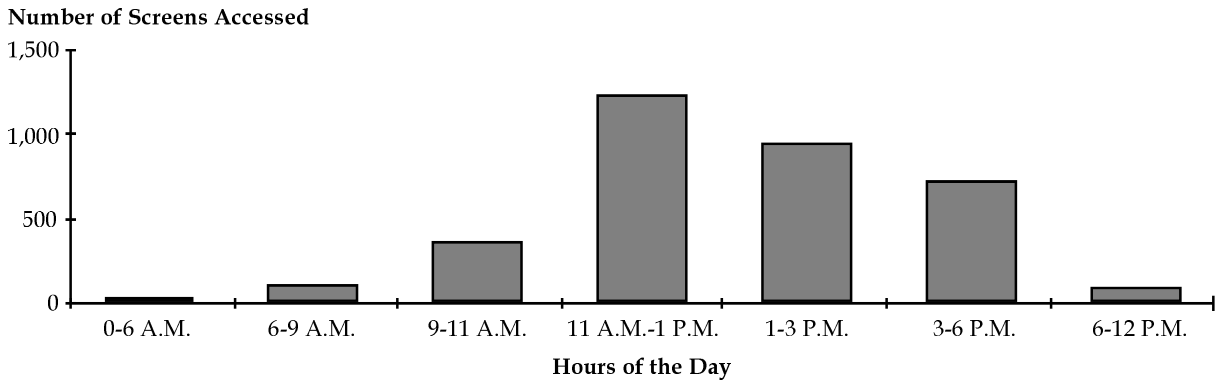


Figure 4.10 Annual Weekday Kiosk Use: Government Center

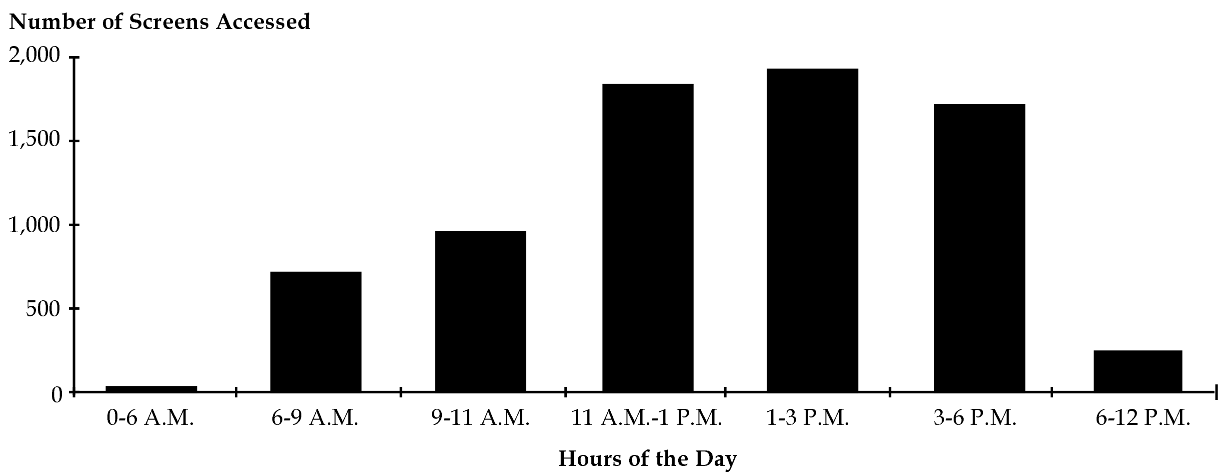


Figure 4.11 Annual Weekday Kiosk Use: Transit Store

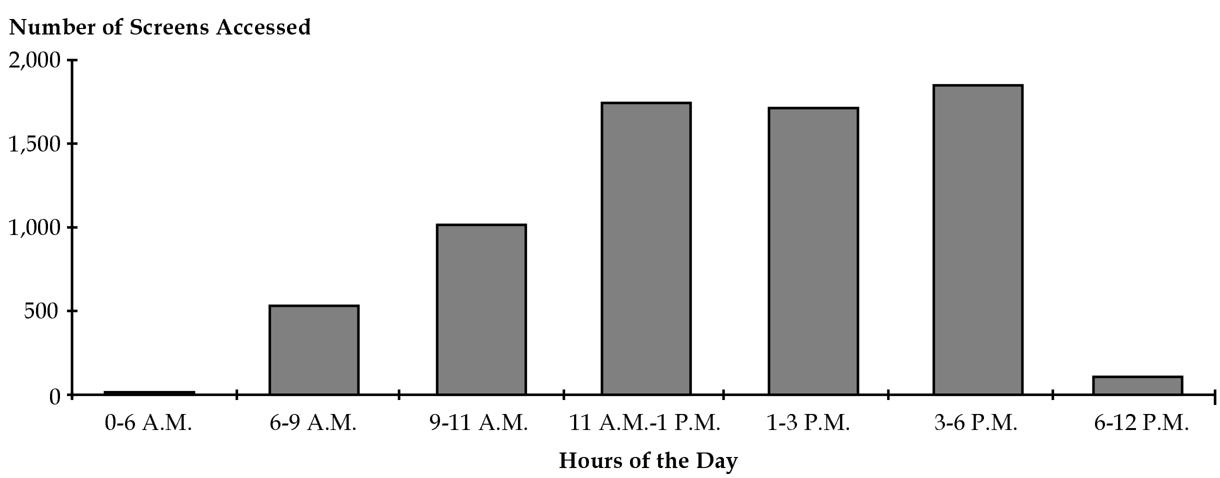


Table 4.20 Kiosk Screens Accessed on Weekdays (Annual Total)

Screen Category	Number of Screens	Percent of Total
Bus schedules and maps	3,690	21%
How do I get there (by bus)?	3,544	20%
Traffic incidents and delays	2,883	16%
Construction and maintenance	2,409	13%
Bus fares	1,900	11%
Park-and-ride locations	821	5%
Is my bus on time (status)?	746	4%
Bus service changes	532	3%
I-394 commuter services	486	3%
Special events	400	2%
Customer service	332	2%
Elderly/disabled services	170	1%
Total	**17,913**	**100%**

■ 4.3 Electronic Signs and Monitors

On December 12 and 13, 1995, a survey of passengers boarding bus routes 67, 70, 71, 73, 74, 75, and 76 at the Plymouth Road, County Road 73 South, or the Louisiana Park-and-Ride lots was conducted to determine the user acceptance of the ATIS electronic signs and video monitors. A few passengers refused to accept a survey form, but for the most part, passengers took a form to be filled out on the bus and handed to the bus driver when completed. A total of 336 survey forms were handed out, and 276 were returned, representing a response rate of 82 percent.

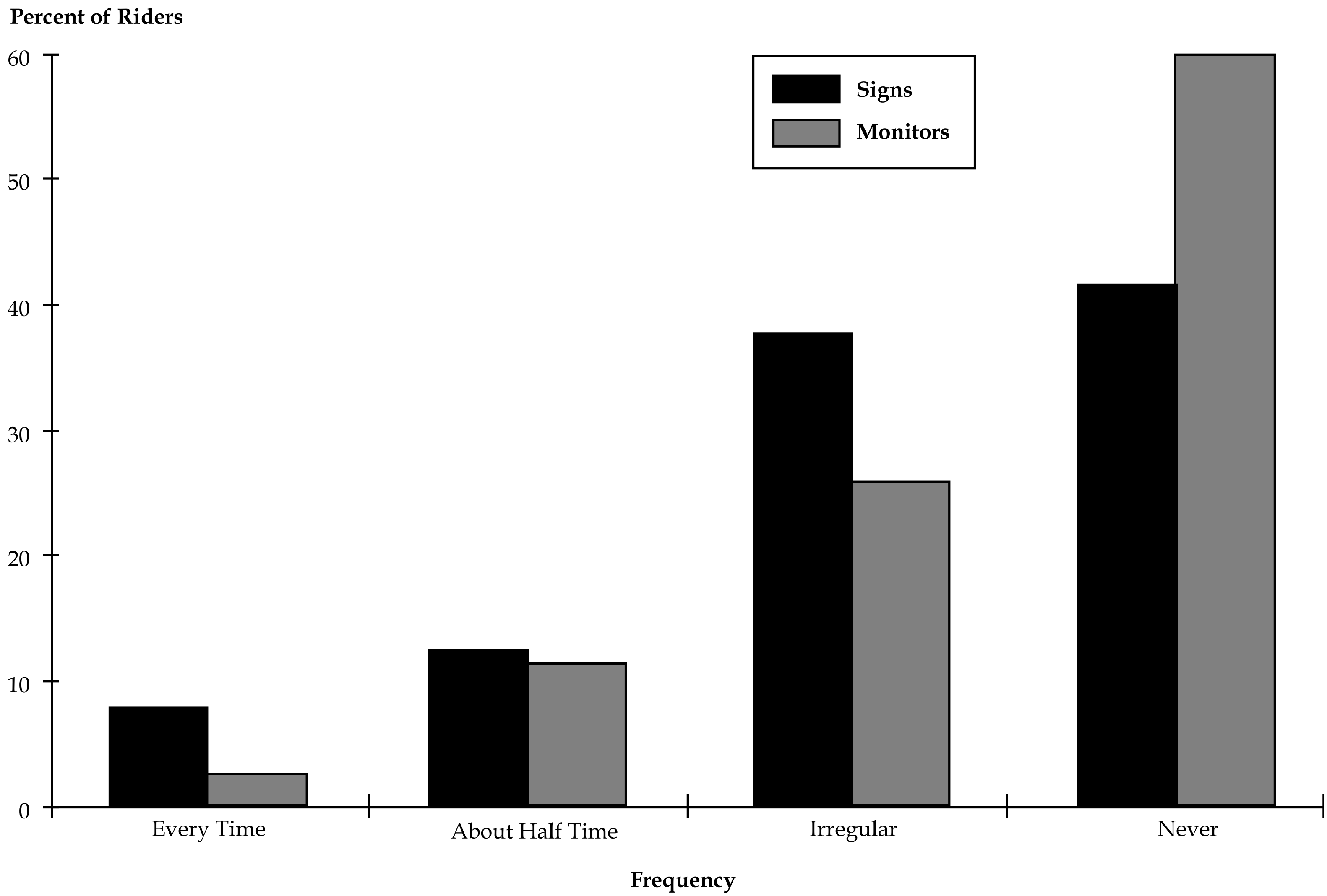
Ninety (90) percent of the respondents were regular riders of an MCTO bus, riding at least three times a week. Sixty-one (61) percent said that they rode five days a week, and 29 percent indicated that they took the bus three to four times a week.

