(see Figure 52). Eleven DMSs and ten video monitors are installed at six bus stops and along bus routes that have stops at the Tapiola Centre and Westend station. DMSs have a 5-inch by 7-inch LED matrix display and are weather and vandal resistant. Each bus route and the waiting time to the next vehicle on that route are displayed on each line of the DMS (see Figure 53). A diamond shape is displayed next to the number of minutes until the next vehicle on the route when the schedule rather than the real-time ETA is being used. The video monitors are 25-in. monitors hung from the ceiling indoors over pedestrian areas, so they are less susceptible to the environment (see Figure 54).

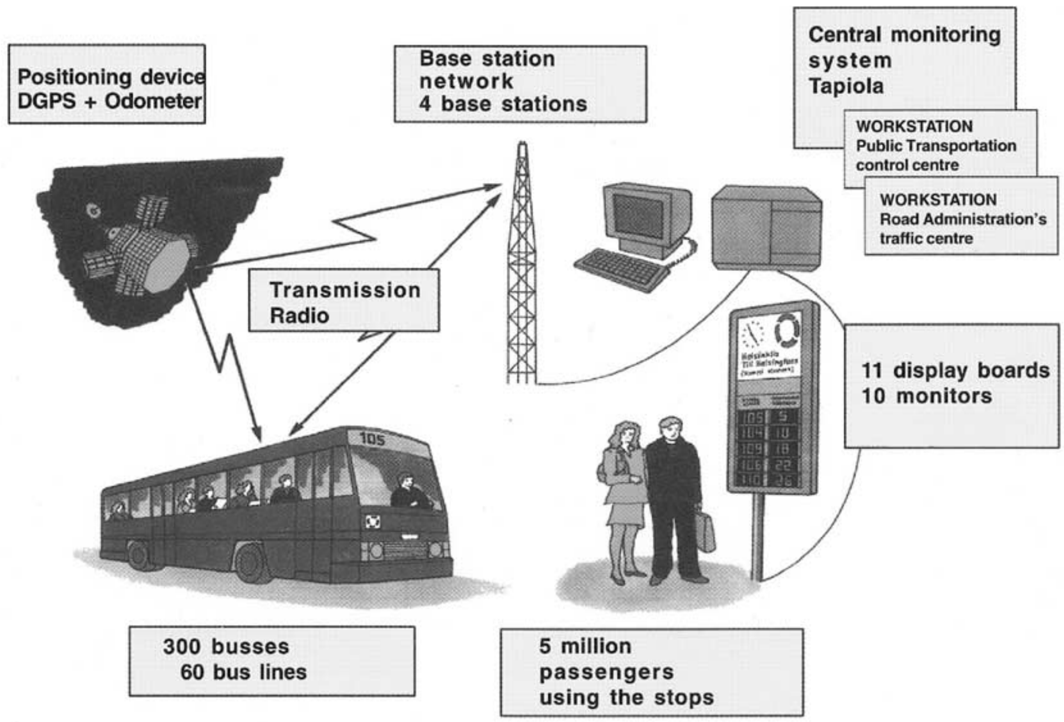

Figure 52. Espoo and Länsiväylä passenger information system (ELMI).

Linja Linje	Odotusaika / Väntetid 1. bussi	2. bussi	Linja Linje	Odotusaika / Väntetid 1. bussi	2. bussi
10	🚌	31 min	12SZ	26 min	
12S	4 min	19 min	195	28 min	58 min
105	7 min	22 min	512	28 min	58 min
109	7 min	19 min	11	30 min	60 min
13	◆ 11 min	31 min	16	30 min	56 min
505	15 min	◆ 30 min	19	30 min	
11Z	18 min		510	35 min	

Figure 53. ELMI monitors.

Figure 54. ELMI display boards at bus stops.

5.2.3 Turin, Italy

In 1992, the City of Turin initiated a large-scale ITS project to improve mobility in the urban area. Seven organizations formed a consortium to establish the Telematics Technologies for Transport and Traffic in Turin (5T) program. Specific objectives of the program were to reduce trip travel times by 25% and to reduce emissions and fuel consumption by 18%. The program's trial period ran from March 1996 through December 1997. During the trial, 5T showed the ability to reduce travel times by 21% (equivalent to a 7-minute reduction for each trip). Given the success of the trial, in July 2000, a company called 5T s.c.r.l. was formed in order to design, develop, manage, maintain, and promote the 5T system. The public transport operator, Azienda Torinese Mobilita S.p.A., is a significant partner in 5T.

5T's objectives are as follows:

- Maintain, service, and manage the 5T system and other Telematics applications for mobility in Turin, including the traffic control system;
- Develop and manage the 5T system and other innovative technologies associated with the system in the greater metropolitan area;
- Promote and manage commercial initiatives and services resulting from previous system development activities, with particular attention to the development of fare integration systems and other systems offering public services;
- Design, install, and manage similar systems in other metropolitan areas in Italy and abroad; and
- Participate in research initiatives aimed at the development of the transport Telematics sector.

5T has seven subsystems (*15*):

1. **Town Supervisor** monitors traffic conditions every 5 minutes, forecasts mobility every hour, and checks on the effects of pollution.
2. **Urban Traffic Control** manages the traffic lights by a traffic-responsive regulation and guarantees traffic-light priority to public transport.
3. **Public Transport Management** ensures public transport regularity and speed by means of the Service Information System (SIS), the AVL system. SIS has been in operation since 1994 and is fully integrated with the Urban Traffic Control subsystem to provide signal priority. The Public Transport Management subsystem also provides real-time arrival information via 200 bus stop displays, called VIA (for Visualizzazione Informazioni Arrivi), and onboard audio-visual next stop displays.
4. **Parking Control and Management** is connected to nine automated parking facilities. It forecasts space availability in each facility and enables remote booking by interactive televideo to customers with smartcards.
5. **Environment Monitoring and Control** uses weather forecasts, data from 11 pollution-detection stations, and traffic data to predict environmental conditions in the short term.
6. **Collective Route Guidance** provides dynamic route guidance to various parts of the city by DMSs. It also provides real-time information on parking availability in automated parking facilities. It operates 26 DMSs and 23 parking guidance signs.
7. **TITOS Public Information** provides real-time information on public transport, traffic and parking, and the environment to the Internet and interactive televideo. A new SMS messaging system is being launched for mobile phone users.

The 22-month experimentation phase, which ended in 1997, included observations and evaluations of the subsystems by extensive measurements and interviews and by a telephone survey of a panel of 500 residents. Public transport priority alone led to improvements of 15% for public transport travel times, with no disadvantage to private traffic cross flows.

To illustrate 5T's capability, the Figures 55 through 60 show the journey planning and real-time transit and parking information available on the Internet (www.5t-torino.it/pia-htm/default_en.php, as of December 2002).

