Technical Memorandum No. 8 -
Final Report

ITS STRATEGIC DEPLOYMENT PLAN

Nashville Area Intelligent Transportation Systems Early Deployment Study

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1.0 Introduction

1.1 Project Overview

Intelligent Transportation Systems (ITS) (formerly Intelligent Vehicle Highway Systems [IVHS]), is the application of advanced information processing, communications, vehicle sensing, and central monitoring and control technologies to surface transportation. The objective of ITS is to promote more efficient use of the existing highway and transportation network, to increase safety and mobility, and to decrease the environmental costs of travel (IVHS Primer, July 1993).

This ***Strategic Plan for Early Deployment of Intelligent Transportation Systems in Nashville*** has described the results, findings, and recommendations of an ITS early deployment study. This planning study, which began in October, 1995, was initiated and administered by the Nashville Area Metropolitan Planning Organization (MPO), in collaboration with the Tennessee Department of Transportation and the Federal Highway Administration. The study consultant was Kimley-Horn and Associates, assisted by Lockheed-Martin Federal Systems, Street Smarts, and Vanderbilt University.

The goal of this study was to develop a Strategic Plan for deployment of ITS technologies within the Nashville Metro Area and to create a long-term coalition of ITS stakeholders, with the objective of expanding the implementation of ITS technologies throughout the Nashville Metro Area. As specified in the procurement document that established the scope for this study, the first ITS priority for Nashville should address the travel information needs of tourists and other visitors to the region.

In December of 1991, the Intermodal Surface Transportation Efficiency Act (ISTEA) was adopted by Congress. ISTEA authorizes the use of federal funds for various transportation improvement projects over a six year period (1992- 1997). ITS applications are a component of these federal aid program finds.

Kimley-Horn developed the Strategic Planning Process shown in Figure 1 specifically for the Nashville Early Deployment Study. In addition, a National Program Plan for ITS has been prepared to provide an overall framework to guide ITS investment decisions and promote ITS goals.

A number of important transportation features indicate that deployment of ITS technologies will improve traffic safety and reduce congestion in the region. First, there is a convergence of three major interstate highways. Several river crossings in the area somewhat constrain travel patterns in the City as well as region-wide. A large number of tourists enter the Middle Tennessee region annually, with a large proportion of those visiting "Music City." High Occupancy Vehicle (HOV) lanes are in operation; additional HOV facilities are being built, and others are in the planning or design stage. Furthermore, there is an excellent transit system including park & ride and interurban commuters. Local officials recognize that these facilities are not enough to alleviate the pressure on the extremely congested highway arteries leading into and out of Nashville.

As a fast-paced, growing, "major league" city, land prices are also rising significantly each year, making it more costly to continue to add lanes to existing facilities. These characteristics, combined with the limited availability of traveler information and the need for improved emergency management services on the Interstate, create a unique opportunity to test the implementation of innovative ITS technologies in Middle Tennessee.

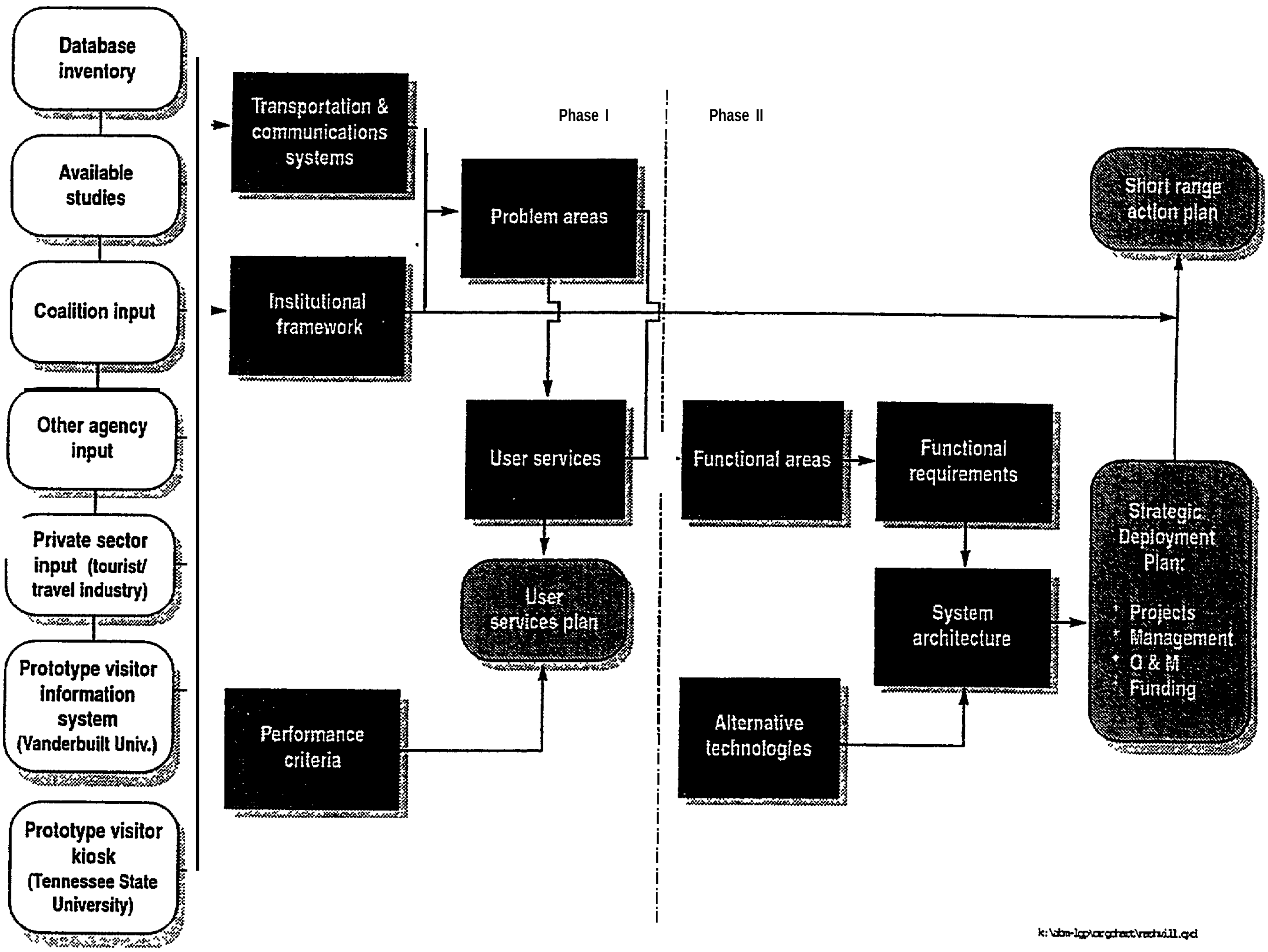
The Nashville Area MPO outlined a process that closely parallels the National ITS Program Plan and FHWA Planning Process. It has been divided into the following eight sequential tasks and project outputs:

Task No. Title	Output
Task 1 a: Define transportation problems and systems.	Database and bibliography on transportation, communications, and visitor information. (TM 1)
Task 1 b: Establish institutional framework and build ITS Coalition.	A cadre of knowledgable professionals and decision-makers. (TM 1)
Task 2: Establish user service objectives.	Broad statements of transportation system user needs. (TM 2)
Task 3 : Establish performance criteria.	Factors by which to measure the results of any future ITS project. (TM 3)
Task 4: Prepare a user service plan.	A logical sequence of how user needs can be met over time. (TM 4)
Task 5: Identify needed functional areas.	Broad technology areas that can address user needs. (TM 5)
Task 6: Define functional requirements to support user services; define system architecture.	More specific requirements and a logical communications network for linking those technologies together into a system. (TM 6)
Task 7: Identify and screen alternative technologies.	Optional technologies within each functional area and an evaluation of those options. (TM 7)
Task 8: Develop ITS strategic deployment plan.	Specific ITS projects using system architecture as guidelines, estimated costs and benefits. (TM 8)

This strategic plan should not be considered as a final design for a particular project, but as a set of guidelines and standards that will provide a common architecture for all ITS projects in the region.

FIGURE 1

PLANNING PROCESS



1.2 Background on Nashville Development Needs

1.2.1 Population and Economy

The five-county region in Middle Tennessee that are part of the Nashville Area MPO is a dynamic, world-class urban area. Between 1980 and 1990, the Metropolitan Statistical Area (MSA) population grew by almost 16 percent and its labor force by 26 percent. The economy is vibrant and progressive, with close to a three percent unemployment rate. Close to a million people reside in the greater Nashville region, with Davidson County providing almost 80 percent of the MSA labor force.

Approximate populations of the five counties in the MPO area as of 1995 were:

Davidson	525,000
Rutherford	140,000
Sumner	108,000
Williamson	95,000
Wilson	70,000

(Source: ***Music City Profile,*** Nashville Visitors and Convention Bureau, January 1995.)

As the Nashville area has grown in size and sophistication, the demand for mobility has grown at an even greater pace. This demand is fueled by a variety of factors, including increased commuter, tourist, and business travel. Recent, dramatic growth in residential and retail development in suburban areas, and tourist/visitor and retail development in the downtown have also contributed to increased demands on the existing transportation infrastructure.

In recent years, it has become increasingly apparent to civic leaders in the Nashville area, the Tennessee DOT, and the Nashville Area MPO that construction and widening of highways alone will not continue to be sufficient to meet the areas's present and future transportation needs. Safety, efficiency and convenience will begin to deteriorate unless advanced technologies are applied to increase through-put and optimize use of existing infrastructure. Better use of existing facilities was one option seen as crucial to the Nashville area's continued growth and economic vitality, including anticipated and desired growth in the tourist industry.

Nashville's nicknames "Music City," "Athens of the South," etc. give testimony to the rich musical and cultural heritage. Founded as a river port, Nashville has historically served as a transportation hub, a role it continues to play. Nashville is only one of a handful of U.S. cities served by three major interstate highways. Interstates 24,40, and 65 intersect at Nashville. Two "urban loop," I-265 and I-440, help complete the Interstate inventory in the metro area. These major facilities will be enhanced in the long-range future by an "outer loop," to be funded with State funds and carrying the designation of SR 840.

The current and future direct access and strategic location, combined with the region's natural scenery, entertainment, historical sites, cultural amenities, educational institutions, hospitals, and recreational facilities, make the Nashville area a mecca for tourists as well as travelers who stop on their way to other Middle Tennessee and Mid-South destinations.

Nashville International Airport (BNA) is also an aviation hub that enhances its role as a convention and business meeting location. In addition, the city recently became the home of a professional football team, and major league basketball, hockey, and baseball are in the plans by the city fathers to further enhance Nashville as a "world class" city. The 19,000 plus Nashville Arena is scheduled to open in late fall 1996, and plans are underway to build a stadium for the NFL football franchise on the east bank of the Cumberland River, across from the downtown.

This extensive surface transportation network in the Nashville region, coupled with the area's central location relative to national population centers, has given the Nashville region an economic advantage over most other metropolitan areas of similar size. However, this transportation system is not without its problems. A review of general problems and opportunities for improvement will be related here, with more detail to follow in this Strategic Plan.

1.2.2 General transportation problems

Highway planners in previous decades did not foresee the tremendous growth that occurred during the 1970's and '80's This growth has spilled beyond the borders of Davidson County into each of the adjoining counties that make up the MPO area. Highway projects in many ways were not designed to accommodate current traffic volumes. For example, around the "Inner Loop" of I-24/ I-40/ I-65/265, making interconnections between interstates is difficult due to functional layout of the highways coupled with inadequate and/or confusing overhead signs. Signing is adequate for those travelers familiar with the area, but for out of town visitors, navigating into the downtown area is a challenge.

Interchanges in the downtown are closely spaced, increasing the potential for vehicle conflicts in weaving areas. This is particularly true on I-40 west/ I-65 south at the Second Avenue South exit. In other places, travelers have little advance warning of where to turn or exit to reach popular tourist destinations or make highways with other highways. This is coupled with the orientation of signs on the Interstates, which provide directions for long-distance travelers but not for visitors to Nashville.

The development of Nashville's arterial highway system was largely determined by the area's topographic features, including the Cumberland River. As a result, streets are often disjointed and in many places do not provide good alternatives to the interstate system. Roads and streets change names frequently and duplicate street names are common.

Due to the city's international reputation as the home of country, and the popularity of attractions such as Opryland, the Opryland Hotel, Music Row, and country music star homes, tourism is a major industry throughout the five-county region. Many "down-home" music halls are located in remote rural areas, such as Leapers Fork in rural Williamson County, as well as in city-based venues such as the Blue Bird Cafe and Printer's Alley, Second Avenue, and the like. Over 42,000 people are employed in the music and publishing industry in Davidson County alone.

However, those in the tourism business who have participated in this early deployment study as a Coalition member have indicated that the area cannot afford to be complacent about this position of leadership in the country music industry. There is recognition that improved access and accessibility to existing and planned tourist attractions and accommodations should be strengthened. This includes improving the ability of visitors to find their way quickly and safely around the area.

Nashville also provides recreational and cultural activities for many residents of the metropolitan area. These activities include concerts, sporting events, festivals, and exhibits. Traffic problems occur for both visitors and residents alike during the peak tourist season, generally May through September. Special events that increase the need for better traffic control and management include the Country Fan Fair, concerts at Stat-wood Amphitheater and the Riverfront, downtown Summer Lights Festival, Vanderbilt University sporting events, Christmas at Opryland, and other Nashville venues. The Metro Department of Public Works (MPW) has some 80 events annually that require closing Second Avenue North between Broadway and Church Street to accommodate heavy pedestrian loads.

In addition, many of the rural communities have activities that require special handling of traffic, such as events at the Murphy Center in Murfreesboro and several annual events on the historic square in Franklin that attract crowds into the tens of thousands.

In early 1994, the Nashville Convention and Visitors Bureau published its Visitor's Profile Study ***(Music City USA Nashville Visitor Profile Study,*** McNabb DeSoto, Salter and Company, January 1994). The surveys during August and October, 1993, consisted of 1,375 completed interviews at various attractions in the area. A complete summary of this survey is related in Technical Memorandum (TM 1).

As this ITS strategic plan was undertaken, the results of the visitor profile provided some insight into the transportation and mobility problems typically faced by tourists and other visitors. For example, approximately 90 percent of Nashville's visitors come as tourists only, while three percent visit primarily for conferences or conventions and seven percent are primarily on business. Music and entertainment were the primary attractions for about 70 percent of the visitors. Over 70 percent traveled to the city by private automobile, the remainder by tour bus and by air. When in the area, fourteen percent took part in a guided sightseeing tour, leaving most visitors traveling around by private vehicle or rental car.

As another insight into Nashville's visitors, the three top detractions from visitors' impressions of the city were:

- Poor maps and directions
- Inadequate signs
- Difficulty in getting around

According to that study, there is every indication that the importance of evaluating the effectiveness of road signs and other traffic guidance systems is especially important for the Nashville region. ITS technologies were determined by the Nashville MPO and the Tennessee DOT to offer the potential to assist by providing a variety of tourist and visitor-oriented information and route guidance services. This Strategic Panning effort has confirmed this fact.

1.3 Introduction of ITS into Transportation and Communications Infrastructure Development

Task 1 of the Nashville Area Early Deployment Plan focused on identifying the problems, needs, and deficiencies of the present transportation and information systems in the five-county region. To assist in identifying these problems and needs, a Steering Committee was appointed to advise the MPO and work with the consultant team. Meetings were held approximately once every six weeks. At the December, 1995 meeting of the Coalition, the members were divided into three focus groups to serve as an "expert panel" to represent the travel and information needs of three groups of travelers. The groups that were simulated by the focus groups were: (1) potential visitors to the region who have not yet left on their trip to the region; (2) the long-distance traveler (visitors from outside the MPO region) who are en-route to the region; and (3) those visitors who have already arrived in the five-county region and have information needs that relate to their travel within the area.

The Steering Committee, comprised of 10 representatives from the public and private sectors, included local, state, and federal agency representation, as well as key appointees from the tourist and transportation service-provider industries throughout the area. The Steering Committee met regularly to coordinate and direct the development of the ITS Strategic Plan. All Coalition members were invited to each Steering Committee meeting and were specifically requested to attend certain meetings to obtain input and consensus on certain issues, such as the Focus Group workshop held in December.

Early in Task 1, the Coalition developed vision and mission statements for the final product of this Strategic Plan. These statements have been refined through Tasks 2 and 3 of the study, and provide a focus to the goals and objectives of this 12-month study. These policy-oriented statements are:

> **Vision for *VISIT-Middle Tennessee:*** To develop an Advanced Traveler and Tourist Information System (ATIS) that will provide specific short-term and long-term improvements to the quantity and quality of information (on tourism, travel, and traffic) available to visitors and residents of the five-county region.
>
> **Mission for *VISIT-Middle Tennessee:*** To interact with transportation users in order to identify community needs and objectives, and apply the appropriate technology consistent with the national ITS program to solve the area's transportation and visitor information problems. The vision for this system will be achieved through the following actions:

- Developing an educated, broad base of support
- Establishing an effective, involved ITS Coalition
- Designing an Advanced Traveler and Tourist Information System Architecture compatible with the National ITS Architecture
- Setting and achieving realistic short-term expectations
- Specifying and following a staged implementation plan
- Promoting a funding strategy that will enhance tourist and traveler information, and encourage repeat visits by visitors from other parts of the country and the world

Needs for transportation and information systems infrastructure were identified through the focus group process described above, and through the review and analysis of previous reports and interviews with key public and private officials and citizens of the region during Tasks 1 through 3 of the study. The Coalition includes representatives from transportation services, airport-related services, transit, business, academic institutions, major employers, tourist industry, and special events facilities. Input from these sources was achieved through the focus group process and through follow-up surveys and interviews to obtain more specificity of perceived travel and information needs and the appropriate user services that could satisfy those needs. These surveys were also used as a tool to initially prioritize the needs identified in this User Services Plan.

With the needs identified, the next step (Task 2) focused on the establishment of deployment time frames and an evaluation of identified needs. The major emphasis of the needs evaluation was to determine the correlation between the needs and the FHWA defined User Services and the goals of the National ITS Program Plan. Additionally, the region's transportation program was reviewed in Task 2 to assure that a linkage was established between the goals and objectives of both the ITS Strategic Plan and the MPO's Long Range Transportation Plan.

The establishment of the deployment time frames was made based upon three major considerations:

- The re-authorization of ISTEA (1997)
- Current plans for transportation improvements including such current proposals and projects as (1) the realignment of the Shelby Avenue Bridge - Demonbreun Street corridor; (2) six potential HOV facilities along radial corridors leading into Nashville; (3) parking and associated commercial development associated with the new Arena; (4) the development of two LandPort inter-modal terminals; (5) downtown traffic signal system upgrades in downtown Nashville; (6) further implementation of traffic monitoring in Murfreesboro, etc.
- The multi-year planning horizon under which most agencies operate

As a result, the following ITS deployment schedules were established for the Nashville area:

- Short Term	1996 - 1999
- Medium Term	2000 - 2005
- Long Term	beyond 2005

1.4 Transportation Needs in the Nashville Area

The entire five-county MPO is included in the study: Davidson, Rutherford, Sumner, Williamson, and Wilson (Figure 2). The region is often shown to include an extended area such as Cheatham and Robertson counties, such as shown in Figure 2. Recommendations have only been prepared for the five-county MPO, although only Davidson, Rutherford, and Williamson counties were represented on the Steering Committee.

1.4.1 Regional Transportation Systems

The database developed on basic transportation infrastructure focused on the following components:

- Roadways
- Transit
- Water Travel

- Air Travel
- Intermodal Facilities

The following findings from the inventory phase were particularly relevant in developing a strategy to deploy ITS technologies:

- Despite the inclusion of some 50 separate highway improvement projects in the last two Transportation Improvement Plans (TIP) for the region, there are 19 major sections of the interstate system that are projected to be operating at level of service D or below in 20 15.

- Five additional Interstate corridors plus the Briley Parkway are projected as candidates for high-occupancy vehicle (HOV) lane treatment.

- Plans to improve flow at many of Metro's most congested intersections are currently under active consideration.

- A parking management system is being developed to serve the new Nashville Arena (opened December 1996), the proposed TENNFL Stadium, and the Entertainment Area.

- New or recent initiatives with transit service offer, in varying degrees, alternatives to the automobile for visitors. These services include trolley service in downtown Nashville, Music Row, Music Valley Drive, and Franklin/Cool Springs (at Christmas time), and the Franklin Interurban commuter bus and other express bus service.

- An incident management plan was developed for the area under a separate contract.

- Elements of a Visitor Information System are being upgraded by the Nashville Visitors and Convention Bureau for users of the region's highway, water, and air transportation systems.

- Intermodal facilities that are considered "high potential" locations where ITS technologies can be deployed include Nashville International Airport, the Deaderick-Petway Transit Center, and the Nashville LandPort. The City of Franklin is also in the process of developing plans for an Intermodal Transfer Center.

- Other facilities that are considered high potential locations for ITS technologies are the Welcome Centers on Interstate highways and other high-use visitor facilities and attractions, such as the Arena/Welcome Center/Convention Center complex in Downtown Nashville, the 2nd Avenue "District" of restaurants, clubs and shops, Music Row, Opryland, and Music Valley Drive; and area hotels.

Figure 2

STUDY AREA

1.4.2 Information Systems

- The passage for the Tennessee Telecommunications Act of 1995 opened up the playing field for current telephone and cable television providers to develop whole new paradigms in the delivery of voice, data and video information.

- The continual development and deployment of new data services technology presents many opportunities. Similarly, Intermedia's acquisition of Viacom and its rebuilding the entire region's cable system with fiber optic cable, including 35 digital channels, provides an important infrastructure upon which to build.

- The development of the CityNet system with its focus on public/private partnerships and cooperative activities is another important development. The development of a Metro information server to serve Metro agencies and the public could serve as the basis for a Tourist Information System. Metro requires that franchises laying new cable provide Metro with four dark lines.

- The explosion of interest and activity in the Internet and its World Wide Web is already affecting traveler information dissemination around the world to individual travelers and to travel agents and tour operators. Electronic pre-trip planning has an important role as part of a Visitor Information System, even if not used by a majority of the region's visitors.

- The developments in direct broadcast satellite technology also provide a huge potential for influencing the information systems field.

- Traveler information touch-screen kiosks are already being used in the Interstate highway Welcome Centers leading into the region and in seven of the area's major hotels

- Relocation of the Nashville's Tourist Information Center from just off I-65 in east Nashville to the Arena site will make it much more visible and accessible.

- The planned radio station for the new Nashville Arena will be broadcasting information on traffic parking, and traveler directions related to its events and the welcome center. This station has the potential to be a vehicle for regional rush hour traffic broadcasts as well.

- The current lack of special event preferential traffic signal control and traffic control centers to monitor and regulate traffic was identified. A three-phased plan to upgrade and connect most of Metro's traffic signals has been developed, with current implementation in the first phase. Also, the area's first traffic video surveillance system is being installed in Murfreesboro to complement its closed loop systems (which already includes volume and speed monitoring capabilities).

- The development of Metro and State Geographic Information Systems (GIS) also provides important base map and database information for Visitor Information Systems. Many local initiative are ongoing, but standardization of platforms between agencies and overcoming of institutional issues need to occur.

1.4.3 Visitors and Visitor Attractions

- The visitor profile study by the Nashville Convention and Visitors Bureau (NCVB) referenced in Section 1.2 revealed that the three leading information sources used for travel plans were: (1) word of mouth, (2) none, and (3) "been here before."

- The visitor profile study findings suggested that additional travel information services could be of extreme value in reducing confusion and unnecessary travel by tourists and other visitors to the area.

- An interesting dichotomy was found when survey responses to "likes" and dislikes" were evaluated. A small proportion of respondents were impressed with Nashville's lack of traffic congestion (3%). Yet, in another question on "dislikes" or disappointments," traffic problems ranked third highest with an 8% response rate. Inadequate signing was also noted in a significant number of responses.

1.4.4 Other Needs

- The need for improved response to incidents and improved congestion management have been identified. Advanced Planning Reports (APRs) are being performed currently on a number of intersections, while recent corridor studies in the Green Hills and Gallatin Road areas have addressed specific problems in these areas. Additional HOV lanes and improving CBD access have also been addressed in regional studies. The MPO undertook a parallel Incident Management Study concurrently with this ITS strategic plan.

- Interstate highway signing is important for both traffic control and for providing information to the Nashville region's visitors and through travelers. A preliminary assessment of Interstate signing was related in TM 1. This assessment revealed twenty-two instances of specific deficiencies or concerns on Nashville's Inner Loop and on access routes leading to the Inner Loop.

1.5 User Services

Each of the identified needs were matched, where possible, to one or more of the 29 FHWA User Services defined in the *National ITS Program Plan* (March 1995). As a result of this evaluation and the development of objectives, the FHWA User Service categories and User Services presented in Table 1 are recommended as best representing the focus of ITS Early Deployment initiatives in the Nashville Region.

A complete description of the 29 User Services included in the *National Program Plan* was contained in TM No. 2, Section III. Not all the 29 User Services are included in the User Service Plan for Nashville. Only those 16 User Services that are considered directly applicable to further consideration and possible deployment in this region are included.

In Nashville, a separate User Service area, Parking Management, has been added due to the specificshort-term need for such a project in Nashville. It would be logically incorporated as part of a Travel andTraffic Management group of services. In addition, the newest ITS User Service, Rail-highway Grade Crossing Protection, has been added to the list in Table 1 although there are no specific projects identified at this time to incorporate these technologies.

Table 1
Nashville Area ITS User Services

Major User Service Areas	Specific ITS User Services
Travel Demand Management	Pre-trip Travel Information Demand Management and Operations
Travel and Transportation Management	En-route Driver Information Route Guidance Traffic Control Incident Management Parking Management
Emergency Management and Safety Management	Emergency Notification and Personal Security Emergency Vehicle Management Rail-highway Grade Crossing Protection
Public Transportation Operations	Public Transportation Management En-route Transit Information Personalized Public Transit Public Transit Security
Electronic Payment Services	Electronic Payment Services
Commercial Vehicle Operations	HAZMAT Incident Response Commercial Fleet Management
Advanced Vehicle Control and Safety	Intersection Collision Avoidance

2.0 Strategic Plan Implementation

2.1 Functional Requirements

There are 7 functional areas which were defined in Technical Memorandum No. 5. The functional areas are:

- Traveler interface
- Navigation/guidance
- Communications
- Surveillance
- Data management
- Control strategies
- Inter-agency coordination.

Table 2 presents a synopsis of the functional requirements of local ITS user services that are targeted for deployment in the Nashville region. Table 2 also describes the implementation horizons of the user services relating to their functional requirements. These time horizons are divided into immediate to short-term (generally through 1999), mid-term (2000 - 2005), and long-term (beyond 2005).

Also in Table 2, the seventeen User Services have been grouped into the seven broad categories that are familiar to everyone associated with the national ITS program:

- Travel Demand Management (TDM)
- Travel and Transportation Management (TTM)
- Emergency Management (EM)
- Public Transportation Operations (PTO)
- Electronic Payment Services (EPS)
- Commercial Vehicle Operations (CVO)
- Advanced Vehicle Control and Safety Systems (AVCSS)

Short-term user services will require the support of five of these functional areas: traveler interface, communications, control strategies, data management, and inter-agency coordination. Based on the number of user services matched with each functional area, communications and interagency coordination are the most needed areas in the short-term, followed by traveler interface, data management, and control strategies. Surveillance and navigation/guidance are projected as more mid-to long-term functions for full deployment in the Nashville Area.

The implementation of modem ITS technologies is expected to solve a number of problems which currently plague the Nashville Area transportation system. Heavy highway and arterial congestion, which lead to accidents and increased trip times, will be addressed by improved traffic control, including short-term goals such as computerized signal control improvements, improved bandwidth of communications infrastructure, and reduced manual control. High Occupancy Vehicle (HOV) lane implementation will also be addressed in the short-term.

Metro-wide communications infrastructure is currently being developed in the CityNet and MetNet systems, and will be one of the first, basic building blocks of ITS deployment. Region-wide communications will be needed to support region-wide ITS applications. A modem communications infrastructure, regardless of system architecture, is required to support all of the user services identified for the area.

Data management and surveillance are among the most fundamental parts of a transportation management system. The functional area of surveillance, plays a supporting role to all of the User Services in Table 2. Some of the more obvious matches between the specific types of surveillance and user service requirements include traffic surveillance to traffic flow optimization or weather surveillance, and hazard-to-driver advisory. All of the matches, however, illustrate the widespread need for some type of surveillance or data collection technology in order to support the services provided by the system.

Table 2
Functional Areas: Coverage of Local User Services

	User Service Areas						
Functional Areas	**TDM**	**T & T M**	**E M**	**PTO**	**EPS**	**C V O**	**A V C S S**
Traveler Interface	S	S		M	L		L
Navigation/Guidance	L	M	L	L		M	
Communications	S	S	S	M	M	M	L
Surveillance	M	M		L	L		
Data Management	S	S	M	M	L	M	L
Control Strategies	S	S		L			L
Inter-Agency Coordination	S	S	S	S	M	M	L

S Short-term, 1996- 1999
M Mid-term, 2000-2005
L Long-term, beyond 2005

Data collected by surveillance mechanisms must be "digested" in order to provide data that is useful to other system components and to travelers. This function is performed by data management. Traffic prediction and control algorithms, executed over real-time or static traffic data, are used for traffic flow optimization and fulfill a number of the device control function requirements of the traffic control user service.

The information extracted from traffic data by the data management function can be used to support the current status information requirement of the pre-trip traveler information service. Similarly, incident management requires the use of real-time and static information provided by the data management functions, including traffic prediction, traffic control, routing, and database processing. Analogous matches were established for all of the user services. In short, data management provides a basic functionality within a modem transportation system, supporting the entire spectrum of user services.

Traveler information needs constitute a significant portion of the needs identified in Task 1. Relating both to public transit and personal vehicle drivers, these needs focus on real-time delivery of information on tourist destination, route/destination information, transit schedules, ridership, incident notification to travelers, and other services. This information will ultimately be available both in-vehicle and in stationary locations.

The majority of these needs were matched to five user services: pre-trip travel information, route guidance, en-route driver information, en-route transit information, and public transportation management. The common thread among these user services is timely delivery of accurate traffic and travel information. Two higher-level functional areas were identified as essential to support these five user services: navigational guidance and traveler interface.

