Providing Technical and Management Services to Intelligent Transportation Systems in Alabama

By

John McFadden, Tom Novak, Maggie Govindu, and Kilim Reddy

Department of Civil & Environmental Engineering
The University of Alabama
Tuscaloosa, Alabama

UTCA Theme: Management and Safety of Transportation Systems

Prepared by

UTCA

University Transportation Center for Alabama
The University of Alabama, The University of Alabama at Birmingham, and
The University of Alabama in Huntsville

UTCA Report 00103
November 30, 2001

University Transportation Center for Alabama

About UTCA The University Transportation Center for Alabama (UTCA) is designated as a "university transportation center" by the U.S. Department of Transportation. UTCA serves a unique role as a joint effort of the three campuses of the University of Alabama System. It is headquartered at the University of Alabama (UA) with branch offices at the University of Alabama at Birmingham (UAB) and the University of Alabama in Huntsville (UAH). Interdisciplinary faculty members from the three campuses (individually or operating in teams) perform research, education, and technology transfer projects using funds provided by UTCA and external sponsors. The projects are guided by the UTCA Annual Research Plan. The plan is prepared by the Advisory Board to address transportation issues of great importance to Alabama and the region.

Mission Statement and Strategic Plan The mission of UTCA is "to advance the technology and expertise in the multiple disciplines that comprises transportation through the mechanisms of education, research, and technology transfer while serving as a university-based center of excellence."

The UTCA strategic plan contains six goals that support this mission, as listed below:

- Education – conduct a multidisciplinary program of coursework and experiential learning that reinforces the theme of transportation;
- Human Resources – increase the number of students, faculty and staff who are attracted to and substantively involved in the undergraduate, graduate, and professional programs of UTCA;
- Diversity – develop students, faculty and staff who reflect the growing diversity of the U.S. workforce and are substantively involved in the undergraduate, graduate, and professional programs of UTCA;
- Research Selection – utilize an objective process for selecting and reviewing research that balances the multiple objectives of the program;
- Research Performance – conduct an ongoing program of basic and applied research, the products of which are judged by peers or other experts in the field to advance the body of knowledge in transportation; and
- Technology Transfer – ensure the availability of research results to potential users in a form that can be directly implemented, utilized or otherwise applied.

Theme The UTCA theme is *"MANAGEMENT AND SAFETY OF TRANSPORTATION SYSTEMS."* The majority of UTCA's total effort each year is in direct support of the theme; however, some projects are conducted in other topic areas, especially when identified as high priority by the Advisory Board. UTCA concentrates upon the highway and mass transit modes, but also conducts projects featuring rail, waterway, air, and other transportation modes as well as intermodal issues.

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16. Abstract

This study reviews the past, assesses the present and outlines a plan for the future needs of Alabama's Intelligent Transportation System (ITS) initiative. This study reviews national and state ITS projects, and documents issues related to the success or failure of these projects.

Based on research conducted on ITS projects throughout the country and current ITS projects in the State, a need was noted for improvements in the methodologies used in planning, design, implementation and evaluation of ITS technology applications. Recommendations were made for strategies for overcoming institutional and technical issues regarding ITS programs.

This project found that video technology was the dominant ITS related technology in the State. Recommendations were made to build upon this existing infrastructure through the expansion of transportation management centers, implementation of fog detection systems, and use of automated enforcement programs to combat red light running, speeding and railroad crossings violations.

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Executive Summary

Intelligent Transportation Systems (ITS) are advanced technologies used to make transportation infrastructure operate more safely and efficiently. This study reviewed the past, assessed the present, and outlined plans for the future of Alabama ITS initiatives. This study also reviewed national and state ITS projects and documented issues related to the success or failure of these projects.

Based upon a review of ITS projects throughout the country and current projects in the State, improvements were recommended for methodologies used in planning, design, implementation, and evaluation of ITS technology applications. Strategies were recommended for overcoming institutional and technical issues regarding ITS programs.

This project identified video technology as the dominant ITS-related technology in the State. Recommendations were made to build upon this existing infrastructure through the expansion of traffic management centers and through implementation of technologies like fog detection and automated enforcement programs (red light running, speeding, and railroad crossings violations).