5.2.4 Magdeburg, Germany

Personalized Information on Disruptions to Public Transport Exclusive to Users of Public Transport (PIEPSER) is a German project in Magdeburg that is piloting the

> operation of an information service which notifies public transport users when there is a delay or a disruption to their selected journey which therefore would prevent them from arriving on time. As a result, the inconvenience and the effort of the daily retrieval of information in finding out the situation beforehand

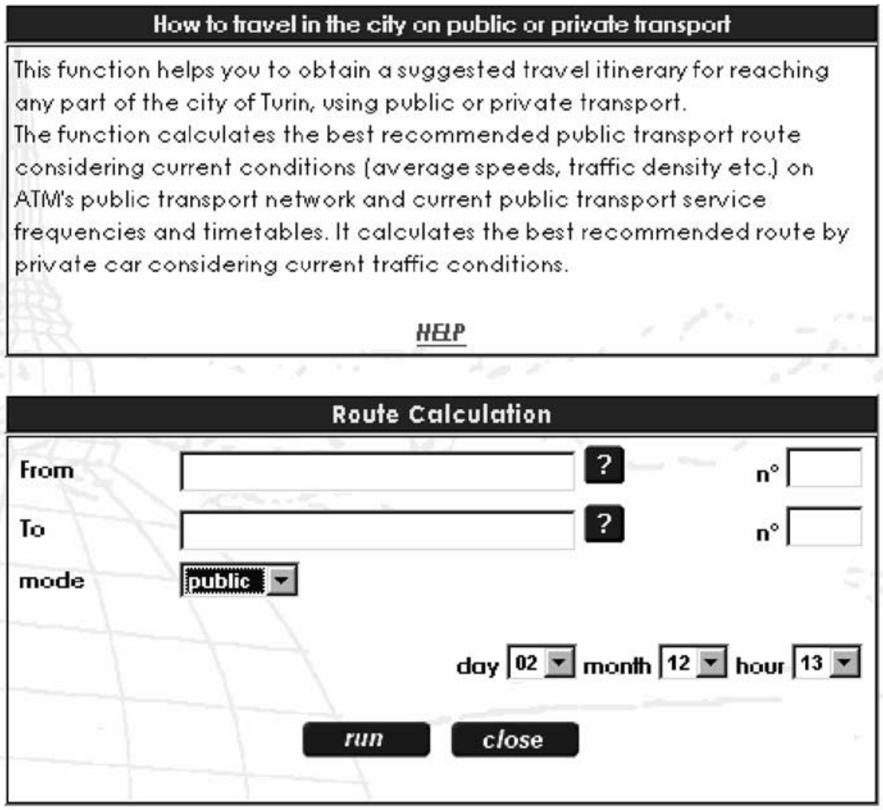

Figure 55.   Trip planning using 5T (December 2002).

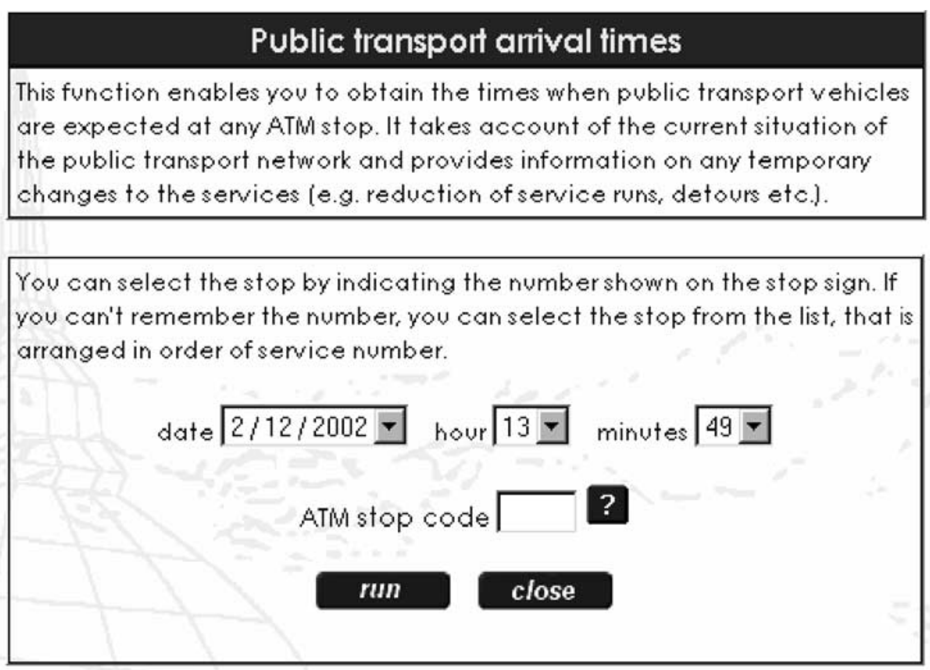

Figure 56.   5T real-time arrival information request.

Figure 57. 5T public transport real-time arrival information by stop.

Figure 58. Real-time parking availability information.

> can be minimized. In addition to the notification of disruption, a multi-modal alternative route will also be provided to the passenger affected, which, depending on the conditions, may still allow the connection to arrive on time. The alternatives of action can be of a spatial, temporary and modal kind. (*16*)

There are several aspects of this project that are unique to most TTI systems, including the following. The system

- Processes and integrates data from several different sources;
- Is only available to customers who purchase monthly transit passes; and
- Uses a standard language for system design and software (Unified Modeling Language).

The distributed system architecture, shown in Table 10, contains six distinct entities that use dynamic and static traveler data: the content owner, content provider, service operator, service provider, network provider, and user. This system, discussed further in Section 8.2, can provide valuable insight into integrating TTI with traveler information.

5.2.5 Karlsruhe, Germany

De Orientierte Mensch (The Oriented Person) (DOM), which was completed in November 2002, demonstrated the capability to provide a traveler with an integrated set of travel services that would be available throughout the whole trip, from the pre-trip stage through completion of the trip. The key concept set forth in this project is the Reisemappe, or travel bag, that contains all of the information collected during the pre-trip phase and is used during the trip (*17*). Another important element of DOM is that all mobile services provided through DOM are location-based so that the customer will receive information specific to his or her location at the time of inquiry.

DOM's features and dissemination media are listed in Table 11. One premium feature of DOM, which not listed in Table 11, is the Delay Manager. This feature

> independently checks previously planned journeys for information which could effect the trip, such as tailbacks or road blocks. The traveler is informed of route-related traffic information before setting off and during the trip. He can react to disruptions, set off earlier, plan alternatives or change the appointment. (*18*)

DOM's services begin with a registered user receiving a Travel Bag, which is used as a repository for information from each service visited (e.g., from those listed in Table 11). All information is saved for use by the traveler as he or she makes his or her trip. A central map, which is employed by all the integrated services, is used by the traveler to identify where the traveler is. Based on that location, specific local services can be offered.

As of December 2002, an extensive evaluation was being carried out. Observed tests were conducted in December

Park name	Location	Price	Service time
D AZEGLIO - GALILEI	C.so Massimo D'Azzeglio - C.so G.Galilei. L'ingresso e l'uscita sono in via Cellini e C.so Galilei.	Feriali L 1.200 dalle ore 8.00 - 20.00 L 800 dalle ore 20.00 - 8.00 Fsetivi L 1.200 dalle ore 0.00 - 24	Dal lun. al sab. 8.00 - 20.00 Dal lunedi al sabato ore 20.00 - 8.00 e giorni festivi orario 0-24

Figure 59. Information about selected parking facility.

2001 and April 2002 in Karlsruhe, Germany. In addition, an Internet survey will be used.

5.2.6 Brussels, Belgium

The Phoebus project focused on three key areas: the public transport database (PTDB), passenger information system (PIS), and demand-responsive system (DRS). PIS provides real-time waiting time information at bus stops and is implemented in the bus network in Brussels. At bus stops, PIS displays three types of information in different fields:

1. The **waiting time field** displays a predefined message with the bus line number and the destination (with routing information if applicable), plus variable data corresponding to the real waiting time in minutes;
2. The **message screen** displays messages that can be predefined in the system or free text messages composed by the operator and received in real-time in ASC II format; and
3. The **date** screen displays the date and time.

