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International Transit Studies Program Report on the Fall 1997 Mission Applications of Intelligent Transportation Systems to Public Transit in Europe

This TCRP digest summarizes the seventh mission performed under TCRP Project J-3, "International Transit Studies Program " The report includes information on the cities visited and the lessons learned and discusses policies and practices that could be used in the United States. This digest was prepared by Tracy E Dunleavy of the Eno Transportation Foundation, Inc., the contractor for the project, on the basis of reports filed by the mission participants. For information on prior ITSP missions, consult TCRP Research Results Digests 20, 22, and 27

INTERNATIONAL TRANSIT STUDIES PROGRAM

About the Program

The International Transit Studies Program (ITSP) is part of the Transit Cooperative Research Program (TCRP). ITSP is managed by the Eno Transportation Foundation under contract to the National Academy of Sciences (NAS). TCRP was authorized by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and reauthorized by the Transportation Equity Act for the 21st. Century (TEA-21). In May 1992, a memorandum of agreement outlining TCRP operations was signed by the NAS, acting through its Transportation Research Board (TRB); the Transit Development Corporation (TDC), which is the education and research arm of the American Public Transit Association (APTA); and the Federal Transit Administration (FTA). TCRP is funded annually by a grant from the FTA.

ITSP is designed to assist in the professional development of transit managers, public officials, planners, and others charged with public transportation responsibilities in the United States. The program accomplishes this objective by providing opportunities for participants to learn from foreign experience, while expanding their network of domestic and international contacts for addressing public transport problems and issues.

The program arranges study missions in which teams of public transportation professionals visit exemplary transit operations in other countries. Each study mission focuses on a central theme that encompasses issues of concern in public transportation. Cities and transit systems to be visited are selected on the basis of their ability to demonstrate new ideas or unique approaches to handling public transportation challenges reflected in the study mission's theme. Each study team begins with a briefing before departing on an intensive, 2-week mission. After this stimulating professional interaction, study team members return home with ideas for possible application in their own communities. Team members are encouraged to share their international experience and findings with peers in the public transportation community throughout the United States. Study mission experience also helps to evaluate current and proposed transit improvements and can serve to identify potential public transportation research topics.

Study missions normally are conducted in the spring and fall of each year. Study teams consist of up to 15 individuals, including a senior official designated as the group's spokesperson. Transit agencies are contacted directly and asked to nominate candidates for participation. Nominees are screened

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by a committee of transit officials, and the TCRP Project J-3 Oversight Panel approves the selection.

Study mission participants are transit management personnel with substantial knowledge and experience in transit activities. Participants must demonstrate potential for advancement to higher levels of public transportation responsibilities. Other selection criteria include current responsibilities, career objectives, and the probable professional development value of the mission for the participant and sponsoring employer. Travel expenses for participants are paid through TCRP Project J-3 funding.

For further information about the study missions, contact TCRP (202/334-3089) or the Eno Transportation Foundation (202/879-4700).

About the Report

The following report is an overview of the seventh study mission. This report reflects the views of the contributing participants, who are responsible for the facts and accuracy of the data presented. The report does not necessarily reflect the views of TCRP, TRB, NAS, APTA, FTA, or the Eno Transportation Foundation.

Appendix A lists the names of the study mission participants and their titles and affiliations at the time of the mission.

APPLICATIONS OF INTELLIGENT TRANSPORTATION SYSTEMS TO PUBLIC TRANSIT IN EUROPE: MISSION 7, OCTOBER 10--OCTOBER 26, 1997

Introduction

The innovative programs implemented in the cities visited by the seventh study mission demonstrate that Intelligent Transportation Systems (ITS) technology is an effective mechanism to obtain better use of existing infrastructures and resources. Many of the same or similar technologies are being applied in the United States--European experience provides further perspectives. The 2-week mission--with meetings and site visits in London and Southampton (United Kingdom), Paris (France), and Berlin and Munich (Germany)--examined the latest applications of ITS technology to public transit in major European countries and culminated in technical sessions and inspections organized as part of the Fourth World Congress on Intelligent Transport Systems in Berlin. Although ITS applications constituted the primary focus of the mission, participants also observed broader European transportation policies and management styles (e.g., privatization in the United Kingdom, and modal integration in all countries visited).

In the United Kingdom, for instance, public transit agencies, which formerly operated transportation systems, have been transformed into managers of private sector companies that control the daily operations of these systems. These public transit agencies see themselves as overall mobility managers rather than taking the traditional view that public transit and automobiles serve separate markets and do not benefit from mutual cooperation.

Modal integration was observed in all three countries visited. Integration extends beyond the transportation network itself. The information gathered through ITS technology is supplied to the media, informing motorists and transit riders how the transportation network is operating and when a change of mode would best serve the traveler.

Transit agencies in the cities visited strive to treat every individual who travels as a customer of the transit system--transit user and nontransit user alike. When road congestion occurs or major events take place, diversion of motorists to transit is encouraged through the use of variable message and changeable direction signs. Investing in and shifting riders to public transit is not viewed as shortchanging the road network or unnecessarily diverting transportation funds to public transit. Rather, investment in public transit is viewed as valuable because it helps maintain ease of mobility throughout the urban region.

The development of traffic management in the communities the mission visited evolved from the recognition that multiple modes of transportation are required to manage anticipated population and vehicle use growth. There is clear recognition that anticipated congestion problems can not be addressed by simply building more transportation infrastructure, which would be expensive and not environmentally friendly. ITS technologies are viewed as tools to integrate all modes of transportation so as to maximize use of the existing infrastructure to move people.

Public transportation agencies within the European community are significant public policy stakeholders and are involved in most aspects of community development. Procurement practices allow the various systems to identify and select project partners to implement ITS projects quickly. These transit systems focus resources on research to define consumer needs in order to involve the public as active partners in the development of their overall mobility plans.

Specific examples of these intermodal policies were observed in all of the cities visited. In London and Southampton, real-time bus tracking and passenger information systems are operational, as well as motor vehicle traffic control and incident detection. The COUNTDOWN and STOPWATCH systems in the United Kingdom indicate that providing comprehensive real-time customer information systems is critical in increasing the attractiveness of public transit systems. Information based on static data (e.g., timetables) is not useful in the event of disruptions, but dynamic information, updated in real-time, improves public perception of the reliability of mass transit and removes a major objection to using public transportation. Paris METRO riders benefit from ALTAIR (a real-time information system comparable to STOPWATCH), from a

contactless smartcard fare payment program, and from an ITS-based security system. Parisian motorists benefit from an advanced traffic control system. All travelers benefit from passenger information systems.