About half of the respondents indicated that they had consulted the electronic signs and/or video monitors at the park-and-ride lots at some time. As Figure 4.12 illustrates, eight percent consulted the electronic signs and three percent consulted the video monitors every time they were at the park-and-ride lot. (Note: With four electronic signs and only two video monitors, electronic sign use would be expected to be higher.) Another 11 to 12 percent of respondents consulted these information outlets about half the time they were at a park-and-ride lot. Some respondents indicated that, although they did not consult the electronic signs and video monitors on a regular basis, they did consult them when there seemed to be an irregularity in the bus service: thirty-eight (38) percent of respondents consulted the electronic signs and 26 percent consulted the video monitors on this irregular basis.

The majority of the passengers using the Travlink-equipped park-and-ride lots were from the communities that surround the western end of the I-394 corridor: Wayzata, Hopkins, St. Louis Park, and Medicine Lake. About 32 percent of the passengers responding to the Travlink survey were from three zip codes in Hopkins. Seventeen (17) percent of the respondents were from St. Louis Park, 16 percent from Wayzata, and six percent from Medicine Lake. Other respondents were from communities throughout the western suburbs.

Most passengers indicated that they have been using the bus about the same amount over the last year, although about one quarter indicated that their use had increased. Sixty-three (63) percent said that over the last year their bus use had remained about the same, 23 percent said that it had increased, and seven percent said that it had decreased. Another seven percent indicated that they had not been using the bus for a year.

Figure 4.12 Frequency of Use of Signs and Monitors



Seventy-five (75) percent of the passengers boarding at the three park-and-ride lots drove and parked at the lot. Nine and one-half (9.5) percent transferred from another bus, and 8.4 percent were dropped off. Five point one (5.1) percent walked to the bus stop.

Almost all (95 percent) of the passengers riding these bus services were going to downtown Minneapolis. Less than one percent were going to the University of Minnesota. However, since the University had already closed for Winter Break, this low number may not reflect normal operating passenger loads. Other passengers were going to other parts of Minneapolis.

Only seven percent of the passengers indicated that they ever had used one of the travel information kiosks located downtown, and only four percent of the passengers indicated that they had ever accessed travel information using the Travlink On-line service.

Most of the respondents did not believe that the addition of the electronic signs and video monitors had made bus service more convenient. Fifty-two (52) percent of the respondents were neutral on this matter, while 33 percent disagreed that bus service was more convenient, and only 15 percent believed it was.

Opinion was split as to whether the information provided by the monitors and electronic signs was useful. Thirty (30) percent of the respondents indicated that the monitors and electronic signs did provide useful information, while 35 percent did not think so. The remaining passengers expressed no opinion.

Half of the respondents were neutral on whether the information on the electronic signs and video monitors was accurate or not. However, 31 percent of the respondents indicated that they did not think the information was accurate, while only 15 percent thought the information was accurate.

The majority of respondents indicated that the electronic signs and video monitors did not play a role in their trip planning. Forty-three (43) percent indicated that they did not think they were better able to plan their trip as a result of the information on the electronic signs and video monitors, and forty-six (46) percent were neutral on this question.

The electronic signs and video monitors got high marks for legibility (i.e., the print is large enough, glare is minimal, and the information is presented in a clear format). Fifty-nine (59) percent of the respondents agreed that the signs and monitors were easy to read.

Forty-six (46) percent of the passengers agreed that the electronic signs and video monitors were in working order when they consulted them.

Thirty-six (36) percent were neutral on this question, and 18 percent did not agree that they were in working order when consulted.

About one-third (36 percent) of the respondents believed that bus service reliability had improved during the previous year, while 52 percent had seen no change.

■ 4.4 CAD/AVL Technology

The users of the CAD/AVL System were the control center supervisors, bus drivers, and MCTO Administrators. The information for evaluating the acceptance of the CAD/AVL technology among these users was gathered from a series of interviews with MCTO administrators, including the control center manager. The evaluation contractor also surveyed bus drivers who drove buses in the I-394 corridor during the Travlink Operational Test.

MCTO Drivers

During the week of December 11, 1995, bus driver survey forms were left at the drivers' lounge at the Heywood Garage. Drivers were asked to fill out these forms to provide their impressions of the CAD/AVL system by responding to 17 scaled questions. The responses to these questions provide an indication of how the bus drivers perceived the benefits of the CAD/AVL system. A total of 72 bus drivers responded to this survey. This included almost every driver who would have driven an AVL-equipped bus during the operational test. This section discusses the responses of these 72 drivers.

In general, the bus drivers did not believe the CAD/AVL system enhanced their ability to operate the buses. This was probably due to the fact that most of them did not believe the AVL equipment was reliable. For example, fourteen (14) percent of the drivers responding to the survey agreed that the equipment is reliable, 69 percent disagreed, and 17 percent remained neutral.

Most of the drivers had problems logging on to the CAD/AVL system, even though they believed they received adequate training in the use of the AVL equipment (i.e., the transit control head mounted in the bus):

- Sixty-eight (68) percent of the drivers disagreed with the statement "I rarely experience problems logging on to or using the AVL system." Sixteen (16) percent responded neutrally to this statement, while the remaining 16 percent agreed with it; and

- Seventy-one (71) percent of the drivers indicated that they believed they had received adequate training to successfully use the AVL system.

In most cases, the bus drivers did not believe the CAD/AVL system enhanced the reliability or the usefulness of the information they received:

- Forty-six (46) percent of the drivers did not think the information they received from the control center was more useful when they were driving an AVL-equipped bus. Forty-seven (47) percent had no opinion about whether the information was more useful or not, and only seven percent thought the information was more useful; and

- Forty-three (43) percent of the drivers did not think the information they received from the control center was more reliable when they were driving an AVL-equipped bus. Fifty-one (51) percent had no opinion about whether the information was more reliable or not, and only six percent thought the information was more reliable.

The bus drivers did not think the CAD/AVL-equipped control center was any better informed about actual road conditions. However, when the equipment was working, many of them did think the information that the CAD/AVL system provided them was accurate:

- Most of the drivers (53 percent) did not express an opinion about whether the control center was better informed or not. One-third (33 percent) did not think the control center was better informed, and only 14 percent did think it was better informed; and

- Thirty-two (32) percent of the drivers thought the information they received from the control center when driving an AVL-equipped bus was accurate. Nineteen (19) percent did not think the information was accurate, while half the drivers (49 percent) did not express an opinion.

The drivers generally did not perceive improvements in the run schedule, nor did they believe they could maintain their route schedules any better with the information provided by the CAD/AVL system. They did not see the CAD/AVL system as an enhancement to MCTO's ability to provide more efficient service:

- Sixty-one (61) percent of the drivers disagreed with the statement that run schedules had become more reasonable since the CAD/AVL-equipment had been installed on the buses. Only four percent agreed with this statement, and 35 percent remained neutral;

- Forty-two (42) percent of the drivers did not think they were better able to maintain their scheduled time checks since the CAD/AVL-equipment had been installed on the buses. Thirty-four (34) percent indicated no difference, while 24 percent did think the AVL system helped them maintain their scheduled time checks;

- However, 51 percent of the drivers disagreed with the statement "The information provided to me by the AVL system helps me stay on schedule." Twenty-two (22) percent did agree with this statement, while 27 percent expressed no opinion; and

- Again, about half (47 percent) of the drivers did not think that MCTO was able to provide service more efficiently because of the CAD/AVL system. About 16 percent of them did think that the system helped provide more efficient service, while 37 percent responded neutrally to this question.

The bus drivers did not think their passengers were any better informed due to the information that the AVL system provided, nor did they think ridership was any higher on their AVL-equipped runs:

- The majority of the drivers either had no opinion (39 percent) or did not think their passengers were better informed (47 percent) having received the information provided by the AVL system. Only 14 percent did believe that their passengers were better informed; and

- None of the drivers saw any difference in the ridership levels on their AVL-equipped runs than on their non-equipped runs.

Most of the drivers did not think that the CAD/AVL should be expanded to the entire MCTO bus fleet:

- Only about one-quarter of the drivers thought the CAD/AVL system should be expanded systemwide. Forty-three (43) percent of the drivers did not think it should, while 33 percent were neutral on this issue.

The biggest benefit the bus drivers saw to the CAD/AVL system was the ability of the control center to respond more quickly to emergency situations. However, they did not feel any safer in an AVL-equipped bus than in a non-equipped bus:

- Sixty-eight (68) percent of the drivers believed that the ability of the AVL system to pinpoint their location would be very useful in case of an emergency situation. Only 14 percent did not see this benefit, while 19 percent remained neutral on this matter; and

- Half of the drivers (47 percent) indicated they did not feel safer driving an AVL-equipped bus. Eighteen (18) percent did indicate that they felt safer in such a bus. The remainder did not have an opinion on this matter.

One interesting note is that most of the drivers did not resent that their location was constantly being monitored:

- The majority of the bus drivers either did not resent their location being constantly monitored (40.5 percent) or did not express an opinion on this matter (40.5 percent). The remaining 19 percent did indicate that they resented this monitoring.

These results suggest that the drivers perceived almost no benefits to having the CAD/AVL system in place. This may be due, in part, to the fact that the CAD/AVL system is a behind-the-scenes improvement that is more perceptible to the control center staff and the administrators. However, the system was intended to make the drivers' job a little easier by providing them with more information about actual operating conditions. The results of this survey suggest that the bus drivers did not gain this advantage over the course of the Travlink Operational Test.

As far as communicating with the control center, drivers continued to rely on radio communication rather than on consulting the transit control head. This may have been due to the fact that many of them had difficulties logging on to the CAD/AVL system. Also, since the CAD/AVL system workstation in the control center was not monitored constantly, drivers might not have received as rapid feedback as they would have, had they been communicating via radio with the control center.

MCTO Administrators

The users of Travlink's CAD/AVL system (i.e., the control center staff and MCTO administrators) did find the system useful in some ways, but also pointed out its shortcomings as far as their work was concerned. The MCTO administration had two main objectives for the Travlink Operational Test:

1. To determine if AVL technology can improve security; and

2. To find out how it can measure schedule adherence.

These objectives were not necessarily the same as Mn/DOT's objectives. The operational test demonstrated to the agency that the CAD/AVL system is capable of meeting their objectives, but some modifications to the system would be necessary. The operational test did make AVL supporters out of many of the staff, and demonstrated to them that it is no longer "pie in the sky" technology.

Usefulness of the Information

The MCTO administrators and control center staff found the information provided by the CAD/AVL system to be useful. The information was lacking in some respects. Real time information is very important to the operation of the control center. To the extent that the CAD/AVL system provided real time information, the information was useful. However, the AVL workstation did not present the real-time information and the bus schedules on the same screen in an easy-to-compare manner for the workstation operator. The schedule and headway would appear on the screen, but staff had to make this comparison manually.