The Phoebus pilot scheme for the waiting time information system at bus stops began in 1994, with five bus stop installations in Brussels. As of 1999, two bus lines were fully operational, with high levels of user satisfaction. The Brussels public transport operator (Société des Transports Intercommunaux de Bruxelles [STIB]) was planning to extend the system on its entire network, including the bus and tramway network throughout the Brussels region.

The system displays real-time information on actual waiting times at bus stops. It gives this information only for those buses belonging to the STIB network. Although the tramway network of STIB is currently being integrated in the system, there is no integration with the networks of the two other bus operators active in the Brussels region.

At the terminal points for transit lines, the system also indicates the next departure time exactly. This information is intended for the drivers, to ensure there is no initial delay from the departure point. It is also available to the users to help them choose between buses when two or more buses are waiting at the terminal point, perhaps on different lines. It also provides some social surveillance from the public to any driver who does not leave at the scheduled time. In a later stage, the system will also be used to provide information on intermodal connections between bus lines and the tramway network at crossover points.

The Brussels bus network was equipped in the early 1990s with a Vehicle Scheduling and Control System (VSCS), which was installed to improve real-time monitoring. VSCS's main function is to compare the actual position of the buses with the theoretical position as defined in the timetables. Formerly, the information was used exclusively by the operators in the central control room for regulation purposes. However, without any major modification, the system is also able to compute and predict the expected arrival times of the buses at the different stops. The operating company decided to take advantage of this capability and to provide the information to the passengers waiting at the stops.

The system has been deployed at very low cost due to the fact that the information about the location of the buses was already available in real time in the existing VSCS. Also, the fact that no information transmission infrastructure was needed because of use of existing broadcast networks (use of available radio data system channels) and the provision of a solar power supply makes the system very suitable for any operator who does not want to spend a lot for new infrastructure.

The system has been very well received by the traveling public. Surveys have shown that more than 90% of the passengers look at the information display when arriving at the stop. Of all passengers, 10% stated that they are now using the network more frequently than before as a result of the system. The system has had an important psychological effect, similar to that of the London Countdown system. The researchers' analysis of survey responses suggests that waiting for 10 minutes at a bus stop, but knowing beforehand that it will be 10 minutes, gives the same psychological feeling as waiting for just 3 minutes, but not knowing how long the wait will be. Most passengers felt that the system gives them more confidence in the public transport system. It also gives passengers the opportunity, if the waiting time allows, to run quick errands before boarding the waiting bus. It is not clear if the system pays off or in what period, but it is certain that on the lines equipped with the system, the decline in the number of passenger journeys is much lower than the declines on other lines. In addition to Phoebus, STIB provides bus

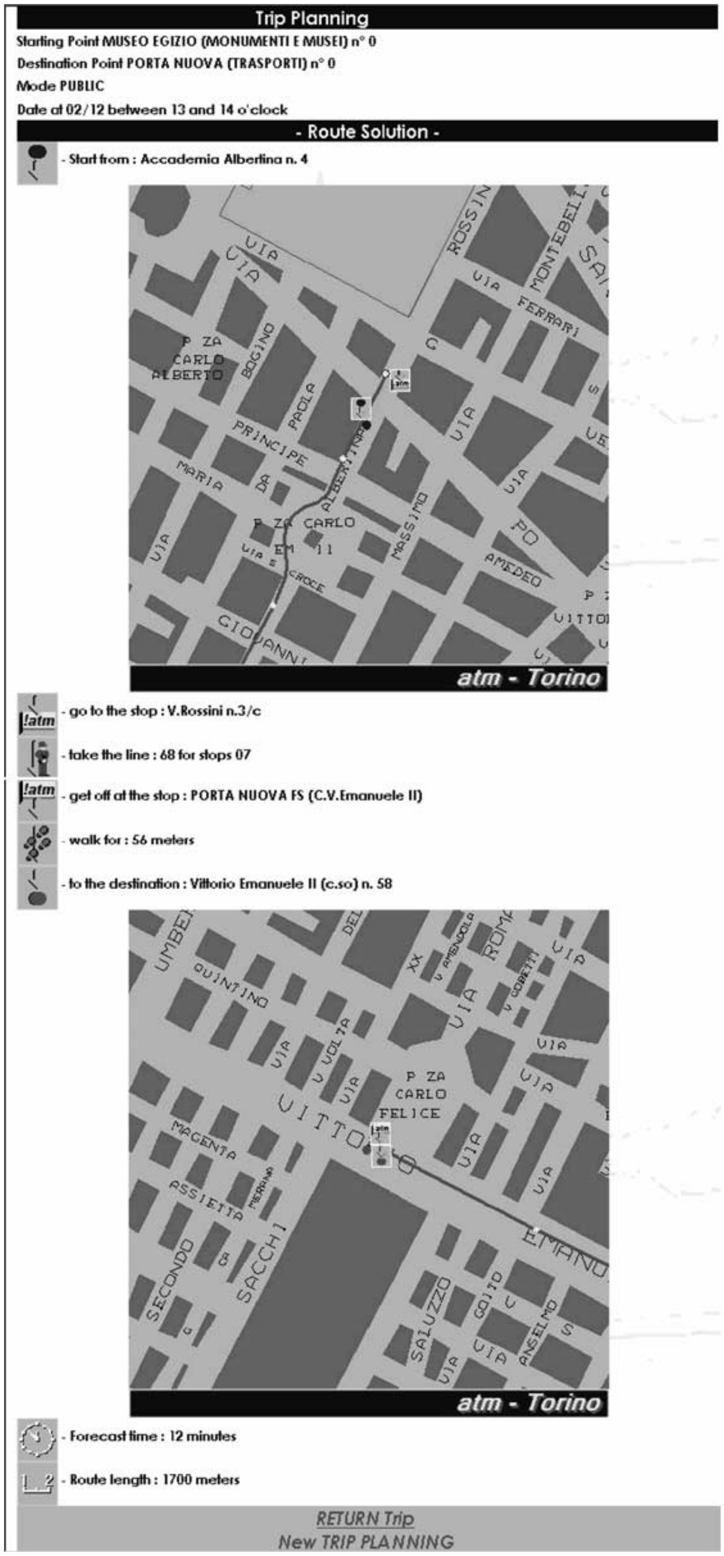

Figure 60.   5T trip plan results.

TABLE 10 Project partners and architecture

Content	Content Owner	Content Provider	Service Operator	Service Provider	Network Provider	User
	Data capture, data processing, data provision	Processing into information, information management, information provision	Processing into service, provision	Service management, customer administration, customer care, service provision	Transport and dissemination	Consume, presentation, requests
Actual departure times of public transport	Local transport company	Local transport company	Local transport company	Local transport company	Operator A Network	Public transport users
Reports on disruptions	Local transport company	Local transport company			Operator B Network	
Timetable of local public transport	Local transport company	Local transport company			Operator C Network	
Timetable of regional transport companies	Regional bus transport companies	Institute of Automation and Communication			Operator D Network	
Actual departure times of regional trains	Central train station management	Local transport company			Landline telephone network	
Timetable of regional trains	Central train station management	Local transport company				
Regular traffic surveillance images	Institute of Automation and Communication, local transport company and city/municipality	Institute of Automation and Communication				
Data on current availability of car parks	City/municipality	Institute of Automation and Communication				
Information on roads under construction	City/municipality	Institute of Automation and Communication				
Data from detectors for road traffic	City/municipality	Institute of Automation and Communication				
Data from detectors of traffic-light control	City/municipality	Institute of Automation and Communication				

Dynamic public transport data

Static public transport data

Dynamic traffic data

Static traffic data

location information on its website (www.stib.irisnet.be/FR/36000F.htm as of December 2002)