In Berlin, ITS applications include computer-aided traffic control and dynamic parking guidance systems, along with ITS-based transit fleet management and route guidance techniques. Munich travelers benefit from a park-and-ride management system and ITS demonstration projects supported by BMW, the auto manufacturer based in Munich.

UNITED KINGDOM

London

Transit Profile

The public transportation systems in London are managed by London Transport (LT) which is controlled by a government-appointed Board. LT's mandate is to plan and then provide or procure services to meet the current and future public transport needs of the city. The systems under control of LT are as follows.

- London Underground (Metro). This 237-mile-long metro rail system is the oldest in the world. The system carries 2.5 million passengers per day and has a farebox recovery ratio of 120 percent before depreciation and debt service. The system, however, has significant capital needs in order to maintain and modernize its infrastructure. The capital needs range from refurbishing and buying new cars to the completion of a 10-mile extension of the Jubilee Line to making the system more accessible to individuals with disabilities. The system operates with 3,922 rail cars with 261 stations; 165 six-car trains are on order.

  Funding for many of the capital needs is being addressed with innovative partnership arrangements with the private sector under the government's "Private Finance Initiatives." These initiatives include financing arrangements, such as leases, and private financing, which includes construction and maintenance of rail cars under long-term service contracts.
- London Transport Buses (LTB). London's bus transportation services were privatized in 1994, and LTB was set up as a separate company. In 1994, the publicly owned London Buses were sold to 32 private operators for a total of $356 million. LTB carries 3,700 million passengers per day on some 6,500 buses serving more than 700 routes. With higher fares and tighter financial controls (which included reduced wages and increased work hours), the private carriers helped to reduce the operating deficit by one-third. LTB is responsible for planning routes and fares, procuring services from private bus operators, and ensuring that bus operators fulfill their contracts. LTB is also responsible for the provision and control of all bus terminals, bus stands, bus stops, and bus shelters. Last year, LTB reported an operating cost recovery ratio of 85.5 percent.
- Suburban Rail. Suburban rail operations serving the London region are provided by several private operating companies. In addition to these companies, several light rail projects are underway.

  The Cross Rail project, still in its planning stages, is a new rail line that will link certain northern, eastern, and western lines to central London, to Heathrow Airport, and to high-speed international rail service that uses the "Chunnel." Virtual reality software is being used to design the project. Three-dimensional simulation and rendering allow engineers to simulate station use, resolve overloading issues, test evacuation plans, verify drawings, assist in training, and communicate station design to the community and intended passengers.

  British rail systems had also been privatized with one central organization--Rail Track--owning the infrastructure, including the track and signaling system. The private operators have long-lease franchises. They are also held to certain performance standards, which include timeliness and safety. Operators are subject to monetary penalties for noncompliance.

  Rail Track is the newly privatized operation that owns and operates the infrastructure of the United Kingdom's rail system. Rail Track operates the rails, signals, crossings, tunnels, stations, and bridges. The rolling stock is operated by 25 operating companies, which have long-lease franchises, and the operations are subsidized; these subsidies will decrease over time. In addition, six maintenance businesses and seven track renewal contractors are involved in this operation. Our contact, Professor Brian Mellitt, reported that Rail Track is engaged in a 10-year major investment program that will include many ITS applications and a general transformation of the system to make it safer and more accountable for meeting certain performance and financial objectives.

Automatic Vehicle Location

An automatic vehicle location (AVL) system, which enables LTB to know where any bus is at any given time, is central to London's Intelligent Transportation Network. With AVL in place, many other opportunities for service are possible, including giving buses priority at traffic lights and having on-bus signs to provide passengers with details of the next stop.

London Transport uses a sign post or beacon system with 10 beacons along each route. London Transport adopted this system rather than the more current GPS systems because of initial GPS tracking difficulties in areas with high buildings and covered stations.

COUNTDOWN

COUNTDOWN is London's real-time passenger information system. COUNTDOWN uses screens at bus stops to inform passengers when the next bus will arrive. The AVL system provides operators and LTB with real-time information on the position of buses and their progress along the route. Operators use this information to help control the route (i.e., by minimizing gaps and bunching) and to improve service delivery to passengers on the route.

The first significant COUNTDOWN network was implemented in west London and was developed in partnership with CentreWest. Subsequently, COUNTDOWN was introduced on the "Nag's Head" network in north London. LTB is installing on-bus AVL equipment--and with it, COUNTDOWN--in other parts of London. The intention is for AVL to be installed fleetwide by late 1999. In 1997, COUNTDOWN will be introduced in Lambeth and Kingston--both areas of intensive bus use. According to current plans, COUNTDOWN will take between 7 and 10 years to complete at 4,000 bus stops (one-fourth of all bus stops in Greater London).

Given that London has privatized its bus operations, deployment of COUNTDOWN required coordinators to strictly lay out requirements with each private carrier. In addition, standard terms and conditions spelling out performance requirements and recognized standards were considered essential and were implemented.

One of the benefits of providing real-time information is that travelers on buses that featured the COUNTDOWN system generally became more positive about traveling by bus. They reported feeling safer and more relaxed and reported using the time they had while waiting for the bus to visit nearby shops, thereby resulting in improved business adjacent to the stops. COUNTDOWN changed passenger perceptions of the quality of the bus service even though the service had not changed significantly. For example, most passengers thought they waited less time for their bus after the introduction of COUNTDOWN, and 64 percent thought that the service was more reliable. Telling the customer when the bus *will* arrive rather than what time it is *scheduled* to arrive (posted schedules) resulted in the perception that there was an improvement in service reliability. Perhaps even more significant is that customers thought that the bus came more often. Providing real-time information may be the most effective way to satisfy some of the demand for service. A preliminary estimate indicates actual patronage increased by 2.5 percent.

The systems being installed to enhance real-time arrival information also enhance security. Voice call boxes at bus stops that provide schedule information also facilitate emergency response. Leased telephone lines and fiber-optic communications infrastructure being installed at bus stops can support closed circuit television for security enhancements at these stops.

ITS-Based Emergency Services

ITS technologies play a major role in system security. London Transport's Network Control Center is responsible for command, control, and coordination of overall emergency services related to the London Underground. The center is designed to receive information from all system security devices throughout the Underground. The center links to other emergency service providers through leased telephone lines and a dedicated ring-down system that facilitates communication during emergencies. The center links and jointly houses the British Transport Police and the Transport Police communication staffs.

The coordinated emergency management room established at London Transport brings together decision makers and provides them with timely information to render appropriate emergency management decisions. Communication links are established with fire, police, utilities, and other emergency service providers (see Figure 1). Pager technology is incorporated into center operations to ensure that crisis management team members and senior management personnel are kept abreast of all pertinent information during emergency operations.