Section 1.0
Introduction

Major improvements and expansions to transportation infrastructure have occurred worldwide over the past 30 years. With the physical and financial limitations associated with the continuous expansion of this infrastructure, new tools like Intelligent Transportation Systems (ITS) are needed to accommodate increasing travel demand and improve safety. ITS is defined as a collection of tools that deploy information processing and integration, communications, and control technologies to improve traffic operations and safety (ITS Handbook, 1999). Simply stated, ITS involves application of technologies to improve the efficiency of the transportation infrastructure. Alabama currently has a modest ITS infrastructure when compared to major metropolitan areas in the United States.

1.1. Project Approach

The focus of this study was to perform an evaluation of Alabama's ITS program. The specific objective of this study was to review the past, assess the present and outline plans for the future of Alabama's ITS initiative. This objective of this research was completed via the following tasks:

Task I. ITS Literature/Project Review
The initial stage of this study included a compilation of relevant national and state literature related to the research topic. This review included analyses of ITS legislation, projects, and technologies in the State of Alabama and relevant nationwide projects.

Task II. Examine Issues Related to Alabama's ITS Initiative
Upon completion of the literature review for this research, additional information was collected on institutional and technical issues related to Alabama ITS initiatives. Major obstacles to ITS program implementation were identified and methodologies were developed for overcoming these issues. Potential benefits of ITS technologies for state and local government agencies, other than departments of transportation (DOTs), were identified. Alabama traffic safety data was reviewed to identify needs that could be addressed via ITS.

Task III. Provide Support to State and Local Government Regarding ITS Research
Contacts were made with State and local DOT's to offer ITS-related services. Based on these contacts, the following research topics were identified for further investigation:

- video detection,
- highway advisory radio,
- dynamic message signs, and
- transportation management center operations.

Task IV. Review of Safety Data and Identification of Potential ITS Opportunities
Safety data was reviewed using the Critical Analysis Reporting Environment (CARE) software (Brown et al, 2000). Recommendations were developed for potential ITS applications to address these safety problems.

Task V. Dissemination of Information
The findings from this research were disseminated via two short courses. The first ITS-related course was taught on the University of Alabama campus in the spring of 2000. The second course was a joint effort of this project and UTCA project 00202 ("Transfer of Transportation Management and Safety Technologies") and was taught on the campus of the University of Alabama in Birmingham in December of 2000. Additional information was disseminated through numerous papers published and presented at conferences. Finally, this research report was produced, published, and posted on the UTCA web site.

Section 2.0
Literature Review

Task I for this project involved a review of literature and projects relevant to ITS and Alabama's transportation system. The goal of this review was to provide an understanding of the breadth and depth of ITS. This information was used to assess potential applicability of ITS technologies for Alabama. The literature review included two sections. The first was a general overview of ITS, and the second was a review of selected ITS projects in Alabama and nationwide.

2.1 Introduction

ITS represents the next step in the evolution of the nation's transportation system (ITS Homepage, 2001). Advances in electronics revolutionize all aspects of our modern-day world and are being applied to our transportation network (ITS Homepage, 2001). These technologies include the latest in computers, electronics, communications, and safety systems (ITS Homepage, 2001). ITS applies these technologies to make more efficient use of the existing transportation infrastructure. ITS programs attempt to solve congestion and safety issues, improve operational efficiencies in transit and commercial vehicles, and reduce environmental impact.

2.2 ITS User Services

ITS technologies are typically segregated into rural and metropolitan elements. Additionally, they are categorized based on their application, and the application categories are identified as ITS "user services." A complete review of the 32 user services, standardized by the International Organization for Standardization (ISO), is given in Appendix A (ITS Handbook, 2000).

2.3. ITS Benefits

The USDOT's ITS Joint Program Office (JPO) collects information on the impacts of ITS and analyzes them on the basis of benefits. This information is published periodically to provide the research community with a basis for future improvements in the ITS program (ITS Benefits, 2000). The principle benefits include the following:

1. Safety
Crashes and fatalities are an inevitable part of the transportation system. This measure concentrates on the reduction of the number of crashes, and the probability of fatalities in these crashes.

2. Reduction of Delay
Reducing delay and saving travel time are two of the important goals of ITS services.

3. Cost
In general, ITS reduces operating costs and allows better productivity. ITS services may have lower acquisition costs compared to traditional options, and may also have lower life-cycle costs.