2.2 Core Infrastructure Adherence

The US Department of Transportation has established a set of seven features forming the "core infrastructure" for deploying ITS traffic management and traveler information services in metropolitan areas. The definition of these seven features is intended to focus near-term deployment decisions being made in metropolitan areas and to maximize future opportunities to implement widespread, advanced ITS user services. The seven core infrastructure features are:

1. Regional Multimodal Traveler Information Center
2. Traffic Signal Control System(s)
3. Freeway Management System(s)
4. Transit Management System(s)
5. Incident Management Program
6. Electronic Fare Payment System(s)
7. Electronic Tolls, Fee Collection System(s) for use on infrastructure

This study's User Service Plan and Strategic Plan recommendations follow the core infrastructure guidelines as they apply to the unique needs of the Nashville Area transportation system. In line with the spirit of the federal guidelines, the recommended projects should be modular in design: various parts of the system can be deployed on an as-needed basis and as funds become available. Table 3 presents a brief outline of the technology implementation and project constraints for the proposed Strategic Deployment Plan.

Table 3
Technology Implementation Summary

Core Feature	Implementation Attributes and Constraints
Regional Multimodal Traveler Information Center and Traffic Operations Center (RMTIC/TOC)	*Determine location of the RMTIC/TOC*
	Base deployment on regional coverage to evolve over time.
	Provide equal access to information and data input.
	Provide automated connection between Traffic Operations Centers at Murfreesboro and Franklin and the RMTIC/TOC using SONET.
	Fee-based and free information available to private organizations.
Traffic Signal Control Systems	*Traffic Signal Control Systems are in various states of upgrading.*
	Use Variable Message Signs for early incident notification/warning.
	Real time control/signal system integration with surveillance, as already underway in Murfreesboro.
	Use CCTV for traffic surveillance (image used for analysis of problems and incidents/management).
Freeway Management System (FMS)	*The system should provide information link between FMS and the RMTIC/TOC possibly co-located FMS to develop signal coordination with surface street progression at freeway interchanges. Emergency response and special event coordination to be developed.*
Transit Management System	*Currently being developedfor LANDPORT (two locations in Nashville), and the Franklin Intermodal Management Center (FIMC).*
	Focus on information sharing & exchange between the transit system operations and the RMTIC/TOC Improvements to transit management and operations to be performed by the transit authority according to its own schedule. ITS will also facilitate transit vehicle preemption to meet schedule and schedule information distribution to transit users.

Core Feature	Implementation Attributes and Constraints
Transit Management System, (continued)	*Responsible for deploying its own AVL/AVM (GPS recommended).*
	Integrated with network: provides schedule and performance information to ATIS; receives corridor conditions and hazard information from traffic management. Coordinates planned LandPort facilities with Franklin Intermodal Management Center.
Incident Management Program	*Emergency services coordination and clearance evaluation. Coordination of incident removal and notification to public.*
	Incident detection and surveillance. Incident evaluation on main corridors through CCTV.
	MAYDAY support/coordination through private partnership with cellular communications company and security monitoring systems (as have been implemented elsewhere).

In addition to these core infrastructure components from the federal guidelines, Nashville will be served by an improved Parking Management System and ITS deployment in rural areas, which will be developed as an integral part of the overall traveler and tourist information system. A brief outline of these two core feature are as follows:

Core Feature	Implementation Attributes and Constraints
Parking Management	***For all parking in the downtown area, particularly serving the Arena, future TENNFL stadium, Entertainment Area, Convention Center, etc.***
	Provide parking status information using combination of static guide signs, flip signs, and variable message signs (VMS).
	Includes space management, detects vehicles inside parking facilities.
	Provides a control system, including central computer plus traffic counting and communications media, Future integration with FIMC/TOC.
	Fee-based and free. information available to private organizations.

Core Feature	Implementation Attributes and Constraints
Rural ITS Deployment	***Extend urban ITS services into surrounding counties of Williamson, Rutherford, Sumner and Wilson, andperhaps others in Middle Tennessee.***
	Provide incident management system on freeways to segments in each of the four outlying counties, to include technologies applied to HAZMAT incident response.
	Focus on safety improvements and new technology for HOV operation.
	Provide traveler and tourist information kiosks at all rest areas on Tennessee Interstate routes, and other selected welcome/visitor centers.
	Need to extend the ITS Coalition to include broader regional representation.

3.0 ITS Projects Recommended for Deployment

Table 4 presents a summary of the projects targeted for deployment in each time period. These projects were adopted by the Nashville ITS Coalition at its meeting on September 24, 1996. In order to focus in on the immediate, most critical needs in Nashville, short-term projects that are recommended for deployment in the Nashville area have been broken into a Phase 1 .A (six month to two year deployment time) and Phase 1.B (two to five year deployment time).

3.1 Recommended Guidelines for ITS Deployment

Throughout the entire process of needs identification and matching, the Coalition continued to guide the study efforts to ensure that the study's final recommendations focused on the most pressing transportation issues in the Nashville area. The Coalition took into consideration the existing communications, visitor information delivery, and jurisdictional infractructure to support a modem traveler and tourist information system. This set of guidelines was prepared, based on all input received by the consultant team from state and regional stakeholders:

- Develop an Advanced Traveler and Tourist Information System (ATIS) in the greater Nashville Metropolitan Region as a coordinated program composed of a set of modest-sized, synergistic, modular projects. These individual projects will form the components to the completely fulfilled needs and established goals. The projects should initially focus on the following user services:
  - Parking and Traffic Guidance (sub-component of overall ATIS)
  - Pre-Trip Traveler Information
  - Traveler Services Information
  - En-Route Driver Information
  - Incident Management

- The ATIS project should provide a set of implementation guidelines, to be followed by the area jurisdictions on a voluntary basis, providing step-by-step directions on the infrastructure deployment and upgrades necessary to achieve a modem and coherent system architecture for the region. This system architecture, developed in Task 6 of this project, will enable the partner agencies to fully benefit from the features of the Intelligent Transportation System, as they become available.

- One of the project recommendations is the development of a common set of plans and specifications, compliant with consensus architecture and technology. This set of plans and specifications would be utilized on a voluntary basis to achieve cost savings, improved overall ATIS system reliability and maintainability and to support seamless interoperability for both the users and service providers.

- Transit-specific components are part of the Strategic Plan. Issues of transit schedule coordination and availability, transit vehicle preemption and tracking, transit user safety, and transit and traveler information availability for the transit user should be addressed, but more in the mid- to long-term.

- In addition, the program should be integrated with the air quality improvement program in the Nashville Area as a set of mitigation measures which could be implemented and become part of the ITS infrastructure.

3.2 Projects by Phase

3.2.1 Short-term Projects (current needs through 1999) - Phase IA

Projects that are recommended for immediate deployment in Nashville include those shown as Phases 1 .A and 1.B in Table 4. Descriptions of the way these projects meet the requirements identified in the Nashville User Services Plan (in Technical Memorandum No. 4) and the Functional Requirements (shown in TM No. 6) are detailed in Section 4.1.

A number of important, high-use facilities will become operational within the next few months to two years, among them the Nashville Arena and the two sites of the Nashville LANDPORT. In addition, the Nashville downtown coordinated signal system is currently being upgraded with new control software, and that project is approximately 50 percent complete as of September 1996.

In addition, the Metro Public Works Department in Nashville has determined that a high priority needs to be placed on the implementation of a comprehensive parking and traffic guidance system to serve the parking associated with the new Arena and the proposed TENNFL stadium that will be built on the east bank of the river across from downtown. The City of Franklin has commitments to develop and build an intermodal safety and traffic management center. The City of Murfreesboro is in process of upgrading its arterial surveillance system for its downtown area.

Table 4
Candidate List of ITS Projects, by Implementation Phase and Potential Sponsor

Candidate Projects	Potential (or Actual) Sponsors
Phase 1A	Proposed for Immediate Deployment (underway or FY 1997)
1. Downtown Signal System upgrade 2. Parking and Traffic Guidance System 3. Franklin Intermodal Safety and Traffic Management Center (FIMC) 4. Variable Message Signing (VMS) 5. FM Traveler Advisory Radio (TAR) 6. Enhanced Nashville Area Web Page 7. GIS database enhancement 8. GIS database standardization and completion 9. CVO AVL	Metro Public Works (MPW) MPW, private sector, Nashville Arena City of Franklin, other public and private partners TDOT, MPW, Nashville Arena, Nashville International Airport (BNA) Convention & Visitors Bureau (NCVB), commercial broadcast stations NCVB, Metro Information Services Dept. (ISD) NCVB, Vanderbilt University MPO, Vanderbilt University, NCVB, Regional Transportation Authority (RTA) Trucking industry, Advantage CVO Partnership
Phase 1B	(FY 1998-99)
10. Incident response/ removal/ clean-up 11. Enhanced Visitor kiosks at all Tennessee Welcome and Gateway centers 12. Special event control software	Public Safety, TDOT, Metro Government TN Tourist Development Office, private sector MPW

Phase 2 (Table 4, continued)	**(FY 2000 - 2005)**
13.a. RMTIC/TOC development and integration	**Metro Nashville and Davidson County, Cities of Franklin and Murfreesboro, others**
13.b. Extension and joint use of fiber plant	**South Central Bell, Metro Government, other communications companies, Cable companies**
14. Radio Broadcast Data System (RBDS)	**NCVB, commercial broadcast stations**
15.a. Freeway surveillance (basic)	**TDOT**
15.b. Incident information clearinghouse including MAYDAY alert, automatic and/or manual	**Public Safety, private trucking firms, vehicle fleets, Metro Government, Counties of Williamson, Rutherford, Wilson, Sumner, others in Middle Tennessee**
16. Regional traffic status map (video wall)	**TDOT**
17. Real-time traffic information to kiosks	**Private sector, TN Tourist Development Dept., TDOT, Nashville International Airport (BNA)**
18. Real-time bus stop security system	**MTA**
19. Commercial Vehicle Operations (CVO) electronic clearance on I-65	**Advantage CVO Partnership, TDOT**
Phase	**(FY 2006 - 2010)**
20. Real-time traffic information	**TDOT, Metro Government, Franklin, other towns**
21. CCTV in selected corridors	**TDOT, Metro Government**
22. Alternative route surveillance (diversion routes during incident re-routing)	**TDOT, local governments in the region**
Phase 4	**(Beyond 2010)**
23. RMTIC/TOC Intermodal Information Integration	**TDOT, MTA, Regional Transportation Authority (RTA), Metro Government, Cities of Franklin and Murfreesboro**
24. Regional signal coordination	**TDOT, local governments**
25. Emergency vehicle preemption	**EMS, DPS, TDOT, MPW**
26. Transit vehicle preemption	**MTA, MPW**
27. Electronic Payment Systems	**MTA, MPW, RTA, Downtown Partnership, BNA Airport**

The Nashville Convention and Visitors Bureau will be opening a new visitor center (to replace the one at the current location on I-65/24 on the east side of town) when the Arena opens later this year. In addition, they are upgrading their GIS database to produce visitor maps, and will be offering hand-held devices that will provide visitors with guidance for the walking tour of downtown Nashville. The Metro Information Services Department has a continuing project to enhance the city's Web Page on the Internet, and enhancements that would include some information on the overall ITS improvements being made would increase the image of the city and provide more information on how to get around in Nashville for tourists and other visitors.

These projects that are already underway to various degrees are included in the list of Phase 1.A projects included in Table 4. Other projects included in Phase 1 .B include enhancements to the overall ATIS components that are a part of the VISIT-Middle Tennessee ATIS program. Initial elements of an incident management capability for the Nashville metro area are also included in Phase 1.B.

3.2.2 Mid-term Projects (2000 - 2005) - Phase 2

Projects that are recommended for deployment during the mid-term include those shown in Phase 2 in Table 4 and described in Section 4.2. By the next century, Nashville and other metro areas of similar size should be able to accommodate a number of navigation and guidance systems for both CVO and private vehicle application, and begin the deployment of surveillance technologies.

Additional ITS User Services that are not scheduled for short-term deployment but will be needed by the year 2000 include electronic payment services (EPS) and a wide range of CVO user services. In reality, it is anticipated that several trucking firms in the region will be well underway with their own use of navigation/guidance and advanced communications systems such as satellite/GPS technologies both now and prior to the year 2000. The Advantage CVO Partnership which includes I-75 through the state of Tennessee also is seeking expansion of their electronic clearance services on other interstate routes through the mid-South, and I-40 and I-65, in particular, are prime candidates for this technology to be deployed.

Projects included in the mid-range are shown in Table 5 as part of Phase 2 deployment. The key additional feature and capability that is recommended for this time period is the Regional Multimodal Traffic Information and Operations Center (RMTIC/TOC) to allow a wider range of operational services and real-time traffic information to be coordinated through one central location. Traffic surveillance using various means including technologies that are non-intrusive and do not require placement in the pavement will become more commonplace and cost-effective during the next decade.

3.2.3 Long-term Projects (beyond 2005) - Phases 3 and 4

The only ITS User Service group of technologies that is not scheduled during the next ten years, and therefore will remain to be deployed in the years beyond 2005, is Advanced Vehicle Control and Safety Systems. Further deployment of electronic payment services, and integration of various intermodal elements are also envisioned for the long-term. In order to identify a slightly higher priority on some projects, Table 4 breaks these long-term projects into Phase 3 (2006 through 2010) and Phase 4 (beyond 2010). Other emerging technologies will be available in the long-term, and an update of this plan that considers these new technologies will be helpful. These projects will of course come under further review and an update of this strategic plan will likely occur within the next decade on order to provide more specificity to the additional projects that will undertaken at that time. Currently known technologies recommended for deployment are described in Sections 4.3 and 4.4.

3.3 Plan Summary

A strategic plan is recommended for the Nashville area that is based on a common architecture, yet leaves individual jurisdictions (Metropolitan Nashville and Davidson County, Murfreesboro, Franklin, the Nashville Convention and Visitors Bureau, the Tennessee Department of Tourism, etc.) free to pursue an integrated set of smaller, incremental projects, to achieve the required ITS services and recommended system architecture.

The recommendations contained in this section are for the ultimate build-out of ITS components in the Nashville region. They should not be construed to imply that all of these components apply to projects that are recommended for short-term deployment. Short-term projects will be recommended based on short-term needs as identified earlier in this TM. The plan recommends providing:

- Adoption of the common architecture outlined in TM 6 supporting incremental build-out of ITS capabilities and services.

- Field infrastructure upgrades to support needed sensor information to determine traffic congestion on corridors and rapid detection and response to incidents.

- A Regional Traffic Management and Information Center (TMC) to provide needed processing hardware, software and display equipment to support field infrastructure upgrades.

- Integrated TMCs in surrounding jurisdictions such as Murfreesboro and Franklin. These TMCs will control local signal systems and be a local clearinghouse for traveler information.

- Implementation of a communications infrastructure to support interoperability between TMCs and to support improvements in traveler information support to the traveler and tourist information system, commercial vehicle management, public transportation, and other components. Development of a detailed communications plan for the Nashville area is recommended.

- Interoperability between Traffic Management in various jurisdictions, in order to provide commonality among traveler information and incident management functions.

Each phase of the plan will provide a building block which, upon completion, will meet the consensus needs of the Nashville area transportation system.

Figure 3

Strategic Plan Implementation

(Reserved for future addition based on consensus-building process between Metro Government, Tennessee DOT, and other stakeholders)

3.4 Strategic Corridors

The recommended project covers the entire five-county Nashville MPO Area with specific focus on the area's major corridors, such as those identified in the recent HOV study and the region-wide Incident Management Plan.. The HOV study and plan evaluated a set of regional arterials (basically all Interstate routes) that are recommended to have HOV lanes added or extended as part of the Transportation Improvement Program for Middle Tennessee. The corridors in the region have been selected as Strategic ITS corridors based on the following criteria:

- Inclusion in previous studies
- Traffic characteristics along the arterial (e.g., proportion of truck traffic)
- Congestion levels
- Speed transition in peak hours (less than 50 mph avg. speed)
- Level of inter-regional travel (from outside the region) vs. primarily commuting travel
- Regional coverage (providing good coverage of the metropolitan area and complimenting the existing and planned freeway system)

Nine freeways and other major arterials have been identified as Strategic ITS Corridors. These nine facilities were identified in previous studies as most in need of congestion relief. One of these corridors is a future Outer Loop for the Nashville Region, SR 840, that is being planned and built as a major intra-regional connector/ circumferential. These nine major arterials are listed in Table 5 .

Tabie 5
Selected ITS Strategic Corridors

Congested Corridors in AM Peak	Congested Corridors in PM Peak
I-24 WB from Smyrna interchange to I-40 interchange	I-65 SB from Inner Loop to I-440 interchange
I-24 EB from SR 155 interchange to I-65 interchange	I-65 NB from I-40 (Inner Loop) to White House interchange
I-40 WB from Mt. Juliet interchange to downtown	I-440 EB from I-65 to I-24
I-40 EB from US 70 S interchange to CBD	Briley Parkway NB from Opryland to I-65/24
I-65 NB from SR 96 interchange to I-40	
I-65 SB from White House interchange to I-40 interchange	
I-440 WB from I-24 to I-65	
Briley Parkway SB from I-65/24 interchange to I-40	

Proposed Outer Loop (SR 840) - circumferential. This facility should be integrated into the ITS/ATIS infrastructure during the design process in order to effectively serve as an alternate route for through traffic in a regional incident management plan. It would not be expected to be justified as a congested corridor during its first stages of operation. Plans should be developed to include communications infrastructure for connection to field hardware. A statewide communications systems plan is recommended in order to fully integrate this facility.

These selected ITS corridors are among those where the deployment of ITS technologies are likely to occur in the next two decades. For planning purposes, these routes should be kept in mind as planning and programming costs are developed. However, in this TM we will develop cost estimates based on a cost per mile basis for ITS corridor facilities, where the project is tied to the highway facility. It is also recommended that the short-term strategic deployment plan consider area-wide application of ITS technologies for implementation. It is suggested that future TIP planning and programming consider those arterials parallel to the region's freeways, where Variable Message Signs (VMS) are recommended. As the technology implementations are tested and proved in the field, their deployment should be expanded to cover additional corridors, which will be chosen through the normal TIP programming process.

4.0 Technology Deployment by Phase

4.1 Phase 1: Deployment of Basic ATIS elements

The following projects were identified in Section 3.0 as short-term deployment projects in the Nashville area. These projects are already in the deployment stage by some public or private entity in the region, and are identified here as base-line information to document the level of ITS deployment.

Project	Status
Downtown signal system upgrade	Half complete; anticipated completion in mid-1997
Parking and Traffic Guidance System	First phase funded; design expected to begin early 1997.
Franklin Intermodal Safety and Traffic Management Center (FIMC)	Feasibility study underway; planned as rural extension of regional system under a USDOT Rural ITS Initiative
Variable Message Signs (VMS)	Planned as part of Parking and Traffic Guidance System; Phase I will include surface street and major arterial VMS installations; freeway VMS to be installed with full Incident Management/ Congestion Management build-out in Phases 2,3, and 4.
FM Traveler Advisory Radio	New station being built and operated at new Nashville Arena and operated by Nashville Convention and Visitors' Bureau.
Enhanced Nashville Area Web Page	Continuing project to upgrade information to visitors using Internet as Information Service Provider (ISP).

The above projects have the endorsement, commitment, and funding stream identified for deployment. One or more agencies and/or private sector firms are already involved in implementation. In addition to these projects that are under way (at some stage of development), the following Phase 1 projects are recommended but still need further discussion and approval by appropriate agencies and organizations in order to begin the implementation stage. Rough order of magnitude cost estimates to complete these Phase 1 projects is given below:

Project	Status	Cost Estimate
Enhanced Visitor Kiosks	**Project to be developed; State Welcome Center kiosks currently under contract to private vendor; potential exists to tie into VISIT-Middle Tennessee ATIS deployment. (See Appendix E for kiosk options.)**	**$22,00O/installation for upgraded hw/sw1 + $40,000 information compiling**
Special Event Control	**Project to be developed: software capabilities exist with current signal system upgrade project; will be part of design of Parking and Traffic Guidance system**	**$400,000**
Incident Response/Removal/ Clearance	**Initial recommendation of Incident Management Plan for the Nashville Region; Cost estimate made of capital and operating cost for next 12 years**	**$420,000 avg. annual cost**
GIS database standardization and completion	**Project needs sponsorship and development. Appendix A provides a preliminary design of a GIS-based ATIS prototype.**	**$2 million[2]**
CVO AVL	**Expansion of Advantage CVO Partnership to I-65 and other southeastern interstates is anticipated**	**N/A**

NOTES: 1 Costs for Kiosks based on 13 Welcome centers in Tennessee; capital costs only; operations and maintenance (O&M) estimated at $33,000 annually.

2 Capital and operating costs for Regional Incident Management program from draft *Regional Incident Management Plan,* Gresham, Smith & Partners, Inc., August 1996

4.2 Phase 2: Expansion of ATIS

Phase 2 provides a core ATIS capability to be integrated with the Nashville Area communications network in the mid-term, roughly 2000 to 2005. The core ATIS should include the following functions:

- Preparation of consolidated information on freeway conditions and hazards through basic traffic surveillance.

- Provide interface to RBDS subsystem of FM radio stations (FM sub-band digital broadcast); transmission of corridor conditions to in-vehicle route guidance systems

- Provide interface to other public broadcast media for use and distribution to viewers/listeners:
  - TV - FM radio
  - AM radio - Cable TV

- Provide interface to cellular telephone and digital cellular system (DCS) management center

- Expand CVO electronic clearance to I-65 corridor

- Provide interface to a private security monitoring service (such as Westinghouse Security Services) for monitoring cellular alarms and reporting "MAYDAY" to associated TMCs

- MTA, private users, commercial companies pay security monitoring cost (similar service provided by Ford Motor Company for purchasers of Lincoln cars).

- Provide interface for traffic information to visitors kiosks at all Tennessee Welcome Centers.

Each jurisdiction provides corridor conditions data over the virtual LAN assigned to functional ATIS data exchange. The "core" ATIS center consolidates corridor status data for user distribution. Similarly, transit system(s) schedule and status data is also received and combined by the "core" ATIS center. The ATIS center provides consolidated ATIS information over the network (see Figure 4).

Some basic assumptions are reasonable to state at the beginning. These assumptions are based on national trends that are emerging that will be responding to market demands and consumer preferences within the next decade. Our assumptions are that the following infrastructure will be provided by the normal progress of market response to new product demand:

- Core ATIS will be developed with public-private partnerships similar to other systems such as the San Francisco Bay Area INFORM project, in order to provide full service ATIS distribution to users.

- A l-900 telephone service for fee-based information services

- Pay subscriber service for graphics map and communications interface software to present corridor status on personal computer via dial-up modem

- Private sector funding of ATIS primarily for:
  - Yellow Pages coverage (paid by advertisers)
  - Reservations (paid by hotels/restaurants)
  - Small, affordable fees to the users

- Increased use of the Internet for advertising of services and information retrieval

The core ATIS will supply basic traveler information which is created by ITS "core" functions such as traffic surveillance, hazards warning, traffic management, and transit management. Information of commercial value such as Yellow Pages are expected to be provided by communications companies.

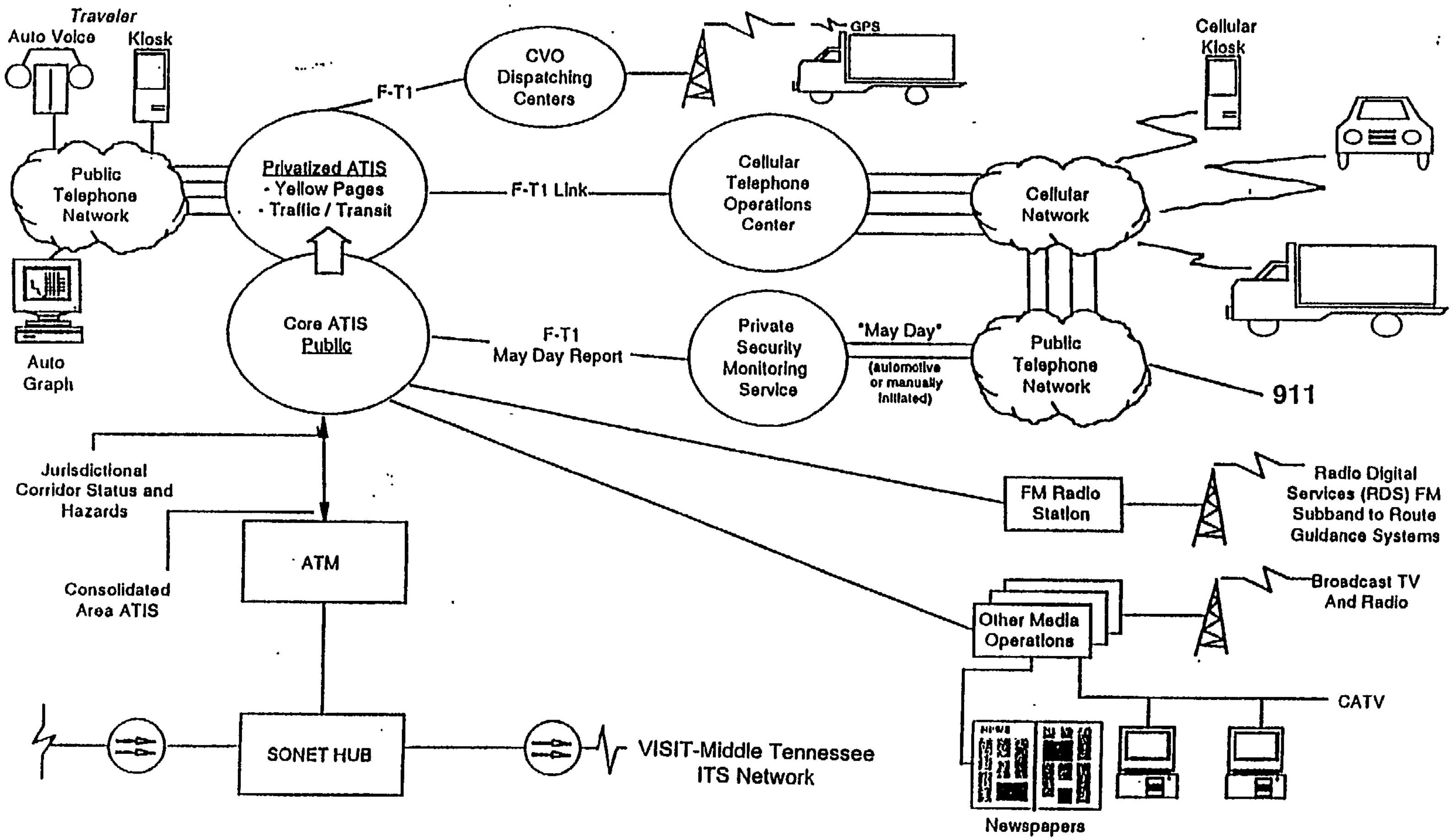


Figure 4

ATIS CORE CAPABILITIES

Where information transfer to users is of primary benefit to the users, it will be privatized. Where the infrastructure derives a clear benefit, the information transfer to the user will be subsidized (e.g. use of FM sub-band to provide corridor status data to route guidance systems).

4.3 Long-Range ITS Deployment Plan

4.3.1 Phase 3A: Field Implementation

The first increment in the ultimate build-out of ITS in Nashville, roughly in the years 2005 through 2010, is to design, install, integrate and test traffic sensors and real-time traffic information devices (i.e., VMS, other) along priority corridors within Nashville Area, thus providing initial capability for monitoring and control of each corridor segment by the responsible jurisdiction. Candidate corridors have been identified in Section 3.4. Based on recommendations developed in Task 7, the following technology should be considered for deployment along the chosen corridors:

- Video sensors such as TraffiCam™ (or equivalent) for volume, speed, presence and classification.
  Utilized for signal control
  Strategically deployed along the corridors to provide critical information on traffic congestion and to support incident detection.

- Passive-acoustic detectors such as SmartSonic™ (or equivalent) along priority corridors to compliment video sensors in areas where video sensors may be obstructed or lighting may be a problem.

Real time coordination for all "smart" corridor controllers by utilizing GPS time base which will further support infrastructure-to-vehicle time base coordination, as recommended in TM 7.

- This feature facilitates event coordination as well as location coordination between infrastructure and vehicles such as commercial vehicles and emergency vehicles. This is accomplished by real-time coordination between trucking firm dispatching and traffic control and generally includes:

  - GPS time coordination between vehicle and traffic control
  - Accurate vehicle location reporting
  - Knowledge by the dispatcher of congestion locations and duration in order to schedule truck departures by an amount of time that will avoid heavy traffic congestion.

Installation of surveillance CCTV along the corridors in such a manner as to support incident and traffic congestion evaluation.

Additional electronic variable message signs to communicate corridor status and to advise alternate corridor(s), including dynamic routing signs (e.g. PathFinder™ or equivalent),

- Implementation of national ITS standard protocols along these HOV corridors as the starting point for an area wide protocol standardization, even if protocol conversion may be necessary at existing TMCs as an interim approach.

- Where the national protocol standard (such as NTCIP) is in draft form, use the version which has the highest probability of evolving to the national standard (even though minor modifications may be necessary to achieve compatibility with the final standard).

- Integration of controllers on alternate routes (for full incident management capabilities) with communications infrastructure necessary to support the surveillance, monitoring, and control objectives.

- Develop the appropriate infrastructure along corridors in such a manner as to support formation of a peer-to-peer, backbone communications network. The possibility of utilizing some of the unused FMS fiber should be investigated.

- Where traffic conditions and business interruption will not allow fiber installation, use wireless seamless interconnect.

- Termination of controller communications within each jurisdictional area into a standard jurisdictional communications gateway as described in TM 7.

  -Size the gateway for fully implemented field environment
  -Integrate the gateway with the TMC via optical communications link
  -Within the TMC, terminate the gateway into a DS- l/Ethernet bridge/router

- Upgrade the TMC information processing and display environment to accommodate the new field environment. Where necessary, upgrade the TMC with medium hybrid control capability.

In addition to the control and surveillance infrastructure deployment along the priority corridors, Phase 3A should incorporate the basic ATIS functions that are deployed in Phase 1 into a regional ATMS that would include incident management and congestion management functions. This basic function would provide for corridor traffic conditions information distribution to the users using simple interfaces such as telephone, dial-up service, (e.g. a public access BBS system), and/or via the Internet.