The bus emergency operations center at London Transport also links to the communications center of the London Metropolitan Police. This center uses the CCTV technology managed by the police to address bus operations issues on the street. It is extremely important to link transit operations with the Metropolitan Police system so that police can assist transit operations during emergencies and when services require rerouting because of a system disruption. As a result, London Transport uses the technology to assist in responding

Figure 1. Fire alarm, emergency alarm, and information in the London Underground

to emergencies on their buses or for operational benefit without having to directly fund the infrastructure.

PRESTIGE Contactless Smartcard

PRESTIGE is London's trial of contactless smartcards for its fare collection system for the London Underground and buses. Although the term "smartcard" technically refers to a card that has an on-board microprocessor and built-in logic, it has come to be used to describe automated card technologies ranging from disposable prepaid memory cards to reloadable multi-application microprocessor cards. There are two basic types of smartcards: contact and contactless. Contactless smartcards are the preferred medium for use in transportation systems. Data are transmitted from the chip to the reader via radio frequency waves, removing the need for direct contact between the reader and the card. Also known as proximity cards, they represent the ultimate in reliability because there are no moving parts or contacts.

Depending on its processing capabilities, a single smartcard may be able to serve several different functions (e.g., providing access to a bank account, carrying medical information, storing loyalty program records, and holding transit fare value). A smartcard may also have a single "electronic purse" that can be used at participating merchants and on the local transit system.

London Transport has had a systemwide bus and Underground ticketing system since the Travelcard was introduced in 1983. With advances in technology in the interim, LT is initiating development of a new, more sophisticated bus and Underground revenue collection system. By using smartcard technology, LT hopes to gain improved information about customers and their travel patterns, reduce fraud, and improve the ability to introduce new fare and ticketing policies. LT also hopes to reduce congestion caused by waiting for fare collection. One-third of fares are paid for in cash, one-third by use of passes, and one-third by farecard.

The PRESTIGE project is being taken forward under the government's Private Finance Initiative (PFI), which was launched in 1992 to attract private sector investment in public sector projects. This partnership allows quicker implementation of projects traditionally pursued through governmental capital expenditure.

Southampton

Transit Profile

The Southampton metropolitan area (population 214,000) is served by two competing bus companies (formerly city-owned), a local electric train, which provides a link to Southampton airport at Eastleigh, and a ferry to Hythe. Southampton CityBus, constituted as a separate company 10 years ago, operates 135 vehicles over 35 routes and carries about 17 million passengers, annually. CityBus was sold to its employees in 1993 and is held through an employee share ownership plan. Solent Blue Lines, another private bus company formed in 1987, competes with CityBus on 18 routes with a fleet of 107 vehicles (ridership figures are not available).

In Southampton, as part of their overall mobility management philosophy, center city parking is extremely limited. Through land-use planning, city officials not only encouraged, but developed bus operations to transport visitors throughout the city center.

ROMANSE

The United Kingdom's government forecasts a 100 percent increase in road traffic by 2020. Using only traditional construction technologies and road management strategies, it was thought such an increase could prove disastrous. Based in Southampton, ROMANSE was started as a European pilot project in May 1992 to develop a flexible solution to increasing congestion. The acronym stands for ROad MANagement System for Europe. The project is a partnership of public and private sector entities led by the Hampshire County Council with partial funding from the European Union (EU).

In order to coordinate the different elements of ROMANSE and to collect, collate, and disseminate information, the project is constructed around a Traffic and Travel Information Centre (TTIC). This consists of numerous components performing varied functions, with the ROMANSE Central Processor (RCP) providing the physical and logical connections between them. A central database allows operators to view or coordinate data. These refined data are then used to formulate transport management strategies and to provide up-to-the-minute information to the public.

The Strategic Information System (SIS) provides an overview of the transport environment in the form of a clear, digital map display. Integrated layers of transport-related data give comprehensive geographic and statistical information. Traffic and travel information from the ROMANSE system is displayed live on the SIS and stored in the system's database. Such data, combined with historical data, are used to plan future transport management strategies.

The largest part of the ROMANSE project has been the development of STOPWATCH. This is a public transport information system that gives real-time bus service information to passengers waiting at bus stops (see Figure 2). STOPWATCH uses AVL technology to locate buses on the road network and then display estimated arrival times on electronic signs at stops downstream of the buses. In 1995, "talking" bus stops were introduced to the STOPWATCH system. A digitally recorded voice gives the same information as the electronic signs and can be activated at bus stops by individual travelers.

The only major technical difference between COUNTDOWN

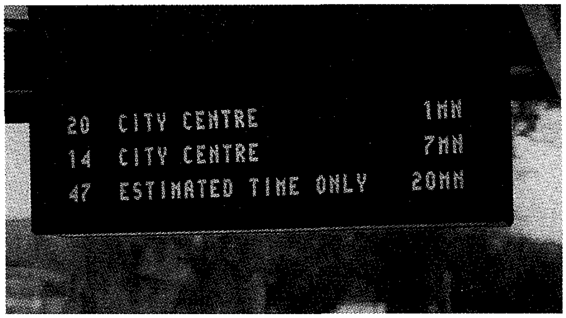

Figure 2. Real-time bus arrival information provided by STOPWATCH in Southampton, England. (Photo by Paul Carter.)

and STOPWATCH is that STOPWATCH supports the use of Global Positioning System (GPS) technology as well as sign post technology to track buses. Only sign post technology is used in COUNTDOWN. STOPWATCH uses both LED and LCD displays so that both technologies can be compared.

TRIPlanner, a service provided by free-standing computer terminals with user-friendly touchscreens, provides upto-date trip-planning information in and around Southampton (see Figure 3). TRIPlanner provides quick and easy information on public transport routes and times and on road conditions; a printout is available if desired. By December 1996, 10 units were operating in three languages (French, German, and English) at public sites in Southampton By late 1996, taxi and tourist information (including maps and telephone numbers and addresses of hotels, taxi stops, and places of interest) was added to the database.

Figure 3. TRIPlanner kiosk in Southampton, England.

TRIPlanner terminals are constantly being refined and new features are developed in response to comments from TRIPlanner users.

Public Involvement--HEADSTART

The mobility manager concept is being developed by ROMANSE managers through an open and thorough public involvement program called HEADSTART. This overall traffic management/mobility manager concept includes a determination of various transportation modes to be used as a part of the community's transportation strategy. This strategy includes principles relating to land use planning, steps designed to encourage greater use and acceptance of bus transportation, use of alternative fueled vehicles to help in the reduction of air pollutants, encouragement of telecommuting to assist in overall traffic flow management, encouragement of increased use of bicycles, and the determination to build only those roadways fundamental to the accomplishment of the overall mobility strategy developed by the community.

Highlighting how valuable this integration can be is the ability of commuters to view information about parking availability and congestion during commutes and to divert to a park-and-ride lot and take public transportation, if it is appropriate (see Figures 4 and 5).