5.2.7 Paris, France

In Paris, as in many other European cities, the two major public transport authorities—Régie Autonome des Transports Parisiens (RATP) and Societe Nationale des Chemins de Fer Francais (SNCF)—have deployed new technologies that enable them to enhance the operation of their network and the services offered to customers. The Aide à l'Intervention Globale sur les Lignes en Exploitation (AIGLE) and ALTAIR systems, implemented by RATP, both rely on DGPS-based AVL (*19*). AIGLE provides a security system for both

TABLE 11 DOM features and media dissemination

SERVICE	WEB	WAP	PDA
Travel Bag—checks time context of travel plans and informs user if an event cannot be reached on time with the selected mode(s)/routing; also, saves all pre-trip planning information	X	X	X
Car routing (static and dynamic)—dynamic portion considers historical traffic patterns and current traffic conditions	X	X	X
Public transport routing (intermodal router)	X	X	X
Multimodal router—finds routing and compares travel times and costs across modes	X		
Timetable and stop information—can be personalized for repeat trips	X		X
Personalized traffic congestion information	X	X	
Weather on the roads	X		
Hotel and restaurant guide	X	X	X
Event guide	X	X	
ParkInfo—provides real-time availability of parking spaces; information linked with navigation routing and a map of surrounding area with display of transit stops	X	X	X
Branch guide	X	X	
Personalization	X	X	
Address and appointment manager	X		
News	X	X	
Find-a-Friend		X	
Map service	X		X
Carpool	X	X	

RATP passengers and staff, and ALTAIR provides real-time information on board and at bus stops. ALTAIR is analogous to the Système d'Information en Ligne (SIEL), which provides real-time information on RATP's Regional Rail (RER) service. SNCF implemented the InfoGare system to provide real-time information for travelers in the Île de France. Info-Train is a project to deliver automated on-board information in the regional trains of the Île de France.

In 1995, after the development of a successful prototype system, RATP started experimental application of ALTAIR on Route 47 (from the Gare du Nord Station to the Kremlin-Bicêtre Station) (*20*). Further demonstrations were conducted in 1997 on additional routes—one bus route and one tram route. Full implementation of ALTAIR began on October 1, 1999, in phases. Phase 1 included the deployment of AVL equipment on 1,500 buses and DMSs at 2,400 bus stops.

The ALTAIR system informs users who are waiting for buses or are making their journeys of the waiting times and destinations for the next two buses. It also informs drivers about their distance and time gaps between the preceding and following buses.

Real-time information on bus times is provided to users in a number of ways via different media. Following a study of the best form of support for this information (French Minitel, Internet, pager, etc.), RATP decided to focus on the telephone. A server delivers voice/audio information about bus stopping times on certain routes. Using the menu, the passenger chooses a bus stop and can receive by phone the same information as that displayed at the bus stop. At bus stops, information is provided about route numbers, final destinations, waiting times, service disruptions, and network information. Up to eight departure times can be displayed, and the information is updated every 25 seconds.

Inside the bus, bus stops are announced and displayed on a running LED sign. The accuracy of the vehicle location is sufficient to trigger announcements without intervention from the driver at any time, synchronized with the arrival at the bus stop, even if the route is changed. Furthermore, the communication network allows the bus to receive service messages sent automatically or by the traffic manager, such as notice of deviations, service cuts, and so on.

The AIGLE system was designed to enhance in-bus safety for both drivers and passengers, enabling a centralized monitoring of bus security and the management of security patrols. In order to operate bus security centrally, buses need to be located precisely, and security has to be monitored. The locations of buses and security patrols are established using the AVL system already described for ALTAIR. Data relevant to security is also monitored in the RATP and police control centers. Alarms and vehicle positions are displayed on a screen. In October 1994, RATP had completed the first phase of vehicle location for security purposes. At the end of 1999, implementation had started, with the goal to equip all buses with security equipment by 2001.

RATP employees also use the Plan d'Information Voyageur Informatisé system, an enquiry office terminal, to answer telephone inquiries from the general public. The system is essentially a reference system that details alternative modes and offers possible itineraries between a given origin and destination. The database encompasses a broad range of information required for trip planning, including the following:

- An interactive network map;
- A list of routes;
- A map of routes to be taken;
- Stops;

- Timetables;
- Addresses, street directories, and main sites;
- Travel times; and
- Tourist information.

The aim of InfoGare, which was developed by SNCF (the national rail operator), was to enhance passenger information at train stations for rail travelers. This project, currently in the demonstration phase, is scheduled for full-scale deployment to the whole Île de France region by 2002 in 350 train stations.

The goals of InfoGare are to

- Provide departure times of trains to travelers via fixed information monitors at the station's entrance and to keep passengers informed about the traffic status at all times (i.e., in normal and abnormal situations);
- Provide passengers with reliable, immediate, and personalized information in every station and on every platform; and
- Inform the station staff simultaneously.

Passengers are kept informed in real time by means of cathode-ray-tube screens set in station buildings and on station platforms. The screens give the following information:

- Time of day,
- Next trains arriving (with their destination indicating codenames of stations to be served),
- The final destination in plain language, and
- The precise time of calling at the station.

The information is supplemented by messages such as "train approaching" or "train delayed," according to the train's actual position. All of the information is continually updated to reflect changing traffic conditions.

InfoTrain, which was planned for deployment in 2001, was supposed to provide audio and visual information on board, including the following:

- Real-time information on the destination and stops;
- Immediate information on the next stop and its multimodal transfer options; and
- Rapid and simple information on service disruptions.

Besides the "technical" information, the passenger would also be informed about the transport products and services available and about offers linked to specific events. Finally, general news, nearby sites of interest, and advertisements would be visually displayed. As of December 2002, the system had not been fully deployed.

RATP has undertaken passenger satisfaction surveys, which indicate that the objectives of both ALTAIR and AIGLE have been achieved. The systems have been repeatedly tested in sometimes very difficult operating conditions, and the information displayed has been shown to be consistently accurate. Measurements have also been taken to check the accuracy of waiting times. These measurements, made in both peak and off-peak periods, were accurate to 30 seconds for waiting times up to 4 minutes and to within 1 minute for waiting times of 10 minutes. This accuracy will, for example, allow passengers to run errands if the waiting time allows or perhaps choose another mode of transport.

Beyond the direct goals of the two systems, the main goal of ALTAIR and AIGLE is to deliver a better quality of service to the user of public transport in two key areas: safety and reliability. The ALTAIR system was also designed after the success of the earlier ALEXIS system, which was used to inform the public.

5.2.8 Munich, Germany

The Munich region—including the city of Munich, which is often referred to as the greater Munich area—has 2.4 million inhabitants with 1.49 million registered vehicles (that is, 0.62 vehicles per capita) and covers over 2,100 square miles. Public transport in Munich comprises 44 miles of subways (i.e., the U-Bahn), 271 miles of rapid transit (i.e., the S-Bahn), 40 miles of light rail, and 2,125 miles of bus routes. On average, rapid transit is used by 700,000 passengers and subways by 800,000 passengers each working day.

The concept of Cooperative Transport Management was developed to contribute to the solution of transport problems in this metropolitan region; the concept solution must accommodate both a medieval city and an industrialized metropolitan area. In the concept of Cooperative Transport Management, administration, industry, and research institutions cooperate to develop strategies and technologies and to carry out assessments of transport ITS systems. The main projects that are relevant to public transport travelers are as follows:

- **BayernInfo** is a large-scale development project for linking multimodal control and information centers to provide a database for traffic information via personal traveler assistants (PTAs) and the Internet.
- **INFOTEN** is a project for multimodal transport information on Trans-European Transport Networks within and between European regions in Austria, Germany, Italy, and Switzerland.
- **Mobilität im Ballungsraum München (MOBINET)** is a €4.5 million large-scale ITS implementation project concerning public transport, traffic management on the arterial roads, information services, and measures to reduce overall transport demand while maintaining sustainable mobility.