4.3.2 Phase 3.B: Communications Between Traffic Management Centers (TMCs)

Phase 3B will consist of completing any future communications path, not established by segment corridor implementation, facilitating installation of the SONET backbone. With the completion of Phase 3 .B, the following base capability will be available:

- Smart corridor traffic condition monitoring, pollution monitoring and incident detection

- Ability to communicate with travelers on the corridors through electronic signs

- The ability to share video along the corridor with all traffic management centers

- The ability of a jurisdiction to open its gateway for control and monitoring by another TMC:
  - as backup, in case of TMC failure
  - as cost saving at night and on weekends by reducing/eliminating operational staff costs
  - as cost saving by sharing in common maintenance

- The ability to share functionally oriented processed data between TMCs and with transit management center(s):
  - Transit schedules and status (virtual) LAN
  - Corridor virtual status (virtual) LAN
  - Emergency coordination (virtual) LAN
  - Others as required to a DS-3 data rate (4 to 8 LANs, depending on data load analysis)

- The ability to provide voice communications coordination for management, planning and maintenance between TMCs.

SONET microwave may be used in areas where further in-ground installation is not feasible. A folded ring may be used for initial interoperable capability. Figure 5 illustrates the Phase 3B build-out, which includes:

- Backbone network implementation

- Installation of SONET hub equipment, sized to accommodate 15 year communications needs; all agencies involved in incident management should coordinate to acquire communications channels, including TDOT, emergency services, Metro government, etc.

- Interconnecting the intelligent gateway with SONET

- Interconnecting the field video CODEC with SONET, which allows network distribution of video and thus sharing of surveillance video

- Interconnecting the SONET hub with bridge/router and CODEC receiver equipment

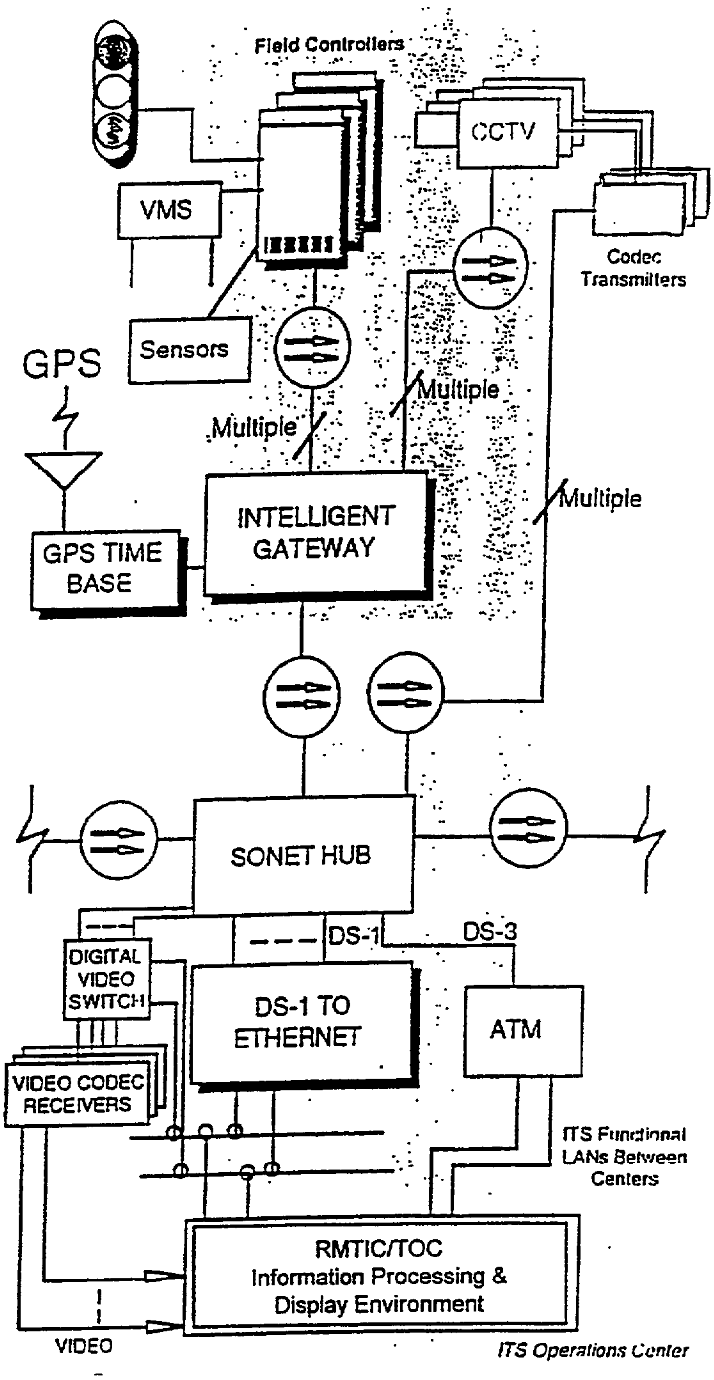


Figure 5

PHASE 3B - COMMUNICATIONS BACKBONE

- Adding ATM Ethernet switches to support ITS functional calls between centers

- Developing concurrently two types of LANs:

  - Field monitoring and control (CITYNET can fill this requirement)
  - ITS functional virtual LANs

Similarly, access to the functional LAN by a centralized ATIS center provides all critical data needed for ITS information distribution to the public, with the exception of "yellow pages" and reservation links to hotels, restaurants, etc.

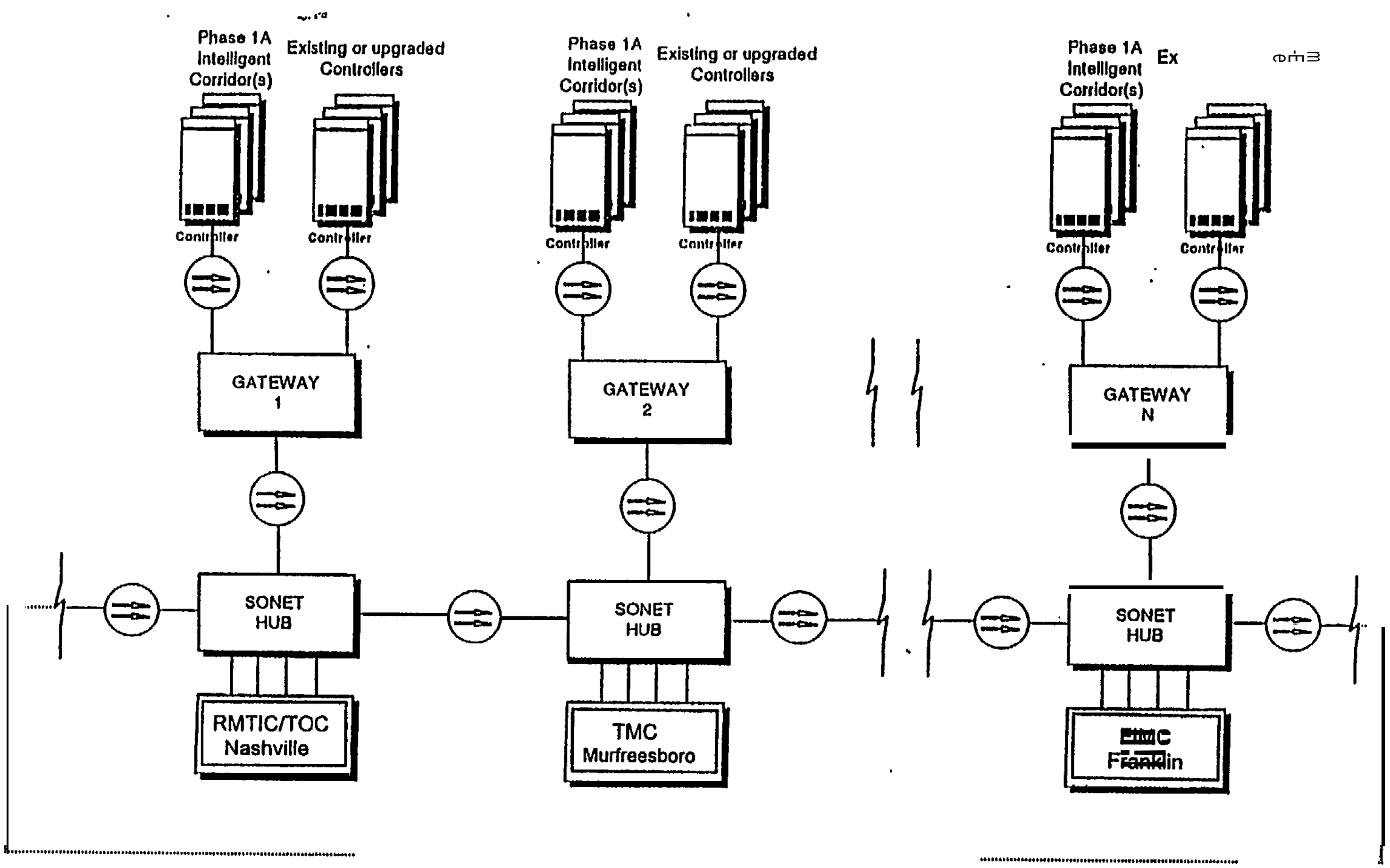
4.3.3 Phase 3.C: Transition of Field infrastructure to the System Architecture

Phase 3.C consists of the integration of field infrastructure (e.g., the downtown signal system, TMCs at Murfreesboro, Franklin, etc.) with the gateway. This phase may include the upgrade of field controllers to types recommended for the common architecture. Where controllers are upgradeable to a common protocol, they may be maintained.

As outlying jurisdictions in the surrounding counties, as well as freeway hardware installations, transition to a common field protocol, they will become capable of "full membership" in the peer-to-peer architecture. To the extent that jurisdictions maintain an incompatible protocol and/or control strategy, they are capable of "partial membership" in the peer-to-peer architecture. Partial membership means ineligibility for: (1) back-up by other TMCs; (2) operational data sharing with other TMCs; and (3) common maintenance monitoring and support.

Features for which "fill eligibility" in peer-to-peer architecture would include: (1) video sharing; (2) functional LAN information sharing (i.e. processed ITS data sharing); (3) high level TMC-to-TMC coordination; and (4) time coordination.

The system architecture can operate at various levels based on peer-to-peer common capability. Figure 6 summarizes Phase 3.C configuration.



Figu re

PHASE 3C - INTEGRATION OF TRAFFIC MANAGEMENT CENTERS

4.4 Phase 4: Deployment of Additional Technologies

During Phase 4 (beyond 20 10), several additional technologies are recommended for deployment:

- Electronic fee collection: it is recommended that BNA International Airport implement electronic toll tags for parking fee collection and taxi management at the airport. An Airport Authority - Nashville Metro Government partnership should adopt a standardized RF tag to meet the needs of commercial, private, and public vehicles and taxies within the area. Electronic toll and traffic management readers with BNA airport electronic tag compatibility will be encouraged for use at downtown parking facilities to standardize Arena and Stadium and other major event parking.

- RF tag readers should be deployed at entrances to major commercial corridors for detection of HAZMAT or commercial vehicles.

- RF tag readers will be deployed strategically along major corridors to support:
  - Use of RF tags of opportunity as probe vehicles
  - Calibration and verification of public transit vehicles position
  - Hazards warning to vehicles with toll tags and not equipped with route guidance

- Where future toll tags are required, the standard tags will be used

Phase 4 complies with core electronic fee collection/electronic toll and traffic management (ETTM) capability. Phase 4 completes the core capability stated as important to ITS success by FHWA for major metropolitan areas.

5.0 Requirements and Costs

5.1 Basis for Cost Estimates

Costs of individual elements in Phase 1 are identified in the previous section. Since the deployment of an advanced, state-of-the-art ATIS for VISIT-Middle Tennessee is expected to take up to two years to develop into a funding package, the cost estimates for Phase 2 are developed in some detail in order to provide a basis for system design.

The full development of the regional Traveler Information System described as VISIT-Middle Tennessee is expected to cover the next 10 to 15 years. Requirements and costs are presented in 4 phases, of which Phase 3 consists of 3 parts. Phase 1 is already underway with a number of strategic initiatives by various entities in the Nashville region, as identified in Section 4.1 of this TM. A rough order of magnitude project cost is presented for those technologies recommended for deployment in Phases 2,3 A, B, C and 4. A preliminary analysis of the requirements is performed to cost each phase. A cost range is provided for these phases with discussions on potential implementations within the range.

Cost detail is provided to allow parametric analysis with respect to the derived requirements and assumptions. Consideration of the assumptions must be forefront in any analysis of these estimates, with a reminder that the cost objective is to obtain a rough order of magnitude cost estimate for the project. This Strategic Plan must not be considered as a preliminary design, but as guidelines for that design.

A cost estimate is provided for a pre-Phase 3A communications analysis. This analysis may present findings that will change assumptions made throughout this analysis and may affect the costs estimated. This analysis is expected to detail specific functional requirements and hence data requirements. For example, the number, placement, and type of CCTV camera and quality of received video image will affect both the arterial communications design and the regional communications backbone design.

The cost breakdown for each task will generally adhere to the following structure:

- Construction Cost
- Engineering Cost
- Capital Cost (equipment, other physical plant other than building/ deployment/ installation)
- Software Development Cost
- Management and Maintenance Cost

Where cost estimates are presented with less fidelity, the cost structure will combine cost elements, e.g., construction cost and engineering cost might be presented as a combined cost or only a total cost will be presented. For clarification of the cost structure, the following definitions are provided:

1. Construction cost - site design and installation including labor costs.

2. Engineering cost - analysis and design, integration, test, and system acceptance of the subsystems and system.

3. Capital cost - material and equipment procurement, including communications lines.

4. Software development cost - design, coding, integration, checkout, and acceptance of the software.

5. Operations and maintenance cost - operator and maintenance labor hours, operating expenses, repair and replacement costs, and any warranty costs for 20 years.

Where specific cost data are not available, the following cost estimates are used. The basis for these estimates are from similar transportation proposals and projects.

- Construction cost - 6%
- Engineering cost - 15%
- Operations and maintenance cost - 10%

It is estimated at a rough order-of-magnitude that when all Phase 1 projects are deployed, a capital expenditure in the order of $12 to $15 million will be invested, or about $4 million per year (see Section 4.1).

5.2 Phase 2

This phase provides a core ATIS capability with each jurisdiction providing corridor conditions data. By reducing or increasing functionality, the costs are expected to decrease or increase, respectively.

5.2.1 Phase 2 Requirements

The ATIS shall be designed based on the architecture specified in TM 6.

The ATIS shall consolidate area ATIS reports from jurisdictions and transit.

The ATIS shall prepare consolidated information on corridor conditions and hazards.

The ATIS shall provide interface to RDS subsystem of FM radio stations.

The ATIS shall provide transmission of corridor conditions to in-vehicle route guidance systems.

The ATIS shall provide interface to other public media for use and distribution to viewers/listeners.

The ATIS shall provide interface to cellular/DCS management center providing traffic reports.

The ATIS is recommended to have many of the features of Charlotte and Phoenix ATIS projects.

The architecture envisioned is more similar to the Charlotte CARAT project, currently under a design-build-warrant procurement.

5.2.2 Phase 2 Tasks

Phase 2 is presented as 3 tasks. These tasks are to: 1) design the ATIS, 2) develop the information database and 3) provide interfaces to the ATIS. Based upon task 1 results, the costs presented in tasks 2 and 3 can change.

5.2.2.1 Task 1 - Design the ATIS including the RMTIC/TOC

This task consists of performing a top-down structured systems design engineering approach to ensure all requirements are properly captured and translated into a system requirements baseline for an integrated system design. This will include coordinating and managing the procurement, implementation, construction, integration, and testing activities of this entire phase. It consists of only the engineering cost.

5.2.2.2 Task 2 - Develop the information database

This task includes the hardware and software for the traveler information database. This includes the database workstation, developing traveler information requirements, designing the database, developing the software, off-the-shelf software, and integration and test.

5.2.2.3 Task 3 - Provide interfaces to the ATIS

The following interfaces shall be provided to the ATIS:

- RDS I/F to FM radio stations,
- In-vehicle route guidance I/F,
- Public media I/F including CATV, kiosk, BBS, telephone, and
- Cellular telephone and DCS I/F,
- Cost estimates for each of these interfaces are provided.
- The RDS interface shall be expected to be a privately funded enterprise and would incur no cost to the ATIS and hence, is not included in the cost table.
- In-vehicle route guidance I/F shall be considered to include a separate server.
- CATV shall include a dedicated CATV channel.
- Kiosk shall include the 10 kiosks and their interfaces.
- Telephone interface shall be an-800 number with approximately 70 lines.
- Cellular/DCS telephone shall be a toll-free hotline.

5.2.3 Phase 2 Costs

Table 6
Phase 2 Cost Summary
(1996 dollars)

Description	Capital Cost ($000's)	Design ($000's)	Software ($000's)	Construction ($000's)	Annual O&M ($000's)
Design the ATIS center (RMTIC/TOC)		400			
Database system	100				10
Develop requirements		50			
Design system		50			
Develop information database		50	200		
Off-the-shelf software including database management system	50				5
Integration/test		50	50		
In-vehicle route guidance I/F	100				10
CATV I/F	50			2	5
10 Kiosk	500			30	50
BBS I/F	50			2	5
Telephone I/F	300			5	30
Cellular telephone I/F	340				34
Phase 2 Total Component Costs	1490	600	250	39	149

5.3 Phase 3

5.3.1 Preliminary Analysis Task

This phase is conducted prior to full deployment. It would consist of an extensive analysis of the communications system in Nashville Area and the transportation needs identified in this study. The analysis will examine Nashville Area and recommend a communication system that best addresses the transportation communication requirements of Nashville Area and is consistent with the architecture framework presented in this study. The results of this analysis may present findings that are inconsistent with the assumptions made in this analysis. Thus, the cost estimates provided in this study may change.

The analysis would examine functional requirements and hence data requirements. These data requirements might affect communications between TMC's and field controllers as well as the regional communications backbone. An example is a monitoring requirement for additional arterials with a full-motion video requirement. This might affect the communications backbone data rate and design as well as communications hubs, and the local TMC requirements.

Throughout the remainder of this analysis, many assumptions are made. It should be noted that they are made in lieu of the recommended Phase 3A. This "Phase 3 preliminary analysis" is expected to cost $200,000 (or $200 K) in engineering and support costs. Throughout this section, thousands of dollars will be expressed in common engineering terminology of "K.")

5.3.2 Phase 3A

This phase is focused on the integration of priority corridors in Nashville Area. In order for ATIS to be developed and deployed to its optimal potential, a basic ATMS infrastructure is needed. This infrastructure is recommended for Phase 3 deployment in Nashville.

The priority corridors identified in this study are analyzed as representative priority corridor candidates. The costs developed from this analysis will provide a range for priority corridor integration using a per mile cost factor. The costs are developed to allow parametric analysis such that costs of alternative corridors and/or variations of the Strategic ITS Corridors can be estimated.

5.3.2.1 Phase 3A Requirements

In order to integrate the priority corridors, functional requirements for this phase are listed below.

- A system design will be required to develop a systems integration of the priority corridors.
- Sonic sensors (e.g., SmartSonic™) shall be integrated if installed along the corridors to complement video sensors in areas where video sensors may be obstructed or lighting may be a problem.
- Controllers shall be installed or upgraded where necessary along the corridors to provide real time monitoring for traffic information and shall be controlled as necessary through selection and adjustments to timing plans.

- Controllers along the corridors shall provide real time coordination using GPS time base.

- Closed-circuit television (CCTV) shall be integrated if installed along the corridors to support incident and traffic congestion evaluation.

- Electronic signs, including dynamic routing signs such as PathFinder™, shall be integrated from the Parking Management System installed in Phase 1 to communicate corridor status and to advise alternate corridor(s).

- The corridor communications architecture shall allow implementation of national standard protocols.

- The corridor controllers shall be integrated if installed with fault tolerant optical communications for new construction and new additions to an existing jurisdictional field environment.
  - Wireless, seamless interconnection shall be utilized where traffic conditions and business interruptions will not allow fiber installation.

  - Corridor controller communications shall be terminated into a standard jurisdictional communications gateway. The gateway shall be an intelligent multiplexer that controls access to the jurisdictional low-speed controller links, complies with NEMA environmental requirements, is fault tolerant, and includes an internal bridge/routing capability.

  - The gateway shall be integrated with the TMC optical communications link, if such a link exists. The gateway shall be terminated within the TMC into a DS- l/Ethernet bridge/router.

  - The TMC information processing and display environment shall be upgraded to accommodate the new field environment.

  - The TMC shall be upgraded with medium hybrid control capability where applicable.

5.3.2.2 Phase 3A Tasks and Cost Estimates

In order to develop rough order of magnitude cost estimates for this phase, a cursory analysis of the requirements was performed. This analysis involved examining the nine priority corridors with respect to the jurisdictions involved, the type of signal system utilized, the length of the segments, current and expected traffic volumes, incident data, the proposed TDOT FMS, and other related data.

A range of the cost estimates for Phase 3A is established by assuming a high-end state corridor and a "basic" corridor. The cost estimates are provided per mile. There is an assumption for Phase 3-B elements that around 15 to 25 miles of freeway are included in the Phase 3-A deployment, in order to make the development of a Regional, Multi-modal Traveler Information and Traffic Operations Center (RMTIC/TOC) in Nashville cost-effective. Tied to the corridor is the associated cost for a "high-end freeway management system (FMS) corridor" and a "basic" FMS. All estimates are rounded up to the nearest whole thousand.

System Design

For both estimates, a cost for the design of the system will be required. This design consists of performing a top-down structured systems design engineering approach to ensure all requirements are properly captured and translated into a system requirements baseline for an integrated system design. This will include coordinating and managing the procurement, implementation, construction, integration, and testing activities of this entire phase. It consists of only the engineering cost estimated at $200K.

High-End ITS Corridor

The following are typical requirements for a "high-end" corridor on a per-mile basis:

- CCTV monitors should be installed at one mile intersections.
- Full-motion video should be used.
- Each mile of a corridor should have one mile of fiber installed to reach the next intersection.
- Each mile of corridor would require l/2 mile of trenching and conduit due to existing infrastructure
- The corridor to TMC would have an estimated five miles of fiber installed (as an average) corridor-to-TMC link added to the corridor mile cost estimate.
- The corridor to TMC would require two miles of trenching and conduit for the average corridor to TMC link added to the corridor mile cost estimate.
- Intersection controllers, at least at freeway entrance ramps, should be a 2070-level controller.
- Electronic signs or VMS's shall be provided every two miles, thus the cost of l/2 electronic sign per mile shall be estimated.
- Mid-link surveillance could be performed using machine vision sensor and connected to the fiber interconnection (not recommended for Nashville).

Costs are estimated for construction, engineering design, capital equipment, and operations and maintenance costs required as specified above:

- Fiber cost is estimated at $5/ft or $26.4K/mile.
- Trenching and conduit $25/ft or $130K/mile.
- The estimate of $5K for the machine sensor; (for both directions of travel, the cost is $l0K).
- CCTV cameras including PTZ controllers are estimated at $16K per corridor site
- CCTV video CODECs installed are $2K/site.
- CCTV camera installation including labor and materials is estimated at $11K per camera.
- The VMS should be full-matrix and is estimated to be $20K each and includes controller costs. ($10K/mile)
- VMS construction cost per site is estimated at $10K, $5K/mile
- VMS engineering cost per site is estimated at $7K.
- Operations and Maintenance is 12% of capital cost.

Table 7
High-End Corridor Cost/Mile
(1996 dollars)

Description	Capital Cost ($000's)	Design ($000's)	Software ($000's)	Construction ($000's)	Annual O&M ($000's)
Corridor fiber	26				3
Corridor trenching and conduit				61	
Corridor optical sensor/ transceiver	10				1
Corridor to TMC fiber	130				13
Corridor to TMC trenching and conduit				244	
Controller/CODEC	3	3			1
CCTV cameras	16			11	2
VMS	10	4		5	1
Total Component Costs, High-End Corridor	175	7		321	21

High-End Regional Multimodal Traveler Information and Traffic Operations Center(RMTIC/TOC)

- The high-end RMTIC/TOC is recommended to be a basic ATIS/ATMS with monitoring of an estimated 12 CCTV cameras for a 25-mile system.
- Capability for short-haul microwave site may be necessary for some CCTV locations.
- Operations and maintenance cost is estimated at approximately 10% of capital cost.

Table 8
High End Traffic Management Center
(1996 dollars)

Description	Capital Cost ($000's)	Design ($000's)	Software ($000's)	Construction ($000's)	Annual O&M ($000's)
ATMS Server	55		65		6
GPS Receiver	2	1			1
Gateway	41				4
Regional hub	50				5
Ethernet LAN/Bridge/Router	8				1
12 CCTV monitors/ CODE/switcher	31				3
Video wall display system	150				15
Data Manager S/W			175		
Short-haul microwave site	15			4	2
System Integration/ test		45			
Total Component Costs - High-End RMTIC/TOC	352	46	240	4	37

Basic Corridor

The following are typical requirements for a "basic" corridor mile:

- Controllers shall be upgraded to accommodate standard protocol
- Loop surveillance shall be required with 6 loops per mile.
- Interconnection to loop surveillance shall be required assuming that 75% already exists.
- Fiber optics shall not be required
- Electronic signs and/or VMS shall be provided every five miles, thus the cost of 1/5 electronic sign per mile shall be estimated.

Costs are estimated for construction, engineering, capital, and operations and maintenance costs required as specified for a basic corridor. (As with other estimates, all costs are in 1996 dollars.)

- 6 loops per mile cost $3K.
- Trenching at $5/ft for 1/4 mile if 75% already exists.
- Controller upgrades cost $3K.
- VMS should be full-matrix, estimated at $20K each ($4K per mile); includes controller costs.
- VMS construction cost per site is estimated at $9K.
- VMS engineering cost per site is estimated at $4K.

Table 9
Basic ITS Corridor Cost/Mile
(1996 dollars)

Description	Capital cost ($000's)	Design ($000's)	Software ($000's)	Construction ($000's)	Annual O&M ($000's)
Loops	3				1
Corridor trenching and twisted wire pair					
Controller	3	3			1
VMS	4	1		2	1
Basic Corridor Deployment Costs	10	4		9	3

Table 10
Basic Traffic Management Center
(1996 dollars)

Description	Capital cost ($000's)	Design ($000's)	Software ($000's)	Construction ($000's)	Annual O&M ($000,s)
GPS Receiver	2	1			1
Gateway	41				4
Ethernet LAN/Bridge/Router	8				1
System Integration/Test		30			
Basic System Total costs	51	31			6

The costs present a range between the high-end and basic Phase 3A. Many intermediate implementations are possible.

An interim system for interconnection can be provided using a leased-line or spread-spectrum wireless option if the video grade requirement is lowered. Either option will reduce the up-front capital requirements; however, for a leased-line option, the operational costs would cause a leased-line option to exceed the life cycle cost of a fiber solution. Rough estimates of cost for a leased-line option would be approximately $5OO/site for the cost of installation. The cost for a digital modem is approximately $ 1K with a $3K charge for integration and testing. A monthly fee of approximately $300/month per line for the leased-line service to support a 64K bps video compression standard.

5.3.2.3 Phase 3A Summary Costs

A summary of the Phase 3A costs is provided below using an estimated cost per mile. Two tables summarizing the high-end and the basic system are provided.

Table 11
High-End Phase 3A Cost/Mile

Description	Quantity	Capital Cost ($000's)	Engineering ($000's)	Software ($000's)	Construction ($000's)	Annual O&M ($000's) *
Corridor fiber	1/mile	26				3
Corridor trenching and conduit	1/mile				61	
Corridor optical transceiver	1/mile	10				1
Corridor to TMC fiber	1/mile	130				13
Corridor to TMC trenching and conduit	1/mile				244	
Controller	1/mile	3	3			1
CCTV cameras/codes	1/mile	16			11	2
VMS	1/mile	10	4		5	1
ATMS Server **	1/25 miles	55		65		6
GPS Receiver	1/25 miles	2	1			1
Gateway	1/25 miles	41				4
Regional hub	1/25 miles	50				5
Ethernet LAN/Bridge/Router	1/25 miles	8				1
12 CCTV monitors/codec/switcher	1/25 miles	31				3
Video wall display system	1/25 miles	150				15
Data Manager S/W	1/25 miles			175		
Short-haul microwave site	1/25 miles	15			4	2
System Integration/Test	1/25 miles		45			
High-End Phase 3A Costs		**547**	**53**	**240**	**325**	**58**

* Operations and maintenance is assumed for a 20 year period.
** Costs for the Center would be the same whether a center served one mile or 25 miles, therefore costs/mile for a minimum 25 mile system are shown

Table 12
Basic Phase 3A Cost/Mile

Description	Quantity	Capital Cost ($000's)	Engineering ($000's)	Software ($000's)	Construction ($000,s)	Annual O&M ($000's) *
Loops	1/Mile	3				1
Corridor trenching and twisted wire pair	1/Mile				7	
Controller	1/Mile	3	3			1
VMS	1/Mile	4	1		2	1
GPS Receiver	1/ 25 Miles	2	1			1
Gateway	1/ 25 Miles	41				4
Ethernet LAN/Bridge/Router	1/ 25 Miles	8				1
System Integration/Test	1/ 25 Miles		30			
Basic Phase 3A Costs		61	35		9	9

* Assuming 20 years of operations and maintenance.

5.3.3 Phase 3B

This phase will result in the installation of a SONET communications backbone.

5.3.3.1 Phase 3B Requirements

- Design of the backbone SONET network
- Installation of SONET hub equipment
- The intelligent gateway is recommended to be interconnected with SONET.
- The field video CODEC must be interconnected with SONET.
- The SONET hub is recommended to be interconnected with bridge/router and CODEC receiver equipment.
- ATM ethernet switch should be added to support ITS functional calls between centers.

5.3.3.2 Phase 3B Tasks

Phase 3B tasks are presented together in this section. Assumptions are as follows:

- An engineering design task shall be required, cost estimated at $200K.
- To support Nashville Area and consistent with a high-end Phase 3A, 11 SONET hub communication equipments shall be required with cost estimated at $50K each.
- 11 CODECS shall be required with cost estimated at $2K each.
- Fiber is estimated at $25/foot for conduit and installation plus $5/foot for cable, or $30/foot.
- The SONET network is 75 miles in length, doubled for dual-ring redundancy.
- All O&M is 10%/year

Costs are shown in the following table, assuming a 25-mile system will be included in the system.