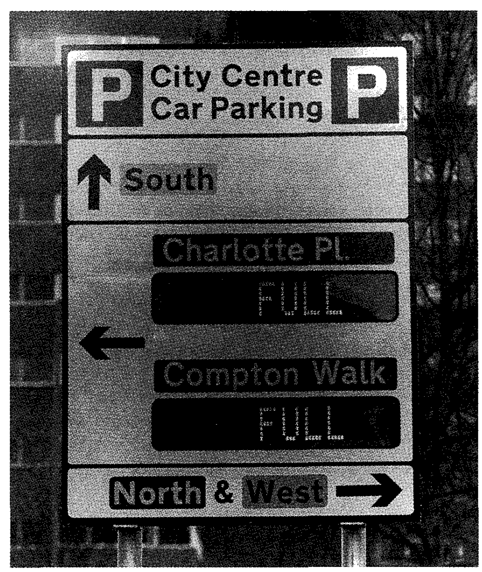

Figure 4. Parking-availability sign in Southampton City Centre. (Photo by Paul Carter.)

Figure 5. St. Catherine's Park-and-Ride lot in Winchester. A self-service parking ticket dispenser is mounted on the sign. Motorists must display the ticket on the dashboard.

Rather than relying solely on public relations efforts, the ROMANSE program also uses visual displays on air quality which reflect how much people drive their cars versus taking public transportation that day. This display is one way the transit initiative integrates technology with public awareness programs.

Bus passengers in Southampton were surveyed to find out their opinions of the system and how they use it. The results confirmed many of the same conclusions made in the COUNTDOWN project regarding perceptions about reduced wait times and increased service reliability. In addition, the study revealed some differences in the way various groups of passengers viewed the system and how useful they found it.

Perhaps the biggest difference in opinion was between age groups. Younger passengers tended to use the system more, be more knowledgeable about it, and found it more useful. They were the most likely to change their plans based on the information displayed. If the wait time is too long, they might take a different bus, walk, or go get a cup of coffee. New or infrequent bus users were also very likely to use the displays and viewed them favorably. People who use the bus more frequently, especially for regular work trips, were familiar with the system and looked at it, but frequently relied on their experience and knowledge of the service to make travel decisions. The group least familiar with the system and who found it least useful were the elderly, who tended to use their printed timetables and often were not even aware of the displays. All groups strongly favored LED displays over the LCD displays.

Because of the popularity of the system with young, new, and infrequent riders, the displays may be a cost-effective way to increase ridership and attract new riders to transit. Southampton reports ridership gains of about 5 percent on the lines that were studied.

FRANCE

Paris

Transit Profile

The Syndicat des Transports Parisiens (STP) is responsible for overall transit policy and fare-setting, coordinating urban and regional transport in the Greater Paris metropolitan region, known as the Ile de France (population 11 million). With representation from the national government and the regional authorities, the STP brings together the operations of the Paris Transit Authority (RATP), the National Railway (SNCF) operating in the Paris region, the regional metro (RER) for which the RATP and the SNCF are jointly responsible, as well as private bus operators. The STP is responsible for authorizing major projects, such as RER expansion, the electrification of suburban railroads, and the renewal of the bus fleet, along with overseeing service levels and setting fare levels. Suburb-to-suburb links are a current priority. The STP also administers a range of contractual agreements with private bus operators. A traffic master plan for strategic development through 2015, when the region will account for some 28 million daily journeys, is under discussion.

The Regie Autonome des Transports Parisiens (RATP), one of the largest public transit organizations in the world, operates more than 4,000 metro and commuter rail (RER) railcars over a 196-mile network with a combined total of 453 stations. The RATP is also responsible for nearly 4,000 city and suburban buses operating on 241 routes covering some 1,600 miles with more than 7,000 bus stops. There is also a tram and a short funicular railway. The operating budget of the RATP is on the order of $4 billion annually, and the system employs 38,000. Major current RATP projects involving ITS technology include the Meteor, a driverless Metro line, and continued expansion of links between existing lines.

The Meteor is a driverless, 4.6-mile, seven-station metro line, running on rubber tires that will connect eight metro and four RER routes. The advanced design MF89 six-car trainsets that will be used on the Meteor line have steerable axles with independent wheels and full-width gangways between cars. To date, 665 MF89 units have been ordered and will eventually replace the entire aging metro fleet. In the long run, RATP plans that the entire urban metro network will be converted to driverless operation.

Interconnection and intermodal projects involving the continued expansion of links between RATP, RER, and SNCF lines as well as the building of intermodal terminals within the Paris region (e.g., Bobigny/Pablo Picasso; Charles De Gaulle airport) are also underway.

The RATP is also planning to build a main network of some 120 miles of exclusive public transport rights-of-way, fully integrated with the existing rail system. The aim is to reduce congestion and improve service quality without the

expense of new heavy rail infrastructure. Some of these alignments may be converted to light rail and guided bus operations in the future.

Creation and expansion of exclusive bus lanes, signal preemption at intersections, and zone passes to reduce bus travel time are being emphasized. Passenger figures for the bus fleet have been declining in recent years--about 800 million trips annually at present. To bolster bus ridership, more than 300 miles of bus priority lanes have been designated to date in the Paris region. Most passengers use zonal passes.

Automatic Vehicle Location

RATP employs GPS technology for the AVL system with a sign post backup in case of GPS failure. On surface streets, several bus routes have real-time electronic information boards in shelters and at some stops. One of the unique features of this system is that of real-time monitors in the drivers' cabs which inform the drivers about spacing with buses in front and behind. This allows operators to do a great deal of vehicle-spacing management to avoid bunching--without the assistance of a street supervisor.

ALTAIR and AIGLE

In Paris, two projects are being deployed that track buses and use the information to improve operations. The first, ALTAIR, uses several technologies to provide passengers with real-time bus arrival information. The second project, known as AIGLE, provides location and audio/video information from inside the bus to security officers during emergencies.

The primary differences between ALTAIR and its British cousins are its greater reliance on advanced technology and its higher level of integration with other systems. ALTAIR uses GPS, map matching, and advanced dead-reckoning technologies in combination to locate vehicles. An interesting technical feature of the ALTAIR system is its use of wireless data communications and battery-powered display units. The combination reduces the cost per unit because there is no need to provide power or land-based communications to each site. As a result, the display units can be placed anywhere there is room to attach them to a shelter or pole.