Münchner Verkehrs und Tarifverbund (MVV) is the public transport authority in the greater Munich area. The public transport executive for the region is the Bavarian state government. Public transport operators are the Deutsche Bahn AG Railways; the regional bus owners; and the city's subway, bus, and light-rail systems, which are operated by the Stadtwerke Munich (SWM).

BayernInfo has provided the foundation for traveler information services in Munich since 1995. It is a project initiated by Bavaria Online as a part of the Program Offensive for the Future of Bavaria of the Bavarian state government and is being financed by the Free State of Bavaria with approximately 5 million. The project was initially supported by the participating industry partners with 4.5 million.

The aim of the BayernInfo project is to develop a regional traffic information system consisting of a statewide traffic information center and two information centers for the metropolitan areas of Munich and Nuremberg. These centers provide dynamic traffic analyses and forecasts, current traffic situation reports, and timetable information for road users in Bavaria. Additional objectives include Elektronische Fahrplanauskunft (EFA), which provides electronic timetable information; an information system for public transport; and the use of small, portable mobility planners (PTAs) and the Internet for information to travelers before and during their journeys. The development and integration of traffic information centers covering publicly and privately operated services called for new models of cooperation between public transportation departments and private undertakings.

EFA Bavaria provides statewide, door-to-door timetable information on public transport, extending beyond the boundaries of individual systems. The complete timetable is stored for this purpose. From these data, EFA supplies departure times, route information on bus and train transfers, and, in certain cases, fares. The information is provided for the complete door-to-door journey and takes into account temporary traffic restrictions. The information is adapted to customer needs because the system stores a large number of important landmarks and transfer points in the individual transport systems. EFA information is obtainable from the Internet.

BayernInfo provides a platform for dynamic, reliable, and user-oriented travel information with easy user access. For given origin and destination points throughout Bavaria, BayernInfo provides the best route, 24 hours a day. Individual travelers are addressed via the Internet and via handheld mobile PTAs.

The development of an intermodal route planner and the testing of a portable traveler assistant is a major objective. The infrastructure is provided for access to information from the traffic information center and the regional centers in the metropolitan areas of Munich and Nuremberg, as well as from the statewide electronic timetable information. In this way, the portable PTA has access to current traffic information at any time, throughout Europe, via cellular telephone.

The intermodal trip planner is able to search the databases of public transport services and highway networks to provide departure and arrival times for public transport, travel times, and cost comparisons for car and public transport travel. This approach combines current information from the traffic centers and EFA Bavaria for the desired journey and transmits them to the user, together with information on any other transport changes that may be useful to the user. Road users without any local knowledge do not have to plan their routes, and even local users are helped with timetable information for interconnecting public transport systems.

Traffic information from BayernInfo on the Internet is shown in Figure 61. The intermodal travel planner is shown in Figure 62. EFA is shown in Figure 63.

The INFOTEN project conducted from January 1996 to March 1999 introduced language-independent systems for traffic information exchange, multimodal traveler information systems, and advanced driver warning in the Alpine region and in Central Europe.

INFOTEN gives a European dimension to BayernInfo by demonstrating multimodal traveler information systems within and between European regions on the Trans-European Networks (TEN). The information is presented to travelers using a set of multimedia traffic information services that are operated as value-added services. Four devices are available for end-users to receive the information available on the INFOTEN backbone: PTAs, fixed information terminals (FITs), cellular phones, and the Internet. PTAs provide mobile information and allow the end-user to make queries to the INFOTEN backbone. FITs provide the same information on multimodal journeys in Europe, but on permanent terminals that can be found in such places as airports and train stations. Cellular phones can also be used via Austrian and Italian GSM-SMS providers Europewide to receive information. Information is also available using the Internet.

INFOTEN has contributed largely to the technical development of the DATEX specification for interoperable exchange of traffic information between traffic control centers and traffic information centers. Theoretical concepts for multimodal and intermodal information services have been produced that will be integrated into the future European Framework Architecture for ITS.

MOBINET is a project financed by the German Ministry of Education and Technology in the context of the Mobility in Metropolitan Areas Program. This project runs from September 1998 through July 2003 and has 26 partners. Major application areas are new mobility concepts, multimodal transport supply in rural areas, optimization of traffic on the arterial networks, multimedia information services, and linking of traffic information and control centers. As of December 2002, several mobility strategies have been deployed, such as

- Parking-space management in the city center;
- Incident management on rapid transit;
- Dynamic bus service (resulting in an increase in the demand on the rapid-transit railway feeder service by 18%);
- A Bike+Ride facility opening;

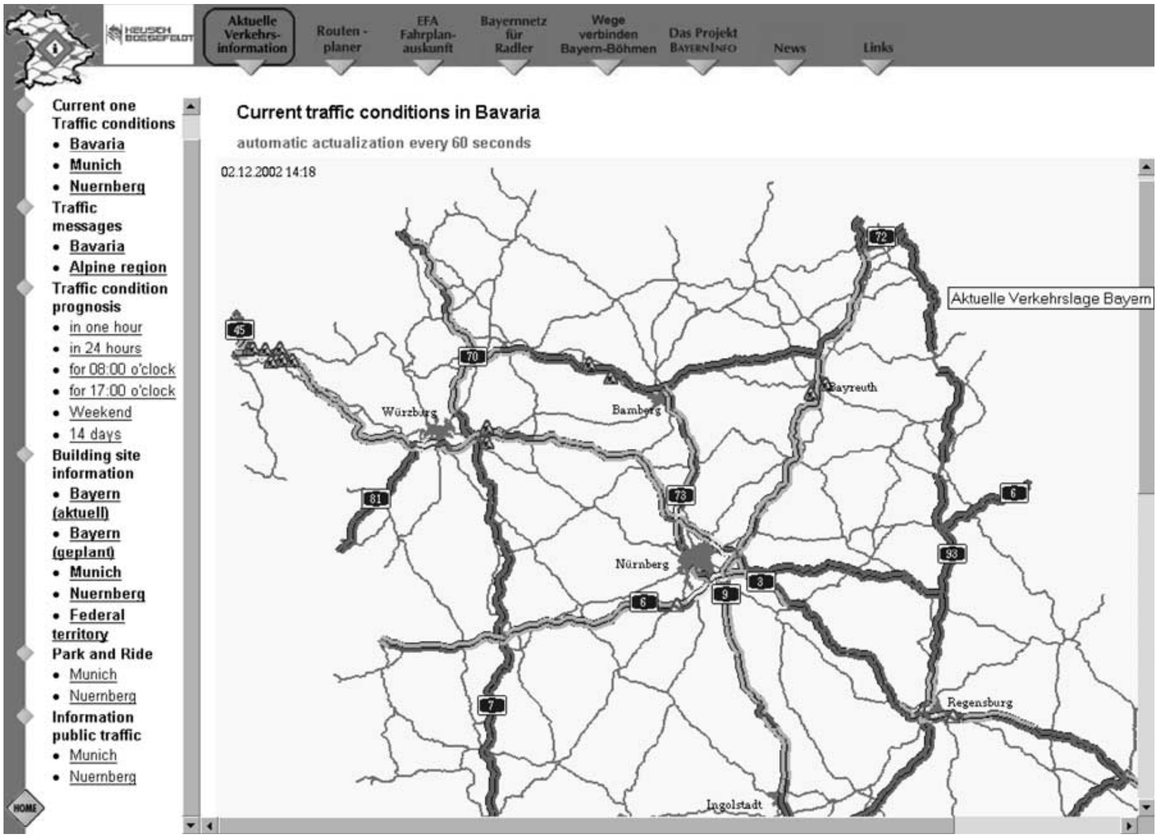

Figure 61. Current traffic conditions from BayernInfo.