Table 13
Phase 3B Cost

Description	Capital Cost ($000's)	Engineering ($000's)	Software ($000's)	Construction ($000's)	Annual O&M * ($000's)
Design the communication system		200			
1 Sonet Hub	5				0.5
1 CODEC	2				0.3
25 miles Fiber	667			3,300	67
1 ATM ethernet switch	1				0.2
Integration/Test					
Phase 3B Costs	**675**	**200**		**3,300**	**68**

* Assuming 20 years of operations and maintenance

6.0 Schedule for Deployment

This Strategic Deployment Plan is presented in four phases. Schedules for the implementation of each phase are presented in terms of the deployment time frames established by the Coalition. These time frames are as follows:

- Short Term, Phase 1 1997-1999
- Medium Term, Phase 2 2000-2005
- Long Term, Phase 3 2006-2010
- Long Term, Phase 4 Beyond 2010

It must of course that it is recognized that each of these phases, and the projects within each phase, are best estimates and recommendations to achieve a logical progression of an ATIS/ ATMS capability for the Nashville region. Each phase is broken down into four primary activities. These activities are:

- Pre-Design/Programming
- Design/Specifications
- Construction/Installation
- Implementation

Specific elements that must be addressed in each primary activity are also presented along with an estimated time frame for completion of the primary tasks. The schedule is based on an understanding of the physical constraints associated with implementation of each phase, with the assumption that the necessary funding will be available.

It should be noted that the schedule assumes overlaps among the primary tasks within each phase. For example, the construction along top priority freeways and other major arterials in Phase 3A would begin prior to the completion of the design for lower priority facilities. Likewise, the schedule requires an overlap among the various phases. For instance, the pre-design and design of Phase 3B must overlap with the design of Phase 3A. Phase 1 projects are already underway. We will therefore begin with a summary of the schedule for Phase 2 (estimated to begin within three fiscal years, or by the year 2000).

6.1 Phase 2: Expansion of ATIS Functions

This phase would continue the initiatives already underway in Phase 1 implementation. This Phase of deployment of the ATIS would begin with the implementation of the first elements of a Freeway Management System (FMS) that would be an integral part of the ATIS for Nashville. The location for the "core" ATIS center, the RMTIC/TOC should be established immediately, as this will affect the communications requirements developed in Phase 1. The completion of this phase is within the 15 year implementation goal. The primary tasks and associated activities for this phase are as follows:

- Pre-Design/Programming (6-12 months)
  Establish location for the "core" ATIS center
  Develop design concept for ATIS system, the information database, and various interfaces Secure funding
  Develop design, construction, and implementation schedule

- Design/Specifications (9-18 months)
  ATIS system
  Kiosks
  RDS interface
  In-vehicle route guidance interface
  CATV interface
  Telephone interface
  Cellular/ CDS interface

- Construction/Installation (6-12 months)
  ATIS system
  Kiosks
  RDS interface
  In-vehicle route guidance interface
  CATV interface
  Telephone interface
  Cellular/ CDS interface

- Implementation (12-18 months)
  Programming
  System testing
  System evaluation

6.2 Phase 3

6.2.1 Phase 3A: Priority Corridor Field Implementation

This phase would begin immediately with the selection and prioritization of specific corridors or arterials. Completion of this phase is within a 10-year implementation goal (roughly 2000 - 2010). It is anticipated a limited number of high priority arterials will be identified for immediate design and early construction. It is projected the high priority arterials could be operational within 18 months.

The corridors identified in this phase (particularly the high priority corridors) would tend more toward the high-end state described in Section 3.1.2.2. The primary tasks and associated activities for this phase are as follows:

- Pre-Design/Programming (6-18 months)
  Select and prioritize arterials
  Inventory existing infrastructure
  Secure funding sources
  Develop design, construction, and implementation schedule
  Establish necessary inter-governmental agreements

- Design/Specifications (12-24 months)
  Communications network
  Intelligent gateway
  Controller upgrades
  TMC upgrades
  Traffic sensors
  CCTV/field video codec
  Electronic signs
  Construction/Installation (12-24 months)
  Communications network
  Intelligent gateway
  Controller upgrades
  TMC upgrades
  Traffic sensors
  CCTV/field video codec
  Electronic signs

- Implementation (12-24 months)
  Develop timing and control strategies
  Programming
  System testing
  Implement timing and control strategies
  Perform evaluation and report

6.2.2 Phase 3B: Communications between TMCs

This phase would begin with the planning and design of the communications backbone. Completion of this phase is within a 10 year implementation goal, but is still considered a priority. The identification of top priority TMC to TMC links (e.g., Nashville to Franklin for example) would occur early in the programming process. It is anticipated one or two priority links would be identified for immediate design and implementation. It is projected the high priority link(s) and TMC upgrades could be operational within 18 months after project kick-off. This would coincide with the design, construction, and implementation of the phase 3A high priority corridors. The primary tasks and associated activities for this phase are as follows:

- Pre-Design/Programming (12-24 months)
  Design concept for communications backbone (coordinate with Phase 1A)
  Prioritize communications links (TMC to TMC)
  Survey proposed backbone layout
  Inventory TMC hardware and evaluate required upgrades
  Secure funding sources
  Develop design, construction, and implementation schedule
  Establish procedures for data sharing and inter-agency transfer of control
  Establish necessary inter-governmental agreements

- Design/Specifications (18-36 months)
  Communications backbone
  SONET hub
  SONET-intelligent gateway interconnect
  SONET-field video interconnect
  SONET-bridge router and codec receiver interconnect
  ATM Ethernet

- Construction/Installation (12-24 months)
  Communications backbone
  SONET hub
  SONET-intelligent gateway interconnect
  SONET-field video interconnect
  SONET-bridge router and codec receiver interconnect
  ATM Ethernet

- Implementation (12-18 months)
  Equipment programming
  System testing
  Test and evaluate procedures for data sharing and inter-agency transfers
  Revise procedures as necessary

6.2.3 Phase 3C: Complete Transition to System Architecture

This phase begins where Phase 3A ends, both functionally and chronologically. This phase consists of converting the remaining field infrastructure (not addressed in Phase 3A) to the system architecture.

Completion of this phase is within a 15 year implementation goal. However, Phase 3C programming is really a transition toward incorporating ITS technology into the TIP process for all roadway capital improvement projects. As new roadways are constructed or existing roadways reconstructed, it is recommended that TDOT integrated ATIS system architecture into the project. The technologies to be used would be at a level consistent with the functional characteristics of that roadway. The primary tasks and associated activities for this phase are as follows:

- Pre-Design/Programming (12-24 months)
  Select and prioritize upgrades
  Inventory existing equipment
  Secure funding sources
  Develop design, construction, and implementation schedule
  Establish necessary inter-governmental agreements

- Design/Specifications (12-24 months)
  Controller upgrades
  Traffic sensors
  Control to TMC communication links (as necessary)

- Construction/Installation (12-24 months)
  Controller upgrades
  Traffic sensors
  Control to TMC communication links (as necessary)

- Implementation (12-24 months)
  Develop timing and control strategies
  Programming
  System testing
  Implement timing and control strategies

6.3 Phase 4: Deployment of Additional Technologies

Much like Phase 3C, the deployment of additional technologies will be a continual process. The system architecture is flexible enough to accept additional technologies such as electronic fee collection. The deployment of these technologies is part of the long term implementation goal. The primary tasks and associated activities for this phase are as follows:

- Pre-Design/Programming (6-l8 months)
  Identify candidate locations for electronic fee collection
  Investigate other opportunities/applications for RF tag technology
  Develop necessary partnerships for standardization of RF tags

- Design/Specifications (12-24 months)
  RF beacons
  BNA central facility
  Communication links (as necessary)

- Construction/Installation (12-24 months)
  RF beacons
  BNA central facility
  Communication links (as necessary)

- Implementation (12-24 months)
  Programming
  System testing
  System evaluation

- In addition, machine vision sensors (e.g., TraffiCam™) or equivalent, could be integrated if installed along the corridors to provide information on traffic congestion and to support incident detection where other sensors are unavailable or to support technology testing. The cost of such sensors is not included in this plan, however, since it is anticipated their cost will decrease dramatically in the next 10 years.

7.0 Management Structure

The objective of preparing a management structure is to establish a framework for policy, process and action between the public and private jurisdictions involved. By establishing a management structure, the interest and involvement of the Coalition created for the development of the Strategic Plan for Early Deployment of ITS technologies in Nashville Area will continue. This interest needs to continue in order that deployment of the technologies can in fact become a reality.

7.1 Nashville ITS Coalition

During the development of the strategic plan, the Coalition met regularly to receive updates on the status of the plan development and to offer their input as well as to review the deliverables from the study. The interaction of this Coalition brought about a strengthening of the coalition of government and private sector stakeholders that are active in the Nashville area in supporting ITS. The Coalition consists of the following agencies representing the stakeholders in a better transportation system for Nashville.

Metropolitan Government of Nashville and Davidson County
- Office of the Mayor
- Metropolitan Planning Commission (MPC)
- Metropolitan Public Works Department (MPW)
- Metro Information Services Department (ISD)
- Metropolitan Transit Authority (MTA)

Tennessee Department of Transportation
- Special Projects Office
- Regional Traffic Office
- Public Information Office

Nashville Convention and Visitors Bureau (NCVB)

Nashville Airport Authority

Greater Nashville Regional Council (GNRC)

Regional Transportation Authority (RTA)

Nashville Arena

Gaylord Entertainment Company

City of Franklin/ The TMA Group

City of Murfreesboro

Tennessee Hotel/Motel Association

Downtown Merchants Association

Tennessee Office of Tourism

Federal Highway Administration

Central Parking

Vanderbilt University

Nashville NOW

It is suggested that the present Coalition continue to function as the advisory body of the deployment plan. A permanent Chairman of this Nashville ITS Coalition should be selected from among the agencies represented on the group. The Coalition's function would be to assure that the jointly developed strategic plan is carried out in the way in which it was intended as a part of the strategic plan development. It is recommended that a neutral 3rd-party chairman be appointed, with strong leadership and consensus building skills.

A second function of the Coalition would be to review new technologies and new concepts, as they become available, and to determine if a change is needed in the original Strategic Plan. The Coalition should work directly with TDOT and the Nashville Area MPO in order to respond to questions or issues dealing with the administration of the Strategic Plan.

7.2 ITS Management Team

The management structure is a significant element of any area-wide plan. A management team, made up of dynamic individuals from the sponsoring agencies, needs to be created to serve as the foundation for project implementation. As the Strategic Plan becomes a reality and implementation proceeds, a flexible approach should be maintained by the early management team. Opportunities may become evident in the early deployment years for earlier implementation of projects originally identified for later development. These opportunities may present themselves in the form of alternative funding sources, local improvements, private initiatives, or higher transit priorities. As these earlier deployment opportunities arise, the management team’s task will be to review the Strategic Plan, in close cooperation with the Coalition, to set new strategies and priorities.

Additional management responsibilities will include initiating the specific parts of the Strategic Plan, getting activities on track, securing funds, scheduling team meetings, and reporting to a collective, regional management structure. Generally, these tasks are most effectively accomplished when made the responsibility of a single project manager or chairman of the early implementation team. The management aspect of the Strategic Plan will define the specific responsibilities, the inter-governmental agreements which must be established, recommendations regarding leadership, the involvement of each agency, and the control hierarchy.

It is therefore suggested that an ITS management team be formed immediately to deal with day to day carrying out of the ITS Strategic Plan. It is suggested that this management team be chaired by a “champion” of ITS for the Region. This person needs to be one that the Coalition feels has the energy and desire to see the deployment plans carried out.

It is recommended that the management team consist of key agencies involved in funding and implementation. TDOT and the Division office of FHWA must be involved, along with Metro Government. The specific function of this management team is to support the city/jurisdiction deployment teams which have the direct responsibility of deploying the various projects. This management team would meet on a more regular basis than the Coalition, perhaps bi-weekly or monthly, to deal with the day-to-day issues of making sure that the Strategic Plan is in fact implemented. Due to the anticipated complex logistics of the deployment issues, it is envisioned that the management team would create an executive group within the team, designed to deal with the day-to-day issues.

7.3 Deployment Teams

A third element of the management structure recommended consists of the deployment teams. As an example, a deployment team for the Parking and Traffic Guidance System is already in place. This team is headed by MPW Assistant Director Gene Ward. Likewise, a team to develop the Franklin Inter-modal Safety and Traffic Management Center is at work on a regular basis. This project is under the oversight of City Administrator Jay Johnson and City Engineer David Parker.

Deployment teams for other projects would consist of the appropriate staff of the member agencies of the Tennessee DOT, DPS, Nashville Area MPO, MTA, Nashville Convention and Visitors Bureau, the BNA Airport, and other entities that are involved in deployment projects, These deployment teams must take the lead in developing the projects that affect their particular agencies and carry them to the MPO TIP process.

The development of the projects and presentation to the TIP process must in turn be supported by the ITS management team, previously discussed. Once the project is on the TIP and is funded, this approval would then go back to the deployment teams for administration of the project and deployment of the particular technologies. If the guidelines of this Strategic Plan are followed, the system will serve well the future traveler and visitor information needs, as well as incident management needs, of the Nashville region.

This recommended management structure utilizes existing organizational structures and existing agencies to the maximum extent possible. The new entity introduced by this management plan is the continuation of the ITS Coalition for the management of the plan and the institution of an ITS management team headed by the ITS champion of the Region. This management team would carry the responsibility of ensuring that the Strategic Plan is carried forward.

Figure 7

Strategic Plan Deployment Management Structure

(Reserved for future addition and consensus-building process between
Metro Government, Tennessee DOT and other Stakeholders in the Nashville ITS Coalition)

8.0 Summary

8.1 Strategic Plan Overview

This ***Strategic Plan for Early Deployment of Intelligent Transportation Systems in Nashville*** has described the results, findings, and recommendations of an ITS early deployment study. This planning study, which began in October, 1995, was initiated and administered by the Nashville Area Metropolitan Planning Organization (MPO), in collaboration with the Tennessee Department of Transportation and the Federal Highway Administration. The study consultant was Kimley-Horn and Associates, assisted by Lockheed-Martin Federal Systems, Street Smarts, and Vanderbilt University. The goal of this study was to develop a Strategic Plan for deployment of ITS technologies within the Nashville Metro Area and to create a long-term coalition of ITS stakeholders to implement an ITS program in the Nashville Metro Area.

A number of important transportation features indicate that deployment of ITS technologies will improve traffic safety and reduce congestion in the region. First, there is a convergence of three major interstate highways. Several river crossings in the area somewhat constrain travel patterns in the City as well as region-wide. A large number of tourists enter the Middle Tennessee region annually, with a large proportion of those visiting "Music City." High Occupancy Vehicle (HOV) lanes are in operation; additional HOV facilities are being built, and others are in the planning or design stage. Furthermore, there is an excellent transit system including park & ride and interurban commuters. Local officials recognize that these facilities are not enough to alleviate the pressure on the extremely congested highways in Nashville.

As a fast-paced, growing "major league" city, land prices are also rising significantly each year, making it more costly to continue to add lanes to existing facilities. These characteristics, combined with the limited availability of traveler information and the need for improved emergency management services on the Interstate, create a unique opportunity to test the implementation of innovative ITS technologies in Middle Tennessee.

The success of this strategic plan will depend on the commitment of state and MPO decision- makers to deploy ITS technologies in the Region. By applying the appropriate technological solutions to address transportation and traveler information needs identified in this document, significant efficiencies in transportation services and operations can be realized. Technology exists, or is rapidly emerging, to implement a wide range of programs that will make the transportation of people and goods safer and more efficient, less impacting on air quality and the environment, and more accommodating to the transportation needs of major metropolitan areas.

This study produced a database of people and organizations who are stakeholders in the cause of improving Nashville's transportation and communications systems. A significant number of these organizations and individuals have been brought into the strategic planning process. Even more will be required as individual projects are approved and implemented. The overall Coalition that was formed has provided critical input throughout the study. They have also been kept abreast of study findings and recommendations through activities such as focus groups and regular meetings. In addition to transportation system users in the Corridor, key public and private partners have been identified.

Presentations on the results of this study have been made to the MPO Technical Coordinating Committee, the Traffic and Parking Commission, and the Downtown Partnership. Other community presentations are needed now that the study is complete.

Specific ITS User Services were stratified into categories that apply to metropolitan areas, maintaining a consistency with the ***ITS National Program Plan*** (March 1995). This Plan, developed by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), represents the position of the U.S. Secretary of Transportation in developing a multimodal ITS program plan for major urban areas. The ***National Program Plan*** and the ***National ITS Architecture*** (April 1996) were primary guidelines in developing the Nashville Metro Area User Services Plan and ITS Strategic Plan.

The following ITS deployment schedules were established for Nashville:

- Short Term 1997 - 1999
- Medium Term 2000 - 2005
- Long Term 2006 and beyond

Each of the needs were matched, where possible, to one or more of the 30 FHA User Services defined in the ***National Program Plan and National Architecture.*** These User Services were modified over the course of this study to include railroad-highway grade crossing improvements. The ***Nashville ITS Strategic Plan*** has been tailored to meet the needs of the regional Incident Management Program, the Parking and Traffic Guidance System being developed by Metro Government, and other local ITS components. The Parking and Traffic Guidance System Conceptual Plan has recently been completed by Kimley-Horn.

The User Need Categories and specific ITS User Services shown in the following table, consistent with the National ITS Architecture and Program Plan, are being recommended for implementation in Nashville.

Table 14
Specific User Services Targeted for Deployment in Nashville

Major User Need Categories	Specific ITS User Services
Travel Demand Management	Pre-trip Travel Information Demand Management and Operations
Travel and Transportation Management	En-route Driver Information Route Guidance Traveler Services Information Traffic Control Incident Management
Emergency Management	Emergency Notification & Personal Security Emergency Vehicle Management
Public Transportation Operations	Public Transportation Management En-route Transit Information Personalized Public Transit Public Transit Security
Commercial Vehicle Operations	HAZMAT Incident Response Commercial Fleet Management
Automated Accounting Systems	Electronic Payment Services
Advanced Vehicle Control & Safety	Intersection Collision Avoidance

A systems architecture was developed for the Nashville Metro Area, representing an evolutionary, open standards architecture that will incorporate specific technologies and market packages for each of the three deployment time frames. Twenty-five separate market packages were incorporated into the architecture, in order to respond to the needs identified in this study. Implementation of this set of market packages will bring the Nashville Metro Area to a level consistent with other major metropolitan regions in the country over the next 15 to 20 years. The long-term deployment of market packages, corresponding with User Need Categories and user needs specific to the Nashville Metro Area, are outlined in the next table.

Table 15
Market Packages Targeted for Deployment in Nashville

ITS User Need Categories	General Transportation and Information Objectives	Market Packages
Travel Demand Management	Route and destination information; Better signing; Tourism and special event information; Travel services information	Broadcast Traveler Information; Interactive Traveler Information; Traffic Information Dissemination
	Traffic incidents and congestion information; Parking information for Arena and Stadium events	Interactive Traveler Information; In-vehicle Signing; Dynamic Parking Management
	Traffic reports; Weather information	Traffic Information Dissemination; Broadcast Traveler Information; In-vehicle Signing
Travel and Transportation Management	Incident detection and notification to motorists; Database development for freeway traffic control	Incident Management; Freeway Operations; Traffic Control
Emergency Management	Improved emergency management; Quicker incident response; Increased availability of automated emergency notification receivers; Improved HAZMAT notification and emergency management enforcement	Emergency Response; Emergency Routing; HAZMAT Management; MayDay Support
Public Transportation Operations	Improved coordination among modes and agencies within the region	Multimodal Coordination; Intermodal Traveler Fare Management
Commercial Vehicle Operations	Improved safety, efficiency, productivity	Fleet Administration; HAZMAT incident response
Automated Accounting Systems	Convenience and efficiency in payment for parking and public transportation use	Transit Fare Payment; Dynamic Parking Management
Advanced Vehicle Control and Safety Systems	Collision avoidance at intersections and interchanges	Traveler Security; Highway Rail Intersection ; Traffic Surveillance

Specific projects that are recommended for each User Need Category and each Transportation/ Information System improvement objective are shown in the luding section.

8.2 Conclusions and Recommendations

The ITS projects recommended for the Nashville region should be developed using the overall systems architecture developed in this project. The following specific projects are recommended, by phase:

Phase1 - Basic Advanced Traveler and Tourist Information System (ATIS) Elements (next two years)

- Parking and Traffic Guidance System (being developed by Metropolitan Government Department of Public Works)
- Franklin Traffic Safety and Intermodal Traveler Information Center (being developed by the City of Franklin)
- Variable Message Signs, controlled by cellular communications interface
- FM Traveler Advisory Radio (being developed by Nashville Convention and Visitors Bureau)
- Enhanced Nashville Area Travel Web Page
- Enhanced Visitor Kiosks at Tennessee Welcome Centers
- Special Event Control Software
- Incident Response/Removal/Clearance (recommended in Incident Management Planning Study)
- GIS database standardization and completion
- Commercial Vehicle Operational (CVO) Automated Vehicle Location utilization

The short-term program also includes two ATMS elements that were already under development before the current ITS Strategic Planning study was begun: the upgrading of the Downtown Nashville Signal System and a Traffic Management Center developed by the Traffic Engineering Department in Murfreesboro. These two systems are included in the overall architecture developed in this plan.

Phase 2 - Expansion of ATIS (roughly 2000 - 2005)

- Development of Regional Multimodal Traveler Information Center and Traffic Operations Center (RMTIC/TOC)
- Basic Traffic Surveillance System
- RBDS Subsystem of FM radio stations
- Interface for traveler information to other public broadcast media
- Interface to cellular and DCS services
- Expanded CVO electronic clearance to I-65 corridor
- Interface to private security monitoring service

Phases 3 and 4 - Long-Range ITS Deployment (beyond 2005)

- Field implementation of additional hardware in priority corridors, including video, sensors, CCTV, etc.
- Communications between Traffic Management Centers in Nashville, Murfreesboro, Franklin, and other satellite locations as they are developed
- Transition of field infrastructure to the system architecture
- Additional ITS technologies, including electronic fee collection, RF tag readers for HAZMAT identification, RF tags on probe vehicles, etc.

As these projects are deployed, the overall Regional Management and Operations Plan for ITS is recommended to include the following components:

- **Adoption of a common architecture.** This step will support all future incremental build-out of ITS capabilities and services.

- **Field infrastructure installations at selected locations.** These projects will support needed information to determine weather information, plus rapid detection and response to incidents.

- **Integration of separately-developed Traffic Management Centers (TMCs) in Nashville and outlying areas including Murfreesboro and Franklin.** These sub-regional TMCs should be coordinated and connected to control response to incidents on the freeways and other highways, assist local jurisdictions in emergency response, and be sub-regional clearinghouses for traveler information. Murfreesboro's TMC is already under development.

- **A single, Regional Multimodal Traveler Information Center and Traffic Operations Center (RMTIC/TOC) to provide needed data processing hardware and software for real-time traffic surveillance data.** This center should be established in the Nashville Traffic Management Center in order to provide the best possible integration of all sources of traffic and travel information for the Nashville region. The electronic component of the tourist information system should be incorporated into an overall visitor and convention business plan called VISIT - Middle Tennessee, as suggested in this study.

- **A strategic ITS communications plan is needed for the State of Tennessee, beginning with the Nashville metropolitan region.** This element should include upgrading the current communications backbone to support interoperability between TMCs as they are built. The proposed Strategic Communications Plan should be directed to the support of improvements in information to the ATIS, the Incident Management System, commercial vehicle management, public transportation, and other ITS components. Without this more detailed communications plan for Tennessee, coordination among the various regional and sub-regional centers may develop on a piecemeal basis without compatible communications protocols and systems and a lack of ability to share data and other information.

- **Interoperability between Traffic Management Centers in various local jurisdictions in the region and beyond, to provide commonality among traveler information and messaging functions.** Adaptation of the International Traveler Information Services (ITIS) protocols should be carefully considered and given some study in Tennessee and throughout the mid-South. It is recommended that TDOT join the ENTERPRISE ITS Consortium in order to stay abreast of this dynamic sub-component of ITS technology deployment.

Each phase of the Nashville Regional ITS Strategic Plan will provide a set of building blocks which, upon completion, will meet the consensus needs of Nashville's transportation system as well as provide an interstate connection throughout the Mid-South region. Similar systems are already in place in Atlanta and being developed in Charlotte and Louisville, among other areas.

In order to provide a framework to manage the deployment of ITS technologies throughout Middle Tennessee, it is recommended that the management structure begun during this Strategic Planning Process be continued and strengthened. The components of the Nashville ITS management plan include:

- **ITS Coalition.** It is recommended that the Coalition be continued, that an Executive Committee to be appointed, and that the overall Coalition expanded to add critical organizations and private sector entities such as the communications and information services industry. The current contract between TDOT and Vanderbilt University might be considered as an optional mechanism for managing this process; a contract with a consultant to carry out these Coalition support and facilitation services would be another option to consider.

- **ITS Management Team.** It is recommended that a management team be developed jointly between TDOT and the Nashville Metro Government that provides (as soon as possible) one person as a full-time ITS manager. This person should have a traffic or communications engineering background, and work under the policy guidance of the Coalition Executive Committee. Administratively, in order to provide future management of the Nashville TMC and the Regional RMTIC/TOC, a decision needs to be made as to whether this function would be assumed by TDOT or Metro Government.

- **ITS Deployment Teams.** An "early action team" has already been formed during the course of this study by Metro Public Works Department (MPW). This agency, recognizing the urgent need of providing a solid plan for deploying ITS technologies in an advanced Parking and Traffic Guidance System for Nashville, developed a public-private partnership that secured support and funding for this system in Nashville. Kimley-Horn has developed a feasibility study and conceptual plan for this system. The City of Franklin is developing a similar approach, with a public-private partnership formed to develop an Intermodal Traffic Management Center for the Franklin area and Williamson County.

Finally, a plan for evaluating the effectiveness of ITS technologies deployed in the Nashville Metro Area needs to be developed as an additional, critical component of the continuing ITS Early Deployment process. The evaluation plan should be developed immediately in order to establish a baseline of information and evaluate specific projects and ITS technologies as they are deployed. It is recommended that a consultant or neutral 3rd-party entity such as a university be selected to develop an evaluation plan, including an immediate database for major corridors in the following categories:

- Accident rates
- Fatal accidents
- Emergency service call-outs
- Tow truck service call-outs
- Availability of traveler information
- Conformance / response to messages
- Number of visitors
- Level-of-service at critical, congested locations in the region

The continuing deployment of ITS in the Nashville Metro Area has become a priority for the Tennessee Department of Transportation and the Nashville ITS Coalition. Federal assistance and recognition is currently being sought, as well as participation from public and private sector partners from Nashville and throughout the country.

APPENDICES

APPENDIX A

ATIS PROTOTYPE DESIGN

Appendix A
Toward an ATIS Prototype Design - Upgrading the Vanderbilt University Model

A.1 Introduction

An Advanced Traveler and Tourist Information System (ATIS) is an important component in the architecture of an Intelligent Transportation System (ITS). An ATIS presents media by which visitor-pertinent information is collected, displayed, disseminated, and updated using a variety of technologies, to ensure an efficient and easy access to information by the tourist. Typically, an ATIS is designed to incorporate the same technologies that are used in other components of the ITS. These technologies depend on certain fndamental components like area maps (on paper and in a digital form), databases of attractions, hotels, and restaurants, in addition to querying and routing capabilities.

This appendix presents considerations that affect the type of ATIS, such as the intended user and use, and design issues related to hardware, software, data and data maintenance. Then the database of visitor-related information that was developed as part of the study is described. Finally, the use of that database is described and illustrated through use of a prototype ATIS developed by Vanderbilt.

A.2 Aspects Affecting the Type of ATIS

The most important aspects that decide the type of ATIS are the intended user and the intended type of use. Based on these parameters, the type and form of the ATIS can be decided.

A.2.1 Intended User

There can be several types of intended users. The most common type is the tourist, or a visitor to a university or a hospital. The ATIS should be capable of identifying the sites of interest in the city and convey this information to the tourist. In addition to offering choices to queries for a particular site, the system should be capable of routing the tourist to that site using optimization criteria like least distance, least time, and least number of turns, among others. The system should also be able to provide written directions to the destination, along with a map ofthe chosen area. Most importantly, the ATIS should be able to perform these fimctions with the greatest level of user-friendliness. The access to this information is usually by touch-screens at information centers, or more commonly, through the Internet.

The second type of intended user is typically the Chamber of Commerce, Nashville Convention and Visitors Bureau, or the State Department of Tourism Development in the city. For purposes of promoting tourism in the city, an ATIS would be extremely useful. An ATIS would be helphI in advertising tourist destinations, and would be a key factor in attracting business, investment, and people to the city. Unlike the ATIS intended for the typical visitor, the major characteristics of the ATIS in this category are the availability of latest information and its accuracy. The access to this type of information is usually made by a visitors' help-desk attendant or the advertising department of the pertinent agency.

The third type of use that is envisioned for the ATIS is its connectivity to other components of a region's ITS. The intended users of the ATIS are other components of the ITS itself, and the information provided by the ATIS can be used as an input to other tasks performed by the ITS, like traffic management, automatic in-vehicle information and routing system, travel advisory, and by other components of transportation management. The access to information in the ATIS in this type of setup is usually automatic. An example of another subsystem that would connect to the ATIS is a Parking and Traffic Guidance System.

A.2.2 Intended Type of Use

The intended type of use determines the final format of the ATIS. One of the major type of uses of travel and tourist information is at a Visitor Center as a kiosk. A kiosk is a booth or enclosure fitted with a computer where current traffic information, travel destinations, travel plans, route guidance, and electronic yellow pages may be obtained. This information is taken from a database that contains information about visitor categories. A touch screen provides the interface through which visitors can obtain information.

Another type of use for the travel and tourist information is through the information center attendant. The attendant has access to all the information that a visitor might require, and is able to disseminate information to the visitor personally, or over the phone. Information can be verbal or map/brochure based.

Travel information through radio has been used in many locations. This method has proved effective in small areas like national parks, stadiums, and historic districts. Information is disseminated on the radio through special frequencies for the visitors' advantage. Other uses are for low-power radio transmissions on historical "walking tours," nature preserves, national parks and the like. Since the range of the radio is quite limited, this type of use is usually limited to small areas. However, efforts are underway to increase the range of transmission through modern technologies so that this type of ATIS can be more useful.

A form of ATIS that is gaining popularity lately is one that is Internet-based. This application is usually a site on the World-Wide Web, through which the tourist can access information at home from a personal computer (PC) about places to visit and how to get there. There are already many sites on the "Web" where one can get real time traffic reports, routing information, information on attractions, airline schedules and other types of information.

A.3 Issues in Designing an Ideal ATIS

The major issues that must be addressed in designing an ATIS are the components, the type of data and information, the type of database management, the means of manipulating the data, and the means of keeping the data current.