The MCTO staff liked the playback feature of the CAD/AVL system. This allowed them to go back and see on the screen map where any particular vehicle was at any time. This was useful, for example, when a customer complained about service. They could keep this information on file.

The CAD/AVL system also allowed MCTO staff to monitor actual bus running times. They could retrieve the data from Travlink and verify that they did, in fact, need to increase the running times on a particular route. Normally, they would need to send field supervisors out to make observations before they could confirm that additional running time was necessary.

The schedule adherence information provided by the CAD/AVL system, however, was of limited use to MCTO staff due primarily to the way this information was presented. The system reported the number of runs that were not on schedule (i.e., outside of the pre-determined parameters) for a given time period, but not the schedule adherence results for all bus runs. One administrator stated that "the hard copy print-out of the schedule adherence data precluded this agency from using the data as a tool for analyzing a day's activities." However, MCTO managers believed that, given the opportunity, a CAD/AVL system could provide them with valuable information. The administrator stated that "I'm absolutely convinced that the technology exists to do what we want."

Ease of Use

The MCTO administrators and control center staff had mixed feelings about the ease of use of the CAD/AVL system. They thought that it provided some valuable information, but that it also required them to do more work. It did not fit seamlessly into their normal operating routine.

The procedure that was used to transfer schedule data from the MCTO scheduling department's Rucus and Trapeze databases to the database for the CAD/AVL system and then to the ATIS system was very slow and cumbersome. Data had to be downloaded from the scheduling department's databases and sent to the software vendor's headquarters. The vendor then processed the data to get them into the form usable by the

CAD/AVL system. The vendor would send the data to MCTO and the ATIS administrator via diskette. This process could take from two weeks to a month depending on staff availability on both ends of the process. An automated interface between the software systems would have resolved this problem. However, this was not included in the Travlink project due to the operational test nature of the project.

Another obstacle to using the CAD/AVL system easily was that the control center staff had to modify the way they worked with the information they got in order to make use of the CAD/AVL output. Although they did like the graphic display of where a bus was at any given time, they had to learn to identify bus runs by their block number rather than by their route number. Customizing the software to perform as similarly as possible to the staff's existing procedures could have made the Travlink CAD/AVL system easier to use. Again, budget constraints could not accommodate customization.

Reliability of the Information

MCTO control center staff had a very high level of confidence in the reliability of the locational information provided by the CAD/AVL system. When the system indicated that a bus was at a given location, they felt very certain that it was actually there. They had so much confidence in the information they were receiving that they actually wrote up two driver violations because the drivers were not running their routes properly according to the information provided by the CAD/AVL system.

However, there were a couple of problems related to the reliability of the information. Specifically, the base map used by the system had some inaccuracies and missing data. As a result, when the CAD/AVL system compared its locational information to the base map, it reported that there were problems in the service, when in fact that was not always the case.

In addition, the CAD/AVL system sometimes calculated the lateness of buses incorrectly. The system sometimes reported buses accumulating additional minutes of lateness with each run they made. Buses could accumulate up to 127.5 minutes of lateness, and then the system would send out the "No Status" message for that bus. However, buses are rarely two hours late. MCTO staff offered a couple of explanations for this problem of accumulated lateness. Either the bus was never on the correct route (this could have been due to log-on problems), or additional minutes were being added at layover points at the end of bus runs. This second explanation was possible because the CAD/AVL system only checked arrival times at a check point, and not departure times.

Utilization

The control center supervisors and the bus drivers did not use the CAD/AVL system to the full extent possible. One reason for this was the lack of staffing. The original plan was for MCTO to hire an additional control center supervisor who would spend about 80 percent of his/her time at the CAD/AVL workstation monitoring the buses that were logged on to the system, and the remaining 20 percent assisting with other dispatching activities in the control center. However, due to budget constraints, this position went unfilled, and the existing control center staff had to monitor the workstation as a part of their already busy schedule. They rotated existing staff to monitor the workstation. Without someone at the workstation at all times, information such as schedule adherence could not be monitored properly, and often went unused.

Another reason that the CAD/AVL system was not used fully was that it required a change in the way the control center supervisor carried out dispatching activities. For example, the CAD/AVL system identified buses by their block number, which control center supervisors usually did not refer to. Another hurdle for the control center supervisors was the issue of interlining (i.e., when one bus operates on more than one route number for operating efficiency reasons). For example, if a bus started its run by serving Route 6 and then switched over to Route 74, the bus run was designated as Route 6 for the entire time that it was logged on to the CAD/AVL system. As a result, when a control center supervisor looked on the screen, it would appear that a bus numbered 6 was on a Route 74.

A third reason that the control center staff was not able to use the CAD/AVL system to its fullest extent was that the bus drivers continued to rely on voice radio communication rather than communicate via the AVL transit control head mounted in the bus. As originally planned, drivers on AVL-equipped buses were supposed to call directly from the control head. The control center staff would then respond through the AVL system. But this practice fell out of use because: 1) many drivers had difficulties logging on to the CAD/AVL system; 2) the CAD/AVL workstation was often not monitored (so a driver might not get any response if he or she did call via the control head); and 3) drivers who did not drive AVL-equipped buses on a regular basis were not in the regular habit of using the AVL control head.

The limited use of the CAD/AVL system is understandable given the circumstances under which the Travlink Operational Test was carried out. However, the problems encountered with the implementation of Travlink can be overcome in future deployment of CAD/AVL systems for public transit systems. The Travlink Operational Test has pointed out the need for adequate staffing to make use of this new technology, the need for technology to serve the user and not vice versa, and the need for adequate training, supervision, and resources to make this technology work.

Training Required

The CAD/AVL system administrator at MCTO thought the training required for using the system was reasonable, and that they had received adequate training. Training on the use of the CAD/AVL system consisted of the following activities:

- Initially, the vendor presented formalized instructions on the basic functions of the system to four members of the control center staff.
- Next, the vendor trained them on the system with its enhancements in July/August of 1994.
- The last portion of training was just before the system went on-line in December 1994.

The CAD/AVL system administrator also received special training on backup, maintenance, and trouble shooting procedures.

The administrator described the vendor as being generally supportive with regard to training, but thought that the vendor personnel expected to be dealing with a more technical person than himself. As a result, on many occasions the administrator had to ask a number of questions in order to understand some of the fundamentals of the system's operation. He felt the documentation was very helpful.

Improved Scheduling and Dispatching

The staff of the control center thought the CAD/AVL system would be a great benefit. They were excited to have it as a new tool to support their operations. Their only reservation was that it created extra work for them, and they were already very busy. As a result, the system met with some resistance because of the additional work required. They did not want to devote time to the Travlink system at the expense of normal operations. They all understood that this was an important operational test and tried to support the project as best they could.

From the limited scope of this operational test, it is difficult to determine if scheduling and dispatching activities would be improved by a Travlink-type CAD/AVL system. Potentially, control center staffing requirements could be reduced. However, to the extent that voice communication between bus drivers and the control center staff is the most efficient means of dealing with most issues that arise for bus drivers, the opportunity for reducing staff may be limited. The major conclusions that can be drawn from this part of the evaluation are that a CAD/AVL system can create more work for control center staff, and, without adequate staffing, the system will not be used to its full potential.

Improved Driver Safety

The consensus among the administrators who were interviewed was that safety could be improved as a result of the CAD/AVL system. The system demonstrated that it could locate vehicles within 50 feet of their actual location. In the case of an accident or a threatening situation to passengers or the driver, they believe that the CAD/AVL system would be very beneficial, as it could reduce the time needed for emergency response. Because the I-394 corridor is not a very high-crime or high-accident corridor, few incidents occurred. As a result, it was not possible to quantify potential security benefits. Nonetheless, all the control center personnel believed that it would be a major advantage in responding to incidents.

Currently, there are silent alarm buttons on the buses, but the driver cannot determine whether or not the alarm has been received at the control center. If the Travlink system could have some way of verifying this to the driver, it would be helpful. One limitation in the operational test was that the existing bus radio system is on 450 MHz. As a result, there were no available frequencies on the 450 MHz to support either Travlink data transmittal or a voice channel for covert microphone.

Improved Schedule Adherence

The CAD/AVL system is capable of gathering and reporting schedule adherence data. However, MCTO staff did not find the reports convenient to use, and therefore did not make use of them for analyzing or adjusting bus schedules. Results of the Travlink Operational Test suggest that, in the future, if schedule adherence data can be made more accessible to transit managers, schedule adherence on bus routes can be improved.

Better Customer Information

From the perspective of the MCTO administrators, customer information does not seem to have been improved as a result of Travlink. One administrator pointed out that MCTO currently has a very reliable telephone information line that can be easily updated. Another administrator pointed out that MCTO had not heard many comments, either negative or positive, about the electronic signs and monitors at the park-and-ride lots. Usually, if something is important to MCTO customers, their office is inundated with telephone calls. That administrator thought that customers may have consulted the signs and monitors a few times, but they quickly learned that most of the time the signs and monitors reported "No Status" for their bus route, and ignored them from then on. The results of the passenger survey also suggest that passengers were not using the information provided by the signs and monitors: only 30 percent of the respondents thought the information provided by the signs and monitors was useful, and only 15 percent thought it was accurate (see Section 4.3).

Some of the administrators believed that customer information deteriorated due to Travlink. As one administrator pointed out: "It's better to give passengers no information and have them go ask for it, than to give them wrong information and have them depend on it."

Improved Service Efficiency

The MCTO administrators believe that a CAD/AVL system could improve service efficiency, but they did not think that this was demonstrated during the Travlink Operational Test. They could imagine how schedule adherence and vehicle location data collected by a CAD/AVL system would be valuable in making scheduling and operating changes that could improve service efficiency. For example, they could use the data to develop timed transfer services that could reduce the number of bus runs. However, the way the CAD/AVL presented the data in the Travlink Operational Test and the limited scope of the test (only ten bus routes in one corridor) did not allow MCTO to improve efficiency in any significant way.

Cost Effectiveness

It was difficult for the administrators to say if a CAD/AVL system such as the one tested in the Travlink project would be cost effective if it were expanded to the entire MCTO bus system. They saw the benefits of such a system, but they also realized that it is an expensive system to implement. They believed the benefits were not sufficiently tangible to support an argument before a board of directors or other governing body that large amounts of money should be spent on such a project, especially at a public transit authority that is often operating under an extremely tight budget.

One of the administrators pointed out that if they were going to convince the Metropolitan Council (their governing board) to make an investment in a CAD/AVL system, they would have to argue that such a system would:

- **Improve Safety** – All of the MCTO administrators were convinced of this benefit. Some pointed out that cost savings might be achieved through a reduction in the legal and medical expenses that could be avoided with an AVL system; and

- **Make Operations More Efficient** – Through better scheduling and dispatching they thought that operating expenses could be reduced. They would also be able to make more accurate observations of operations. However, they did not believe that this second point was clearly demonstrated in this operational test.