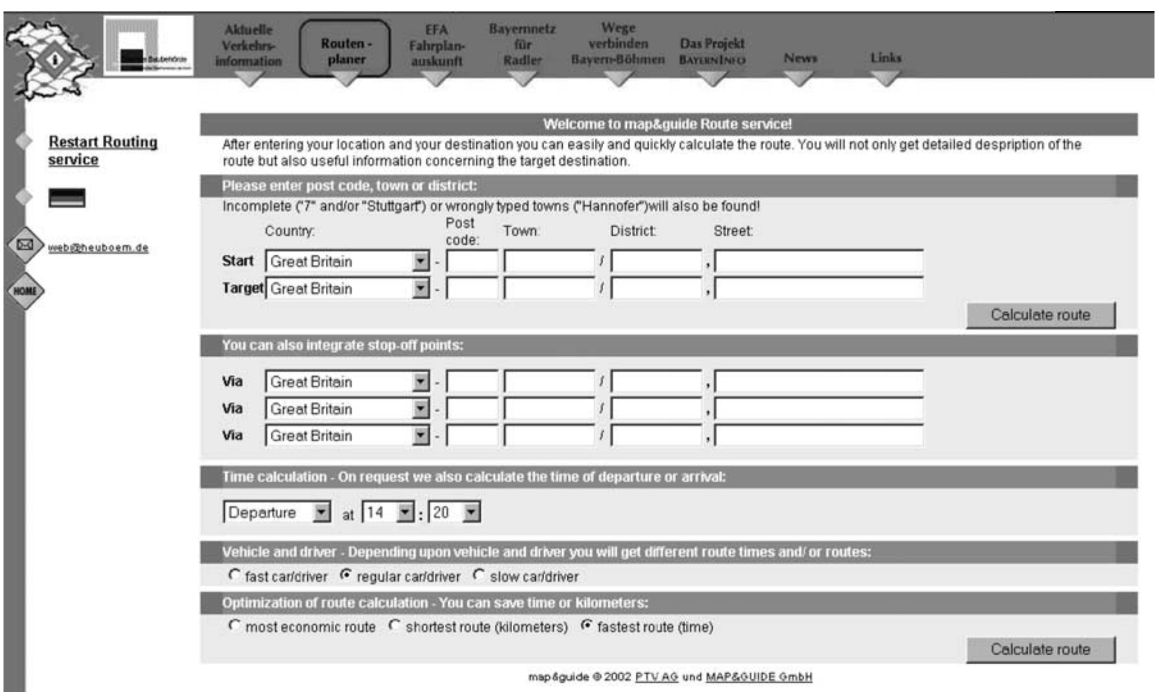

Figure 62. BayernInfo route planner.

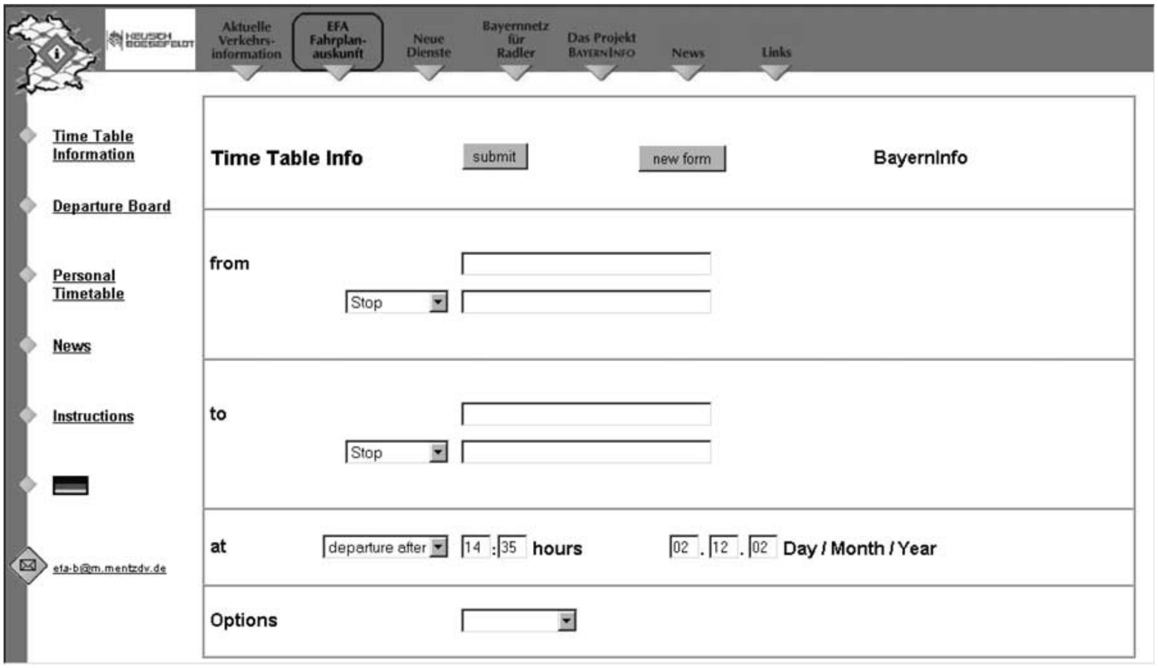

Figure 63. Electronic timetable from BayernInfo.

- Dynamic traffic-control systems deployment;
- Information services such as
  – Net Info, which informs drivers about the traffic situation on the approach roads to Munich;
  – FUNI Info, which integrates traffic and weather information into leisure planning;
  – URBAN Info, which offers Munich city information; and
  – Park Info, which informs users about parking-space allocation and predictive availability;
- Adaptive signals and DMSs; and
- Multimodal information for those with mobility impairments.

So far, several innovative concepts have demonstrated success: 150 teleworkstations have reduced the rush hour, mobility consultation for children (MOBIKIDS) has increased the security of children on the way to school, and 20% to 30% of school children are not brought to school by automobile. The current demonstrations are showing influences in mobility behavior. The evaluations of MOBINET have begun. Building on the success of BayernInfo—which demonstrated that transport ITS applications are accepted by network owners, service operators, and travelers or end-users—MOBINET aims to implement the prototypes and tools developed in some of the earlier projects.

All of the Bavarian and Munich projects discussed are guided by complex evaluation programs to define user requirements and objectives, to assess user acceptance, and to carry out a cost-benefit analysis of the system. For INFOTEN, comprehensive surveys of 1,000 travelers within the regions of the four Alpine countries—Germany, Austria, Switzerland, and Italy—showed a high demand for dynamic information and individualized multimodal information. More than 50% of those interviewed seriously considered changing their planned departure time or route regularly. While only 26% would consider changing mode en route, about 40% could be influenced to change the means of transport in the trip-planning phase.

5.2.9 Bologna, Italy

Azienda Trasporti Consorziali (ATC), the public transport operator in Bologna, is an integral partner in almost all of the ITS projects that have been deployed there. ITS, many systems of which focus on providing TTI, includes the following:

- **Urban traffic control,** which includes integration between private and public transport:

> A special traffic light network was realized which is linked to the buses operative center, [and] special bus lanes have been marked in order to guarantee circulation to buses. The main accesses to the city center are controlled through an automatic system (SIRIO) that detects vehicles approaching the access gate by reading the license plate number. The not-authorized vehicle's image is stored and then forwarded to the control center to be fined. (*21*).