On-street displays provide bus arrival information in much the same way as the other projects (see Figure 6). Real-time bus information is also available on a touch-tone telephone and there are plans to make it available through the Internet and through the Minitel, a widely distributed system of small computers connected to the phone system. The information is used on board buses to display the travel time to major destinations and make Next Stop announcements. The system also informs drivers of the time interval between their buses and the buses ahead and behind--this

Figure 6. ALTAIR bus arrival information display in a bus shelter in Paris.

helps the drivers maintain optimum spacing between buses. The system provides the service controllers with well-organized information on bus spacing so that they can assist the drivers in maintaining optimum service.

The evaluation information available on the ALTAIR project focuses on the accuracy of the information and how well the project components function rather than on the customer's perception of the system or what it has accomplished. The evaluation material available indicates that the system performs well. ALTAIR has performed so well, the bus operating agency for the Paris region, RATP, has decided to extend it in phases to the entire 4,000-bus fleet.

Selected Customer Information Service Project (SUROIT)

The objective of SUROIT is to give access to information on the transport supply in the Paris region. The Paris region transport system has 18,000 RATP bus stops and 560 stations. Passengers want to know their travel options and associated trip times. The information must be accessible from where they plan their trips--often the user's home.

Since February 1993, agents of the RATP telephone inquiry center have been using this advanced technology to answer passengers' questions. Using the keyboard, the agents key the departure and arrival addresses requested. The system proposes alternative means of transportation, routes, and trip times. The screen displays the itinerary of the journey and detail of the route. Home users can also access SUROIT through French Minitel.

Telephone access information is also being used in conjunction with ALTAIR. In addition to real-time information at the bus stop, the home user can obtain the same real-time information by entering the bus stop number on the telephone Plans call for expanding the system to televisions and home computers.

Smartcard Applications

Phasing in a contactless smartcard for the entire system, a pilot project involving RATP staff, is underway. Magnetic-striped fare media have been experiencing a high degree of counterfeiting at the systems visited. Expanding the use of smartcards is a method to control this problem. Proponents of smartcards hope that their use will expand the transit ridership base if smartcards offered by the transit system are linked with banks, telephone systems, and other service providers

Planners are also testing a hybrid or combination card that combines contact and contactless features to expand utility. This medium involves the integration of contact and contactless capabilities through the use of a contact card inserted into a contactless "sleeve" or "transponder" (see Figures 7 and 8).

Use of card security technology lessens the potential for counterfeiting. In addition, the Paris Metro smartcard has been developed to include a personal security feature. The card includes a radio frequency computer-based chip that identifies a card's location in a Paris Metro station, should the card be activated. This notification is relayed to a communications center at the respective station and is also transmitted to the appropriate police/security communications center to facilitate an appropriate response. No data are yet available regarding the use of this personal security feature.

Discussions of the security feature of the smartcard suggested that the lack of a dedicated response to this notification would make evaluation of its effectiveness difficult. However, even without a dedicated response, information was developed about where security problems were occurring on this system. Application of the personal security feature of smartcard technology could enhance system security through potential deterrence and through enhanced passenger comfort.

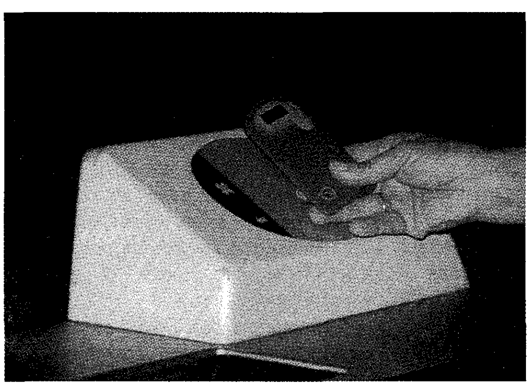

Figure 7. Contactless smartcard in a sleeve transponder at a turnstile in the Paris Metro.

Figure 8. Contactless smartcard reader on a bus in Paris. Next to the reader is a traditional ticket validator.

Smartcard technology has numerous applications in the United States as well, many of which are being studied by U.S. transit agencies. A "smartcard" can be used for fare collection as well as receiving other government services. The card can be used to access the library, pay tolls, or even provide access to parking lots. Perhaps the card could store enough information so that premium parking spaces could be given to those users who have maximized their use of transit for home-to-work commuting, but choose to drive to a sporting or cultural event held at a location not easily accessible to public transit. The cards could be programmed to give substantial discounts to riders whose transit trip originated in the most heavily populated areas of a community. This could attract new riders and reduce congestion considerably in these areas.

Public-Private Partnering

RATP maintains its own research and development organization, which develops, customizes, and integrates applications. RATP uses European Commission grants and its partnerships with other cities to share its development costs. As part of the development of a smartcard standard, RATP, through a private sector partner, granted licenses for its contactless smartcard architecture to companies in other countries. The users of the system formed the ContactLess Users Board (CLUB), a nonprofit organization created to promote standards and technology development for contactless payment systems. The current members of CLUB are Paris, Konstanz, Lisbon, and Venice.

The National Center of Traffic Information (CNIR), founded in 1968, incorporates three French ministries--the Ministry of Defense (Gendarmerie), the Home Office (Police), and the Ministry for Transport--to inform road users about conditions throughout France and optimize the use of the national road network. Seven regional centers back up the National Center that has headquarters at a French military base near Paris. Other partners include the French weather service, motorway companies, and automobile associations.

The CNIR brings together all information gathered by the regional centers concerning the state of the road network, weather conditions, major migrations because of holidays, accidents, and other events. Travelers can access this information through special telephone numbers, national radio and television station updates, and the Internet.

GERMANY

Berlin

Transit Profile

The Berlin municipal transit authority (BVG), part of a newly organized regional transit authority (VBB), provides metro, light rail, bus, and ferry services. Regional commuter service (the S Bahn) is provided by a subsidiary of the privatized German National Railway (DB), which operates regional routes serving the outer suburbs to complement the S Bahn. The overriding priority in recent years has been to integrate, modernize, and expand the municipal and regional networks that were torn apart after the city was divided by the Berlin Wall in the 1960s and, in effect, became part of two different countries.

The Berlin Metro (U Bahn), which opened in 1902, accounts for about 450 million passenger trips a year over a nine-line network of nearly 90 miles with 3-minute headways during peak periods. The system has a rolling stock of more than 1,550 cars, includes 168 stations, and is fully integrated with the bus and S Bahn networks. Under its modernization program, 130 trainsets are on order from Adtranz and automatic train operation is being introduced as part of a move to raise capacity, improve customer service, and reduce operating costs.

The commuter rail S Bahn system provides service over a 180-mile network composed of 13 routes with 146 stations. The rolling stock includes 1,486 cars. Peak-period headways are down to 2 minutes, and fares are fully integrated with the other modes. Most of the S Bahn lines that were disrupted for decades by the division of the city have been rebuilt and reopened; by the year 2002, all lines that were in operation in 1961 will have been restored. Next to the U Bahn, the S Bahn system has the highest ridership--most recently 250 million passengers annually.