4. Capacity
The optimization of roadway capacity through ITS reduces the need for construction of new facilities, and saves time and money that might otherwise go into huge projects. Increasing throughput of existing facilities, measured in terms of either people or vehicles per unit of time, is a better approach to this issue.

5. Customer satisfaction
Customer satisfaction measures the effectiveness of the program and gives directions for future improvements.

6. Energy and environment
Environmental benefits resulting from some studies indicate positive impact of ITS on the environment. The long-term effects of the deployment of ITS services need to be estimated to determine the total impact on the environment.

2.4 ITS National Architecture

The national ITS architecture provides a framework for planning, defining, and integrating ITS (ITS Architecture, 2001). It reflects the diversity of ITS use in a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, consultants, etc.) over a five-year period, and defines the following important items (ITS Architecture, 2001):

1. functions (e.g., gather traffic information or request a route) that are required for ITS,

2. physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle), and

3. information flows that connect these functions and physical subsystems into an integrated system.

ITS architecture defines the functions necessary for implementing a user service, the location of these functions, the information flow, and the communication requirements for information flows. The requirements for the critical standards and the product standards in deployment are identified and specified by ITS architecture.

The national ITS architecture, a set of functional requirements based on user needs or user services, assures that the technology implemented is responsive to the needs of the people, thus achieving technology maturity. It may be viewed on a US DOT website (ITS Handbook, 2000). It promotes clear and articulate definitions of the key interfaces where the standards need to be applied. It helps identify the scope of various standards (e.g., local, regional, national, or international).

One of the main issues addressed by ITS architecture is risk management (ITS Handbook, 1999). By identifying the specific needs for the standards and the reasons for developing them, the architecture reduces the risk in product development by manufacturers. It also links ITS to the transportation planning process to produce better efficiency. It sets the base criteria for data sharing and software development. These are ways that the national architecture establishes the framework for future system expansions and technology updates (ITS Handbook, 1999).

2.5. ITS Standards

The diversity in users, applications, hardware and software are so great that standards must be applied to ITS products and services to ensure safety and system integration. Standards can be at the local, regional, national, international, or global level, so they must be clear and certain. They can be as simple as protocols and message sets for smooth data flow and information exchange (ITS Handbook, 1999). In a theoretical world, some agency or organization would define ITS standards for all to use during development or application. As an alternative, de facto standards can be set by the dominant manufacturer or supplier. The emergence of de facto standards led to the development of the ITS Critical Standards (ITS Handbook, 1999).

2.5.1 ITS Critical Standards

The U.S. Department of Transportation published a report on the critical standards in June 1999, coordinated by the Intelligent Transportation Society of America (ITSA). This report required by the Transportation Equity Act for the 21st century (TEA-21) (ITS Handbook, 1999). TEA-21 required USDOT to identify standards that are critical to the national interoperability or to the development of other standards. Critical standards designated as the national type "ensure national interoperability in those circumstances where large numbers of users, particularly mobile users, must access available ITS services" (Critical Standards, 1999). Critical standards designated as the foundation type are the standards that are needed for the development of other critical standards (ITS Critical Standards, 1999).

2.6 ITS Legislation

Two legislative acts have largely defined ITS programs. These were the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and the Transportation Equity Act for the 21st Century (TEA-21) of 1998. ISTEA provided funding for ITS in two key areas, namely research/development and deployment. Resources from ISTEA focused on conventional and innovative techniques to make America's transportation system safer. TEA-21 made progress toward better safety, protection of public health and the environment, and creating better opportunities for ITS use in public transportation (TEA Facts, 1999). Appendix B contains highlights of each of these Acts.

2.6.1 TEA-21 Financial Features

TEA-21 authorized a total of $1.282 billion in contract authority for the period 1998-2003 to fund the ITS program. Of this amount, $603 million goes to research, training, and standards development, $482 million goes to interoperability and integration in metropolitan areas, and $184 million goes to rural areas. In addition to these monies, ITS activities are eligible for funding under other programs. The following are some of the key ITS provisions in TEA-21 (TEA21, 1998).

- ITS funds are no longer limited to 100% of available funding. They are based on a formula distribution and receive a prorated share as do other federal-aid programs (Section 1102 of TEA-21).
- ITS funds are subjected to a limitation imposed on Research and Development (R&D) obligations (Section 5002).
- National Highway System and Surface Transportation Program eligibilities are clarified to specifically allow funds for infrastructure-based ITS capital improvements.
- Congestion mitigation and air quality (CMAQ) funding eligibilities are clarified to include programs or projects that implement ITS strategies.