The administrators did not think that the ATIS system would be cost effective if it were expanded to the entire MCTO bus system. They pointed out that they already have an effective telephone information line, with a high level of user acceptance (i.e., 84 percent of Travlink On-line users who are bus riders cited the telephone information line as their primary source of bus information), and that passengers did not seem to make much use of the kiosks, electronic signs, or video monitors. One administrator thought that the ATIS system might have some value if MCTO decided to restructure its bus network to be a hub bus system, in which case ATIS could provide information to support timed transfers.

One difficulty that MCTO staff encountered was the problem of isolating the 80 AVL-equipped buses to deploy them on the AVL routes. This was an added complication to the garage dispatchers' many responsibilities. They also have to ensure that lift-equipped buses were deployed on certain routes, passenger counter-equipped buses on other routes, and that "opt-out" buses were assigned to suburban routes. The problem would be eliminated if a CAD/AVL system were expanded to the entire bus fleet.

Several administrators pointed out that the CAD/AVL system would have to provide information on departures times as well as arrival times at checkpoints if the system were to be expanded to the entire bus system. Information based solely on arrival times at checkpoints is of limited use to the MCTO staff. As a result, it would not be worth investing in a system that provided limited information.

5.0 APTS Functionality

5.0 APTS Functionality

The functionality of the Travlink equipment was evaluated based on the reliability of the equipment and the accuracy of the information provided by ATIS. The following sections describe the evaluation of these two areas. The evaluation found that, for the most part, the Travlink system functioned well, although some areas of improvement are discussed.

■ 5.1 Equipment Reliability

The reliability of the equipment of each of the three different components of the Travlink system was considered separately.

Equipment on the Buses

Between December 1994 when Travlink was brought on-line and the end of September 1995, the electronic maintenance division at the Heywood Garage logged 68 problems with the AVL equipment on the buses. These problems included burned-out fuses, loose wires, keypad malfunctions, broken antennae, buzzing from the transit control head in the bus, and software problems.

As shown in Table 5.1, of the 68 problems with the AVL equipment installed on the buses, all but ten had been fixed by the end of September. In 27 cases, the vendor repaired the problem as a part of their warranty on the equipment.

In addition to actual problems encountered, bus drivers and other users sometimes reported equipment malfunctions that were later determined not to be problems. Such complaints of malfunction were likely the result of operator error or misuse.

Equipment at the Transit Control Center

As far as the MCTO administrators and control center staff were concerned, the CAD/AVL equipment performed reliably. During those times when a control center supervisor was monitoring the system at the work station, they did not observe malfunctions with the equipment. The

Table 5.1 Frequency of Problems with Equipment on Buses

	Number of Problems	Percentage
No Problem Found	0	0
Vendor Repaired	27	40
Reconnected or Tightened	13	19
Part Replaced	12	17
Canceled	6	9
Not Repaired	10	15
Total	**68**	**100**

vendor was under contract to maintain the equipment. There was some discussion about what responsibilities were the vendor's and what were MCTO's, and the two parties had to reach an agreement about maintenance responsibilities.

ATIS Equipment

During the 12-month period that the ATIS system was in service (December 15, 1994 through December 15, 1995), the ATIS administrator reported approximately 214 occurrences of an operational malfunction with one or more of the devices (i.e., a kiosk, monitor, or electronic sign). Most of these problems (65 percent) were reported in the first three months of operation. Since these devices are new to transit operations, the large number of malfunctions during the first three months can probably be attributed to working out the bugs in the system.

Problems with the kiosks, however, occurred consistently throughout the duration of the operational test. The majority of these problems were paper jams in the kiosk printers. When a customer identified the information that he or she was seeking on the screen of the kiosk, they were given the option of printing out a hard copy. The paper that the kiosk printed the information on was fed from a roll. If the customer tried to pull the paper out of the kiosk before the kiosk printer had cut the paper, the delivery mechanism would jam. The ATIS system administrator had to fix these problems on-site when he visited the kiosk locations.

The kiosk at the Commuter Connection outlet had very few problems (three reported), while the kiosks at the Government Center and Transit Store locations experienced problems on a fairly regular basis. It should be noted that the kiosk at the Commuter Connection location saw half as much use as the Government Center kiosk and less than a quarter of the use of the Transit Store kiosk (see Section 4.2, Kiosk Utilization). The ATIS administrator reported that the Government Center kiosk was down 28 times during the operational test, with 21 of those times being due to paper jams. Of the 28 times that the Government Center kiosk was down, about half (13) of those malfunctions occurred during the first three months, while the other half were spread out over the remainder of the operational test. The kiosk at the Transit Store broke down 27 times during the operational test, with eight malfunctions in the first three months and 19 during the remainder of the operational test.

Almost all of the problems related to monitors occurred during the first three-month shake-down period. The ATIS administrator reported that the monitor at the Louisiana Transit Center was out of order 16 times, and the monitor at the Plymouth Road Park-and-Ride Lot was down 20 times during the operational test. All of the Louisiana Transit Center monitor problems were reported during the first three months. The only problem that the Plymouth Road monitor experienced after the first three months occurred in August. That monitor had a bad modem and PCMCI board which was repaired by replacing the board. After the three-month shakedown period, the monitors functioned well. Only normal maintenance and repair were required.

There were four electronic signs that provided passengers with information. The ATIS administrator reported that only two of these signs had any problems after the first three months of operation. These problems were:

- The telephone line that connects the sign's modem to the Transportation Management Center's ATIS system was interrupted due to road construction near the sign. This problem was fixed after five days. (County Road 73 Sign).

- The sign was disconnected from the ATIS server at the Transportation Management Center. It took about a week to identify the cause of the problem, which was a faulty modem. The modem was replaced a few days later. This problem occurred twice. As a result of the first problem, the sign was out of order for about 11 days. With the second problem, it was out of order for four days (County Road 73 Sign).

- On four occasions, signs were disconnected from the ATIS server, but subsequently reconnected and displayed correct information after their modem was turned off and then on again (County Road 73 Sign and the Plymouth Road Sign).

- On one occasion, the Plymouth Road sign displayed garbled text, but after turning it off and then on again, it displayed correct information.

These problems were routine in nature, and were solved within a reasonable amount of time. Once the vendor and the Transportation Management Center worked out the bugs in the operation of the electronic signs, they functioned very well. This suggests that the ATIS equipment is reliable given the normal expectations of maintenance and repair.

■ 5.2 Accuracy of ATIS Information

Of the total of 46 buses observed between 6:00 a.m. and 9:00 a.m. on December 12 and 13, only five buses showed a message other than "No Status." All five buses had an "On Time" message. Table 5.2 shows how scheduled and actual arrival times compared. The ATIS system is programmed to report as "late" any bus that was four or more minutes behind schedule. In the cases of the 7:30 bus at County Road 73 and the 6:28 bus at the Louisiana Transit Center, the ATIS system did not report

Table 5.2 Scheduled versus Actual Arrival Times

Location	Route	Scheduled Arrival	Actual Arrival
Plymouth Road	71E	6:40	6:40
Plymouth Road	76	7:22	7:24
Co. Road 73	73	6:40	6:40
Co. Road 73	73	7:30	7:35
Louisiana	9C	6:28	6:32

the correct status according to the evaluation contractor's observations. Because of the very small number of observations, further investigation into the actual schedules, and significantly more observations would be necessary to determine the frequency of such inconsistencies with any degree of statistical significance.

6.0 Impacts on Transit

6.0 Impacts on Transit

At the beginning of the project, team members anticipated that the Travlink improvements would have a positive impact on transit ridership and operations. This section examines the extent to which these impacts were realized.

6.1 Change in Transit Use

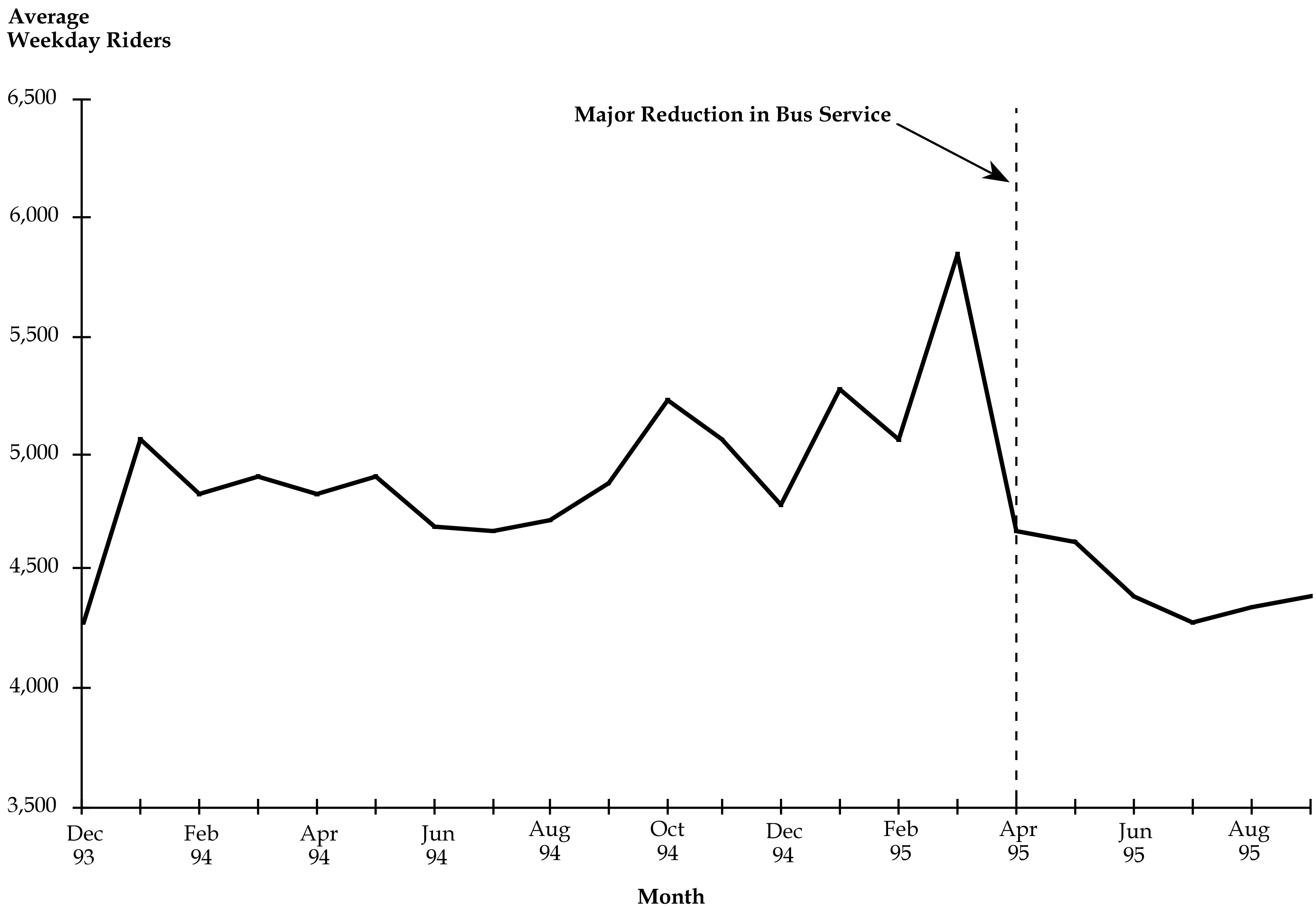
One expected benefit of the Travlink project was that the enhancements in passenger information would entice new transit riders in the I-394 corridor, thus increasing transit ridership. Unfortunately, it was not possible to measure Travlink's effect on transit ridership in the corridor because of two other factors which had a much stronger influence on transit ridership: the reduction in the level of transit service provided in the I-394 corridor; and the bus operators' strike in October 1995. The following sections examine how transit ridership changed over the course of the Travlink project, and illustrate that transit ridership declined in the corridor because of these other factors, thus obscuring any positive impacts of the Travlink project on transit ridership.