The tramway fleet, which operated mainly in the eastern part of the city, is being extended and modernized with plans on the drawing board including links to new and reopened U Bahn and S Bahn stations in the city center. The rolling stock is approximately 760 cars--most of it modernized Czech Tatra models with German AEG and Adtranz units now being phased in. Passenger totals, which have shown a slight decline in recent years, now stand at 146 million annually. The 27-line network has a route length of 111 miles and 359 stops. Besides its expansion into the western part of the city, a total modernization of the existing network is in progress, including renewal of tracks and catenaries.

The bus fleet of 1,867 vehicles--more than a thousand of which are double-deckers, is primarily used by farecard passengers. Among the 403 million annual passenger trips (down from 455 million in 1993), only about 13 percent are made by single-ticket holders. The Berlin bus network accounts for 157 routes over 784 miles--46 miles of which are on bus priority lanes. In the city center, there are plans to expand these priority lanes to roughly 100 miles. Full fare integration with U Bahn and S Bahn services is in effect and multimodal passes are available. Lift or ramp-equipped buses are in operation on 39 routes, complementing the demand-responsive Telebus van service operated by the city's human services department for travelers who use wheelchairs. A rechargeable smartcard (electronic purse) is on trial in a demonstration projected funded by the Federal Ministry for Research and Technology.

A portion of the bus network is now being contracted out to private operators. Taxi companies provide subsidized service under contract on the night routes. Long-term planning envisions the reduction of the double-decker fleet to 40 percent of the total. These remaining double-decker buses will be for use only in the inner city.

Safety and Security

Berlin has developed an effective information and safety system for the U Bahn network. The system uses brightly colored pylons marked with the letters SOS. Customers can obtain information by pushing a button on these pylons and connecting with a customer information agent at a central location (see Figure 9). If a customer has an emergency situation, they can press an alarm button on the pylon and the command center is notified. Closed circuit television cameras in the station are automatically adjusted to the area where the alarm came from so that the command center can view the scene and dispatch the appropriate personnel.

Enforcement of Self-Service Fares

Fare enforcement in the United States consists primarily of "pay-as-you-enter" systems on buses. Subways generally use a combination of ticket/token booths and faregates

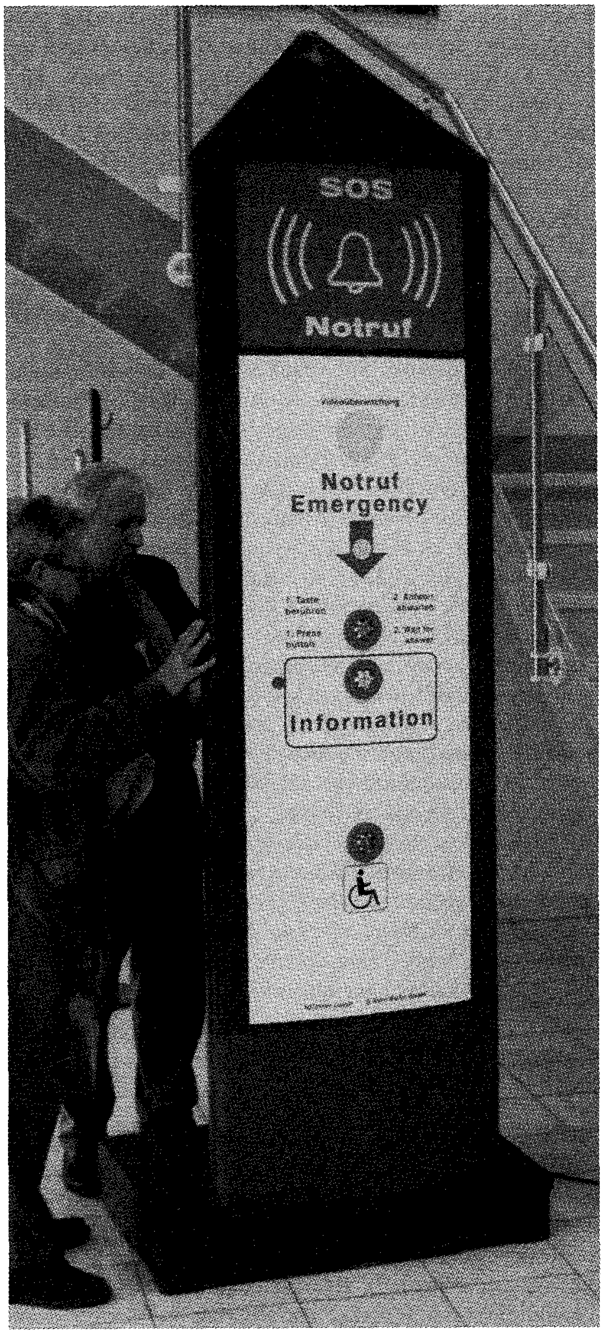

Figure 9. *Bilingual SOS pylon in the Berlin S Bahn.*

to ensure proper fare collection. European systems, especially in Germany and Switzerland have adopted "Proof of Payment" (POP) fare collection systems where roving fare inspectors check passengers for proof that they have paid the proper fare in the form of a ticket, pass, or transfer. The POP system has been introduced in North America with the renaissance of light rail. Transit operations in Edmonton, Calgary, San Diego, Portland, and Sacramento all introduced POP with the opening of LRT It is generally regarded as successful, with evasion rates being held to between 1 percent and 3 percent

There is an almost total lack of inspection on the system in Berlin. Mission members heard comments from citizens that "only tourists buy tickets." In Munich, the other German city visited, there was a perception that fare inspections occurred regularly, with officers often in plain sight throughout the system.

ITS Applications

In Berlin, variable message signs are used to inform motorists of the expected travel time to destinations ahead on the autobahn (freeway). However, because Berlin is still making societal and economic adjustments in response to the reunification of Germany, technological advancement is not a top priority. Because the necessity for public transit is obvious and the number of people who have private vehicles is more limited, there is less focus on developing better systems to expand the customer base

Munich

Transit Profile

Public transport in the Munich metropolitan area (population 2.4 million) is coordinated by the regional transit authority (MVV) and actually managed by the municipal public utility (Stadtwerke Muenchen), which operates a bus, metro, and light rail fleet that collectively accounts for some 530 million passenger trips a year with a farebox recovery of approximately 51 percent. The bus fleet of 75 lines, with a route length of 276 miles and 160 million passengers in 1996, consists of 487 vehicles, of which about 40 percent are operated under contract by private carriers; the Metro (U Bahn), with its six lines, 78 stations, and 44-mile network, had nearly 280 million riders in 1996. There is also an eight-line light rail (tramway) network that operates eight lines over 43 track miles and was used by 73 million passengers in 1996 The transit networks feature full fare integration. All-night bus and tram services were introduced in 1994.