A.3.1 Important Components an ATIS

The most important components of an ATIS are the hardware and the software. The hardware is significant because it determines the size of the ATIS and its capabilities. For example, a modern Unix workstation has a great deal of memory storage and is capable of processing queries and perform routing with ease. A server that is running an Internet site with an ATIS is typically slower, because it has to handle multiple requests over the network simultaneously. PCS are very common today, being increasingly powerful and having very user-friendly interfaces to the point where the distinctions between workstation and microcomputer are being blurred.

An ATIS intended for direct use by the public typically consists of a PC with a touch screen, commonly referred to as a kiosk. The following information on desirable hardware/equipment characteristics of kiosks is from the Internet site of North Communications, a kiosk manufacturer:

> "A kiosk is distinguished by several minimum characteristics: a powerful CPU ... often networked to a proprietary telecommunications system or the Internet, with full-motion video and audio, usually with MPEG hardware, a receipt printer, and magstripe card reader. Kiosks are appearing . . . with high-resolution laser printers, video teleconferencing, fingerprint and barcode readers, smart cards, and more. . .
>
> "A good kiosk answers many different requirements: durability, attractiveness, ease of service, flexibility, security, ease of use. It is much more than a computer in a box; a good kiosk delivers a single cohesive message of solidity and credibility to the people who use it. The enclosure itself reinforces the multimedia message delivered, and makes itself invisible to people once they start using it; it is vital to the effective delivery of the message, but it gets out of the way.
>
> "A kiosk must be of solid construction, yet light so it can be moved easily; a rigid internal frame onto which tough external panels are fastened is required. When someone touches the screen, writes on the surface, or leans against the kiosk, the unit should not move or vibrate. It should be anchored to the floor, yet have hidden, secure retractable casters so it can easily be lifted off its fixture and rolled to a new location by one person. The kiosks surface must be finished in such a way as to resist scratches, be easily cleaned when marks and scuffs appear, and to resist color bleaching from sun, sea or acidic air.

"A kiosk should feature streamlined shapes and soft edges, both for safety and for attractiveness of design. Its color scheme should be subdued and in the mid-range of colors, so that it doesn't clash with its surroundings, or with the bright imagery on the multimedia screen. The kiosk should have ample external space for signage, both above and on the sides. It should state, through its streamlined design, that it's not an ATM -- this keeps away unwanted traffic.

"Valuable equipment and data, and very often data connections to remote hosts, reside in a kiosk -- so security is a central concern. The kiosk itself should be armored against intrusion with tough material, powerful hinges, and heavy pick-resistant locks. Every opening, including printer paper slots and credit card slots must be sealed in various ways. The next line of defense is an alarm system: if any intrusion is attempted, a loud alarm should sound. Finally, the network software must be continuously monitoring the system for any unauthorized activity, from a central facility, so that the network to that kiosk shuts itself down and a remote alarm is triggered.

"[A good] kiosk enclosure [is] carefully designed with ergonomic standards in mind to allow any person easy access to the touchscreen, and is fully compliant with the public access standards of the 1993 Americans with Disabilities Act. The screen is placed at a height, and set at an angle, which allows handicapped access.

"[Finally, a kiosk should be] designed to control ambient light and reflections on the touchscreen."

Source: http://www.kioskstore.com/human.htm, North Communications, Marina de1 Rey, CA.

Software also plays very important roles in an ATIS. On the one hand, it is the front end that the visitor gets to see and manipulate to obtain the desired information. On the other hand, it is the means by which information or data is stored, manipulated and updated, as described in section A-3.3 below. The most important characteristic of a software interface is its user-friendliness. The visitor should be able to work his or her way through the menus and extract the required information with ease. The procedure to extract information should be short and straightforward. The software should be flexible to accommodate a variety of demands and the processing time should be minimal. Software combined with voice support or video and/or picture animation is usually very effective and may be preferred by the tourist

A.3.2 Type of Data and Information

Data and information are important because they should be relevant, descriptive yet concise, clear, and unambiguous. For this reason, data should be properly formatted so that anyone can understand and interpret them. Access to the data should be simple, and data files should be easily transferable between platforms and software. Addresses should be very accurate, and items like times of visit of attractions, cost of entry, and parking should be current.

A.3.3 Type of Database Management System and Manipulation of Data

The type of database management system is very important, since it decides how the data will be stored for later retrieval. A typical database management system should be "relational." "Relational" means that a single database design will suffice to manipulate the data and that stored information will not have data redundancy. That is, no more than one copy of a specific information string should exist in the database. Data should not have "update anomalies," which means that by updating information about one aspect of the database, all the supporting pieces of information get updated immediately. Data consistency is important to ensure that all pieces of data are identical in format. Also, data security is an important feature of a relational database, where the deletion of a record in the database does not result in the deletion of other records that have links to it.

The data in the database should be able to be manipulated easily. Tables and fields should be easily created, deleted, and linked. Searching and sorting should be capable of being performed by the keyword.

A.3.4 Issues Related to Keeping Data Current

Probably the determining factor in the success of an ATIS is the ability to keep data current. Information that is offered to the tourists should be up to date. Since the information contained in an ATIS comes from different parties and agencies, it becomes necessary for each of them to take up the responsibility of keeping current the information that is specific to their mission. An example, the NCVB should not have to keep the roadway data current; instead, the Tennessee DOT (TDOT) or the Metropolitan Planning Commission should be responsible for that portion of the database. Likewise, TDOT should not be tasked with keeping an updated list of hotel names or attraction hours of business. However, a central agency can take the responsibility of incorporating the changes desired by the contributing agencies to keep the information current.

A.4 Visitor Attractions Database Developed by Vanderbilt University

A.4.1 Introduction

Vanderbilt University developed an attractions database as part of this Nashville Area Intelligent Transportation Systems Early Deployment Study. This database covers the major points of interest, major hotels, information centers, a selection of road signing, and intermodal transportation facilities in the five-county area of Davidson, Williamson, Sumner, Wilson, and Rutherford counties. This information was initially stored in an ORACLE database allowing users to query any of the database items. The database contains latitude and longitude coordinates for all points for use with a Geographic Information System (GIS), which allows a graphical map representation of the elements in the database. A GIS using the database was initially implemented on Inter-graph's MGE (Modular GIS Environment) software, and was later exported for subsequent importing into Caliper's Maptitude software where the database is now stored in Maptitude's format.

A.4.2 Description of the Database

There are five tables in the database including:

- attractions
- information centers
- intermodal facilities
- road signing, and
- congested intersection locations.

Details on each of these categories follows:

1. **Attractions:** Attractions are places that tourists and other visitors commonly visit. The sources of the attractions are the Vacation Guide, the State's vacation guide, the Yellow Pages telephone directory, and existing NCVB and TDOT paper maps. To the extend possible, the attractions have been assigned to the "themes" used in the NCVB's ***Music City Vacation Guide*** (music, fine arts, museums, science and nature, history, rivers and transportation). In addition, all state parks and other major parks in the five-county area have been included. Also, the major hotels with conferencing facilities have been included in the database, as well as universities and hospitals. The information for each attraction includes (as applicable) the name of the attraction, its address, its theme, times of operation, phone number, and geographic position in terms of latitude and longitude.

   Figure A.1 shows a sample from the ATTRACT database table illustrating the "fields" (types of information) for each "record." Each record (or line in the database) represents a single attraction.

2. **Information Centers:** Information centers include the welcome center on Interstate 65, the information kiosk at that welcome center, and other tourist information centers such as the center to be housed in the new Arena. Also, in counties where tourist information is maintained by the Chamber of Commerce, the location of the Chamber is included. The database contains information about the "owner" of the facility, the times of operation, and the location of these centers. Figure A.2 shows a sample from the INFO database table.

3. **Intermodal Facilities:** Intermodal facilities include the Landport, bus terminal and water taxi terminal in downtown Nashville, and the airports in the five counties. Of particular note, of course, is the Nashville International Airport (RNA). The airports include information on connecting ground transportation. Park-and-ride lots have also been included as part of the database. While the existence of these latter facilities is not necessarily important to a current-day Middle Tennessee tourist, they could become important in the future as the region grows (for example, park-and-ride lots were used extensively by visitors to Atlanta for the 1996 Olympics). Park-and-ride lot locations would, however, be of immediate interest to area residents who might use the ATIS. Figure A.3 shows a sample from the INTER database table.

4. **Signing:** Also included in the database are the locations of three types of road signs.

   a. The first sign type indicates the location of the trolley stops in downtown Nashville, with a list of the nearest attractions. This feature could be used to allow a user to query on the nearest attractions to a trolley stop.

   b. The second sign type represents signs on the interstates or selected other highways that point to specific points of interest. The information in the database includes the message on the sign, the location of the sign, and the attraction to which it refers.

   c. The third type of sign is a selection of signs on the interstates that were identified in Technical Memorandum No. 1 for this project as being problematic or confusing to a visitor. Reasons for inclusion were confusing messages, missing messages, or less than ideal placement and maintenance. Technical Memorandum No. 1 pointed out that consideration and rectification of these problems should help to improve the messaging system to the driving visitor.

   The second and third types of signs would not normally be part of a database in an ATIS used by a visitor, but have been included to illustrate a potential use of an ATIS in the management of the area's transportation systems.

   Figure A.4 shows a sampie from the SIGNING database table.

5. **Congested Intersections:** The database contains information about the most congested intersections in Nashville as determined by the MPC and Metropolitan Department of Public Works, and identified in Technical Memorandum No. 1. Information includes the names of the intersecting roads and the latitude and longitude of the intersection. As with the second and third types of road signs, this database table would not be part of the visitor-accessible part of an ATIS. The purpose of its inclusion here is to illustrate one type of data that could be stored that could be of use

to transportation professionals. Figure.A 5 shows a sample from the INTER database table.

A.4.3 Features of the Database

The main features of the database are its indexing capabilities and its flexibility over operating system platforms and software. The user can query on any record of the database using the record's unique identity. The database was developed on a Unix operating system, but it can be imported into any other operating system or software. To demonstrate this transferability, the entire database was imported into a PC on Caliper's Maptitude GIS system for Windows, whose underlying database was dBASE IV. The latitude and longitude fields in the database records helped accurate positioning of the points in the new software. Manipulations and querying on the records could be carried out with the same ease as before. Thus, the database satisfies important requirements of easy sorting and flexibility of an ideal database as described earlier.

A.5 Prototype Visitor Information System

A.5.1 Introduction

The ATIS prototype developed at Vanderbilt is specically a visitor inquiry system. The initial version of the system contained information about places of attraction, historic sites, entertainment areas, hotels and restaurants, but was limited to downtown Nashville and its immediately surroundmg areas. The current version includes the full five-county study area, but does not list restaurants or hotels without conference facilities. Instead, it lists the types of attractions defined in the above section on the database. The system is capable of being searched by user through "queries," and is capable of providing routing information to the traveler from any site in the area to any other site of his or her choice.

A.5.2 Description of the System

The system was implemented initially in the Vanderbilt Intergraph's Intelligent Mapping and CAD Laboratory. It used Intergraph's MGE software and the ORACLE database. The map of Nashville was obtained in a digital form from the Davidson County TIGER files. After the initial clean-up of the map to suit the needs of the system, a "network was built on the map that comprised of all the roads being represented in a link and node fashion. The attractions and points of interest that would be put into the database were identified and located on the network. The initial system area was confined to the Vanderbilt/Downtown area of Nashville to facilitate greater speed in manipulations.

A process called "digitizing" was used to locate all points of interest, and information about these points was updated simultaneously in the ORACLE database. To ensure accurate location and to test a concept, the geographic coordinates of several points were determined by a special instrument called the Global Positioning System (GPS) receiver, which displays in the field the latitude and longitude of the receiver's current location.

The initial system was then moved to the Widows-based PC environment. The database tables on the points of interest, including their latitude and longitude, were exported from MGE and imported into Maptitude. The coverage area was extended to the entire five-county region, with the addition of many additional attractions and other features.

A.5.3 Typical Use of the System

The Vanderbilt prototype ATIS uses commands given by the user through "mouse" control of icons on the screen. For example, to get information on a particular attraction on the map displayed on the screen, the visitor would click on the "Info" icon and then "point" to the attraction using the mouse and click again. No text input is required by the user, although queries can be made by typing in the name of a place of interest. The following is a brief sequence of steps currently needed to use the prototype.

a. The user runs the Maptitude so&ware and loads the needed files, bringing up the map of the five-county (with the database loaded as well). Figure A.6 shows a "zoomed-in" view of the downtown area. The ultimate system that would be installed in an information kiosk, for example, would already have these files loaded. The different GIS software packages that could be used with the database typically offer features such as the control of font and icon style and size, selection of the level of detail of display of features (for example, including or excluding local streets), control of the display of overlapping labels of features, and map manipulation features such as zooming and panning (moving to another part of the map at the same scale as the previous view).

b. The user can select a point on the map and click on it to obtain information about it. Figure A.7 shows information about Municipal Auditorium on a zoomed-in view of the region. Figure A.8 shows information about Long Hunter Park on a zoomed-out view of the region. The prototype currently shows the information a simple listing of the items in the database. The ultimate system would not show certain items that would not be of interest to the visitor, such as latitude and longitude, but that are needed by the system. Also, the format of the display of the information may be customized, and items such as photos, textual descriptions or even audio/video clips could be added.

c. The user can also query on the type of feature. For example, the query can be to find all the attractions in the area. Figure A.8 shows a listing of the attractions table with the map in the background. Again, the display format would be customized in the ultimate version of the system.

d. Once the user looks at the choices offered by the system, he or she can proceed to route Corn the user's position to the chosen destination. Routing can be performed based on minimizing distance, time, or number of turns. In the Maptitude system, the user clicks on the starting and ending points on the map. The optimal route is computed and displayed. As an example, Figure A.9 shows the minimum distance route from the Belle Meade Plantation to Opryland. Multiple-stop trips can also be routed (for example, an intermediate stop and the Nashville Arena's Welcome Center). Finally, the user can request a set of directions to the routed destination. These directions can be brief, detailed, or tabular. Figure A.9 also shows the directions from the Belle Meade Plantation to Opryland. The reader familiar with the area will note that the minimum distance route is not necessarily one that the average driver would take; the ultimate system might restrict the routing to major facilities, perhaps by miniming turns.

The current limitation of the system is the fact that it is not as user friendly as a tourist would prefer or need. For example, a touch screen format is commonly preferred by most tourists. Additionally, while the current interface is Windows-based and mouse-driven, it was not customized to be specific to the application. More effort on developing a specific tourist interface is needed.

A.6 Summary

An Advanced Traveler Information System is an important component of the Intelligent Transportation System architecture. It allows the tourist to get information about and directions to points of interest at the click of a button or at the touch of a screen. Such systems could also provide real-time traflic conditions to the tourist when tied into other components of a regional ITS.

Important components of the Vanderbilt prototype ATIS include the hardware, software and database tables. The ultimate system's hardware might use touch screen technology in a kiosk configuration for direct use by visitors and a mouse-based system for the system maintainer.

Data management is very important to ensure high quality, accurate and up-to-date information for the visitor. There must be an established means and well-defined set of roles and responsibilities for maintenance of the hardware, the mapping and the database. Vanderbilt's prototype of a tourist information system and the attractions database are among the first steps in developing ATIS technologies in Middle Tennessee.

ho-c:\data\vu\nash-its\its-app.fin

IDENTITY NO	NAME	THEME	ADDRESS NO	STREET	CITY	COUNTY
10005	Belle Carol Riverboat Compan		106	First Avenue North	Nashville	19
10006	Tennessee State Capito	History		Charlotte Avenue	Nashville	19
10007	Cheekwood, Botanical Gardens	Fine Arts	1200	Forest Park Drive	Nashville	19
10008	Cumberland Science Museum	Science & Nature	800	Ridley Blvd	Nashville	19
10009	The Governer's Residence	History	882	Curtiswood Lane, South	Nashville	19
10010	The General Jackson Showboa	Riverboats & Trains . .	2802	Opryland Drive .	Nashville	19
10011	Belmont Mansion	History	1900	Belmont Blvd	Nashville	19
10012	Music Valley Wax Museum	Music	2515	McGavock Pike	Nashville	19
10013	Music Valley Car Museum	Museum	2611	McGavock Pike	Nashville	19
10014	Barbara Mandrell County	Music	1510	Division Street	Nashville	19
10016	Fort Borough	History	170	First Avenue North	Nashville	19
10017	Hatch Stow Print	Museum	316	Broadway	Nashville	19
10020	Broadway Dinner Train	Riverboats & Trains		Riverfront Park	Nashville	19
10021	Nashville Toy Museum	Museum	2613	McGavock Pike	Nashville	19
10022	Shotgun Red's Collection	Music	2611A	McGavock Pike	Nashville	19
10023	The Grand Ole Opry Museum	Music	2802	Opryland Drive	Nashville	19
10024	Opryland Hotel Conservatory	Science & Nature	2800	Opryland Drive	Nashville	19
10025	Nashville on Stage	Music	2806	Opryland Drive	Nashville	19
10026	TNN: Nashville Network	Music	2806	Opryland Drive	Nashville	19
10027	Chaffin's Barn Dinner Theater	Music	8204	Highway 100	Nashville	19
10028	Traveler's Rest Historic House	Histroy	636	Farrell Way	Nashville	19
10030	The Hermitage	History	4580	Rachel's Lane	Nashville	19
10031	ClubHouse Inn & Conf. Center	Hotel	920	Broadway	Nashville	19
10032	Union Station Hote	Hotel	1001	Broadway	Nashville	19
10033	Doubletree Hotel-Nashville	Hotel	315	4th Avenue North	Nashville	19
10034	The Hermitage Hote	Hotel	231	6th Avenue North	Nashville	19
10035	Days Inn - Vandelbilt	Hotel	1800	West End Avenue	Nashville	19
10036	Hampton Inn - Vanderbil	Hotel	1919	West End Avenue	Nashville	19
10037	Loews Vanderbilt Plaza	Hotel	2100	West End Avenue	Nashville	19
10038	Holiday Inn - Vanderbil	Hotel	2613	West End Avenue	Nashville	19
10039	Sheraton Music City Hote	Hotel	777	McGavock Pike	Nashville	19
10043	Days Inn Downtown Convention	Hotel	711	Union Street	Nashville	19
10044	Holiday Inn - Crowne Plaza	Hotel	623	Union Street	Nashville	19
10045	Quality Inn - Hall of Fame	Hotel	1407	Division Street	Nashville	19

Figure A.1 Fields and Sample attraction records in ATTRACT database table (page 1 of 2)

TIME-OPER	PHONE	EXIT-NO	ROAD-NEAR	LONGITUDE	LATITUDE
----------------	----------------	.			-----|----
Daytime, Dinner	615-244-3430			-86.774184	36.1624364
M-F 9-4	615-741-2692			-86.784291	36.165927
Sep-May, Jun	615-356-8000			-86.873242	36.0864723
Su, M 9:30-5	615-862-5160			-86.775375	36.1469964
Jan-May Tu-Th	615-383-5401			-86.776211	36.0917253
Day, Night	615-889-6611			-86.701618	36.2146846
M-Sa 10-4	615-269-9537			-86.793569	36.1331456
Sep-May, Jun	615-883-3612			-86.69919	36.217553
Sep-May, Jun	615-885-7400			-86.698814	36.2175447
Sep-May 9-5	615-242-7800			-86.791193	36.1519898
9-5, Daily				-86.775248	36.1638281
M-Sa 10-5, Su	615-256-2805			-86.77674	36.1614358
6:30pm	615-254-8000			-86.774043	36.1620393
Sep-May, Jun-Au	615-883-8870			-86.694645	36.2171082
Sep_May, Jun	615-885-7400			-86.694921	36.2171206
Apr-Oct 9-6	615-889-6611			-86.695789	36.2157162
	615-889-1000			-86.694757	36.2161
Varies	615-889-6611			-86.695654	36.2160249
M-F	615-883-7000			-86.695648	36.2160249
Tu-Sa 6pm	615-646-9977			-86.907728	36.0619862
Sep-May, Jun	615-832-2962			-86.766748	36.0742212
9-5, Daily				-86.613337	36.2136161
	615-244-0150			-86.783225	36.1586639
	615-726-1000			-86.784209	36.1578465
	615-244-8200			-86.779444	36.1639211
	615-244-3121			-86.782453	36.1636054
	615-327-0922			-86.795859	36.1529462
	615-329-1144			-86.795945	36.1514106
	615-320-1700			-86.802232	36.1501932
	615-327-4707			-86.810479	36.1458106
	615-885-2200			-86.702656	36.2175492
	615-242-4311			-86.783848	36.1634761
	615-259-2000			-86.782962	36.1634656
	615-242-1631			-86.789366	36.1516963

Figure A, 1. Fields and sample attraction records in ATTRACT database table (page 2 of 2).

IDENTITY NO	FACILITY TYPE	OWNER	ADDRESS-NO	STREET	CITY
30008	Chamber of Commerce	Franklin, Williamson County		City Hall Complex, Ste. 107	Franklin
30009	Airport Welcome Center	Nashville International Airport			Nashville
30016	Welcome Center	TN Dept. of Tourist Development		I-65 South Bound	Mitchellville
30017	Chamber of Commerce	Nashville Tourism Council	1281	Mt. Juliet Road	Mt.Juliet
30026	Chamber of Commerce, Wilson CO	Lebanon, Wilson County	149	Public Square	Lebanon
30027	Information Center	TN Dept. of Tourist Development		I-65	Nashville
30028	Chamber of Commerce	Nashville, Davison County	161	4th Avenue North	Nashville
30029	Chamber of Commerce	Gallatin	118	W. Main Street	Gallatin
30030	Chamber of Commerce	Goodlettsville	100	Main Street	Goodlettsville
30031	Chamber of Commerce	Murfreesboro, Rutherford County		S. Front Street	Murfreesboro
30032	Information Center				Portland
30033	Information Kiosk	Touch and Go, Inc.		I-65 South Bound	Mitcheville
30034	Information Center	Opryland Hotel	2800	Opryland Drive	Nashville

Figure A.2. Fields and information center records in INFO database table (page 1of 2).

COUNTY	PHONE1	COMMENTS	SOURCE	MSLINK
94	615-794-1225		Tennessee Group Travel Direct.	8
19	615-225-4256		Tennessee Airport Direct.	9
83			Tennessee Vacation Guide, 1995	16
95	615-758-3478		Tennessee Group Travel Direct.	17
95	615-444-5503		Tennessee Group Travel Direct.	26
19			Tennessee Vacation Guide, 1995	27
19	615-259-4700		Tennessee Group Travel Direct.	28
83	615-452-4000		Tennessee Group Travel Direct.	29
19	615-452-4000		Tennessee Group Travel Direct.	30
75	615-893-6565		Tennessee Group Travel Direct.	31
83	615-325-9337			32
85			Tennessee Vacation Guide, 1995	34
19	615-889-1000		Tennesse Vacation Guide 1995	34

Figure A.2. Fields and information center records in INFO database table (page 2 of 2).

IDENTITY_NO	FACILITY	ROAD1	ROAD2	NAME	CITY
-----------	--------------------	------------------------------	------------------------------	------------------------------	------------------------------
40001	Park and Ride	I-24	Thompson Lane		Nashville
40002	Park and Ride	I-24	Harding Place		Nashville
40003	Park and Ride	I-65 S	Harding Place		Nashville
40004	Park and Ride	I-65 S	Old Hickory Blvd		Nashville
40005	Park and Ride	I-40 W	Old Hickory Blvd		Nashville
40008	Park and Ride	I-65 N	Old Hickory Blvd		Nashville
40009	Park and Ride	I-40 E	Donelson Pike		Nashville
40010	Park and Ride	I-40 W	Old Hickory Blvd		Nashville
40011	Park and Ride	I-65 N	Long Hollow Pike, Rivergate		Nashville
40012	Park and Ride	I-40 W	70S		Nashville
40013	Airport			Nashville International Airport	Nashville
40014	Airport			John C. Tune Airport	Nashville
40015	Airport			Cornelia Fort Airpark Airport	Nashville
40016	Airport			Rutherford County Airport	Smyrna
40017	Airport			Murfreesboro Airport	Murfreesboro
40018	Airport			Sumner County Airport	Gallatin
40019	Airport			Portland Municipal Airport	Portland
40020	Intermodal Terminal		Demonbreun Street	Landport	Nashville
40021	Bus Terminal		200 8th Avenue South	Greyhound Lines	Nashville
40023	Waterway Terminal		2802 Opryland Drive	Opryland USA - River Taxi	Nashville

Figure A.3. Fields and intermodal facility records in INTER database table (page 1 of 3).

COUNTY	PHONE	LONGITUDE	LATITUDE	COMMENTS
19		-86.719111	36.1084775	
19		-86.699773	36.087489	
19		-86.762299	36.0826651	
19		-86.788556	36.034471	
19		-86.666912	36.1401427	
19		-86.742674	36.2406015	
19		-86.885408	36.1409417	
19		-86.602034	36.1709353	
19		-86.701832	36.3231191	
19		-86.952883	36.0813548	
19		-86.669406	36.1254104	Transportation: Limousine, Taxi, Bus, Rental & Courtesy Car
19		-86.883524	36.177139	Transportation: Taxi Rental & Courtesy Car
19		-86.70411	36.1892107	Transportation: Taxi, City Bus
75		-86.509966	36.0073463	Transportation: Rental & Courtesy Car
75		-86.380586	35.8778855	Transportation: Taxi, Rental Car
83		-86.410643	36.3777972	Transportation: Taxi, Rental Car
83		-86.478705	36.5919082	Transportation: None
19		-86.784225	36.1555576	
19		-86.780322	36.1559967	
19		-86.691749	36.207722	

Figure A.3. Fields and intermodal facility records in INTER database table (page 2 of 3).

SOURCE	DATE-MOD	
Regional Transportation Authority		
Regional Transportation Authority		
Regional Transportation Authority		
Regional Transportation Authority		
Regional Transportation Authority		
Regional Transportation Authority		
Regional Transportation Authority		
Regional Transportation Authority		
Regional Transportation Authority		
Reaional Transportation Authoritv		
Tennessee Airport Directory		
Tennessee Airport Directory		
Tennessee Airport Directory		
Tennessee Airport Directory		
Tennessee Airport Directory		
Tennessee Airport Directory		
Tennessee Airport Directory		
The Tennesean, Aug 24, 1995		
Music city Vacation Guide, 1995		
Music city Vacation Guide, 1995		

Figure A.3. Fields and intermodal facility records in INTER database table (page 3 of 3).

IDENTITY~NO	SIGN~LOCN	HIGHWAY	DIRECT	SIGN-PROB	PROBL
40001	N. of Murray Lane	US-431	NB	N	
40002	S. of Old Hickory Blvd	US-431 .	NB	N	
40003	N. of Harding Place	US-431	SB	N	
40004	N. of Woodmont Blvd	US-431	SB	N	
40005	S. of Magnoia Blvd	US-431	NB	N	
40006	North of Blakemore	US-431	SB	N	
40007	North of Garland	US-431	SB	N	
40008	South of Edgehill	US-431	NB	N	
40010	S. of Meadowgreen DN	US-431	SB	N	
40011	S. of Meadowgreen Dr	US-431	SB	N	
40012	Columbia Road	US-431	SB	N	
40013	Bridge Street	US-431	EB	N	
40014	Harding Place	US-431	NB	N	
40015	Farrell Parkway	I-65 Northbound	NB	N	
40016	Milepost 76.5	I-65 Northbound	NB	N	
40018	Milepost 74.5	I-65 Northbound	NB	N	
400191	N of 440 Interchange	I-65 Northbound	NB	N	
40020	Milepost 81.2	I-65 Northbound	NB	N	
40021	Milepost 85	I-65 Northbound	NB	N	
40023	Milepost 85.8	I-65 Northbound		N	
40025	Milepost 78.8	I-65 Northbound	SB	N	
40028	Milepost 35.2	I-65 Northbound	SB	N	
40030	SR 96	I-65 Northbound	WB	N	
40034	21st Ave. & West End	Broaway/West End	EB	N	
40035	22nd Ave.& 23rd Ave	Broaway/West End	EB	N	
40036	Centennial Park	Broaway/West End	WB	N	
40037	31st Avenue South	Broaway/West End		N	
40038	31 st Avenue South	Broaway/West End	EB	N	
40039	31st Avenue South	Broaway/West End	WB	N	
40040	Leake Street	Broaway/West End	WB	N	
40041	Percy Warner Blvd	Broaway/West End	EB	N	
40042	I-40	I-40	EB	No indication to Airport/Downtown	
40043	Exit 215A-B	I-40 West	EB	N	
40044		I-40 West	EB	N	

Figure A.4. Fields and sample road sign records in SIGNING database table (page 1 of 3).

MESG	SIGN TYPE	ATTRACTION	LONGITUDE
--	----------	--	----------
Entering Davidson County, Home of Grand Ole Opry			-86.86486
Cheekwood (left arrow)			-86.86287
Cheekwood (right arrow)			-86.828594
David Lipscomb University (left arrow)			-86.811097
Belmont University, Belmont Mansion (right arrow)			-86.801227
Vanderbilt University Medical Center			-86.800883
Vanderbilt University Medical Center			-86.800187
Cumberland Science Museum (right arrow)			-86.799821
Welcome to Franklin			-86.885799
Columbia State Community College(straight arrow)			-86.882459
Columbia State Community College (left arrow)			-86.880642
Historic Tour, Franklin (right arrow)			-86.872731
David Lipsc. Univ, Traveler's Rest (left arrow)			-86.763484
Historic Home, Traveler's Rest , Next Right			-86.768425
Exit 78, David Lipscomb University			-86.764842
Davidson County, Home of the Grand Ole Opry			-86.782836
Nashville Zoo			-86.773111
General Jackson Showboat			-86.775806
Exit 85, Tourist Information Center			-86.768433
Exit 85, Performing Arts Center and State Museum			-86.775091
Exit 78B, Historic Home, Travelers Rest			-86.76355
Historic Sites, Battle of Franklin			-86.820919
Downtown Franklin, 2.5 miles			-86.818724
Vanderbilt University Information Sign			-86.805868
Vanderbilt University			-86.808163
Centennial Park			-86.811097
Belmont University, Belmont Mansion (left arrow)			-86.815445
Belmont University (right arrow)			-86.815577
Belmont University (right arrow)			-86.815636
Belle Meade Mansion (right arrow)			-86.871373
Belle Meade Mansion (right arrow)			-86.894261
Exit 215A-B, Route 155, Briley Parkway, Opryland			-86.712849
Exit 215B, 155 North, Briley Pkwy, Opryland			-86.696181
Exit 216A, International Airport 3/4 mile			-86.680856

Figure A.4. Fields and sample road sign records in SIGNING database table (page 2 of 3).