Change in Ridership and Levels of Service

Average weekday ridership in the I-394 corridor between December 1993 and September 1995 is presented in Figure 6.1. Due to the bus operators' strike, September 1995 is the last month for which comparable pre- and post-operational test data is available. During the ten months of the operational test (December 1994 through September 1995), MCTO made some significant changes in service in the I-394 corridor. These changes are reflected in the reduction in the number of scheduled hours and miles of bus service. Ridership is significantly affected by the amount of transit service available. Therefore, as service is reduced, ridership tends to decline as well. As a result, any examination of changes in ridership must take into consideration change in service levels.

MCTO cut its service on the nine AVL-equipped routes (Routes 61, 63, 67, 70, 71, 73, 74, 75, and 76) in the I-394 corridor by approximately one-third (in terms of hours and miles of service provided) during the course of the Travlink Operational Test. MCTO changes their schedule approximately

Figure 6.1 Average Weekday Ridership in I-394 Corridor



every quarter so that service levels match the seasonal demand. Table 6.1 compares these seasonal schedules and illustrates the reduction in service in the I-394 corridor.

In the spring of 1995, MCTO eliminated Route 61. On other routes, service was cut by as much as 60 percent. However, on two routes, 73 and 74, service was increased by about 12 percent. Route 73 is an express service between the County Road 73 Park-and-Ride Lot and downtown Minneapolis. Route 74 serves all three of the Park-and-Ride Lots that had Travlink electronic signs and video monitors installed at them.

The ridership per revenue-mile and ridership per revenue-hour on the MCTO bus routes in the I-394 corridor increased during the Travlink Operational Test, but it is difficult to say how the operational test has affected these ratios (see Table 6.2). A large part of the explanation of these better ratios is that ridership has not decreased at the same rates as service levels, which means that MCTO operations became more efficient.

As shown in Table 6.3, ridership on the entire MCTO transit system remained relatively stable over the course of the Travlink Operational Test, with only modest increases of one to three percent monthly. Ridership on MCTO bus routes in the I-394 corridor, however, declined significantly during the operational test, with up to 14 percent fewer riders in September 1995 than in September 1994.

Change in Fare Revenues

Fare revenue on I-394 bus routes have increased at a slightly lower rate than for the entire MCTO bus system. During the period of the Travlink Operational Test, the entire system brought in seven percent more revenue from the fareboxes than it did during the same period the previous year. A comparison of the farebox revenues from the I-394 bus routes for the same two time periods indicates an increase of six percent (see Table 6.4).

■ 6.2 Impact on Operations

Route Schedule Adherence

The data on schedule adherence are inconclusive as to whether schedule adherence has improved as a result of the Travlink Operational Test. First of all, pre-test data are very limited. In order to collect schedule adherence data before Travlink, MCTO had to send staff out to the checkpoint to record manually the time each bus passed a checkpoint.

Table 6.1 MCTO Weekday Service Levels in the I-394 Corridor*, 1994-1995

	Hours			Miles		
Schedule	**1994**	**1995**	**Change (percent)**	**1994**	**1995**	**Change (percent)**
Winter	254.5	219.8	-14	5,132.3	4,813.7	-6
Spring	254.5	162.4	-36	5,132.3	3,521.2	-31
Summer	254.3	159.4	-37	5,130.5	3,431.7	-33
Autumn	235.3	N/A		5,009.7	N/A	

* This table shows the total number of scheduled weekday revenue service hours and miles for MCTO bus routes 61, 63, 67, 70, 71, 73, 74,75, and 76.

Table 6.2 Passengers per Revenue-mile and Revenue-hour

	Passengers per Revenue-mile			Passengers per Revenue-hour		
	1994	**1995**	**Change (percent)**	**1994**	**1995**	**Change (percent)**
December 1993, 1994	0.81	0.96	17	16.4	20.9	28
January	0.90	1.01	12	18.1	22.1	22
February	0.89	1.02	14	18.0	22.3	24
March	0.92	1.04	13	18.5	22.8	23
April	0.94	1.36	45	19.0	29.6	55
May	0.91	1.28	40	18.4	27.8	51
June	0.89	1.00	13	17.9	21.7	21
July	0.88	1.02	16	17.7	21.9	24
August	0.88	1.04	17	17.8	22.3	25
September	0.95	1.05	11	19.1	22.7	18
October	1.00	N/A		21.3	N/A	
November	0.98	N/A		20.8	N/A	

Table 6.3 Weekday Ridership: I-394 Corridor vs. MCTO System

	I-394 Corridor			MCTO Systemwide		
Month	**1994**	**1995**	**Change (percent)**	**1994**	**1995**	**Change (percent)**
December 1993, 1994	94,338	100,550	7	4,868,153	5,152,526	6
January	101,191	110,421	9	5,138,167	5,332,881	4
February	96,520	101,127	5	5,036,977	4,930,618	-2
March	112,441	116,943	4	5,708,047	5,710,044	0
April	101,445	93,475	-8	5,132,230	5,016,560	-2
May	102,723	101,735	-0	5,403,418	5,688,118	5
June	103,334	96,869	-6	5,277,606	5,342,424	1
July	93,350	85,549	-8	4,866,325	4,997,647	3
August	108,216	100,200	-7	5,770,763	5,756,745	-0
September	102,199	87,919	-14	5,378,205	5,245,983	-2
October	109,798	N/A		5,460,066	N/A	
November	106,258	N/A		5,276,640	N/A	

Table 6.4 Change in Fare Revenue: I-394 Routes vs. MCTO System

	I-394 Corridor			MCTO Systemwide		
	1994	**1995**	**Change (percent)**	**1994**	**1995**	**Change (percent)**
December 1993, 1994	$25,633	28,485	11	1,230,298	1,415,223	15
January	26,904	29,147	8	1,314,168	1,407,227	7
February	25,061	27,299	9	1,257,363	1,281,118	2
March	28,823	31,931	11	1,404,379	1,480,536	5
April	25,010	27,208	9	1,243,450	1,304,323	5
May	26,510	30,527	15	1,336,801	1,494,624	12
June	28,283	28,948	2	1,372,157	1,449,849	6
July	26,394	26,485	0	1,284,060	1,401,568	9
August	30,321	30,746	1	1,580,913	1,677,836	6
September	28,055	27,648	-2	1,465,752	1,530,232	4
Total	**270,994**	**288,425**	**6**	**13,489,341**	**14,442,535**	**7**

This was a very labor-intensive effort. For each of the checkpoints along I-394, MCTO sent out one person for one day to collect the pre-operational test data.

The next complication is that the data collected by the CAD/AVL system only reflected the schedule adherence of those buses logged onto the system. For example, if only 50 percent of the buses that pass a particular checkpoint are logged on, the schedule adherence of the other 50 percent of the buses that are not logged on is unknown. To obtain the schedule adherence for those buses, manual collection would be necessary. As a result, in order to truly determine if schedule adherence has improved, the times all buses passed a series of checkpoints would have to be collected over a period of several days.

With these complications in mind, it is possible to report the schedule adherence for those days and those buses for which data were collected. In November 1994 and January 1995, MCTO sent staff out to collect schedule adherence data at several checkpoints along I-394. The vendor provided data collected by the CAD/AVL system for two different weeks. These data indicated the number of buses during the week that were recorded as being four or more minutes late at each of eight checkpoints. Table 6.5 presents the results of these collection efforts. The results of the data collected before Travlink represent the schedule adherence for all buses, but for only one day. The data from August and September only show the schedule adherence for those buses logged onto the CAD/AVL system. These results show no clear trend in schedule adherence.

Impacts on Dispatching Activities

Travlink presented MCTO with a new way of dispatching and supervising buses from the control center. The system offered the transit agency new information for making dispatching decisions and could have had significant impact on the dispatching activities of the control center. However, two factors prevented MCTO control center staff from realizing the full dispatching benefits of Travlink:

- MCTO did not hire a dedicated control center supervisor to monitor the Travlink workstation and communicate with buses via its CAD/AVL system on a regular basis. Since the control center staff already operate at full capacity in terms of the number of calls from buses they can handle, the workstation was often overlooked as a dispatching tool.

- The Travlink workstation identified buses by their block number (i.e., a number identifying the block of work or series of route runs a bus is assigned to make) rather than the route number the bus is currently on. In order to use the CAD/AVL system, the control center supervisors (dispatchers) had to adapt their operations and their procedures to using block numbers. This further deterred the control center supervisors from using Travlink for dispatching purposes.

Table 6.5 Schedule Adherence before and after Travlink

Checkpoint	No. of Buses Reported Late	No. of Buses thru Checkpoint	Percentage
Before Travlink			
General Mills P&R Lot	1	8	13
Louisiana Transit Center	8	30	27
County Road 73 P&R Lot	1	10	10
Xenia P&R Lot	0	8	0
Plymouth Road P&R Lot	2	29	7
Wayzata P&R Lot	0	16	0
12th and Hennepin	16	41	39
7th and Nicollet Mall	N/A	N/A	N/A
After Travlink Results of data from one week in August 1995			
General Mills P&R Lot	2	6	33
Louisiana Transit Center	1	19	5
County Road 73 P&R Lot	0	16	0
Xenia P&R Lot	1	2	50
Plymouth Road P&R Lot	1	20	5
Wayzata P&R Lot	0	14	0
12th and Hennepin	6	28	21
7th and Nicollet Mall	4	33	12
After Travlink Results of data from one week in September 1995			
General Mills P&R Lot	2	9	22
Louisiana Transit Center	6	33	18
County Road 73 P&R Lot	0	12	0
Xenia P&R Lot	4	10	40
Plymouth Road P&R Lot	4	24	17
Wayzata P&R Lot	0	16	0
12th and Hennepin	7	33	21
7th and Nicollet Mall	7	16	44

Because of these factors, Travlink did not have an impact on MCTO's control center dispatching activities. To determine the impact of a Travlink-type system on the dispatching activities of a transit agency, it would be necessary to assign a dedicated staff person to the CAD/AVL workstation and to customize the CAD/AVL system so that control center staff do not have to significantly alter their normal operating procedures.