Transit-Supportive City Policies

Munich's city administration has been a strong advocate of public transit and a promoter of the regional transit association. It has gone so far as to ban all on-street parking in the downtown area except for residents and has eliminated curbside parking meters. Permission to build new offices in the central business district is given only on condition

that no parking will be provided. Innovative public transit marketing initiatives include the subsidized annual "job-ticket" negotiated with public and private employers including the city of Munich, and the negotiation of "combi tickets" which allow transit use by ticket holders to a major cultural or entertainment attraction without extra charge, the ticket itself serving as a transit pass. Organizers compensate MVV with a fixed fee. Another transit incentive is an annual "green card" that is available for the price of 10 monthly passes.

ITS Applications

Munich has developed an all-modes fully integrated ITS application known as COMFORT. The purpose of COMFORT is to provide information to better manage the use of the entire transportation network. Variable message signs suggest to road travelers that they use U Bahn park-and-ride facilities because of congestion ahead Variable messages signs and changeable directional signs can indicate the best route for travelers to use to avoid road congestion and delays The latter effort usually results in a shift of about 20 percent of travelers to the preferred route.

In Munich, variable speed limits are displayed that change according to traffic and weather conditions. Signs also direct motorists to the nearest park-and-ride lot and tell how many parking spaces are available and when the next train is due. The center of the city has been blocked off as a very successful pedestrian area that is full of thriving retail establishments and restaurants.

Private-Sector Partnering and Support

Europeans have a positive attitude toward public transit. One of the most striking aspects of the visit to Munich was a discussion with the chief engineer at BMW. He noted that his business card had the nearest U Bahn station listed on it so that colleagues could reach his office easily. It was intriguing for study participants to discuss the role of public transit with an automobile manufacturer and find common ground.

BMW is one of the major participants in the development of COMFORT. According to BMW executives, travel congestion is not good for the automobile industry. If traveling by car becomes too inconvenient, this will affect BMW's ability to sell cars BMW personnel support public transportation and believe that, by balancing travel among all modes, the road network will be available for trips that must be made by car.

Smart Park-and-Ride Facilities

An important point in solving parking space problems is to reduce the flow of individual transport into the inner city. The prerequisite for convincing at least some motorists to change to public transport is to provide facilities with a high standard of efficiency, convenience, and safety. Another important feature is providing the motorist with detailed real-time information on park-and-ride facilities.

Not all motorists are able or willing to leave their cars at home when driving from the outskirts into the city center--park-and-ride facilities offer a good solution to this challenge. BMW is promoting a new policy to make park-and-ride facilities attractive so that they become more convenient. The objective is to convince everyone--not just commuters--to use park-and-ride facilities.

There are many standard considerations in designing an appealing park-and-ride facility The facility should be as close as possible to public transport and should have covered passways. The facility itself should be designed as an attractive business and service center allowing people to shop on their way or use various services. Low fares, combined park-and-ride tickets, short travel times, and brief intervals between trains are needed, as well as direct public transport connections

Static information on the facilities location, cost, and operating times, along with real-time information on the availability of parking spaces, and the public transport system, need to be provided. Information of this kind will promote the use of the public transport system. Pretrip information can be supplied through the Internet. On-trip information can be made available either by variable message signs at the roadside or individually within the car through a service provider and mobile phone.

A new service, Personal Travel Assistant (PTA), is being used to promote the park-and-ride facilities in Munich. PTA can be used to receive information on a mobile or "smart" phone. PTA offers all the information for optimum travel and the most suitable means of transport. PTA offers public transport, railway, and airline timetables; enables bookings to be made electronically; and provides information on parking availability.

LESSONS LEARNED

European government and transit officials tend to take a broader view of the role of public transportation than do their counterparts in the United States. Rather than developing technology to enhance overall transit operations, Europeans work to enhance mobility throughout all modes in their communities. A similar shift in perspective would be very helpful in improving public transportation in the United States. In the United States, we might begin to look at ourselves not as only public transportation managers, but as mobility managers.

If policy-makers in the United States are to take the best from the European model of using ITS technology to improve public transit the key lessons to be learned are as follows.

- Integrate all transportation modes,
- Do not short-change pre- and post-launch research on new programs;
- Encourage public-private partnerships;
- Provide travelers with real-time information to eliminate uncertainty about waiting time;
- Use smartcards to streamline service, increase revenue, and benefit customers;
- Provide information that customers can understand;
- Use ITS technology to enhance security for travelers.

Each of these lessons is discussed below.

Integrate All Transportation Modes

Transportation networks operate best as integrated systems--both in their use and in the collection and dissemination of information. The newest United States acronym for intelligent transportation technologies is ITI, Intelligent Transportation Infrastructure. In its simplest form, ITI implies that transportation modes should not compete with one another but that the entire transportation system (all modes) should be seen as a network system that works together. Information on all types of transportation modes and a network that shares data to provide that information are necessary.

Europe's adaptation of this concept is apparent in many of its customer information systems. The ROMANSE project in Southampton includes traffic movement and congestion, public transport, and parking information. The project collects, collates, and disseminates information to local radio, information display units, TRIPlanners, variable message signs, and electronic displays at bus stops. The ROMANSE TRIPlanner provides details about journeys by both public and private transport and enables the user to make informed decisions on how to travel. The RATP SUROIT project gives extensive information on the transport supply in Paris, including public transport, transport networks, parking lots, and taxi stations. The BMW park-and-ride lots in Munich combine private car transport with public transport options.

The European experience suggests that it would benefit the United States to continue working toward the integration of ITIs, in order to meet the transportation needs of the next century and beyond. Transportation systems also benefit from broadening their collaboration to include entities outside the transportation field to build an infrastructure of data sharing. The greatest benefit is obtained when ITI emphasizes the movement of people rather than the mode of transportation.

Public transit must link transit information systems to those of other modes of transportation. Vehicles in the future will have state-of-the art communications systems. Drivers and passengers will be global communicators. Transit systems must be equipped with appropriate technology in order to remain a competitive travel option.

Do Not Short-Change Research

It is important to conduct research on ITS if the benefits of ITS are to be fully achieved. Europe has done an exceptional job of pre- through post-research on implemented ITS technologies. Extensive post-research was performed on the implementation of the COUNTDOWN project London Transport Buses conducted extensive pre-launch research to identify the information passengers wanted on the COUNTDOWN system. RATP also conducted pre-launch studies to identify how to best support their AVL system, ALTAIR RATP conducted comprehensive post-research on the AVL system in terms of reliability, accuracy, and passenger acceptance.