LATITUDE	COMMENTS	SOURCE	IMSLINK	MAPID
			----------	----------
36.0446532		Nashville Tourist Info System	1	100005
36.0470944		Nashville Tourist Info System	2	100005
36.0916023		Nashville Tourist Info System	3	100005
36.114237		Nashville Tourist Info System	4	100005
36.1329444		Nashville Tourist Info System	5	100005
36.1376597		Nashville Tourist Info System	6	100005
36.1429281		**Nashville Tourist Info System**	7	100005
36.1437917		Nashville Tourist Info System	8	100005
35.9736224		Nashville Tourist Info System	10	100005
35.9514011		Nashville Tourist Info System	11	100005
35.9448145		Nashville Tourist Info System	12	100005
35.9254591		Nashville Tourist Info System	13	100005
36.0823602		Nashville Tourist Info System	14	100005
36.0740947		Nashville Tourist Info System	15	100005
36.0789129		Nashville Tourist Info System	16	100005
36.0391765		Nashville Tourist Info System	18	100005
36.1167573		Nashville Tourist Info System	19	100005
36.1381874		Nashville Tourist Info System	20	100005
36.1721777		Nashville Tourist Info System	21	100005
36.1882063		Nashville Tourist Info System	23	100005
36.0977023		Nashville Tourist Info System	25	100005
35.928641		**Nashville Tourist Info System**	28	100005
35.9475647		Nashville Tourist Info System	30	100005
36.1567421		Nashville Tourist Info System	34	100005
36.1563687		Nashville Tourist Info System	35	100005
36.1476586		Nashville Tourist Info System	36	100005
36.1425007		Nashville Tourist Info System	37	100005
36.1424041		Nashville Tourist Info System	38	100005
36.1424396		Nashville Tourist Info System	39	100005
36.1001349		Nashville Tourist Info System	40	100005
36.0842031		Nashville Tourist Info System	41	100005
36.141669		Nashville Tourist Info System	42	100005
36.1446201		Nashville Tourist Info System	43	100005
36.1420719		Nashville Tourist Info System	44	100005

Figure A.4. Fields and sample road sign records in SIGNING database table (page 3 of 3).

CONGEST

IDENTITY-NO	ROAD1	ROAD2	LONGITUDE	LATITUDE
20002	Gallatin Pike	Old Hickory Blvd.	-86.711823	36.2631124
20003	I-40	Broadway	-86.7893	36.1558028
20004	Clarksville Pike	West Hamilton	-86.839738	36.2074784
20008	Gallatin Pike	Due West Avenue	-86.720087	36.248429
20009	Nolensville Pike	Thompson Lane	-86.745139	36.1110133
20010	Nolensville Pike	Harding Place	-86.726317	36.079501
20011	Harding Place	I-24	-86.700072	36.0859757
20012	Harding Place	Sidco	-86.761634	36.0820032
20013	Hillsboro Road	Woodmont Blvd.	-86.810922	36.1140495
20014	West End Ave	Murphy Road	-86.819085	36.1393247
20015	West End Ave	440 Parkway	-86.821695	36.1369707
20016	Dickerson Pike	Trinity Lane	-86.768656	36.2058344
20017	Charlotte Pike	White Bridge Road	-86.857901	36.1501814
20018	Murfreesboro Pike	Fesslers Lane, Elm Hill Pike	-86.743913	36.1426798
20020	Bell Road	Murfreesboro	-86.638567	36 0745585
20021	Lebanon Pike	Donelson Pike	-86.663098	36.167276
20022	Gallatin Pike	Two Mile Parkway	-86.699334	36.2968333

Figure A.5. Fields and congestion intersection records in CONGEST database table (page 1 of 2).

CO LST

COMMENTS	SOURCE	MSLINK	MAPID
	Congested Intersection Study, 1995	2	100005
	Congested Intersection Study, 1995	3	100005
	Congested Intersection Study, 1995	4	100005
	Conjested Intersection Study, 1995	8	100005
	Congested Intersection Study, 1995	9	100005
	Congested Intersection Study, 1995	10	100005
	Congested Intersection Study, 1995	11	100005
	Congested Intersection Study, 1995	12	100005
	Congested Intersection Study, 1995	13	100005
	Congested Intersection Study, 1995	14	100005
	Congested Intersection Study, 1995	15	100005
	Congested Intersection Study, 1995	16	100005
	Congested Intersection Study, 1995	17	100005
	Congested Intersection Study, 1995	18	100005
	Congested Intersection Study, 1995	20	100005
	Connested Intersection Study, 1995	21	100005
	Congested Intersection Study, 1995	22	100005

Figure A5. Fields and congestion intersection records in CONGEST database table (page 2 of 2).

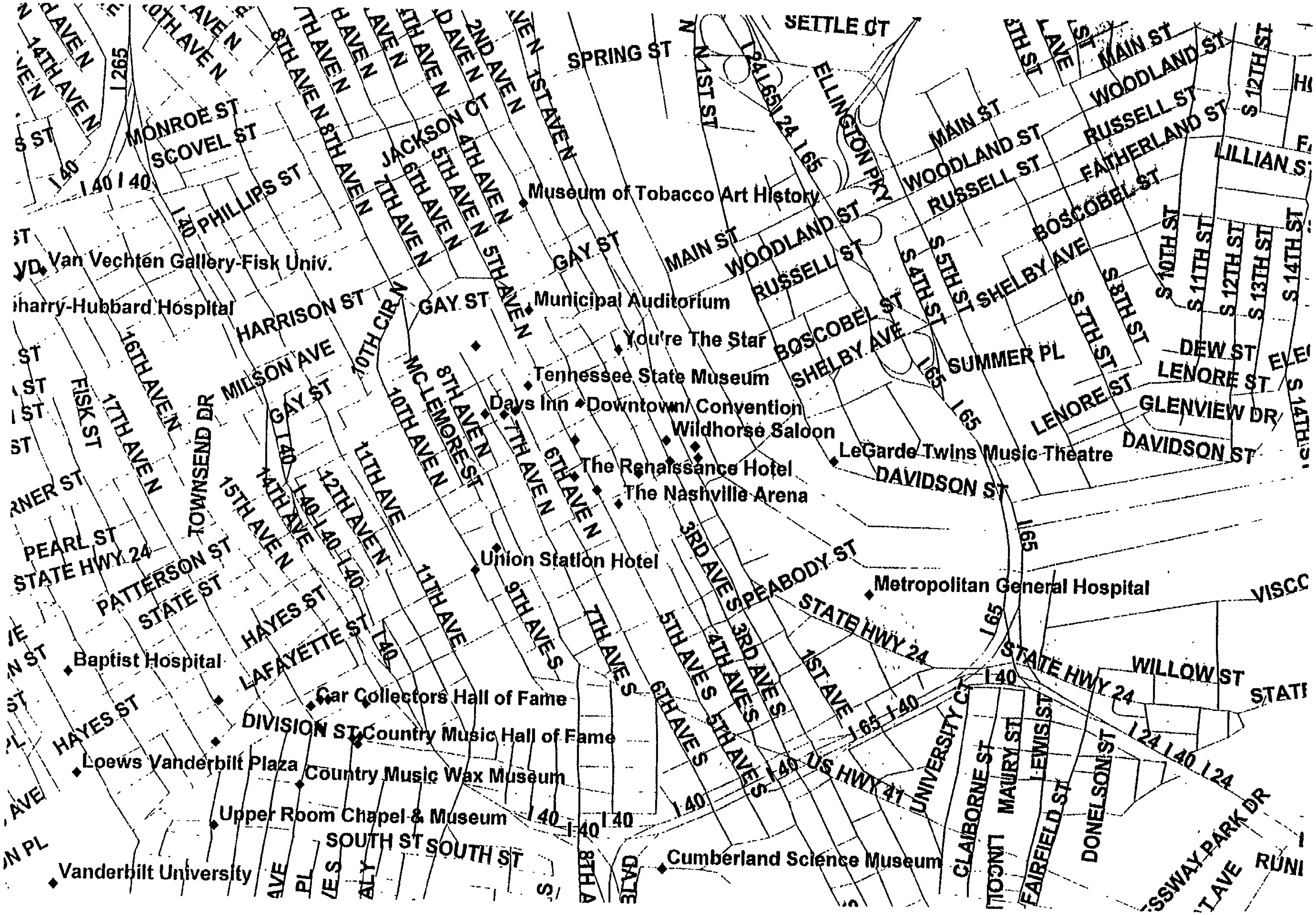


Figure A.6 Sample screen zoomed in on downtown Nashville showing selected attractions.

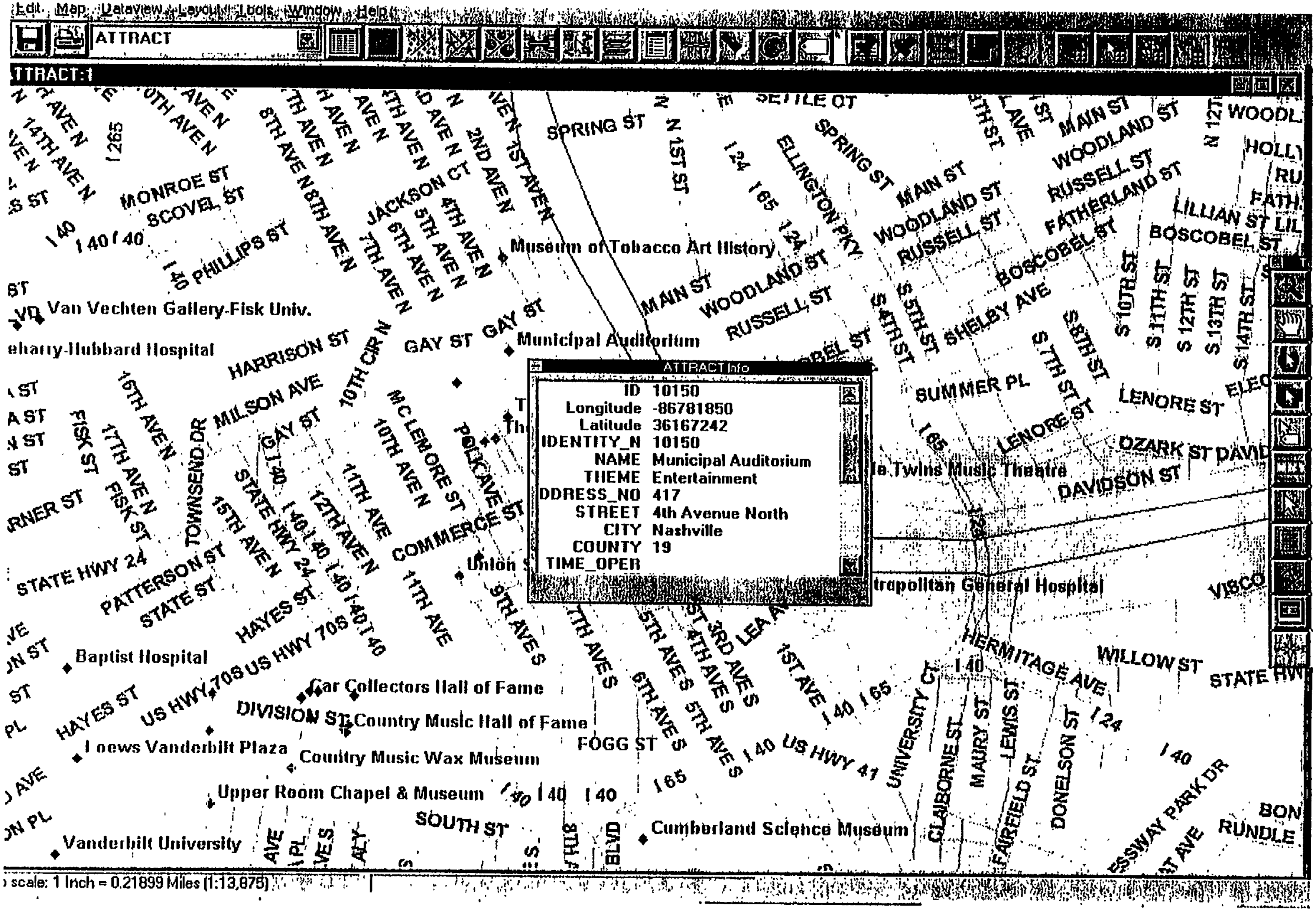


Figure A.7. Sample screen zoomed in on downtown Nashville showing information on Municipal Auditorium

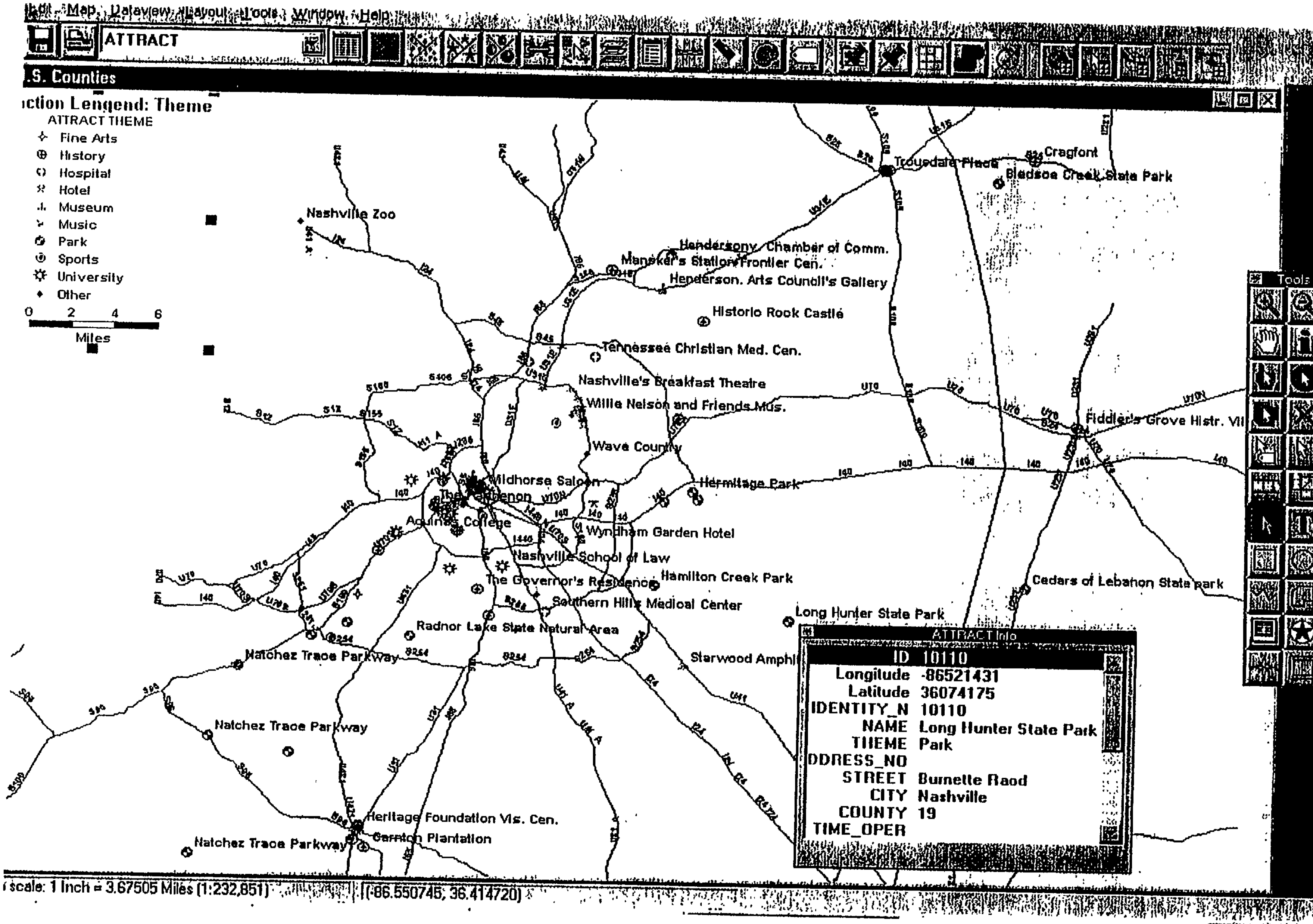


Figure A.8. Sample screen of full region showing information on Long Hunter State Park.

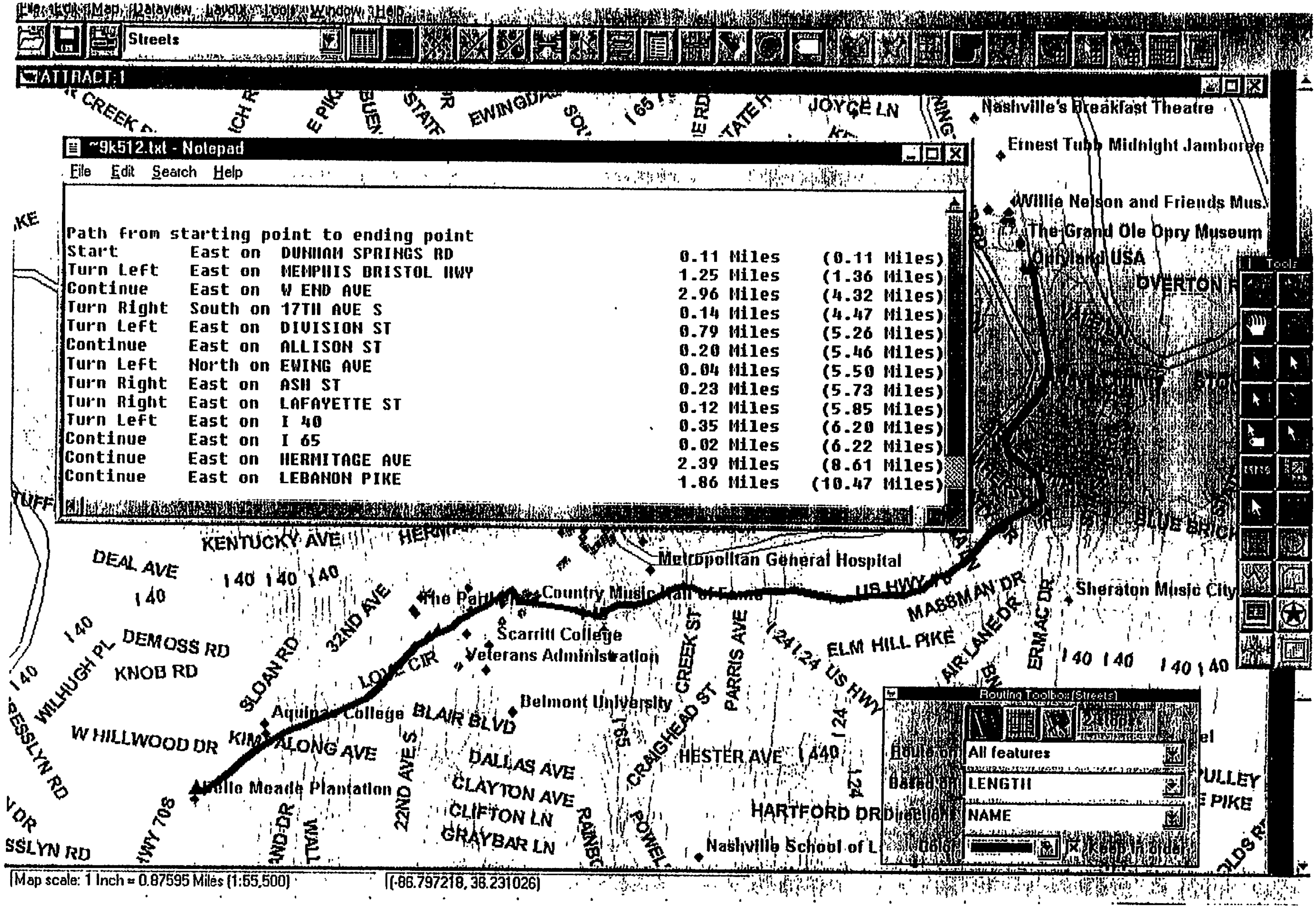


Figure A.10. Sample screen of metropolitan Nashville showing route and directions from Belle Meade Plantation to Opryland.

APPENDIX B

RELATIONSHIP OF POTENTIAL ITS PROJECTS TO TRANSPORTATION AND INFORMATION NEEDS, ITS USER SERVICES, AND USER SERVICES OBJECTIVES

USER SERVICE CATEGORY		USER SERVICE
Travel & Transportation Management		**En-Route Driver Information**
1.	**NEED:**	Better detour signs
	PROBLEM:	Motorists are unable to effteiently reach destination once detoured due to inconsistent signing of detour routes
	SYSTEM OBJECTIVE:	To efftciently move traffic on detour routes
	USER SERVICE OBJECTIVE:	*To* use in-vehicle and roadway signing to give users verification **of** detour routes
	CANDIDATE PROJECTS:	VMS TAR Traffic status map
2.	**NEED:**	Special event parking information
	PROBLEM:	Drivers are not given information on parking location/availability, causing congestion problems near high-density parking areas
	SYSTEM OBJECTIVE:	To reduce congestion at high-density parking areas
	USER SERVICE OBJECTIVE:	To inform users of parking availability and location
	CANDIDATE PROJECTS:	Downtown signal system Parking and route guidance system VMS
3. *	**NEED:**	Alternative routing during incidents Accurate, timely traffic reports/travel advisories to the public Real-time in-vehicle displays of traffic information
	PROBLEM:	Congestion due to incidents Congestion due to recurrent traffic volumes
	SYSTEM OBJECTIVE:	To reduce user travel time To divert traffic to alternate route safely and efftciently
	USER SERVICE OBJECTIVE:	To provide accurate, real-time en-route driver information To coordinate surveillance and incident detection
	CANDIDATE PROJECTS:	VMS TAR RBDS
*	**NOTE:** PROJECTS IDENTIFIED BY ASTERISKS ARE INCLUDED IN DRAFT INCIDENT MANAGEMENT PLAN	

USER SERVICE CATEGORY	USER SERVICE
Travel & Transportation Management	**Route Guidance**
NEED:	Coordination of travel information system with all modes
PROBLEM:	Information not readily available to the average traveler
SYSTEM OBJECTIVE:	To improve operation of an intermodal transportation system
USER SERVICE OBJECTIVE:	To reduce time lost in intermodal interchange
CANDIDATE PROJECTS:	Franklin Intemodal Management Center (FIMC) Enhanced Web Page Visitor kiosks
NEED:	Improved efficiency of existing bus routes and system
PROBLEM:	On-time arrival of transit vehicles affected by recurrent or nonrecurrent congestion
SYSTEM OBJECTIVE:	To improve travel times for transit vehicles
USER SERVICE OBJECTIVE:	To provide transit with en-route information on existing traffic conditions so express routes can divert from congested areas
CANDIDATE PROJECTS:	AVL- transit Bus stop security system

6.	**NEED:**	Route information Better identification of highways
	PROBLEM:	Simple instructions are not available to provide motorists unfamiliar with Nashville travel instructions to their destinations
	SYSTEM OBJECTIVE:	To aid motorists who are unfamiliar with the area
	USER SERVICE OBJECTIVE:	To improve static signs and provide real-time instructions to motorists
	CANDIDATE PROJECTS:	VMS TAR Parking and route guidance system GIS database enhancement
7.	**NEED:**	Special event information
	PROBLEM:	Congestion is compounded by uninformed motorists
	SYSTEM OBJECTIVE:	To relieve congestion created by special event traffic
	USER SERVICE OBJECTIVE:	To detect current conditions and inform motorists on major corridors of traffic conditions and give guidance to event venues and parking
	CANDIDATE PROJECTS:	Special event control Parking and route guidance system Visitor kiosk enhancements CCTV RBDS

	USER SERVICE CATEGORY	USER SERVICE
	Travel Demand Management	**Pre-Trip Travel Information Services**
8.	**NEED:**	Parking information
	PROBLEM:	Drivers are not given advanced information on parking location, availability, and cost
	SYSTEM OBJECTIVE:	To reduce congestion at high-density parking areas
	USER SERVICE OBJECTIVE:	To inform users of parking availability and location so decisions can be made in advance about parking alternatives
	CANDIDATE PROJECTS:	Music City Vacation Guide - hand-held guide Enhanced Web page Parking and route guidance system
9.	**NEED:**	Reduced congestion at Nashville International Airport
	PROBLEM:	Congestion during peak periods causes excessive delays
	SYSTEM OBJECTIVE:	To reduce delay
	USER SERVICE OBJECTIVE:	To supply users information on current traffic and parking conditions at airport in order to determine departure time or alternative transportation modes to and from airport
	CANDIDATE PROJECTS:	Visitor information kiosks VMS
10.	**NEED:**	Accurate, timely traffic reports to public Incident notification to motorists More information on street operating conditions
	PROBLEM:	Congestion due to incidents Congestion due to recurrent traffic congestion
	SYSTEM OBJECTIVE:	To reduce user travel time, improve safety, reduce emissions
	USER SERVICE OBJECTIVE:	To give users information before they leave so they can make decisions about alternate routes or modes of transportation To coordinate surveillance and incident detection (aerial, electronic, CCTV, etc.)
	CANDIDATE PROJECTS:	Traveler Advisory Radio (TAR) Radio Broadcast Data System (RBDS)

	USER SERVICE CATEGORY	USER SERVICE
	Travel Demand Management	**Pre-trip Travel Information Services**
11.	**PROBLEM:**	Destination information
	SYSTEM OBJECTIVE:	Travel services, tourist attractions, and traffic information not conveniently available
	USER SERVICE OBJECTIVE:	To improve traveler access to information on services, and tourists attractions, and traffic conditions To provide quick and detailed interactive access to travel-related services and facilities using kiosks, radio, cable and network TV, and electronic bulletin boards
	CANDIDATE PROJECTS:	Visitor information kiosks GIS database standardization and completion VMS RBDS Enhanced Web Page

USER SERVICE CATEGORY		USER SERVICE
Travel Demand Management		**Pre-trip Traveler Information** **Traveler Information Services**
12.	**NEED:**	A dynamic real-time traffic status map for the region
	PROBLEM:	Under congested conditions, travel routing and diversion information is not available
	SYSTEM OBJECTIVE:	To disseminate real-time traffic information to improve operating conditions
	USER SERVICE OBJECTIVE:	To provide a regional travel information system of current traffic conditions to be made available to tourists and other motorists, agencies, and the media
	CANDIDATE PROJECTS:	Traffic status map Freeway surveillance Traffic Operations Center (TOC) Enhanced Web page Visitor kiosks

USER SERVICE CATEGORY		USER SERVICE
Travel & Transportation Management		**En-route Driver Information** **Route Guidance** **Traveler Information Services** **Traffic Control**
13.	**NEED:**	Improved regional mobility
	PROBLEM:	Decision making on street and highway operations and traffic control systems management
	SYSTEM OBJECTIVE:	To facilitate traveler movement
	USER SERVICE OBJECTIVE:	To improve region-wide traffic flow and reduce unnecessary travel due to lack of information
	CANDIDATE PROJECTS:	VMS FIMC TAR RBDS GIS database completion CCTV Regional TOC

USER SERVICE CATEGORY		USER SERVICE
Travel & Transportation Management		**Traffic Control**
14.	**NEED:**	Improved traffic control at special events
	PROBLEM:	Congestion due to heavy traffic at special events
	SYSTEM OBJECTIVE:	To reduce congestion at special events .
	USER SERVICE OBJECTIVE:	To minimize the delay associated with special event traffic volumes for both event and non-event drivers
	CANDIDATE PROJECTS:	Special event control system Parking and route guidance system Regional TOC
15.	**NEED:**	Computerized traffic control Regional signal coordination Emergency vehicle preemption
	PROBLEM:	Lack of coordination between adjacent signals
	SYSTEM OBJECTIVE:	To improve coordination of signals within and among jurisdictions
	USER SERVICE OBJECTTVE:	To improve and manage traffic flow and signal operations within and among jurisdictions
	CANDIDATE PROJECTS:	Downtown signal system upgrade TOC integration Emergency vehicle preemption

USER SERVICE CATEGORY		USER SERVICE
Travel & Transportation Management		**Traffic Control**
16.	**NEED:**	Reduced manual traffic control
	PROBLEM:	Manual traffic control can be inefficient and unsafe to direct traffic at special events
	SYSTEM OBJECTIVE:	To improve safety and efficiency
	USER SERVICE OBJECTIVE:	To provide automated traffic control measures at intersections which accommodate the special event traffic
	CANDIDATE PROJECTS:	Downtown signal system upgrade TOC integration
17.	**NEED:**	More consideration for pedestrians at signals
	PROBLEM:	Lack of respect for pedestrian control
	SYSTEM OBJECTIVE:	To reduce delays to pedestrians
	USER SERVICE OBJECTIVE:	To make traffic signals more adaptive to pedestrian demand
	CANDIDATE PROJECTS:	Downtown signal system upgrade
18.	**NEED:**	Improved bandwidth of communication infrastructure
	PROBLEM:	Limited ITS-grade data transfer capacity
	SYSTEM OBJECTIVE:	To incorporate ITS devices on a wide scale (throughout the system)
	USER SERVICE OBJECTIVE:	To improve Emergency Management System/roadway services requirement, thereby improving availability of roadway conditions/travel information services
	CANDIDATE PROJECTS:	TAR RBDS Common RF for Emergency Management

USER SERVICE CATEGORY		USER SERVICE
Travel & Transportation Management		**Traffic Control**
19.	**NEED:**	Regional Freeway and Arterial Traffic Control Center
	PROBLEM:	Freeway and major arterial congestion due to recurrent traffic and incidents
	SYSTEM OBJECTIVE:	To reduce freeway and arterial congestion
	USER SERVICE OBJECTIVE:	To reduce time-delay associated with congestion, thereby reducing cost to travelers
	CANDIDATE PROJECTS:	Regional TOC development and integration FMIC, Murfreesboro TOC development and integration
20.	**NEED:**	Arterial network coordination
	PROBLEM:	Some agencies lack coordinated signals and/or signal systems
	SYSTEM OBJECTIVE:	To coordinate signals in order to improve traffic flow
	USER SERVICE OBJECTIVE:	To provide advanced traffic management systems
	CANDIDATE PROJECTS:	Alternative route surveillance Regional traffic status map Expanded signal system integration (closed loop systems)
21.	**NEED:**	Regional signal system database
	PROBLEM:	Inadequate interagency exchange of information perpetuates system incompatibilities
	SYSTEM OBJECTIVE:	To improve regional signal system coordination, strengthen interagency partnerships and planning efforts
	USER SERVICE OBJECTIVE	To provide a centralized, accessible, regional signal system database to facilitate improved regional traffic operation and planning
	CANDIDATE PROJECTS:	Regional signal system upgrade and coordination