Impacts on Other MCTO Activities

One difficulty that MCTO staff encountered was the problem of isolating the AVL-equipped buses to deploy them on the AVL routes. This was an added complication to the garage dispatchers' many responsibilities. There are 225 buses in the Heywood Garage, and the dispatchers already have to ensure that lift-equipped buses are deployed on certain routes, passenger counter-equipped buses on other routes, and "opt-out" buses on others. Ensuring that the 80 AVL-equipped buses were assigned to the nine routes (out of the 38 served by the Heywood garage) that were set up to be monitored by the CAD/AVL system added a significant complication to an already complicated bus assignment formula. The dispatchers could not always make this match work. If the CAD/AVL system had been implemented for all of MCTO's routes, this would not have been a problem.

7.0 Costs

7.0 Costs

The Travlink Operational Test cost almost $6.9 million. This project was a public-private partnership: both the sponsoring public agencies and the private vendors shared the costs of carrying out this operational test. This included actual amounts invoiced to the project as well as in-kind contributions (i.e., products and labor) and discounts on items and services.

The Travlink Operational Test Evaluation Plan outlines a thorough analysis of the fixed and ongoing costs of the operational test. However, detailed unit cost data were not available for the most part. In some cases, project partners did not keep detailed records of how much each component in this complicated project cost, while in other cases they were unwilling to share detailed cost information with the evaluator due to the competitive market for their product. Therefore, costs are discussed in aggregate in the following sections.

■ 7.1 Funding

Funding for the Travlink Operational Test came from four sources: the U.S. Department of Transportation (both FHWA and FTA), the Minnesota Department of Transportation, the Metropolitan Council (both Transit Operations and Office of Transit Development, which was formerly the Regional Transit Board), and the private partners. The largest source of funding for this operational test was the U.S. DOT, which contributed 59 percent of the money. The private partners contributed 25 percent of the resources necessary for implementing this project. The Metropolitan Council contributed 12 percent, and Mn/DOT provided four percent. Table 7.1, below, identifies the sources of funding.

■ 7.2 Overview of Expenses

There were 13 cost categories in the Travlink Operational Test, as listed in Table 7.2. Costs either were invoiced to the project directly or were paid for by a project partner as an in-kind contribution. The following section describes these costs and how they were paid.

Table 7.1 Summary of Travlink Operational Test Funding

Project Partner	Amount Contributed	Percent of Operational Test Total
U.S. Department of Transportation		
Federal Highway Administration	3,717,500	
Federal Transit Administration	400,000	
Federal Total	**4,117,500**	**59**
Minnesota Department of Transportation	255,620	4
Metropolitan Council Transit Development	750,000	12
Metropolitan Council Transit Operations	70,350	
Private Partners		
Transportation Management Solutions	1,000,292	
U S West	560,125	
Motorola	82,068	
Rennix (3M)	91,850	
ETAK	27,500	
Private Partners' Total	**1,761,835**	**25**
Operational Test Total Funding	**6,955,305**	

Table 7.2 Summary of Travlink Operational Test Expenses

Item	Invoiced Amount	Partner Contribution	Total Cost
Marketing and Research	$139,152	$0	$139,152
Systems Integration	380,000	0	380,000
Project Management	472,533	0	472,533
CAD/AVL System	1,383,620	0	1,383,620
ATIS System	1,675,945	1,000,292	2,676,237
ATIS On-line	128,578	560,125	688,703
AVI System	150,817	91,850	242,667
Radios	277,300	82,068	359,368
Mapping	30,000	27,500	57,500
Travel and Training	2,964	0	2,964
Mn/DOT Salaries	229,256	0	229,256
MCTO Salaries	0	70,350	70,350
Evaluation	252,955	0	252,955
Operational Test Total Expenses	**$5,123,120**	**$1,832,185**	**$6,955,305**

The cost associated with marketing and market research for the operational test was $139,152. This amount included costs for focus groups, recruiting activities for Travlink On-line participants, and public information activities such as exhibits at conferences. This cost came in under the pre-project estimate of $150,000.

The systems integration for the Travlink Operational Test was carried out by Transportation Management Solutions (TMS), which was a branch of Westinghouse Electric Company at the beginning of the project. The cost of systems integration was $380,000, which was 56 percent higher than the original estimate of $250,000. This increase over the earlier estimate was primarily due to additional tasks that came up over the course of the project that had not been anticipated at the beginning of the project.

The SRF Consulting Group, Inc., carried out the project management for the Travlink Operational Test at a cost of $472,533. This amount was about four percent higher than the original estimate of $450,000 for this task.

The cost of bringing the CAD/AVL system on line was approximately $1.4 million. Items paid for as part of the CAD/AVL systems included the workstation at MCTO, the GPS devices on the 80 buses, the IVLU devices on the buses (for calculating schedule adherence), and the computer software for running the system. This component of the Travlink Operational Test came in five percent under the original estimate of $1,462,000.

The cost of providing passengers (and potential passengers) with real-time travel information amounted to almost $2.7 million. This was the cost of the ATIS system, which provided information via the kiosks, video monitors, and electronic signs. In addition to these hardware items, this amount also included the costs associated with the ATIS workstation at the Transportation Management Center (TMC), the fiber optic link between MCTO and TMC, the software and the software development for running the system and for interfacing with the CAD/AVL system, the construction of kiosk and sign structures, telephone lines to kiosks, monitor and sign locations, furniture for the equipment at TMC, and the value of the warranty for the equipment. This system came in slightly higher (five percent) than the original estimate of $2.5 million.

The cost of providing the Travlink On-line service (i.e., making the ATIS information accessible by videotext terminals or personal computers) was about $690,000. This cost covered 200 videotext terminals, a bank of 30 modems at TMC to connect Travlink On-line users with the ATIS computer, the software to make this connection possible, as well as demonstrations of this service at the Minnesota State Fair and the annual ITS America conference. The value of U S West Community Link personnel time was also included in this amount. The costs associated with this part of the operational test were 45 percent greater than originally expected, but the private partner, U S West, covered the majority of these additional expenses as reflected in their contribution.

Included in the total cost of the Travlink Operational Test was the amount of money spent on an element of the project that was not fully implemented: the AVI and signpost system. The public and private partners spent about $243,000 towards the development of this system. However, due to complications related to the interaction of on-board infrared emitters and traffic signals, this element of the project was discontinued. The estimated amount of $232,000 to be spent on this element was exceeded by five percent before work was stopped.

New radios were required on the 80 AVL-equipped buses so that the CAD/AVL system at the MCTO Control Center could communicate with the bus drivers. Motorola provided these radios at a total cost of about $359,000. Motorola's contribution to this total cost was $82,000, which included discounts on equipment and the value of the site license. The estimate for these radios at the beginning of the project was $300,000.

During project development, the project team realized that a computerized map of the I-394 corridor would be necessary. This map and related services were provided by ETAK, a California cartography firm. ETAK's contributions to the operational test were a 50 percent discount on the standard license fee and a 33 percent discount on the annual maintenance fee which amounted to $27,500. ETAK invoiced the project for $30,000, making the total cost of these mapping services $57,500. This cost was not anticipated at the beginning of the project.

The Minnesota Department of Transportation spent approximately $229,000 on salaries for personnel over the three-year duration of this project. A large part of this sum went towards paying the salaries of the project manager and the ATIS system administrator. Other Mn/DOT personnel who worked on this project were in marketing, engineering design, land surveying, programming, and personnel in the electrical services unit. Prior to implementing the operational test, Mn/DOT did not report an estimate of the salaries for its personnel. Travel and training expenses for Mn/DOT personnel involved in the Travlink Operational Test amounted to less than $3,000. This amount is less than the $5,000 originally estimated.

The evaluation cost was $253,000. This amount covers the cost of the development of the Evaluation Plan, data collection efforts (including Travlink user surveys, focus groups, etc.), data analysis, and the production of the Evaluation Report. This amount was the same as the anticipated evaluation cost at the beginning of the project.

8.0 Summary and Conclusions

8.0 Summary and Conclusions

Travlink was a complicated project that involved nine public and private partners working together to design and operate a passenger information system that combined an automatic vehicle location system (AVL) and an advanced traveler information system (ATIS) for the first time in an urban public transit environment. Section 8.1 reviews the objectives stated at the outset of the Travlink project and discusses to what extent they were met in the operational test. Section 8.2 describes the conclusions the team partners reached through their participation in the Travlink project. Finally, Section 8.3 provides recommendations for future applications of Travlink technologies in the Twin Cities area.

■ 8.1 Travlink Objectives and How They Were Met

The general national objectives for Advanced Public Transportation Systems (APTS) projects and the specific local objectives for the Travlink project were outlined in the *Travlink Operational Test Evaluation Plan*. These objectives can be summarized as follows:

- Improve customer information;
- Improve safety, security, and incident response;
- Improve transit operations;
- Improve management information systems;
- Observe various APTS devices under actual operating conditions;
- Reduce worker stress and increase job satisfaction;
- Increase HOV use and ridership;
- Advance system design and integration; and
- Develop an effective information dissemination process.

The following is a discussion of these local and national objectives and the extent to which they were met in the Travlink Operational Test. The ways in which the Travlink project was successful at meeting these objectives or the mitigating circumstances that prevented objectives from being met are also discussed.

Improve Customer Information

One objective of the national APTS operational test program is to enhance the quality of on-street service to customers by improving the quality, timeliness, and availability of customer information. This national objective corresponds to the local objectives of increasing the ways that customers can access information and the outlets for doing so, and making the information more timely, flexible, and pertinent to customers needs.

Travlink made strides toward improving customer information. Customers had three new sources of transit information: interactive kiosks at three downtown locations, video monitors and electronic signs at park-and-ride lots, and a computer on-line service providing bus schedules and other transit information. To some extent, Travlink also improved the quality and timeliness of transit information by providing real-time transit information. Usage indicators suggest that kiosks were used moderately, the electronic signs and monitors at the park-and-ride lots were not referred to extensively, and the Travlink On-line service use declined during the 12-month operational test.