- **Traffic light management,** which uses real-time information to control traffic signals. This system is integrated with ATC's AVL system so that buses receive priority at intersections.

- **Traffic network monitoring,** which includes a traffic-control center that provides real-time information to DMSs installed in various locations in and around Bologna.
- **ATC AVL system,** which monitors all buses.
- **Electronic bus shelters,** which contain DMSs that display real-time arrival information, land-line telephones, ticket-issuing machines, and video surveillance systems.
- **Real-Time Information via GSM mobile phone (hellobus),** which provides the same information as that which is displayed at equipped bus stops. The user selects an SMS message that contains a predefined code that identifies a particular bus stop and route. This message is sent to ATC from the mobile phone provider. ATC then provides the prediction of arrival time for the next bus at that stop on that route in the form of an SMS message back to the user.
- **Demand-responsive public transport,** which uses three types of services:
  - Freebus, which provides route/point deviation service;
  - Videobus, which operates only based on demand (also known as checkpoint service); and
  - Prontobus, which provides service in outlying areas.

5.2.10 Western Europe

Western Europe has regional ATIS systems that are designed to provide itinerary-planning and other transit information via the telephone and Internet. The systems include the OV reisinformatie (OVR) national phone system in the Netherlands; transnational services such as EFA, EU-Spirit, and ARISE; and the United Kingdom's national public transport information system.

5.2.10.1 Dutch OVR: One Phone Number for All Modes

The core activity of the OVR was to offer the Dutch public an integrated travel information service in the Netherlands through one national telephone number. Prior to this program, each public transport company had its own telephone number, and it was difficult to obtain integrated and consistent travel information. There is 1 national rail company, 13 regional bus companies, 9 city bus companies, 4 ferry companies, and 10 other private transport companies.

OVR was deployed in May 1992. Since then, the Dutch have only one telephone number, 0900-9292, to call for public transport information. Available for 18 hours a day (6:00 A.M. through Midnight), for 7 days a week, OVR provides door-to-door information about

- All possible different modes—tram, bus, metro, train, ferry, and so forth;
- Service schedules;
- Fares; and
- Other relevant information.

The timetable information comprises static information about departure, transfer, and arrival times; stops; stations; route numbers; and directions for every form of public transport in the Netherlands. The dynamic information covers temporary changes in timetables such as service disruptions and incidental changes caused by work and events.

The service costs approximately US23¢ a minute, and the average time it takes to get travel advice is 2½ minutes, including waiting time. The costs for the public transport companies stayed at the same level as they were before OVR because the Ministry of Transport supported the initiative financially for the first 4 years, providing 50% of operating costs. OVR installed a national telephone and computer network consisting of 9 call centers with 150 workstations. These are staffed by 400 part-time (20 hours per week) advisors. Since the launch of the OVR service, the number of calls has doubled; during 1992, 0900-9292 handled 5.8 million calls. By 1994, this number had risen to 8.1 million, and by 1997 to 11 million.

5.2.10.2 EFA: Electronic Timetable for Germany, Austria, and Switzerland

EFA, the electronic timetable information system used by about 40 public transport companies in Germany, Austria, and Switzerland, uses a data transmission protocol that was developed and implemented on the Integrated Services Digital Network (ISDN) system. Anyone with a Windows-based PC and an ISDN card can obtain on-line information from every information server. The largest transport operator using EFA is the Verkehrsverbund Rhein-Ruhr (VRR), which covers the region of Ruhrgebiet with about 100,000 trips offered per day.

The EFA user will receive various types of support when inputting departure points and destinations. Instead of the names of stops, one can enter addresses, and EFA will find the closest stop. In addition, there is a search tree for important points in most of the larger German towns. As the precise spelling of the name of a stop or of an address is often not known, EFA uses a phonetic search, seeking to replace unknown names with a valid, but similar sounding, one.

5.2.10.3 EU-Spirit: Seamless Passenger Information Europewide Network

EU-Spirit was a 2-year research project partly funded by the European Commission. Its goal was to develop and demonstrate a customer-friendly, Internet-based, multimodal information system. By using the so called "EU-Spirit travel planning ring," existing and independent transport travel planning systems from several long-distance and local operators will be connected. With the integration of long-distance railway and local transport information systems, EU-Spirit can provide integrated door-to-door public transport information across Europe. This concept is central to the development of future traveler information systems in Europe.

EU-Spirit was set up in 1998 to work toward the above-stated goals. The project lasted 28 months, ending in spring 2001. The consortium comprises 35 partners in 7 countries, representing national and local operators, regions, system developers, and researchers. Deutsche Bahn AG, the German railway company, is leading the consortium as the project coordinator. Initially, the system was demonstrated in a north-south corridor covering Sweden, Denmark, Germany, Austria, and northern Italy. However, in the longer term, the system has the capability to extend coverage to other regions and the potential to cover the whole of Europe, including Eastern Europe.

A key point of the system is that unlike other systems described in this report, EU-Spirit is not a travel planner: the system only compiles information from existing travel planners into a complete door-to-door itinerary. EU-Spirit is only involved in travel planning when a customer not only wants to travel inside a regional transport system or between two main stations, but also needs an itinerary from one local stop to another local stop in another region. EU-Spirit is available at www.eu-spirit.com.

As of December 2002, the following regions or organizations were participating in the system:

- Berlin-Brandenburg,
- Swedish Regional Trains and Buses,
- Scania and southern Sweden,
- Denmark, and
- Emilia Romagna in Italy.

EU-Spirit will develop additional service applications to attract and integrate a wide range of service features. Future services being assessed are as follows:

- Integration of flights, long-distance buses, and ferries;
- Standardization of site information; and
- Fare information and e-payment.

See Figure 64 for the structure of EU-Spirit.

5.2.10.4 *ARISE: Dutch, French, and Italian Railway Telephone Enquiry System*

Travel schedule information is essential for public transport users if the trains, trams, subways, or buses run at intervals longer than 10 minutes. This information reaches travelers through different media. Telephone enquiries play a crucial role and are now running at more than 200 million calls annually to railway centers in Europe; however, the number of calls that can be handled is limited due to the cost of this human-operated service, with at least 20% of calls going unanswered. ARISE aims to improve this situation by handling the bulk of routine telephone enquiries automatically, thus freeing the operator for more complex and higher-valued services. The project is backed by strong demand from public transit operators.