USER SERVICE CATEGORY		USER SERVICE
Travel & Transportation Management		**Traffic Control**
22.	**NEED:**	Alternative communication technologies for deployment of ITS
	PROBLEM:	Traditional communication technology for traffic control systems is ineffective and expensive
	SYSTEM OBJECTIVE:	To research and deploy alternative communication technologies
	USER SERVICE OBJECTIVE:	To establish field demonstrations of wireless communication technologies for advanced traffic management systems
	CANDIDATE PROJECTS:	RBDS TAR VMS controlled by cellular communications
23.	**NEED:**	Region-wide communication infrastructure
	PROBLEM:	Lack of full deployment of regional communication links limits the capability for interagency cooperation, information sharing, and region-wide synchronization and coordination of signals
	SYSTEM OBJECTIVE:	To improve regional mobility
	USER SERVICE OBJECTIVE:	To use existing communication infrastructure as a backbone to facilitate local ATMS and ATIS functions
	CANDIDATE PROJECTS:	Fiber plant extension and integration METNET integration

USER SERVICE CATEGORY		USER SERVICES
Travel & Transportation Management		**Incident Management**
24.	**NEED:**	Incident detection
	PROBLEM:	Lack of incident detection delays incident removal
	SYSTEM OBJECTIVE:	To reduce delays due to incidents
	USER SERVICE OBJECTIVE:	To provide quick incident detection/ response
	CANDIDATE PROJECTS:	Freeway surveillance TOC development and integration Incident information clearinghouse VMS
25.	**NEED:**	Central clearinghouse for incident information
	PROBLEM:	Lack of availability and consistency of incident information
	SYSTEM OBJECTIVE:	To improve the collection and dissemination of information on incidents
	USER SERVICE OBJECTIVE:	To provide a single source of incident information for traffic reporting services
	CANDIDATE PROJECTS:	Incident information clearinghouse
26.	**NEED:**	Enhanced incident management
	PROBLEM:	Lack of sufficient coordination which results in longer incident response time
	SYSTEM OBJECTIVE:	To reduce incident duration and response time
	USER SERVICE OBJECTIVE:	To implement coordinated incident management system between the TDOT and local agencies (using a single radio frequency, pagers, and other communications devices)
	CANDIDATE PROJECTS:	Incident response/ removal/ clean-up Incident information clearinghouse Real-time traffic information to kiosks

USER SERVICE CATEGORY		USER SERVICE
Travel Demand Management		**Demand Management and Operations**
27.	**NEED:**	More HOV lanes Increased carpooling incentives
	PROBLEM:	Too many vehicle trips on network during peak hours
	SYSTEM OBJECTIVE:	To reduce congestion and emissions
	USER SERVICE OBJECTIVE:	To support facilities, incentives/disincentives, policies that encourage reduction of individual vehicle trips
	CANDIDATE PROJECTS:	HOV lane control VMS TAR
28.	**NEED:**	Incentives for bicycle and transit travel
	PROBLEM:	Public is reluctant to use bicycles and/or transit as an alternative mode of travel
	SYSTEM OBJECTIVE:	To increase use of alternative modes of transportation
	USER SERVICE OBJECTIVE:	To implement management control strategies which support programs that penalize individuals who choose to drive alone; ultimately automate this program so it can be applied dynamically
	CANDIDATE PROJECTS:	HOV lane control VMS TAR
29.	**NEED:**	Reduced congestion on streets and freeways
	PROBLEM:	Congestion increases delays and causes pollution
	SYSTEM OBJECTIVE:	To reduce the number of vehicle trips on the network
	USER SERVICE OBJECTIVE:	To use demand and management techniques to discourage the use of single occupancy vehicles
	CANDIDATE PROJECTS:	HOV lanes Regional signal coordination

	USER SERVICE CATEGORY	**USER SERVICE**
	Public Transportation Operations	**Public Transportation Management**
30.	**NEED:**	Improved efficiency of the existing bus routes and system
	PROBLEM:	Average speed of transit vehicles is affected by congestion
	SYSTEM OBJECTIVE:	To improve system travel times
	USER SERVICE OBJECTIVE:	To provide transit with en-route information on existing traffic so express routes can divert from congested areas
	CANDIDATE PROJECTS:	Transit vehicle preemption
31.	**NEED:**	Additional and more accurate information on transit locations, efficiency and ridership information
	PROBLEM:	Lack of accurate route and ridership information limits efficient transit operation, capital planning, and maintenance
	SYSTEM OBJECTIVE:	To improve transit planning and operations
	USER SERVICE OBJECTIVE:	To provide additional and more accurate data on ridership, boarding locations, etc. in order to BEST prioritize the assignment of transit funds and improve central control management
	CANDIDATE PROJECTS:	AVL/ bus stop information TOC intermodal information integration

	USER SERVICE CATEGORY	USER SERVICE
	Public Transportation Operations	**Public Transportation Management**
32.	**NEED:**	Automatic vehicle location for buses
	PROBLEM:	Lack of real-time bus location information Lack of accuracy of schedule and route information
	USER SERVICE OBJECTIVE:	To use real-time vehicle tracking to inform tourists and travel information centers of changes in schedule
	CANDIDATE PROJECTS:	AVL TOC integration

USER SERVICE CATEGORY		USER SERVICE
Public Transportation Operations		**En-Route Transit Information**
33.	**NEED:**	Visual and/or audio announcements for transit travelers with disabilities
	PROBLEM:	improved transit information delivery for passengers with disabilities
	SYSTEM OBJECTIVE:	To facilitate transit usage by disabled passengers
	USER SERVICE OBJECTIVE:	To make en-route transit information available and user friendly to disabled traveling public
	CANDIDATE PROJECTS:	Visual and auditory cues CCTV

USER SERVICE CATEGORY		USER SERVICE
Public Transportation Operations		**Personalized Public Transit**
34.	**NEED:**	Additional transit service for special events More transit routes Express routes to non-downtown locales More frequent transit service Region-wide demand responsive transit
	PROBLEM:	Existing transit system needs to cover entire metropolitan area
	SYSTEM OBJECTIVE:	To increase transit usage
	USER SERVICE OBJECTIVE:	To provide more convenient, flexible, and extended transit routes and schedules
	CANDIDATE PROJECTS:	AVL Visual and auditory cues Transit vehicle preemption TOC integration

USER SERVICE CATEGORY		USER SERVICE
Public Transportation Operations		**Public Travel Security**
35.	**NEED:**	Improved safety on buses improved safety at bus stops
	PROBLEM:	Low levels of security has the potential to discourage transit usage; problem more severe at bus stops
	SYSTEM OBJECTIVE:	To improve transit security
	USER SERVICE OBJECTIVE:	To enhance security features on buses and at bus stops in order to monitor and notify authorities of security problems
	CANDIDATE PROJECTS:	Bus stop security system Manual MAYDAY alert

USER SERVICE CATEGORY		USER SERVICE
Electronic Payment Services		**Electronic Payment Services**
36.	**NEED:**	More efficient parking payment
	PROBLEM:	Inconvenient payment methods at major parking facilities
	SYSTEM OBJECTIVE:	To facilitate convenient parking and reduce associated parking problems (emissions, delays, etc.)
	USER SERVICE OBJECTIVE:	To provide quick and convenient parking payment methods
	CANDIDATE PROJECTS:	Electronic payment/ debit system Parking management and guidance system
37.	**NEED:**	Electronic transit fare collection
	PROBLEM:	A convenient payment method is not available
	SYSTEM OBJECTIVE:	To increase transit usage and inter-modal travel passenger carrying capability of the transportation network
	USER SERVICE OBJECTIVE:	To provide electronic payment method for transit fares
	CANDIDATE PROJECTS:	Electronic payment/ debit system

USER SERVICE CATEGORY		USER SERVICE
Commercial Vehicle Operations		**Commercial Fleet Management**
38.	**NEED:**	Real-time traffic information to commercial vehicle operators
	PROBLEM:	Traffic congestion creates inefficient operations for trucks
	SYSTEM OBJECTIVE:	To improve commercial fleet efficiency
	USER SERVICE OBJECTIVE:	To provide information to commercial vehicle operators to allow them to make decisions about vehicle routing
	CANDIDATE PROJECTS:	CVO/AVL Freeway surveillance Traffic Operations Center CVO electronic clearance Real-time traffic information for CVO
39.	**NEED:**	Automatic vehicle location capability
	PROBLEM:	Dispatchers do not know location of vehicles at all times
	SYSTEM OBJECTIVE:	To improve coordination between drivers and dispatchers
	USER SERVICE OBJECTIVE:	To allow public and private fleet operators to effectively track, route, and schedule their vehicles
	CANDIDATE PROJECTS:	AVL- CVO

USER SERVICE CATEGORY		USER SERVICE
Emergency Management		**Emergency Notification and Personal Security**
40.	**NEED:**	MAYDAY alert capability
	PROBLEM:	Lack of immediate notification and response for motorists in need of emergency assistance
	SYSTEM OBJECTIVE:	To improve personal security and safety for motorists To improve medical/ emergency response time in remote locations, particularly rural areas
	USER SERVICE OBJECTIVE:	To allow user-initiated distress calls and relaying of information regarding nature of emergency
	CANDIDATE PROJECTS:	MAYDAY - manual and automatic

APPENDIX C

ITS GLOSSARY

A

AASHTO American Association of State Highway and Transportation Officials.

ACS Automatic Clearance Sensing. Asissting large vehicles negotiate low clearences.

AHAR Automatic Highway Advisory Radio. U.S. traffic information broadcasting system whose transmissions are received through car radios which automatically interrupt other radio reception and tune to the correct station.

AHS Automated Highway System. Project to research and demonstrate fully highway-controlled vehicles mandated for initial implementation by 1997 by the Intermodal Surface Transportation Efficiency Act (ISTEA).

AI Artificial Intelligence. A computer software programming technique in which a computer "learns" from past experience, allowing it to make more intelligent decisions with greater program use.

ANSI American National Standards Institute. Umbrella organization for U.S.-based consensus standards setting. U.S. representative on the International Standards Organization.

APTS Advanced Public Transportation Systems. FTA program to focus R&D and funding efforts on ITS technologies composed of four main areas: vehicle operations and communication, high occupancy vehicles, customer interface, rural transportation, and market segment development.

ARTS Advanced Rural Transportation Systems.

ASTM American Society for Testing and Materials.

ASCE American Society of Civil Engineers.

ATA American Trucking Associations.

ATC Automated (electronic) Toll Collection.

ATIS Advanced Traveler and Tourist Information Systems. Vehicle features which assist the driver with planning, perception, analysis, and decision-making.

ATMS Advanced Traffic Management Systems. An array of institutional, human, hardware, and software components designed to monitor, control, and manage traffic on streets and highways.

AVCS Advanced Vehicle Control Systems. 1) Vehicle and/or roadway-based electromechanica1 and communications devices that enhance the control of vehicles by facilitating and augmenting driver performance. Will ultimately relieve the driver of most tasks on designated. instrumented roadways.

ATSAC Automated Traffic Surveillance and Control.

AVC Automatic Vehicle Classification. Used in CVO to identify vehicles by type in order to reduce the necessity for record-keeping by drivers and speed interstate travel.

AVI Automatic Vehicle Identification. A system which combines an on-board "tag" or transponder with roadside receiver for the automated identification of vehicles. Used for electronic toll collection (ETC), stolen vehicle recovery, and tracking vehicle fleets. A necessary component of AVL.

AVL Automatic Vehicle Location. The installation of devices on a fleet of vehicles (e.g. buses, trucks or taxis) to enable the fleet manager to determine the level of congestion in the road network. AVL is also used to enable the fleet to function more efficiently by knowing the location of vehicles in real-time.

B

BBS Bulletin Board System. A database accessible to multiple users via computer, modem, and phone lines.

Beacons Short-range roadside transceivers for communicating between vehicles and the traffic management infrastructure. Common transmission technologies include microwave and infrared.

C

CAAA Clean Air Act Amendments (1990).

CB Citizen's Band Radio. A band of radio frequency designated by the FCC for civilian use.

CCATS Camera and Computer Aided Traffic Sensor. Commercial video image analysis system launched in 1988 in Belgium by Devlonics Control NV.

CCTV Closed Circuit television.

CD-ROM Compact Disc - Read Only Memory.

CMS Changeable Message Sign. Used in ATIS and ATMS. Also called Variable Message Sign (VMS).

CHART Chesapeake Highway Advisories Routing Traffic. Provides traffic information to motorists travelling between the Baltimore-Washington metropolitan area and Maryland's Eastern Shore.

C M A Q 1) Congestion Management and Air Quality. A federal program which funds air quality improvement projects.
2) Congestion Mitigation for Air Quality.

CVO Commercial Vehicle Operations.
1) The application of ITS technology to commercial vehicles.
2) An ITS America committee.

Communications
Transmission of voice, data, and video information among vehicles, and system infrastructure.

COMPASS Canadian ATMS system focused on incident detection and management. In-pavement sensors transmit traffic information to a central facility, which notifies the appropriate incident management personnel and adjusts local changeable message signs (CMS) accordingly. Sponsored by the Ontario Ministry of Transportation (OMT).

CARAT Congestion Avoidance and Reduction for Automobiles and Trucks. ATIS/ATMS system in Charlotte, NC. Includes a subscription-based advanced traveler information system (ATIS) that will provide incident location and response as well as consumer information to its users, and an advanced traffic management center (TMC).

Control Strategies
Strategies implemented to help regulate traffic flow and ensure traveler safety.

CVSA Commercial Vehicle Safety Alliance.

CVO Commercial Vehicle Operations

D

DAR Digital Audio Radio.

DART Diversion Advice Recommendation Technology. Term used to identify the common focus of ADVANCE, TravTek, and Fast-Trac on dynamic route guidance to assist in diversion after the detection of an incident.

Database Standards Task Group

A subcommittee of SAE's ITS Division. The task group's purpose is to develop standards for digital street map databases. That includes standardization of terms and the use of that nomenclature to facilitate evaluation and comparison of the completeness and content level of various databases.

Data Management

Management integration and quality control of all data and algorithms pertaining to ITS.

DATIS Dulles Area Travel Information System. Dulles International Airport Corridor project. Testing techniques for collecting and disseminating traffic information, including highway accidents, transit service delays, and parking availability at selected sites. Information will be provided at home, office, and malls.

Differential Correction

Technique for overcoming GPS selective availability by placing a receiver at a precisely known control point from which corrections can be broadcast for an area.

DLG Digital Line Graphs. Geographic computer plots produced by U.S. Geological Survey, available on CD-ROM. Includes data on political and administrative boundaries, water bodies, roads and trails, railroads, and points of interest. Drawn from 1:2,000,000 scale maps of the National Atlas of the U.S. Last updated in 1979.

DRIVE Dedicated Road Infrastructure for Vehicle Safety in Europe. A European Community program to find ways to alleviate road transportation problems through the application of advanced information and telecommunications technology.

DIRECT Driver Information Radio Experimenting with Communication Technology. U.S. operational field test sponsored by the FHWA, Michigan DOT, and several automobile and electronic component manufacturers. Will deploy four alternate low cost methods of communicating advisory information to motorists and evaluate impact on driver behavior, benefits and costs, and technical feasibility. Includes RDS, AHAR, LPHAR, HAR, and cellular telephone. Uses a Transportation Advisory Center (TAC) to process data and generate advisory messages.

DRS Dead Reckoning System.

E

ECPA Electronic Communications Privacy Act.

ERP Electronic Road Pricing. Use of smart card technology or simple tags to charge motorists for road use based on demand, congestion, day and time, miles traveled, and other flexible criteria.

EMS
1) Emergency Medical Service.
2) Emergency Management Systems.
3) Emergency Message Systems.

En-Route Driver Information
One of 29 user services, defined by FHWA, part of the Travel and Traffic Management "bundle". En-Route Driver information provides driver advisories and in-vehicle signing for convenience and safety.

ENTERPRISE
Evaluating New Technologies for Roads Program Initiative in Safety and Efficiency. North American ITS cooperative initiative to facilitate the rapid development and deployment of ITS technologies.

ERGS Electronic Route Guidance System. A 1968 to 1971 **ERGS** Electronic Route Guidance System. A 1968 to 1971 route guidance project sponsored by the Federal Highway Administration. The system provided in-vehicle directional guidance to the driver. Although it was not implemented in the U.S., the Japanese CACS project established the feasibility of ERGS technology.

ERTIS European Road Transport Information Systems. A $2.7 million, three-year project to develop a common road information and communications system for motor carriers across Europe. Part of EUREKA. Has the objective of applying systems for automatically communicating motor freight information.

ESCORT A proprietary ACTS software package developed by the Sonex Corporation, a wholely owned subsidiary of Kimley-Horn and Associates. Successfully installed in several North American cities.

ET-NET European traveler information network developed under the INTERCHANGE project of DRIVE II.

ETC Electronic Toll Collection.

ETSI Institut Europeen des normes de telecommunication. European Telecommunications Standards Institute. Includes both public and private sectors.

ETTM Electronic Toll and Traffic Management.

EZ-Pass The electronic toil collection system to be used in the New York/New Jersey/ Pennsylvania area.

F

FAST-TRAC Faster and Safer Travel through Traffic Routing and Advanced Control. A demonstration project that integrated ATMS and ATIS, Fast-Trac utilizes the SCATS adaptive, coordinated traffic control system with video image processing for vehicle detection and is linked with the Siemen's ALI-SCOUT technology. Field tested in Oakland County, Michigan.

Fault Tolerant

Fault tolerance is the ability of a system to perform fault management and continue operating in the event of system failure.

FCC Federal Communications Commission. The federal agency which regulates telecommunications in the United States.

FHWA Federal Highway Administration. Authorized by the ISTEA legislation to spend $660 million on ITS projects from FY92 through FY97. Twenty nine inter-related user services defined by FHWA as part of the national ITS program planning process.

FISITA Federation Intemationale des Societes d'Ingenieurs des Techniques del' Automobile. (International Federation of Automobile Engineering Societies). Interested in international databases and vehicle research systems. Sponsors international conferences.

FMS Freeway Management System - A freeway management system is mix of electronic equipment and human operating procedures that work together to help reduce traffic congestion, increase safety, and keep traffic flowing as smoothly as possible.

FAME Freeway and Arterial Management Effort. Includes the.Incident Management and Integrated Systems project which will develop a framework for establishing and implementing an incident management system. Sponsored by the Washington Department of Transportation.

FTA Federal Transit Administration.

G

Genesis A Minnesota Guidestar project. A personal traveler information system that will provide real-time route specific vehicle and transit travel times. Trafftc data will come from transit vehicles used as probes and conventional data sources.

Geocode A code representing a political or geographical unit (for example, a city, county or zip code area) incorporated into a GIS.

GIS Geographic Information System. Computerized data management system designed to capture, store, retrieve, analyze, and report on geographic/demographic information.

GEOSTAR A satellite system which was used for determining vehicle location. Pioneered satellite-based commercial truck tracking and communications services. Now defunct.

GPS Global Positioning Satellite. Government owned system of 24 Earth-orbiting satellites which transmit data to ground-based receivers. Provides extremely accurate latitude/longitude ground position

GPS Global Positioning Satellite. Used by networks for synchronization. GPS Time Base allows for traffic signal coordination based on the GPS clock.

Guidestar An ITS program of the Minnesota Department of Transportation and a series of private partners. University of Minnesota Center for Transportation Studies provides technical assistance and evaluation services.

H

HAR Highway Advisory Radio. The transmission of localized traffic advisory messages using 520 AM and 1610 AM frequencies.

HAZMAT HAZardous MATerials.

HUD Heads Up Display. Display of instrument readings which appears (usually by reflection) on the inside of a vehicle's windshield.

HOV High Occupancy Vehicle. Any vehicle containing more than one person.

HPR Highway Planning and Research. Funds set aside in the Federal Aid Highway program available to each state for research and/or planning.

HUFSAM Highway Users Federation for Safety and Mobility.

I

I/M Inspection and Maintenance Program for motor vehicle emissions testing, with the objective of reducing air pollution from automobiles.

IBTTA International Bridge, Tunnel, and Turnpike Association.

IDEAS Program for Innovations Deserving Exploratory Analysis. A program of the National Academy of Sciences/National Academy of Engineering that includes an ITS component.

IEEE Institute of Electrical and Electronics Engineers.

IFTA Interstate Fuel Tax Agreement.

IMS Incident Management System.

Incident Accident, stalled vehicle, any other delay-causing problem on street or freeway.

Incident Management
In ITS terms, incident management helps public and private organizations quickly identify incidents and implement a response to minimize their effects on traffic.

Interoperability
The ability of heterogeneous systems and networks to communicate and cooperate through specified standards.

ITI Intelligent Transportation Initiative. A description of the ITS deployment program as envisioned by the U.S. Department of Transportation.

ITS AMERICA
Intelligent Transportation Society of America. A nonprofit, public/private scientific and educational corporation. Objective is to advance a national program for safer, more economical, energy efficient, and environmentally sound highway travel in the U.S.

Inter-Agency Coordination
Interaction between agencies to ensure consistency and system integration.

ISTEA Intermodal Surface Transportation Efficiency Act of 1991. Provides primary federal funding for highway and other surface transportation programs in the U.S. Contains the Intelligent Vehicle Highway Systems Act. Directs the establishment of a national ITS program.

IS0 International Standards Organization. An international standards umbrella organization. Includes a Technical Committee (TC-204) on ITS/RTI

In-Vehicle Sensors
Monitoring of vehicles, drivers, and external driving environments that pertains to vehicle operations.

In-Vehicle Signing
In-vehicle signing, the second component of en-route driver information, provides the same types of information found on physical road signs today, directly in the vehicle.

IR Infrared.

IRP International Registration Plan. An international system for registering commercial vehicles operated in this country by state departments of motor vehicles.

ISTEA Intermodal Surface Transportation Act, passed by Congress and approved by the President in December of 1991, becoming Public Law 102-240.

ITE Institute of Transportation Engineers.

IVHS Intelligent Vehicle and Highway Systems. Now known as ITS (Intelligent Transportation Systems). The application of advanced technologies to improve the efficiency and safety of transportation systems.

IVSAWS In-Vehicle Safety and Advisory Warning System. Developed by Hughes. Being tested with FHWA funding.

J

JDRMA Japan Digital Road Map Association.

JIT Just-in-time delivery of freight by trucking companies.

JSAE Japanese Society of Automotive Engineers.

K

Kiosk An interactive information center for traffic or travel data located in shopping malls, parking decks, hotels, airports, businesses, transit terminals, etc., always has interactive computer capability. Sometimes has communications linkage to real-time traffic data.

L

LAN Local Area Network. A method of connecting several computers together using either high or low bandwidth communication media.

LCD Liquid Crystal Display.

LED Light-emitting Diode.

LEO Low Earth Orbit. Satellite system to provide positioning and two-way messaging services.

LOS Level of Service. A rating between A and F as a measure of highway congestion.

LPHAR Low Powered Highway Advisory Radio. Traffic information broadcasting system. Requires the traveler to manually tune in to a traffic message channel after being alerted by flashing roadside lights.

LPRS License Plate Reading System. Automatically reads the license plates of moving vehicles.

LRT Light Rail Transit.

LTL Less Than Truckload.

M

MAGIC Metropolitan Area Guidance, Information and Control an ITS demonstration project in New Jersey.

Memory Card A plug-in computer memory card containing prerecorded information. May function as mass storage for on-board navigation systems. Also called IC card and Flash Memory.

MAGIC Metropolitan Area Guidance, Information and Control. Demonstration project using variable message signs (VMS), closed circuit television (CCTV), highway advisory radio (HAR), loop detection, and ramp metering to help relieve congestion in several New Jersey counties. Operated by New Jersey DOT.

MITI Japanese Ministry of International Trade and Industry.

MMI Man-machine Interface (or Interaction). The interface between the system hardware and the person who is using the system. This general term includes touch (for example, buttons, levers or touch screens), vision (such as lights or various displays), and auditory effects (such as chimes, beeps, voice synthesis, and voice or speech recognition).

MNA Mobile Navigation Assistant.

Mobility Manager
FTA-sponsored APTS project testing an experimental information clearinghouse aimed at integrating and coordinating transportation services offered by multiple providers. Combines Smart Traveler and Smart Vehicle technology with the integration of communications and billing systems.

MOE Measure of Effectiveness. Used to evaluate results of operational field tests.

MPO Metropolitan Planning Organization.

MTA Metropolitan Transportation Authority. The public transit authority of the Los Angeles metropolitan area.

Multi AV Nissan-Sumitomo navigation system. Uses microwave beacon receivers for the transmission of static information. Applies RACS communications technology and protocols.

N

National ITS Program Plan
A publication by US DOT and ITS America (formerly IVHS America). The primary purpose of the National Program Plan is to identify the kinds of user needs that can be addressed through ITS technologies, and describe the services that are being developed or can be developed to meet those needs.

Navigable Database
A digital streetmap database containing sufficient detail and scope to support driver and vehicle guidance applications (e.g., the generation by computer of a high quality driving route between two stated addresses).

Navigation/Guidance
Systems to assist travelers in route planning, position identification, and route following.

Navstar See Global Positioning System.

NCHRP National Cooperative Highway Research Program.

NHS National Highway Systems. A federal program which funds transportation projects.

NHTSA National Highway Traffic Safety Administration.

NIMC National Incident Management Coalition. NIMC was created to serve as a focus for consensus-building, and for promotion and wider implementation of incident management programs. Sponsors include AASHTO, American Trucking Associations, and FHWA.

NTIA National Telecommunications and Information Administration of the United States.

O

OBC On-board Computer.

OTIS On-Line Travel Information System. Microcomputer-based system which helps agents to respond to telephoned requests for travel information. Used by the New York City Transit Authority. Also displays a map of the area around the caller's origin or destination, faxes or mails itineraries, displays a description of the bus stop or train station, and reports service delays.

Open Standards Interconnection
A standard communications architecture, also called "open architecture" adopted by the International Standards Organization in 1983.

OST Office of the Secretary of Transportation for the U.S. Department of Transportation.

P

PCD Personal Communication Device. A small portable device used for communications, such as pagers and cellular phones.

PCS Personal Communication Service. A next generation mobile telephone service which associates an individual with a universal telephone number.

PIARC Permanent International Association of Road Congresses. The oldest international association concerned with roads. Objective is to foster progress in the construction, maintenance, operation, and economic development of roads.

Personalized Public Transit
Provides flexibly-routed transit vehicles to offer more convenient customer service. Small publicly or privately-operated vehicles provide on-demand routing to pick up passengers who have requested service and deliver them to their destinations.

Platooning Linking cars closely together in small groups for high-speed, high-density freeway travel under control of an Automatic Vehicle Control System (AVCS).

Pre-Trip Traveler Information
Provides information for selecting the best transportation mode, departure time, and route. Pre-trip travel information allows travelers to access a complete range of intermodal transportation information at home, work, and other major sites where trips originate.

Public Transportation Management
Automates operations, planning, and management functions of public transit systems. The public transportation management service provides computer analysis of real-time vehicle and facility status to improve transit operations and maintenance.

PVEA Petroleum Violation Escrow Account. A fund administered jointly by the state of California and the U.S. Department of Energy into which companies pay compensation for environmental pollution.

Q

QASPR Qualcomm Automatic Satellite Position Reporting. Uses existing civilian communications satellites for vehicle tracking. Introduced by Qualcomm in February 1990.

Quad Sheets A series of maps produced by the U.S. Geological Survey (USGS) at scales of 1:24,000 and 1:62,000. Available to the general public. Covers the entire U.S.

R

RFID Radio Frequency Identification. A type of electronic identification that uses radio frequency signals to read on-vehicle tags for Automatic Vehicle Identification and Classification (AVI and AVC).

Ramp Metering
Traffic-responsive regulation of vehicle entry to a freeway, typically via sensor-controlled freeway ramp stoplights.

RDS Radio Data System. A use of FM sideband radio for wide area transmission of digital information, program information, radio control, etc. Standardized in 1984 by the European Broadcasting Union CEBU). One application is the Traffic Message Channel (TMC).

RDS-TMC Radio Data System-Traffic Message Channel.

RSPA Research and Special Programs Administration.

RFID Radio Frequency Identification.

RNS Radio Navigation System.

Route Guidance
Provides travelers with simple instructions on how to best reach their destinations. The route guidance service provides a suggested route to reach a specified destination.

Route Guidance Database
The detailed information that is required to enable a computer to generate a high quality driving route between two locations. The information includes such items as road geometry, street names, addresses, speed limits, turn restrictions, one-way restrictions, road levels, and roadway connections.

RTMS Road Traffic Microwave Sensor. Canadian pole-mounted traffic sensor with multi-zone and multi-target capability for all-weather operation at intersections and for free-way surveillance. Funded by Ontario Ministry of Transportation through EIS, a Canadian company.

S

SAE Society of Automotive Engineers.

SAFE San Diego Service Authority for Freeway Emergencies. Operates a system of solar powered cellular phones installed along San Diego freeways to facilitate incident reporting.

SCA 1) Subsidiary Carrier Authorization. An additional FM signal (or two) included in regular commercial broadcasts for transmission of data. Also called FM subcarrier. Called Multiplex in Europe and Japan.

SCANDI Surveillance, Control, and Driver Information System.

SCATS Sydney Coordinated Adaptive Traffic System. Currently in use in several countries including the U.S.

SCOOT Split, Cycle time and Offset, Optimization Technique. Traffic signal control system which allows dynamic signal response to traffic flow. Presently in use in several countries.

SDTS Spatial Data Transfer Standard.

SIP State Implementation Plan. A statewide air pollution abatement plan required by the Clean Air Act Amendments of 1990.

Smart Commuter
Demonstration project in Houston. Testing HOV and ATIS, especially ride-sharing, along the 1-45 North and I-10 West corridors.

Smart Corridor
Santa Monica ITS Corridor Demonstration Project, one of the first ITS projects in the Country.

SMR Special Mobile Radio. 900400 mHz band. Privately owned.

SONET Synchronous Optical Network. A family of optical transmission channels for speeds from about 45 Mb/s to 2400 Mb/s today, and higher in the future. Provides broadband connectivity for existing networks on a global scale. "SONET is to broadband what T1 is to digital."