TEA-21 guaranteed that each state received a minimum of 90.5% of the amount it contributed to the Highway Trust Fund. It included special programs to achieve mobility and access to jobs, health care, and recreational activities for all Americans. The fiscal year limitations in funding were as follows (Nagendranath, 2000):

1. not more than $15 million for a single metropolitan area,
2. not more than $2 million for projects in a single rural area,
3. not more than $35 million for projects in any one State,
4. outreach activities are limited to $5 million per year, and
5. projects over $3 million require an analysis of life-cycle costs of the operations and maintenance of ITS elements along with a multi-year financing and operations plan.

The funding was to be used primarily for integration in metropolitan areas. For projects outside of metropolitan areas, it may also be utilized for installation. At least 10% must go into integration in rural areas.

In addition to ISTEA and ITE-21 provisions, future transportation legislative issues are bound to affect ITS funding. An example is the current reauthorization discussions of TEA-21 (Nagendranath, 2000).

2.7 Alabama's ITS Initiatives

Alabama is working toward a strong infrastructure with an emphasis on transportation improvements. Since 1996, the State has acquired close to $11 million in earmarks for ITS programs. The dates, programs, and funded amounts are summarized in Table 2-1.

Table 2-1 Alabama ITS Earmarks (ITS State Reports, 2000)

Year	Amount	Information
1999	$1,978,673.78	Mobile, AL; Fog Detection*
1999	$791,496.51	Huntsville
1999	$989,336.89	Montgomery; Traffic Management System*
1998	$2,200,000.00	Tuscaloosa, AL; Traffic Integration and Flow Control*
1997	$2,000,000.00	Mobile; Fog Detection
1996	$3,000,000.00	Mobile; Fog Detection
Total	$10,959,507.18	
	$40 million/4years	Birmingham ATMS (CMAQ Money)*

*ITS programs in these four locations were evaluated in this project.

As of 2000, ITS deployment in the state of Alabama consisted of four programs which operated independently and utilized video technology for traffic management and safety. The programs were located in Birmingham, Mobile, Montgomery and Tuscaloosa, four of the major urban areas in the state (populations over 100,000). These programs have been reviewed by others (McFadden et al, 2000), and are summarized in the following sections of this report.

2.7.1 Mobile

The City of Mobile provides an example of taking ITS from its infancy to full deployment. The first ITS application in Mobile was variable message signing (VMS) technology. VMS was used in Mobile's Bankhead Tunnel to relay lane closing, maintenance work, and traffic crash information to drivers. Video detection is also used at various intersections and interstate ramps throughout the city (McFadden et al, 2000).

Perhaps the most widely recognizable ITS application in Mobile is the City's fog warning system. This was developed following a multiple-vehicle accident that took place on the I-10 bayway bridge, on March 20, 1995. The incident resulted in one fatality, 91 injuries, and 193 involved vehicles. The cause was excessive vehicle speed during a major fog event. Consequently, a warning system was developed to detect fog, provide adequate warning to motorists, inform motorists of detours, and reduce vehicle speeds. The system includes the following components to detect fog and warn motorists (McFadden et al, 2000):

- Weather monitoring station - condition detection
- Visiometer - measures visibility
- VMS - provides motorists with information and pre-programmed messages
- Changeable Speed Limit Signs- used for slowly reducing vehicle speeds
- Vehicle Detection Systems (VDS) - alerts motorists to congestion
- Tunnel Control Room Operation Center - operates 24 hours per day, 7 days per week, and 365 days per year; monitoring equipment, quad screen monitors, and alarms
- Closed Caption Television (CCTV) - traffic congestion and incident verification

The majority of the ITS projects implemented in the City of Mobile used ITS funding appropriated by Congress.

2.7.2 Montgomery

In the State Capitol of Montgomery, a simple plan was developed for the deployment of ITS technologies. The first phase included a closed loop along I-65 service roads and ramps in downtown Montgomery, installation of CCTV and VDS cameras, plus microwave radar equipment for traffic detection. Initial fiber optic cable construction was also included in Phase I.