- During the initial two months that they were on-line, the kiosks were used lightly, but for the remainder of the operational test, people used them to access more than 1,000 screens per month, except for those months when one or more of the kiosks were not in operation for all or part of the month (i.e., June, July, and November).

- Passenger surveys indicated that few passengers consulted the signs and monitors on a regular basis. Only about fifteen percent of the passengers boarding at three park-and-ride lots during the two-day survey period in December 1995 consulted the electronic signs and monitors. (Note that the passenger survey was conducted about a month and a half after the bus strike in October, which may have had some impact on the passengers' behavior.)

- The 212 people who had access to the on-line service indicated through surveys, focus groups, and their actual use that they used these information outlets less frequently as time progressed. In July 1995, 174 of the registered users logged on to the Travlink On-line service. By September, that number had dropped to 75. In October, the number of users accessing the service increased to 94 despite the bus strike. In November, only 26 registered users logged on during the first half of the month, and then the service was discontinued in the middle of that month. In addition, the number of times each user logged on, and the number of screens accessed per log-on also declined. In August, log-ons per user averaged 5.2, and screens per log-on averaged 7.0. These ratios continued to decline until the service was discontinued, except that screens accessed per log-on increased from October to November from 5.5 to 6.4.

One possible explanation for the declining use of Travlink electronic or on-line information was that real-time information was not provided consistently. For example, in many instances the buses operating in the Travlink corridor were not AVL-equipped, and so the Travlink system could not report on their real-time status. There were also some periods during which transit schedules and real-time status information were not available through the on-line service due to quarterly Metropolitan Council Transit Operations (MCTO) schedule changes that required a period of re-programming into the ATIS database.

A total of 80 buses were instrumented with AVL capabilities, which was sufficient for the major bus routes operating on I-394, plus spares. However, competing demands for some of these buses to be operated on routes outside the I-394 corridor made it operationally difficult for the MCTO to provide full AVL coverage on I-394. (MCTO operates with a fleet spare ratio much lower than that of industry norms.) Since Travlink could report only on AVL-equipped buses, it reported “no status” for all non-AVL-equipped buses in the I-394 corridor. This limited the amount of new information that Travlink made available to customers.

The lack of an automated interface for the test between the MCTO’s schedule database and the ATIS database (due to budget constraints) adversely affected ATIS service quality. Sometimes there was a lag of up to a month between the schedule change for buses and the time when the new schedule appeared on video monitors, electronic signs, kiosks, and on the on-line service. This lack of consistent information was undoubtedly a major factor contributing to the decline in use of Travlink On-line and to the relatively small proportion of bus riders making use of the monitors and electronic signs at park-and-ride lots.

It should also be pointed out that the need for improved transit information in the I-394 corridor may not be as high as in other corridors for existing riders. I-394 has fairly frequent peak-period commuter service to downtown Minneapolis. Passengers generally travel only to and from work or school, and they likely know their bus route’s schedule. In addition, service is fairly reliable since the buses travel mostly in HOV lanes with few traffic delays to disrupt service schedules. However, neighborhood or arterial collector segments on some I-394 bus routes do incur delays.

Because of the moderate need for transit information along I-394 and the disruptions in information provision, transit riders may not have perceived significant added value in the information provided by Travlink. However, carpoolers and drive-alone users of the on-line service accessed bus schedule information at a fairly high rate, indicating a demand for this type of traveler information among non-transit riders. Advances in traveler information were made through the Travlink Operational Test. Travlink demonstrated that ATIS and AVL technologies can be integrated to provide customers with real-time transit information, along with real-time traffic conditions. For Travlink, acceptance of the ATIS was strongly affected by local circumstances and the reliability of the ATIS service.

Improve Safety and Security

On both the national and local levels, improvements in safety and security for passengers and bus operators are objectives for projects such as Travlink. The national objective was to enhance the quality of on-street service to customers by improving safety and security as well as by improving response to incidents and vehicle or facility failures. The local objectives included evaluating the functionality and integration of ATIS/AVL into MCTO's transit control and security systems.

At the beginning of the project, the evaluator and project team members did not anticipate that the Travlink project would demonstrate significant improvements in the safety and security of bus drivers and passengers in the I-394 corridor. Being a peak-period suburban-to-downtown commuter service, the safety and security incidents on MCTO buses in this corridor are minimal. However, one incident did occur on an AVL-equipped bus, which demonstrated the potential of this technology to improve safety and security. In this incident, the MCTO Transit Control Center (TCC) received a silent alarm from a bus indicating a problem. The TCC supervisors realized that this bus was an AVL-equipped bus and used the AVL map to locate the bus' actual location. This information was passed on to the MCTO police. The police responded and met the bus. A man on the bus was verbally threatening the driver. The police arrested the passenger before his threats escalated to an assault. If this situation had occurred on a non-AVL-equipped bus, the TCC would have had to direct the police to begin looking for the bus based on its scheduled rather than actual location. As a result, precious time would have been lost, and the outcome may not have been as favorable.

Improve Transit Operations

Two of the national objectives were related to improving operations. One national APTS objective was to enhance the quality of on-street service to customers by increasing service reliability, and the other was to improve transit system productivity by improving schedule adherence. Likewise, there was a local objective to evaluate the impact of AVL on service-efficiency and quality, including on-time performance.

The Travlink Operational Test did not demonstrate conclusively that service reliability was improved. However, based on their experience with Travlink, the transit managers recognize how service reliability could be improved if an AVL system were put in place and used to its fullest capabilities, allowing them to better monitor operator performance and to keep service moving.

A comprehensive study of whether Travlink could improve schedule adherence was not possible because of the limited number of AVL-equipped buses consistently deployed in the corridor. However, the operational test did demonstrate how Travlink could collect schedule adherence data in a much more efficient manner than the current manual way of monitoring schedule adherence.

On two occasions, MCTO managers used the information provided by Travlink to identify bus drivers who were not performing their duties correctly. The vehicle run data that the CAD/AVL system provided corroborated the managers' suspicions that the two drivers were intentionally not staying on schedule. This resulted in these bus drivers being reprimanded.

Improve Management Information

The improvement of management information for the transit system was included as both a national and a local objective of the Travlink project. The national objective of improving system productivity includes improving the timeliness and accuracy of operating data for service planning and scheduling, providing integrated information management systems, and developing improved management practices. The local objective related to improving management information includes evaluating the functionality and integration of ATIS/AVL into MCTO's service planning and information systems.

This objective was not directly addressed in the Travlink Operational Test. Each public transit agency has their own unique information needs based on their operations and agency procedures. Because this was an operational test funded only for one year of operation and was limited to a single service corridor, the development of a comprehensive and useful management information system using the AVL system was not feasible. MCTO staff and the software vendor indicated that if the agency were to bring an AVL system on-line permanently, they would invest the time and resources necessary to develop specifications for useful management information software.

One factor limiting MCTO's full use of the technology was the inability to provide sufficient staff needed to operate the control center workstation. Originally, the plan was to hire a full-time person who would spend at least 80 percent of his/her time at the CAD/AVL workstation. However, because of budget cutbacks at MCTO, this position was never filled, and the control center supervisors rotated coverage of the workstation. The coverage was given lower priority than other tasks. As a result, the CAD/AVL workstation was not used to its fullest capabilities.

Observe APTS Technologies under Actual Operating Conditions

Both the national and local objectives for the Travlink project included an assessment of how APTS technologies perform under normal operating conditions. The national objective was described as showcasing successful APTS innovations in model operational tests. The local objective was described as determining the performance of the selected technologies in the real world environment in terms of accuracy, timeliness, and reliability.

The Travlink Operational Test clearly demonstrated how two APTS technologies, AVL and ATIS, perform together under actual operating conditions. The AVL and ATIS technologies were linked to provide information to daily commuters about the location and status of the buses they planned to board along with real-time traffic conditions and other static traveler information. When AVL-equipped buses were assigned to routes in the I-394 corridor, ATIS accurately reported the real-time running status of each bus.

A third APTS technology, an automatic vehicle identification (AVI) signpost system, was originally planned to be tested under actual operating conditions as a part of the Travlink Operational Test. However, due to interference this technology caused with traffic signal preemption at certain intersections, this part of the operational test had to be discontinued.

Reduce Worker Stress and Increase Job Satisfaction

The national objectives include the expectation that worker stress would be reduced and job satisfaction would increase as a result of the implementation of APTS technologies. The local objectives did not include a similar objective.

There is no evidence that the Travlink project had any impact on worker stress or job satisfaction. Anecdotally, the manager of the Transit Control Center suggested that the addition of the workstation to the already busy control center increased stress levels, although this was due primarily to lack of staff to operate this workstation. Originally, MCTO planned to hire an additional control center supervisor to staff the Travlink workstation, which would have alleviated any additional job responsibilities on existing staff. Due to budget constraints, however, this position was never filled. If the APTS technologies had been implemented fully and had been adequately staffed, control center staff would have had access to more and better information about the location and status of the buses they were supervising, which could have reduced stress and increased job satisfaction.

The bus drivers did not indicate any change in stress or job satisfaction in their responses to the Travlink survey. The evaluator had anticipated that the impacts of Travlink on bus drivers would be neutral at the outset of the project.

Increase HOV Utilization

The national objectives include the expectation that high-occupancy vehicle (HOV) use would increase as a result of the implementation of APTS technologies. The corresponding local objective was to increase the number of transit users.

It is not possible to say whether Travlink led to an increase in transit ridership in the I-394 corridor because other, stronger influences affected transit ridership. In April 1995, just as many of the Travlink features were coming on-line, MCTO cut its bus service by about a third in the I-394 corridor because of budget constraints. Also, towards the end of the operational test in October, MCTO bus drivers went on strike. As a result, transit service was completely halted for a month. Due to these extenuating circumstances, no definitive statement can be made about Travlink's impact on I-394 corridor transit ridership or on HOV use.

Advance APTS System Design and Integration

One of the national objectives of the APTS program is to assist transit agencies in APTS system design and the integration of APTS technologies into actual transit operations. Although this was not a specifically-stated objective at the local level, many of the participants viewed Travlink as an opportunity to learn more about AVL and ATIS technologies and how they might fit into transit operations in the Twin Cities.

The Travlink project was the first operational test that combined the two APTS technologies, AVL and ATIS, to provide real-time bus information to passengers and transit managers. The Travlink project clearly advanced the knowledge base of transportation professionals concerned with APTS innovations. Both public and private sector participants expanded their knowledge about how these technologies work together, which will allow them to improve upon the implementation of future projects that make use of the technologies tested in the Travlink project.

Develop an Effective Information Dissemination Process

The Minnesota Guidestar Office carried out extensive public information efforts to disseminate information about the Travlink Project. Travlink was publicized via television, radio, newspapers, magazines, trade journals, trade shows, as well as presentations to various groups. Appendix B lists the many appearances the Travlink Project made in the media.