SDTS Spatial Data Transfer Standard. U.S. federal database information interchange standard for geographic databases. Provides specifications for digital spatial data transfer, data transfer encoding, and definition of spatial features and attributes.

Spread Spectrum
Type of radio transmission. Signal is spread over excess bandwidth by means of a special code signal and received by synchronizing the data and receiver with the same code. Reduces interference and jamming, and allows multiple user communications.

SPS Standard Positioning Service. Civilian version of Global Positioning System (GPS).

STIP State Transportation Improvement Program.

STP Surface Transportation Program. A federal program which funds transportation projects.

Surveillance Collection of speed, volume, densities, travel time. queue length, position, classification, weather, hazardous material information. etc.. for us in providing user services.

T

TCC Traffic Control Center. Sometimes used interchangeably with Traffic Operations Center (TOC), but strictly defined, TCC's primarily control traffic while TOC's are headquarters for enforcement, operations and maintenance personnel. TCC's and TOC's are often combined functionally.

TDM Transportation Demand Management. An attempt to reduce demand for transportation through various means, such as encouraging the use of high occupancy vehicles, alternative work hours, telecommuting, improvement of jobs/housing balance.

TeleMap Traveler information system providing information via telephone and fax. Offered by Wayfinder Systems in cooperation with the American Auto Association.

Teletrac AVL system for emergency and corporate vehicle and stolen vehicle location. Communication is limited to location and status information. Being **tested** by Los Angeles Rapid Transit.

TIGER files Topologically Integrated Geographic Encoding & Referencing. Computer-based map files built by the Census Bureau to help support the 1990 census process. Contains DIME information and information for new suburbs and small cities as of 1987.

TIP Transportation Improvement Plan. A MPO program for transportation projects, developed jointly with the state for a 3 to 7 year period.

TMA Transportation Management Association.

TMC 1) Traffic Message Channel (radio).
2) Traffic Management Center.

TOC Traffic Operations Center (see also TCC).

Traffic Signal Systems
A system of interconnected traffic signals (signal controllers) whose major objective is to support continuous movement and minimized delay along an arterial or a network of arterials

Translink Debit card that can be used on bus and rail in San Francisco's Bay Area Rapid Transit System (BART). Will be used for parking payment and fare payment on other modes. such as ferries.

Transport Canada
Canadian Federal Ministry of Transportation.

TRANSCOM TRANSCOM Transportation Operations Coordinating Committee. An ETTM project for managing a heavily traveled corridor between northern New Jersey and New York City.

TRB Transportation Research Board. Part of the National Academy of Science, National Research Council. Serves to stimulate, correlate, and make known the findings of transportation research.

TRIPS Transportation Resources Processing System. An audiotex/videotex-based ATIS in suburban California. Gives information on traffic delays and altemate routes, as well as public transportation. Being tested in California's Smart Traveler Program. Sponsored by Caltrans.

TravelAid Traffic surveillance and roadway condition warning system for the Snoqualmie Pass in Washington State. Includes variable message signs (VMS) and in-vehicle displays. Focus is on safety in a rural corridor, rather than congestion reduction. Participants include Washington DOT, Farradyne Systems, Inc., Westinghouse, FHWA and NHTSA. will involve up to 200 vehicles. Estimated cost is $4.5 million. Also known as Washington State Portable ATIS.

Traveler Interface
Means by which a user interacts with information devices.

TravelMatch Express
Prototype self-service traveler information terminal, Developed by the American Automobile Association (AAA). Includes information on hotels, restaurants, and tourist attractions. Provides point-to-point driving directions using technology from Navigation Technologies. Exists for telephone and fax as TeleMap.

Traveler Services Information
Provides a business directory, or "yellow pages," of service information. Traveler services information provides quick access to travel-related services and facilities.

TVC Traffic Vision Center. The integrated traffic management and traveller information system for the Tampa Bay, Florida metropolitan area.

U

USCAR United States Council for Automotive Research. Umbrella consortium formed by Chrysler, Ford, and General Motors to oversee the activities of existing research consortiums.

UTCS Urban Traffic Control System. A software package used for controlling the timing of traffic signals in an urban road network; developed by the Federal Highway Administration and used by most local traffic engineering departments in the United States.

UTMS Universal Traffic Management System.

V

V/C Volume/Capacity Ratio.

VMS Variable Message Sign. Electronic signs used in ATMS and ATIS. Also called Changeable Message Sign (CMS).

VORAD Vehicle On-board Radar. Experimental low-powered radar unit to support collision avoidance. May be connected to a vehicle's cruise control as part of a platooning system or to maintain a safe driving interval when following a slower vehicle.

VRC Vehicle/Roadside Communications. Used in ETTM, AVI, CVO and ATMS. Technologies include transponders, readers. cellular telephone, and beacons, among others.

VIC Vehicle Inter-communication. DRIVE project. Objective is to specify protocols for real-time vehicle-to-vehicle communication. with possible AVCS applications.

VICS Vehicle Information Communication System.

W

WAN Wide Area Network. A method of connecting several computers together in a wide geographic area using fiber optic cable.

WGS-84 World Geodetic System 1984. Standard, widely accepted scheme for laying out longitude and latitude lines on the globe that attempts to compensate for the earth's irregularities of shape. Used by GPS systems.

Wireless Seamless Interconnect
A communications link established using wireless hardware performing without signal degradation and supporting the communications protocol(s) employed over the remaining part of the line.

APPENDIX D

COMMUNICATIONS GLOSSARY

A

AM Amplitude Modulation. One of two basic methods to modify a signal to allow it to carry information by audio waves.

AMIS Audio Message Interchange Standard. A standard recommended by a special voice mail industry project group, which defines the way in which messages are sent from one voice mail system to another.

Architecture The manner in which hardware or software is structured. Architecture typically describes how the system or program is constructed, how its components fit together. Network architecture defines the functions and description of data formats and procedures used for communication between nodes or work stations.

ASCII American Standard Code for Information Interchange. Usually pronounced "ask-ee". An eight-level code for data transfer adopted by the American Standards Association to achieve compatibility between data devices.

ATM Asynchronous Transfer Mode. A multiplexed information transfer method in which the information is organized into a fixed length (53 octet) "cells" and transmitted according to each user's instantaneous need. Each cell contains a 5-octet header whose primary purpose is to identify ceils belonging to the same "virtual channel."

Attenuator 1) An electronic transducer, either fixed or adjustable, that reduces the amplitude of a wave without causing significant distortion.
2) A component that is installed in a fiber optic network to reduce the power of the optical signal.

Audio A term used to describe sounds within the range of human hearing. Also used to describe devices which are designed to operate within this range.

Audiotex A generic term to used to refer to callers obtaining voice information over the telephone interactively. It was coined from the term videotex, which refers to interactive video services.

B

Balanced A transmission line in which voltages on the two conductors are equal in magnitude, but opposite in polarity, with respect to ground.

Bandwidth 1) The range of frequencies that can be used for transmitting information on a channel, equal to the difference in Hertz (Hz) between the highest and lowest frequencies available on that channel. Bandwidth indicates the transmission-carrying capacity of a channel.

Bandwidth 2) Measure of the carrying capacity of an optical fiber, normalize to a unit of Mhz-km. This term is used to specify capacity of multimode fibers only. For single mode fibers, use dispersion.

Baud Unit of signaling speed. The speed in bauds is the number of signal events per second. If each signal event represents onIy one bit condition. the baud is the same as bits per second. When each signal event represents other than one bit, baud does not equal bits per second.

Bellcore Bell Communications Research, Inc. Research and development organization owned by the seven Regional Bell Operating Companies.

BISYNC Binary Synchronous Transmission. A byte-oriented. half-duplex, synchronous protocol originated by IBM in 1964.

Bit Contraction of "binary digit." The smallest unit of information in a binary system. A bit represents the choice between a mark or space (one or zero) condition.

BR The rate of data throughput (bit-rate) on the trunk coaxial medium expressed in hertz.

Broadband 1) A method of communication in which the signal is transmitted by being impressed on a higher-frequency carrier.
2) Any signal with a bandwidth of over 5 megahertz.
3) A network in which the band width can be shared by multiple simultaneous signals that are encoded with radio frequency.

Byte A binary digit word, usually 8 bits wide. A byte is often part of a much longer word that must be placed on an 8-bit bus in multiple stages.

C

Carrier, Communications Common
A company which furnishes communications services to the general public, and which is regulated by appropriate local, state, or federal agencies. The term strictly includes truckers and movers, bus lines and airlines, but is usually used to refer to telecommunication companies.

CATV Community Antenna Television.

CBX Computer controlled PBX.

CCITT International Telegraph and Telephone Consultative. A standards organization that specializes in the electrical and functional characteristics of switching equipment. The CCITT sets standards for interfaces to ensure compatibility between data communications equipment (DCE) and data terminating equipment (DTE).

CD-ROM Compact Disk - Read Only Memory. The use of "compact disks" (similar to audio CDs) for the storage of digital data which, after manufacture is only intended to be READ - i.e. cannot be WRITTEN or changed.

CDPD Cellular Digital Packet Data. An industry standard for data transmission. CDPD utilizes the analog cellular networks already in place in the U.S. and Canada to provide 2-way data communications for users of devices such as laptops and PDAs.

Cellular Phone

Also know as a cellular radio or cellular telephone. Refers to a radio based system which uses multiple transmitter/receiver sites, each serving a geographic area called a "cell". As a mobile cellular subscriber moves from one cell to another, he is automatically transferred to the next cell site serving that adjacent cell.

Centrex Service

Provision to subscribers, by means of a specially equipped public telephone exchange, of services normally available only in PBX's (e.g., internal dialing of PABX type, operators' desk, direct access to the network, direct dialing-in, transfer of calls).

Circuit A means of two-way communications between points, consisting of transmit and receive channels.

Coaxial Cable A cylindrical transmission line comprised of a conductor centered inside a metallic tube or shield, separated by a dielectric material, and usually covered by an insulating jacket. Coaxial cable is noted for its wide bandwidth and its low susceptibility to interference.

Code A specific way of using symbols and rules to represent information.

CODEC Code-Decode. An assembly comprising an encoder and a decoder in the same equipment.

Coding A method of adding redundant information in order to detect or correct errors in the transmitted signal.

Communications Applications Compiler

A piece of software that translates instructions written in a high-level language into a lower-level language so that the processor can understand them.

Communications Link

The method or channel by which useful information is transmitted. Electrically, this link can be via wires or radiated through space electromagnetically.

Compression Reducing the number of bits needed to encode a signal for transmission and storage, typically by eliminating long strings of identical bits or bits that do not change in successive sampling intervals.

Connector A device that allows you physically to connect and disconnect copper wires or fibers in cable to other wires or fibers. Copper wire and fiber optic connectors most often join transmission media to equipment or cross connects.

CSU Channel Service Unit. User owned equipment installed on a customer premises at the interface to phone company lines to terminate a DDS or T1 circuit. CSUs provide network protection and diagnostic capabilities.

D

DACS Digital Access and Cross-connect System. A computerized or manual facility which allows the DS-1/(T1) lines to be remapped electronically at the DS-0 level. Also called DCS or DXS.

Data Acquisition
Gathering information from sources such as sensors and transducers in an accurate, timely, and organized manner. Modem systems convert this information to digital data which can be stored and processed by a computer.

Database Data stored in a computer-readable form, and usually indexed or sorted in a logical order. Users can use the index or logical arrangement to find the item of data they need. Databases in a central file server are one of the most common LAN applications.

Data Bus A system incorporated into fiber optic communications characterized by severally spatially distributed terminals that are served with the same multiplexed signal.

DTE Data Terminating Equipment. General terminology for data equipment such as terminals and host computers. DTE can also stand for Data Terminal Equipment.

DFI Digital Facilities Interface.

Digital Cellular Radio
A form of cellular radio which involves digital processing of baseband signals, rather than analog processing of both radio frequency and baseband signals. Digital cellular radio has the advantage of greater number of users per radio channel and superior speech quality.

Dispersion The cause of bandwidth limitations in a fiber. Dispersion causes bandwidth limitations in a fiber by broadening input pulses along the length of the fiber. Two major types are mode dispersion and material dispersion.

Distortion The unwanted change in waveform that occurs between two points in a transmission system. These types are AMPLITUDE vs FREQUENCY DISTORTION, DELAY vs FREQUENCY DISTORTION, and NON-LINEAR DISTORTION.

Distributed Data Processing
The processing of information in separate locations equipped with independent computers connected by a network.

DLC 1) Data-Link Control. The set or rules used by two nodes, or stations, on a network to perform an orderly exchange of information over the network. A data link includes the physical transmission medium, the protocol, and associated devices and programs.
2) Digital Loop Carrier.

DOV Data Over Voice. A technology for transmitting data and voice simultaneously over twisted-pair copper wiring.

DS Digital Signal.

DSX Digital Signal Cross-connect.

Duplex Connectors
Used as the physical connections between stations on the FDDI ring to connect fiber optic cables. The connectors are polarized to prevent the transmitting and receiving fibers from becoming inadvertently interchanged.

Duplexing The use of duplicate computers, files or circuitry. In the event one component fails, an alternative one can enable the system to carry on its work.

E

EIA Electronic Industries Association. A standards association that publishes various test procedures and specifications. It is an industry standard defining commercial building telecommunications wiring.

Ethernet A Local Area Network (LAN) design, standardized as IEEE 802.3: Ethernet uses 10 Mbps transmission over coaxial bus and the CSMA/CD access method. Recently adopted for star topology applications over twisted pairs and standardized as 1 OBASE-T.

F

FDDI 1) The Fiber Distributed Data Interface LAN developed by the ANSI X3T9.5 committee. Development was started in 1982. FDDI was the first LAN based exclusively on optical fiber components.
2) A standard for fiber optic data transmission systems that will make fiber optic components from different manufacturers compatible with each other under specifying parameters.

Fiber Bundle An assembly of unbuffered optical fibers. Usually used as a single transmission channel as opposed to multifiber cables, which contain optically and mechanically isolated fibers, each of which provides a separate channel.

Fiber Optic Cable
A transmission medium consisting of a core of glass or plastic surrounded by a protective cladding, strengthening material, and outer jacket. Signals are transmitted as light pulses, introduced into the fiber by a light transmitter (either a laser or light-emitting diode [LED]).

Fiber Optic Interconnect
An interconnection unit used for circuit administration and built from modular cabinets, It provides interconnection for individual optical fibers but, unlike the fiber optic cross-connect panel, it does not use patch cords.

File Server A computer that stores data centrally for network users and manages access to that data.

Firmware Programming functions implemented through a small special-purpose memory unit.

FM Frequency Modulation. One way to modify a signal to make it "carry" information. The frequency of a carrier signal is modified in accordance with the amplitude of the information signal.

G

H

Hertz 1) Standard unit of frequency; equal to one cycle per second.
2) In communication systems, hertz represents a rough measure of two things about a transmitted signal: its center frequency and its bandwidth about the center frequency.

Heterogeneous Networks
Networks composed of hardware and software from multiple vendors, usually implementing multiple protocols.

High Frequency
The band from 3 to 30 MHz in the radio spectrum, as designated by the Federal Communications Commission.

Hologram An interference pattern that is recorded on a high resolution plate. The two interfering beams formed by a coherent beam from a laser and light scattered by an object. After processing, monochromatic light will result in a three-dimensional image.

Hybrid Network
A local area network (LAN) with a mixture of topologies and access methods. For example, a network that includes both a token ring and a CSMA/CD bus.

I

I/O Application
The device used to insert information, data or instructions into a computing system, or the device used to transfer information or data, usually processed data from a computing system to the external world.

Image Processing
The ability of a computer or other electronics to implement complex mathematical algorithms to analyze, enhance, or manipulate digitized electronic images or video.

INTELSAT International Telecommunication Satellite Organization.

IAC Interapplication Communication. Protocol by which applications can pass messages. Messages can be either blocks of data and information packets, or instructions and requests for application(s) to perform actions.

Interconnect A circuit administration point. other than a cross connect or information outlet. that provides capability for routing and rerouting circuits. It does not use patch cords.

Interface A shared boundary, defined by common physical interconnection characteristics, and meanings of interchanged signals.

Interference Disturbances of an electrical or electromagnetic nature that introduce undesirable responses into other electronic equipment.

ITT International Telegraph and Telephone Consultative. (See CCITT.)

Internet The network of networks that were originally connected together by the ARPANET, now expanded to include those networks connected to the NSFnet.

Interoperability
The ability to operate and exchange information in a heterogeneous network.

IR Infrared.

ISDN Integrated Serviced Digital Network. An international standard that defines end-to-end transmission of voice, data, and signaling.

ISO International Standards Organization. An independent international body formed to define standards for multivendor network communications. Its seven-layer OSI reference model specifies how different vendor's products communicate with each other across a network.

Isochronous 1) Data transmission where timing is derived from the signal carrying the data. No timing or clock lead is provided at the customer interface.
2) The time characteristic of an event or signal recurring at known, periodic time intervals, e.g. circuit switched voice, video, DS 1, all generate isochronous signals.

J

J-PEG 1) Joint Photographic Experts Group. A consortium of suppliers, users, and designers, representing both ISO and CCITT, who are responsible for developing the still picture standard for digital compression.
2) An emerging standard for the compression and coding of continuous-tone, (i.e. grayscale or color) still images.

Junction Bo A connection point in an underfloor duct system that allows access to cables running in the ducts.

K

KHz Kilohertz. A unit of frequency equal to 1,000 hertz.

L

LAN Local Area Network. A communications system linking computers in a local area, usually a building or building complex.

Laser A device that produces monochromatic, coherent light through stimulated emission. An acronym for Light Amplification by Stimulated Emission of Radiation. A device which transmits an extremely narrow and coherent beam of electromagnetic energy in the visible light spectrum.

LASER Light Amplification by the Stimulated Emission of Radiation.

LATA Local Access Transport Area. LATA defines the public telephone network service boundaries within which most LECs (the RBOCs and GTE) can provide end-to-end multi-switch service. If the called party is inside a different LATA than the call originator, then the affected LECs must hand off the call to an IEC (such as AT&T, MCI, 360 Communications, etc.).

LCN Local Communications Network. A Layer 3 indicator which identifies the virtual circuit with which the data contained in the packet is associated.

LEC Local Exchange Carrier. The local telephone company, which could be either a Bell Operating Company (BOC) or an independent. which provides the local transmission services.

LED Light Emitting Diode. A semiconductor device which emits incoherent light from a p-n junction (when biased with an electrical current). It typically has a large spectral width.

LEN Local Exchange Network. Local exchange carrier owned, Broadband ISDN main switch which performs grooming, concentration, and switching.

LMR Land Mobile Radio System.

LAN Local Area Network. A geographically limited communications network intended for the local transport of data, video. and voice. Often referred to as a customer premises network.

M

MAN 1) Metropolitan Area Network. A network linking LANs and other networks at many sites within a city area.
2) A network connecting computers in the same city. ANSI X3T9 FDDI is the standard for a private MAN, where IEEE 802.6 is the standard for a public MAN.

Modem Short for modulator-demodulator: a device that converts audio tones of an analog telephone system to digital pulses and vice versa.

MPEG 1) Motion Picture Experts Group. A consortium of suppliers, users, and designers who are responsible for developing the motion picture video standard for digital compression. 2) The Emerging IS0 standard for the compression and coding of motion video at bit rates up to about 1.5 Mb/s and suitable for storage on digital storage media, e.g. hard disks, CD-ROMs, etc.

Multi-Fiber Cable
An optical cable that contains two or more fibers, each of which provides a separate information channel.

Multi-Channel Cable
An optical cable having more than one fiber.

N

NEMA National Electrical Manufacturers Association.

Network Interface
The point of interconnection between the outside service carrier's teIecommunications facilities and the premises wiring and equipment on the end user's facilities. Also called Network Demarcation Point.

Network Topology
The physical and logical relationship of nodes in a network. Networks are typically of either a star, ring, tree or bus topology or some hybrid combination thereof.

NEP Noise Equivalent Power. The optical input power to a detector needed to generate an electrical signal equal to the inherent electrical noise.

NTSC National Television Standards Committee.

0

OC-X Optical Carrier Level X Signal. The optical building block for SONET. Photons carrying DS3 plus additional overhead for a rate of 51.840 Mb/s. This is also the rate of the au STS-I.

OSI Open System Interconnect Reference Model.

OSI Model Layer 1
Physical Layer. Includes the transmission of signals and the activation and deactivation of physical connections.

OSI Model Layer 2
Link Layer. Includes synchronization and some control over the influence of errors within the physical layer.

OSI Model Layer 3
Network Layer. Includes routing and switching functions.

OSI Model Layer 4
Transport Layer. Uses Layers 1 to 3 to provide an end-to-end service with the required characteristics for the higher functions.

OSI Model Layer 5
Session Layer. Allows presentation entities to organize and synchronize their dialogue and to manage their data exchange.

OSI Model Layer 6
Presentation Layer. Includes data formatting and code conversion.

OSI Model Layer 7
Application Layer. Provides the means by which the user programs access the OSI environment and may contain part of the user programs.

P

Packet A grouping of binary data, typically from 1 to 5 12 characters in size, which usually represents one transaction. A packet is always associated with an address header and control information, and switched as a composite whole and arranged in a specific format. The term “Packet” is usually used to refer to a Layer 3 data unit in X.25.

Passive Bus A configuration of the ISDN basic interface having up to eight Terminal Equipments (TEs) connected in parallel, each having physical access to the D channel and to both B channels.

PAX Private automatic exchange.

PBX Private branch exchange.

PAS Personal Computer System

PAS Fiber Plastic-clad Silica Fiber.

Pixel 1) Contraction of “picture element.” A small element of a scene, often the smallest resolvable area, in which an average brightness value is determined and used to represent that portion of the scene. Pixels are arranged in rectangular array to form a complete image.
2) The fundamental “Picture Element” in a picture, i.e. a “dot” usually described by its location in the picture and certain attributes such as color, brightness, etc.

POTS “Plain old telephone system.”

Public Network

Can be shared by independent and even competing customers and thus has security and privacy features plus high availability and reliability. Must offer billing capabilities and inter-exchange carrier selection. To fit well into telephone networks, equipment must support standard operations support systems, standard transmission equipment and standard network equipment.

R

RAM Random Access Memory. A chip or collection of chips where data can be entered, read and erased. The basic idea of RAM is to speed your computer up. Your CPU could use your floppy as RAM, accessing your floppy every time it needed information, but this would be excruciatingly slow. RAM is the fastest memory device.

RDDS Radio Digital Data System.

DSS Radio Determination Satellite Service.

RF Radio Frequency. The electromagnetic spectrum which comprises frequencies from 10kHz to 4,000GHz

RFPA Radio Frequency Power Amplifier. After mixing, the signal is amplified to power levels appropriate for feeding the transmitting antenna. This final power level may be in the thousands of watts.

RFI Radio Frequency Interference.

RG/U "RG" is the military designation for coaxial cable, and "U" stands for "universal."

RS232 An EL4 recommended standard (RS); most common standard for connecting data processing devices.

RS-232C A serial asynchronous communications standard used to connect modems, terminals and printers with serial interfaces.

S

SCADA Supervisory Control And Data Acquisition. A common PC function in process control applications, where programmable logic controllers (PLDs) perform control functions but are monitored and supervised by a PC.

Scanner 1) A scanner used to trace out an object and build up an image.
2) A device that automatically measures or checks a process or condition and may initiate a desired corrective action by means of switching.
3) A device for sending recorded data, such as a supermarket bar code.

Serial Port A communications interface that uses one data line to transfer data bits sequentially. On the IBM PC the serial port refers to a standard serial interface which uses the RS-232C and ASCII standards.

Signal 1) Any electronic, visual or audible, indicator used to convey information. Signals are coded in frequency or amplitude to separate them from unwanted noise.
2) Any communication message-based device consisting of a write to a signal register.

Simplex Mode Operation of a communication channel in one direction only, with no capability for reversing.

Simulation 1) Simulation for design and monitoring. This is a technique whereby a model of the working system can be built in the form of a computer program. Special computer languages are available for producing this model.
2) Simulation of input devices. This is a program testing aid. For various reasons it is undesirable to use actual lines and terminals for some of the program testing. Therefore, magnetic tape or other media may be used and read in by a special program which makes the data appear as if they came from actual lines and terminals.
3) Simulation of supervisory programs. This is used for program testing purposes when the actual supervisory programs are not yet available. This type of simulation is the replacement of one set of programs with another set that imitates it.

Single Mode Containing only one mode. Beware of ambiguities because of the difference between transverse and longitudinal modes. A laser operating in a single transverse mode typically does not operate in a single longitudinal mode.

Single-fiber Cable
A plastic-coated fiber surrounded by an extruded layer of polyvinyl chloride (PVC), encased in a synthetic strengthening material, and enclosed in a PVC sheath.

Spread Spectrum
1) A method of transmitting and receiving RF signals. It involves sending part of a single signal over multiple narrow channels. The resulting signal looks like noise unless a rake filter is used.
2) Fast SMDS switching system that connects LANs together into a MAN.

STS Space-time-space digital switching structure.

STS-1 Synchronous Transport Signal Level 1. The electrical building block for SONET. Electrons carrying DS3 plus additional overhead for rate of 5 1.840 Mb/s. This is also the rate of an OC-1.

STS3 Synchronous Transport Signal Level 3. Rate is 155.520 Mb/s.

STS-3c Synchronous Transport Signal Level 3 Concatenated. SONET combines 3 STS-1 envelopes into one 150.336 Mb/s payload containing only one path overhead. This is known as the “Foundation for B-ISDN.”

STS-N Synchronous Transport Signal Level N. Rate is n times 5 1.840 Mb/s.

Synchronous Network

A network in which the clocks are controlled so as to run, ideally, at identical rates, or at the same mean rate with limited relative phase displacement. Note: Ideally the clocks are synchronous, but they may be mesochronous in practice.

SONET Synchronous Optical Network. A standard for fiber optic telecommunications interfaces, with a 1300 nm data link operating over a single-mode fiber at data rates of 52, 155, and 622 Mb/sec.

Synchronous Transmission

1) Transmission in which there is a constant time between successive bits, characters or events. The timing is achieved by sharing of clocking. The synchronizing of characters is controlled by timing signals generated at the sending and receiving stations (as opposed to start/stop communications).

2) Data communication protocol set where data is sent continuously. The receiver and transmitter are in constant bit synchronization. Character (byte) synchronization is achieved by a Layer 2 flag character transmitted at the start of each block.

T

T1 1) "Tee-One." ANSI - Telephony Committee open to the industry at large to develop U.S. standards for telecommunications. Coordinates U.S. participation in CCITT under auspices of the State Department. Agrees on content of CCITT Recommendations to be included in the national standard.

2) An AT&T term for digital carrier facility used to transmit a DS-1 formatted digital signal at 1.544 Mbps. A T1 frame has 24 timeslots or channels.

T3 Telecommunications transmission at 44.736 Mbps.

TAMS Telephone Answering Message Service.

Telecommunications

The transmission and reception of electrical or optical signals by copper wire, optical fiber, or electromagnetic means.

Tie Line A dedicated circuit connecting two private branch exchanges.

Token Used in shared medium access contention resolution for Token Ring, FDDI, Arcnet. There is one token which must be received then held by a station to transmit. When the transmission is completed, the token is passed to the next station.

Token Ring The IEEE 802.5 Token Ring protocol provides a deterministic method of shared media access. Two standards exist, one with 4-Mbit/sec operation and the other with 16 Mbit/set operation.

Traffic Engineering

(In a communications system), a network planning activity that determines the number and type of channels or communications paths required between switching points and the call-handling capacity of the switching points.

Traffic Flow (Again, in communications systems), flow on a group of circuits or switches equals the amount of traffic divided by the duration of the observation. The period of observation and the holding times are expressed in the same time units.

Transmission Line
An arrangement of two or more conductors or a wave guide used to transfer signal energy from one location to another.

Transmitter 1) An opto-electronic circuit that converts an electronic logic signal to an optical signal.
2) An electronic circuit or device that is capable of accepting analog or digital information, modifying it to suit specific media requirements and broadcasting the modified information.

TRANSMUX Transmultiplexer. An equipment that transforms signals derived from frequency-division-multiplex equipment (such as group or supergroup) to time-division-multiplexed signals having the same structure as those derived from PCM multiplex equipment.

Transponder A receiver and transmitter pair acting in concert.

Twisted Pair Two insulated copper wires twisted together. The twists, or lays, are varied in length to reduce the potential for signal interference between pairs.

Two-way Trunk
A trunk circuit that can be seized at either end of the circuit.

Two-wire Circuit
A circuit consisting of a singular pair of wires and capable of simultaneously carrying signals in opposite directions.

U

UL 1) Underwriters Laboratories. A private testing laboratory concerned with electrical and fire hazards of equipment. With SYSTIMAX SCS components, several abbreviations are used to designate the approved use.
2) Tested and listed by Underwriters Laboratories, a private testing laboratory concerned with electrical and fire hazards of equipment.

UMTS Universal Mobile Telecommunications System.

UNI User Network Interface. Point of access by the customer to the ISDN (narrowband or broadband) network.

UNIX Computer operating system AT&T that also works on some personal computers. Considered to be very flexible and very powerful and has enjoyed popularity among engineers and technical professions. Personal computer versions of Unix are Xenix (for IBM Pas and compatibles) and AU/X for Macintosh.

UTCS Urban Traffic Control System.

V

Vaporware A term for software (and sometimes hardware) that is discussed or advertised but is not yet available.

VHF Very High Frequency. The spectrum extending from 30 to 300 MHz as designated by the Federal Communications Commission.

VIPS Video Image Processing System.

VLF Very Low Frequency. The spectrum extending from 10 to 30 KHz, as designated the Federal Communications Commission.

VLSI Very Large Scale Integration. A manufacturing and design process that allows great quantities of electron components to be put on a single chip. Used for semiconductor devices such as microprocessors, memory and ASICs.

VOX Voice Operated Switching.

W

WAN Wide Area Network. A computer network covering a geographic area bigger than a city or metropolitan area. Treated as a subject distinct from a Metropolitan Area Network (MAN).

WATS Wide Area Telephone (or Telecommunications) Service.

Wavelength The distance an electromagnetic wave travels in the time it takes to oscillate through a complete cycle. Wavelengths of light are measured in nanometers (10^{-9} m).

Wideband Speeds between 1.5 Mb/s and 45 Mb/s. A service or system requiring transmission channels capable of supporting rates between 1.5 Mb/s and 45 Mb/s.

X, Y, Z

XMTR Transmitter.