Continued research is needed in the United States to demonstrate the benefits of ITS to the transit industry, to provide decision-makers with tools to formulate future ITS management strategies, and to guarantee that ITS systems meet the needs of customers.

Encourage Public-Private Partnerships

Public-private partnerships are vital to the advancement of ITS technologies There are numerous public-private sector investments being carried out in the European Economic Community. The United Kingdom has a Private Finance Initiative (PFI). This requires that a suitable amount of risk be transferred to the private sector, that competition is sought, and that value for money spent is achieved The PFI is intended to attract private sector to public sector projects, thereby creating partnerships between the private and public sectors and allowing early implementation of projects traditionally pursued under capital expenditure but delayed because of lack of funds. RATP participates in various public-private sector investments, including partnerships with private sector companies on the development of a universal contactless smartcard. The city of Munich is also very involved in public-private consortiums.

Although public-private sector investments are encouraged in the United States, standards and open systems must be further developed before the ITS technologies can reach their potential.

Provide Real-Time Information

Providing comprehensive real-time information to the customer is essential to providing exceptional customer service. Passengers want real-time information on the next bus or train, even when the scheduled headway is as little as 2 minutes during peak hours. Real-time information eliminates one of the principal deterrents to using public transit-the uncertainty of waiting time. Despite rescheduling of routes and enhanced bus priorities, traffic density will inevitably result in occasional and unpredictable delay. Most people

who do not use a bus regularly will say that this uncertainty is one of the main reasons they prefer to use their cars. The people who already use public transit want this type of information as well. Customers want opportunities and choices If customers know that the bus has been delayed, they can run errands at nearby shops or choose another means of transportation.

The London Transport Buses did extensive research on their COUNTDOWN project, and the results emphasize the importance of real-time information on public transport. About 70 percent of passengers refer to the display when they arrive at the stop, and 90 percent look at the sign while they wait. About 60 percent say they look at the sign at least once a minute. Approximately 65 percent of the passengers felt that they had waited less time and 83 percent stated that time seemed to pass more quickly when they knew how long their wait would be. The display also made waiting more acceptable for passengers (89 percent), and 68 percent of the passengers said they now had a higher opinion of bus travel. Sixty-four percent of passengers thought that the service was more reliable, although service reliability had not changed.

Use Smartcards to Streamline Service, Increase Revenue, and Benefit Customers

In the move toward a cashless society, transportation providers can either be leaders or followers with respect to implementation of new technology. Innovations, such as smartcards, offer advantages that will benefit customers. Smartcards bring us closer to the creation of a seamless transportation network that will provide customers with conveniences in purchase of fare media and use of the system. Transportation providers need to be key players in the development of smartcards, their implementation, and their expansion.

Universal standards are needed that would allow customers to carry one card that meets basic financial needs (e.g., banking) and can be used for transportation, public telephones, and parking. Although assistance from the private sector would facilitate implementation of smartcard projects, its absence should not prevent transit providers from implementing such technology on their own.

Slowness of adoption in the United States of smartcard technology results from many factors: smartcards, known as the most counterfeit-proof card technology in use today, are more popular in Europe because they are much more necessary in places where telephone and computer infrastructure is not as well developed. Until recently online transaction verification was not widely available in Europe because of higher telecommunication costs. Thus, Europeans required smartcards for fraud reduction. In the United States, banks and credit card associations invested heavily in creating online verification systems for credit cards that function well with magnetic-stripe technology.

In Europe, adoption of technology is facilitated by business conglomerates, which are able to dictate policy decisions. For example, France Telecom, a monopoly, was able to simply mandate that its pay phones would only accept stored-value smartcards for payment. Consequently, more than 120 million memory-only cards per year are used in France; this constitutes 10 percent of world demand. In the United States, the presence of many competing telephone operators makes it impossible for any one company to mandate the use of smartcard technology.

Another reason smartcards have not been easily adopted in the United States is the cultural difference between bankers in Europe and in the United States--European banks are the main sponsors of smartcard trials in Europe European banks view themselves as social institutions. Consequently, when the opportunity arises to test new technology, the business case is usually not the top consideration. In contrast, the business case typically rules in the United States. U.S. businesses do not recognize the business case for smartcards because businesses believe their biggest vulnerability, fraud costs, is under control--and businesses do not see a need to replace magnetic-stripe technology with a smartcard system

Banks do not see transportation, in general, as an appropriate area to use smartcards. Only in urban areas (e.g., New York City, Chicago, and Washington, DC) do they see any potential. Transportation providers need to establish partnerships with the private sector to implement smartcard technology.

Provide Information the Customer Understands

The information provided to the customer should be concise, easy to understand, and useful. Although information may be disseminated through sophisticated ITS technology, the message itself should be clear. Passengers should not be bombarded with useless or obscure information. One of the problems identified in the COUNTDOWN project was that some messages sent by the dispatcher were confusing to the passengers. ROMANSE's Vehicle Message Sign system uses messages selected from a menu approved by the Department of Transport. These messages are designed to be informative and quick and easy to read. This menu option should be available in ITS technologies or for a sign with a nonintelligent display. Customer information systems should always provide the information in a manner that is helpful to the customer.

Use ITS Technology to Enhance Security for Travelers

The use of ITS technologies presents an opportunity to broaden the partnerships between local police, transit operators, and the private sector. In Paris, vehicle location communications with transit security and the municipal police is shared. In Munich, integrated public traffic management

with transit and the police is in operation. These examples demonstrate how a system can be leveraged to serve expanded needs. Using public funds and public systems will allow communities to meet the mobility and overall quality of life issues that confront them today and in the future.

Mobility management plays, and will continue to play, a fundamental role in the livability and economic vitality of our communities. As such, transit providers should ensure that public transit systems are safe and secure for those who depend on these services and for those who choose to use these services. Transit providers should ensure that all multidisciplinary stakeholders are included in the development of mobility systems.

European security practices are more proactive than those in the United States. This is a result of terrorist acts on systems in Europe. Buses and the Underground in London, as well as the Metro in Paris have been targets of terrorist activity, resulting in numerous injuries and fatalities. In the United States, it is quite possible to ride large systems without seeing a police officer or sheriffs deputy. In London and Paris, it is very common to see large groups of heavily armed officers patrolling the stations and trains. Bomb-sniffing dogs and their handlers regularly patrol subway stations. As a last example, the EUROSTAR high-speed rail service between the United Kingdom and France has security measures in place that rival airport security in the United States.

APPENDIX A
MISSION PARTICIPANTS AND THEIR TITLES AND AFFILIATIONS AT THE TIME OF THE MISSION

Mission 7--October 10-26, 1997: Application of Intelligent Transportation Systems to Public Transit in Europe (London, Southampton, Paris, Berlin, Munich)

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