As of 2000, the city was in Phase II of ITS deployment. This phase included installing fiber optic cable along the Montgomery bypass to create a ring around the City. The closed loop system will provide communications to the Alabama Department of Transportation (ALDOT) 6^{th} Division office and to the Montgomery Traffic Engineering Department.

Phases III and IV will include the deployment of more fiber optic cable throughout the City along major arterials. Additionally, CCTV cameras will be installed at a number of intersections for incident detection and congestion management. Use of VMS is planned for outlying areas. Finally, construction of a transportation management center (TMC) is planned at the 6th Division Office. The Montgomery system is designed as an open system that will be linked with agencies such as transit, fire, police, and emergency management systems (EMS). Funding for the Montgomery ITS projects has come primarily from Congressional appropriations (McFadden et al, 2000).

2.7.3 Tuscaloosa

The City of Tuscaloosa has taken a different approach from other cities in its implementation of ITS technology. Tuscaloosa developed its own ITS network, predominately with City funds, City equipment and City labor. In fact, it is fair to say that Tuscaloosa was the early leader in developing its own traffic operations center using video cameras and other surveillance methods.

The construction of Tuscaloosa's ITS network included the expansion of the City's TMC and installation of CCTV cameras at various locations throughout the City. Further expansion of the network will include the installation of additional fiber optic cable, VMS, and upgrading the traffic control center with advanced features and an active status map for TMC operations (McFadden et al, 2000). Also, the City plans to include other stakeholders such as the police and fire departments, and the City of Northport.

2.7.4 Birmingham

The metropolitan areas of Jefferson and Shelby Counties, which includes both the City of Birmingham and City of Hoover, has transportation problems and issues that are unique to large urban areas. For instance Birmingham must contend with CMAQ issues, which could limit transportation development due to air quality standards violations.

The first ITS deployment action was the creation of the Alabama Service and Assistance Patrol Program (ASAP). ASAP vehicles locate problems on the roadway and clear them as quickly as possible. The ASAP Program is a partnership between ALDOT and the Alabama Department of Public Safety.

The next phase of Birmingham's ITS implementation was deployment of fiber optic cable throughout downtown. This phase connected all stakeholders, including the fire department, police, EMS, city engineering department, and ALDOT. The cable will connect to CCTV cameras and VMS in the future. The cameras are mounted at high exposure locations and will provide overlapping coverage of freeway routes.

Future phases of ITS implementation in Birmingham will be installation of more fiber optic cable and CCTV, VDS, and microwave radar units in the metro area, and extending south to Shelby County. Finally, the City plans to begin work on a regional TMC. The center will be staffed and operated for approximately 16 hours per day. An operations manual is presently being developed for the TMC. It should be mentioned that the City also plans a WWW site for its map display, giving drivers access to real-time traffic data. The densely-populated City of

Hoover, a smaller municipality south of Birmingham, is currently constructing a CCTV surveillance system along US 31 and already has a traffic control center in its engineering office.

The purpose of Birmingham's video technology is to efficiently monitor arterials and interchanges and to achieve traffic signal optimization. Officials feel that using video technology saves time and money for the City by serving as the "eyes" for transportation officials and other government agencies. Video allows quicker incident management and saves money by reducing the manpower necessary for traffic observation. The City uses its video network for safety and transportation management only. There are no plans to use the technology for enforcement purposes. In addition to video traffic applications, the network is set up for access by the police department, fire department, and EMS. Providing access to the fire department allows fire officials to gain instant fire verification and severity estimation 24 hours per day without requiring that the center be manned around the clock.

The video network in Birmingham is predominately fiber optic in nature; however, there is some use of wireless technology. A Birmingham official interviewed for this report indicated that future video applications will move toward digital technology because fiber deployment can be reduced to a four-fiber connection, sonic network. The City intends to deploy 30 more cameras in the downtown area and 40 cameras along vital arterials. Officials expressed that a reasonable cost expectation for camera installation was approximately $24,000 for acquisition and installation of each camera unit.

While much of Birmingham's video deployment is in the developmental stage, officials have already begun to look toward the future. The hopes of city traffic engineers are to move from being restricted to "sight in the field and control in the office operation" to "control from the field and see from the office" using mobile data terminals.