■ 8.2 Findings

Through the implementation of the Travlink project, the evaluator reached the following conclusions regarding the application of AVL and ATIS technologies in the public transit setting:

- All buses running on routes for which ATIS reports the status must be AVL-equipped. One of the major advantages of the Travlink system was that it provided real-time information to passengers and transit managers. But the system can only provide real-time information for those buses that are logged onto the AVL system. Every time ATIS reports "no status," the value of the system as a source of information for travelers is diminished.

- CAD/AVL technology is generally accurate and reliable. All participants agreed that the AVL technology accurately located buses when the buses were logged onto the CAD/AVL system.

- The interface between the bus schedule and route information and the AVL/ATIS system has to be as seamless as possible, and the ATIS software has to allow for normal and frequent modifications in transit schedules. Data needs to flow quickly and easily from one system to the other for the information to remain accurate and valuable. If data transfer and/or updates take more than a few hours, the resulting "no status" reports would diminish the credibility of the system among travelers as a source of information that can be relied upon.

- CAD/AVL systems are complex and all components of the system must be coordinated and work together. The AVL system accurately reported the location of buses. However, when the inputs to the Travlink system, such as route schedules or base maps, did not reflect actual operating schedules or routes, Travlink reported the bus off schedule or off route.

- Reports and other information outputs from the CAD/AVL system need to be designed to provide operational information in a format that is useful to transportation managers. The AVL system has the capability of gathering schedule adherence data and other types of operational data, but the system needs to present these data in a clear and manageable format both on-screen and in printed reports in order to be valuable to transit managers.

- Information provided by ATIS is useful to some travelers, and people are willing to pay for certain features. Of the people who had access to ATIS via the Travlink On-line service, 53 percent said the service was a better source of transit information than the transit agency's bus information telephone line. Travlink On-line users also indicated they are willing to pay small monthly fees ($1.00 to $7.00) to receive travel information on-line covering such topics as traffic delays, weather, bus on-time status, and bus trip planning.

- It is difficult to isolate the impacts of a system such as Travlink on transit ridership due to a variety of factors influencing ridership. However, such systems may be useful as part of a customer information and marketing program.

- CAD/AVL systems require full support and participation of all the agencies and companies involved in providing the service. The successes in the Travlink project were a result of project partners honoring their commitments and participating as team members. The value of the system declined when one or more of the participants did not carry through with one of their responsibilities to the project.

- Dedicated staff are necessary. New technology requires new skills. Staff need training and time to gain experience in the use of new technology. If other responsibilities prevent staff from spending time with the new CAD/AVL system, additional staff may be necessary to take full advantage of the technology.

- The AVL system offers significant safety advantages to a transit system. Knowledge of the exact location of each vehicle at any time is extremely valuable in emergency situations, including vehicle breakdowns, medical emergencies, and crimes. When such incidents occur, the AVL system can prove very valuable in resolving the situation.

■ 8.3 Recommendations

The Travlink Operational Test demonstrated some useful aspects of the combination of AVL and ATIS technology. However, the way in which the project was implemented imposed limitations on the ability of the system to achieve its full potential in terms of expected benefits. There was general agreement among the partners that if such a system were to be implemented on a permanent basis (rather than as a one-year operational test) these benefits would be realized. The evaluator recommends that the Travlink concept be deployed on an expanded basis (e.g., an entire operating division, garage, or service area, if not the entire MCTO system) under conditions that would allow full implementation. The following points outline the recommendations that should be met for any future implementation of a Travlink concept system.

- The transit operator ensures that all buses on routes for which ATIS provides information are AVL-equipped.

- The bus routes chosen are a diverse set of routes, including local service routes to all types of neighborhoods so that the AVL/ATIS system can demonstrate its capabilities in a variety of situations.

- The transfer of data between the transit authority's scheduling system and the AVL/ATIS system is streamlined so that data can be downloaded from one system to the other quickly, resulting in user interfaces, such as screens and printed reports, that are updated and meaningful to transit managers.

- Adequate funding is available for hiring and training the staff necessary for operating the system and for customizing user interfaces so that the information is useful for transit managers.

- Transit schedules and real-time transit information is integrated into a multimodal ATIS service, as it was in the Travlink Operational Test. The advantage of any ATIS service is that travelers can make well-informed decisions on how to get from one place to another based on complete information about the full range of transportation options.

- To the extent possible, the traffic and transit information services are integrated with one of the many commercial on-line services, such as America On-line, etc. As indicated by the on-line users' responses to the conjoint survey, most users are willing to pay for traffic and transit information.

- In addition to the other menu choices, transit trip planning is a capability of the kiosks and computer on-line service. This capability would allow users to identify their current location and their desired location, and then the software would tell them what bus(es) to take to make the trip.

- Passenger information screen displays, such as those on the kiosks and the computer on-line service, include maps and other useful graphics.

Appendix A

Synopsis of *Institutional Issues: Public-Private Partnerships and the Minnesota Guidestar Travlink Operational Test*

Synopsis of *Institutional Issues: Public-Private Partnerships and the Minnesota Guidestar Travlink Operational Test*

The Travlink project was formulated through a public/private partnership. The evaluator produced a separate report entitled, *Institutional Issues: Public-Private Partnerships and the Minnesota Guidestar Travlink Operational Test,* which describes the process used to evaluate the institutional issues, the results of the process, and a summary of key issues and lessons learned. The key objectives of the analysis were to assess whether the public/private partnership mechanism was the most effective implementation mechanism for a project such as Travlink, and to identify the extent to which the partnership structure facilitated the project. The analysis was based on interviews with project participants.

Some of the issues examined in the report included the formulation of the partnership process, the expectations of the participants, legal issues and other issues and stumbling blocks, what participants liked most and least, how much time participants spent on the partnerships, what participants would change about the process, comparison of the public/private partnership process with the traditional Request for Proposal (RFP) process, and advice for those undertaking a public/private partnership.

The most interesting finding overall was that although all of the participants noted problems associated with public/private partnership agreements, all of the private partners, and several of the public participants have been involved in at least one, if not several, partnership agreements since Travlink.

Many of the participants, both public and private, expected different (and better) working relationships to develop from the public/private partnership process. Several of the participants expected that the partnership process would allow them to explore new technologies and bring them to a test market more quickly and with less risk than would a traditional approach. It was also expected that the partnership would allow the public sector to explore these technologies while leveraging public funds.

The major stumbling blocks to carrying out the agreements were legal issues. The key issues of concern included proprietary issues and property rights, copyright and ownership, license agreements, confidentiality, and ability to carry out partnership agreements under Minnesota enabling legislation. The key non-legal stumbling blocks identified included the turnover of key staff mid-way through the project, internal staff resources and competition, obtaining senior level buy-in, and lack of a single project manager.

Among the positive benefits of the partnership approach were creativity and flexibility, the ability to share information and resources, the ability to share risks, the ability to test leading-edge technology, and the funding potential associated with private sector contributions. Among the negative impacts were the inability to control private vendors and enforce the agreement, the lack of profit for private vendors, the difficulties associated with team decision making, and the length of time involved in developing and executing the agreements.

Appendix B

List of *Travlink* Public Information Efforts

List of *Travlink* Public Information Efforts

■ B.1 Television

CNN	April 1994
KARE	Monday, November 21, 1994
WCCO	Wednesday, December 14, 1994
KARE	Thursday, December 15, 1994
KMSP	Thursday, December 15, 1994
KSTP	Tuesday, January 10, 1995

■ B.2 Newspaper, Magazine, Trade publications

FTA Technical Brief	January 1994
Inside IVHS	Monday, March 28, 1994
The RTB Messenger	Summer 1994
ITE North Central	Summer 1994
Mn/DOT Express	June/July 1994
Mn Guidestar monthly	July 1994
MCTO Takeout	October 1994
U S WEST Today	October 1994
Passenger Transport	Monday, November 14, 1994
Star Tribune	Monday, November 21, 1994

St. Paul Pioneer Press	Monday, November 21, 1994
Mn/DOT Today	Monday, November 28, 1994
USA Today (USA and international)	Monday, November 28, 1994
Mass Transit	November/December 1994
Mn/DOT Today's News	Thursday, December 15, 1994
Mn/DOT Today's News	Wednesday, January 9, 1995
St. Paul Pioneer Press	Monday, January 9, 1995
Skyway News	January 24-30, 1995
Radio Resource	March 1995
Mn/DOT Express	March 1995
Government Technology	March 1995
GPS World	October 1995
U.S. DOT "Traveling with Success"	October 1995
PTI Prism	December 1995
Inside ITS	December 1995
ITE Journal	June 1996

■ B.3 Radio

Mn/DOT Minute	Friday, November 10, 1994
WGEM, Quincy, IL	Tuesday, December 6, 1994
Voice of America	Monday, December 12, 1994
KNOW (MPR)	Tuesday, January 10, 1995
WCCO AM	Tuesday, January 10, 1995

■ B.4 Small Group Presentations

IVHS North America Study Tour, 1994

I-95 Corridor coalition IVHS Tour, 1994

UK Parliamentary Roads Study Group, 1994

New Technology Forum – Mn/DOT, 1995

Enterprise Tour, 1995

Detroit Suburban Mobility Authority for Regional Transportation (SMART) Group, 1995 (tour also)

Cedar Rapids Transportation Group, 1995 (tour also)

■ B.5 Trade Shows

During the past three years, Travlink has been demonstrated at numerous trade shows and conferences, including:

- FHWA/FTA Transportation Fair, Washington, D.C., 1994
- ITS America, Washington, D.C., 1993 and 1995; Atlanta, GA, 1994; Houston, TX, 1996
- 2nd Annual Minnesota Guidestar Forum, Rochester, MN, 1995
- Center for Transportation Studies Conference, Minneapolis, MN, 1994, 1995
- APTA Bus Operations Conference, Reno, NV, 1995
- Tech Trans Conference, Las Vegas, NV, 1995
- GIS in Transit Conference, Tampa, FL, 1995
- ATMS Workshop, St. Petersburg, FL, 1995
- GPS User's Conference, Minneapolis, MN, 1995
- Pacific Rim Trans Tech Conference, Seattle, WA, 1995
- Public Transit Conference, OH, 1995

- ITE Annual Meeting, Denver, CO, 1995

- Scheduled to present at:
  - ITE Annual Meeting, Minneapolis, MN, 1996
  - Third Annual World Congress on Intelligent Transport Systems, Orlando, FL, 1996

B.6 Miscellaneous

Presented Travlink information to individuals from Norway, Sweden, Finland, Japan, Vietnam, Romania, and the United States.

Discussed Travlink with individuals working on reports for FHWA.

Mailed information packages to approximately 100 individuals worldwide.