The Dutch, French and Italian railway operators want to enhance the quality of their services, and easy access to timely

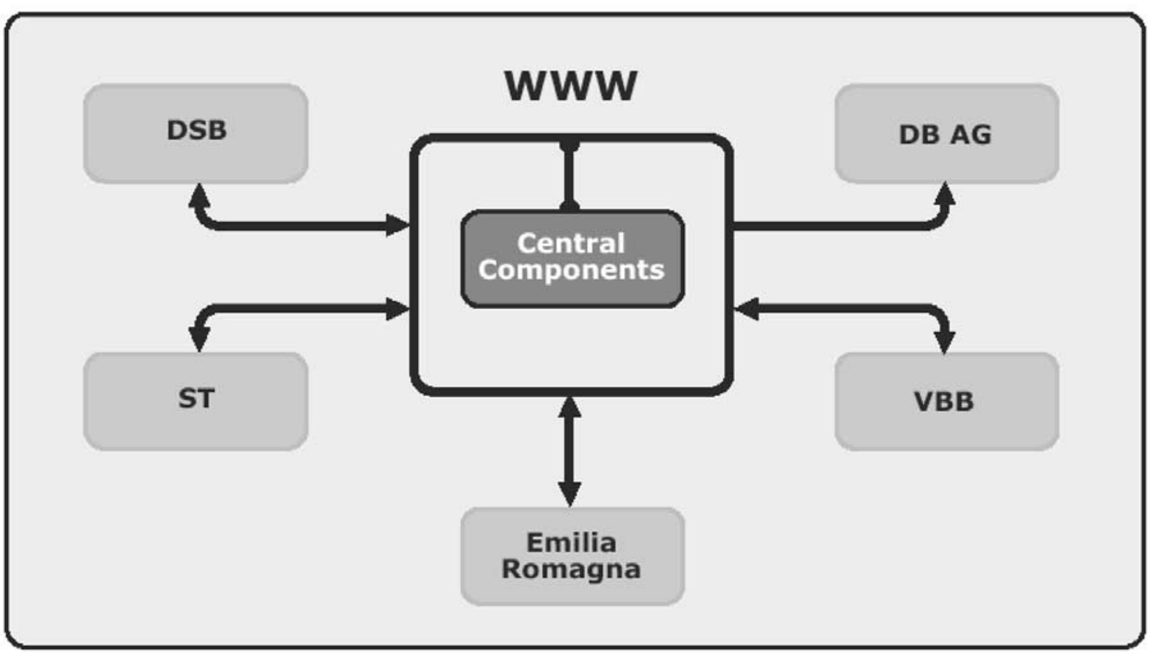

Figure 64. EU-Spirit general system structure.

and accurate information about schedules and travel options is considered essential. With this intention, the railway operators have already had a number of telephone enquiry systems installed that are manually operated or that use dual-tone multifrequency (DTMF) technology. However, due to cost and a need for easier accessibility, the routine operations need to be fully automated.

Today, speech recognition is at a crucial turning point: it is moving from a situation of technology push to demand pull. The ARISE projects reflect this shift in organizational terms, and the research focuses on more pragmatic viewpoints. In principle the market prospects appear large since many call-center operations can be usefully supported by the technology. One of the key questions that ARISE is hoping to address is whether transit customers will be willing to accept the technology and to talk to a machine.

ARISE operates in three language environments—Dutch, French, and Italian—each bringing together a service provider, technology providers, and system integrators. In the Netherlands, the railroad operator has commuter traffic mainly in two relatively short periods of the day and has a need to increase off-peak traffic by providing timely information for the casual traveler. A subsidiary company handles more than 11 million calls annually, using 400 operators. Sixty percent of these calls require information concerning more than one public transport service. One of the technology providers was a pioneer in voice recognition technology and now has 20 years of experience with that technology. The provider has achieved an 80% success rate for a German train schedule enquiry system that has been operational since February 1994.

In France, the railroad operator has 1,300 staff to answer more than 40 million telephone calls for train information each year. It has extensive experience with public information systems over the telephone network, especially dialogue systems. One of the technology providers has a spoken language processing group that specializes in speech analysis and synthesis. The university partner has experience in automatic speech processing, mainly in phonology, lexica, and analysis of speech corpora. The two system integrators have particular experience in speech recognition and synthesis and in public transport information systems.

In Italy, the railroad operator deals with over 20 million telephone requests annually. One of the technology providers has focused research on speech recognition in adverse environments. The system integrator has already supplied a videotext train timetable and has much experience in on-line services.

The main goal for ARISE is to develop an automatic train schedule information system that can communicate verbally via the telephone. Other goals include the following:

- A system that is easy for the public to use;
- A high level of satisfaction for the caller;
- A level of quality that is comparable with human-operated systems;
- The ability to work as part of a full-blown, human-operated service that provides door-to-door information, especially for the Dutch transport system;
- Greater revenue from the information.

Specific objectives vary according to the requirements within each environment.

5.2.10.5 *United Kingdom: National Public Transport Information System*

The British Government wanted to see greater integration between different transport modes so that people could “mix and match” their travel mode choices according to their particular circumstances. Part of the initiative for a national public transportation information system was to deploy a traveler information system that allows people to find information on any public transport services in the country. Information would be available nationally via a common access point: a telephone enquiry point with a number that is easily memorized. The same information would be available to public transit enquiry bureaus and to the public on TV teletext and on the Internet. This telephone enquiry system has been deployed and is called Traveline. The national phone number for Traveline is 0870 608 2 608.

A national partnership among the bus operators, the local transportation authorities, and users’ representatives was established for the delivery of this project. A steering group chaired by the Confederation of Passenger Transport (representing bus, coach, and light rail operators) developed the project plan. The plan is complemented by local Public Transport Information (PTI) partnerships in each region.

The initial focus of the plan was to make comprehensive timetable information available for local, regional, and national services—the equivalent of a “roadmap” of transit services—detailing the entire public transit network. There are plans to add fare information at a later stage. The implementation strategy builds on information services that are already up and running. There is, for example, already a national timetable enquiry service for the passenger railroads. Nothing similar exists for the local bus networks and rail systems, although some county councils have established their own Internet sites. The local PTI partnerships are being asked to fill in the gaps. Legislation is being considered to make it a duty of local authorities to secure the availability of transit information for their area with cost recovery from the operators. In effect, the national public transit information system is a federal system that is being constructed from the bottom up.

One website currently provides information on all public transport in the United Kingdom, but it is not integrated. See Figure 65 for an image of this website (www.pti.org.uk/).

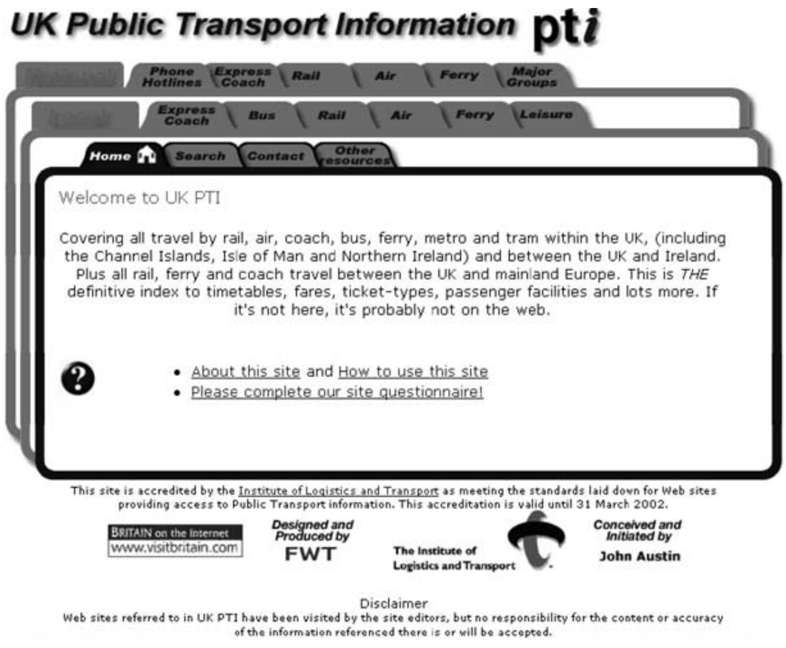

Figure 65. UK website for public transport information.

Local PTI partnerships brought together information on local journeys for all modes, with trunk journeys to and from the area in Traveline. Traveline includes a variety of access media and common standards of service. The added value of the project is that it draws together information from a large number of different sources.

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