Birmingham's deployment of video technology is a good example of how peripheral benefits may be achieved by the proper identification of stakeholders, which are then provided access to video data and advanced technologies (McFadden et al, 2000). For the ITS systems of any metropolitan area to be compatible with other nearby cities, the hardware for each city must be similar and the system architecture must be nonproprietary in nature. If ITS systems throughout the state lack these two things, then compatibility will be difficult.

2.7.5 Future of ITS in Alabama

ITS technologies will continue to develop in the above-mentioned metropolitan areas, and also in other cities across the State as transportation needs call for ITS applications. One example is the City of Huntsville. Officials there are developing a strategic plan for the implementation of ITS. First, the City plans to identify user services such as freeway management and incident management. Then, the city will identify stakeholders such as the fire department, police department, and EMS. The next course of action will be to install a fiber optic cable network along major arterials for connection to traffic signals and cameras. Then officials plan to add traveler information services and VMS displays (McFadden et al, 2000).

Another metropolitan region that plans to implement ITS technologies is the Muscle Shoals area. Plans are in the works to develop a fiber network with CCTV cameras, monitoring stations, and

VMS. A fog warning system has been proposed for the O'Neal Bridge crossing the Tennessee River. It would be similar to the bayway bridge system in Mobile.

As transportation problems develop across the state, the need for ITS technologies will intensify. Fortunately, the projects described earlier in the section can serve as benchmarks for ITS implementation strategies. Transportation officials can use them to determine what works well in Alabama (and what does not work well) to better address problems that can be solved through ITS (McFadden et al, 2000).

2.8 Review of National ITS Projects

The following section of this report reviews several national projects. They were selected because of their similarity to Alabama ITS initiatives, their proximity to the State, or their applicability to solve transportation challenges in Alabama (McFadden et al, 2000).

2.8.1 Atlanta, Georgia

The Georgia Department of Transportation (GDOT) began planning a statewide ITS in 1991, later named NAVIGATOR. The first phase of the system was in the Atlanta metropolitan area. GDOT's plan for Atlanta had four major categories: surveillance and detection, incident management, traveler information, and traffic control strategies. The first phase of Atlanta's ITS development was completed in 1996 (Atlanta NAVIGATOR, 1998).

NAVIGATOR is an integrated system that allows rapid updating of elements of the established ITS infrastructure. For example, signal timings and variable message signs can be updated by central operators via computer. Traffic information is also available in real-time on the Internet (McFadden et al, 2000).

The nerve center of the Atlanta ITS is its TMC, which is linked via fiber optic cable to satellite Transportation Control Centers (TCC). TCCs were established for five metropolitan counties, the City of Atlanta, and the Metropolitan Atlanta Rapid Transit Authority (MARTA). A comprehensive freeway management center used by the TMC consists of the following components (Georgia's NAVIGATOR, 1998).

- 66-color pan/zoom/tilt surveillance cameras,
- over 300 fixed black and white cameras,
- 41 VMSs,
- 318 video VDS cameras, and
- five ramp meters.

In addition to the above technologies, an incident management program was established to complement existing efforts. It consisted of the following components (Georgia's NAVIGATOR, 1998):

- 26 highway emergency response operators (HEROS),
- over 100 accident investigation sites,
- a motor vehicle emergency response (MOVER) team, and

- a metro-wide incident management task force.

Studies showed that the NAVIGATOR system produced an average reduction of 23 minutes in incident duration in 1997, resulting in cost savings of $44.6 million due to reductions in delay. Based upon an investment of $72 million (over the course of the system's development) for freeway and incident management components, a present worth benefit-cost ratio of 2.3 was obtained for 1997. However, the actual benefit-cost ratio for the NAVIGATOR system was probably much greater, because of the ultra-conservative manner in which the benefit-cost ratio was calculated (McFadden et al, 2000).

2.8.2 I-95 Corridor

For ITS development to continue to be successful in the United States, there must be an integration of systems covering both urban and rural areas. One such development is taking place along the I-95 Corridor spanning 13 states and the District of Columbia. By implementing a complex system of surveillance, the I-95 Corridor Coalition seeks to encourage the development of traffic management systems, travel demand management (TDM), and traveler information services (TIS). An early survey identified eight goals of the I-95 surveillance system (McFadden et al, 2000):

1. enhance traffic incident management,
2. enhance real-time traffic control operations,
3. enhance traffic management during snowstorms and other emergencies,
4. improve multimodal and intermodal transportation operations,
5. support TIS,
6. enhance the transportation systems planning database,
7. facilitate TDM strategy implementation, and
8. support traffic law and regulation enforcement.

The corridor length was estimated at 5600 miles. A survey of the corridor identified about 4000 traffic detection devices covering approximately 630 miles of roads. 2700 additional traffic detection devices were counted but the mileage associated with them was not known. Plans are for 504 more miles to be covered in the immediate future, after 3400 new traffic detection devices are deployed.

The conceptual surveillance system was designed for both urban and rural roads. Because the system is so land-intensive, design must focus on the integration of information from multiple sources and use of multiple technology types. Surveillance technologies must gather data for traffic management, TDM, intermodal transportation, traveler advisory information, and transportation facility planning. At locations with high incidences of traffic crashes, stand-alone incident detection systems will be installed. Other means for incident detection may originate from human surveillance, aerial surveillance, and in-vehicle Mayday devices. These other forms of notification will be implemented to the fullest in rural areas. The implementation of surveillance technologies will be beneficial in acquiring traffic data, and may also be used to gather data concerning pavement conditions, weather, and environmental conditions.

To ensure that the I-95 Corridor surveillance system will function properly, careful consideration has been given to the choice of technologies and the needs of coalition members. The technologies chosen for the corridor have region-wide application and impact. To test the usefulness of new technologies, field operations tests are being conducted, with the following objectives:

- assess the feasibility of integrating surveillance information from multiple sources,
- identify and formulate institutional arrangements that enhance cooperation of agencies and organizations that are gathering surveillance information,
- determine the best technology or technologies for implementation throughout the entire I-95 corridor, and
- gather information for the coalition to prepare a corridor-wide surveillance system deployment plan.

After the field operation tests have been conducted, preparation for deployment will begin. First, a traffic study will determine areas along the corridor that require surveillance. Next, monitoring and regular updating will occur for the surveillance technologies used at particular points along the Corridor. Finally, the cost database will be updated periodically. While the development of the surveillance system is an ongoing process, the design and deployment of technologies are important steps in the success of this corridor surveillance system.

2.8.3 Minnesota

The Minnesota Department of Transportation has made a concerted effort to provide innovative, technology-based traffic information in rural and small urban areas. These areas have experienced growth in traffic volume that generated increased needs for real-time traffic and weather data. Because the transportation and information needs of rural and small urban areas are rapidly evolving, it is necessary to develop solutions that are both flexible and upgradeable (McFadden et al, 2000).

A major portion of the solution involved placing transportation operations and communication centers (TOCC) in the St. Cloud and Duluth areas. These centers served as the precursors to a large development that will place TOCCs in seven more Minnesota cities. In addition to TOCC development, virtual transportation operations center (VTOC) software was used (McFadden et al, 2000).

The VTOC software allows a user to monitor and control the various ITS components operated by the TOCCs. Each individual component is integrated into a network that is accessible from the Internet, allowing users to operate the components from remote locations. The VTOC software provides the following features (McFadden et al, 2000):

- responsive - local needs and concerns were addressed as part of the design and deployment processes,
- innovative - VTOC solutions utilize new and emerging technologies linked to field proven devices,
- user friendly - current staff, with training, can operate and maintain the system,

- existing infrastructure - the new systems are designed to interface with existing systems and existing technology,
- fault tolerant - the VTOC system in one region can provide backup for another region since the operator can be located virtually anywhere,
- transferable - VTOC concepts are readily transferable and usable state and nationwide, and
- flexible- systems are designed for flexibility and expansion in order to accommodate new products and technologies.

Of particular interest to this research, the VTOC software allows transmission of video data through conventional or wireless means. Thus, a user can view traffic video feeds from a variety of locations via a personal computer connected to the Internet.

2.8.4 Des Moines, Iowa

The Des Moines metropolitan area is relatively small (92nd largest metropolitan area in the U.S.). In fact, it was the smallest city with an ITS program at the time the study was initiated. Cities this size may experience no more than modest congestion, and the key issue may become identification of appropriate ITS deployments for such situations. In Des Moines, the bottlenecks for the initiation of the ITS program were lack of congestion and competition with traditional transportation improvements for capital requirements (Kane, Maze and Pearce, 1999).

The Des Moines metropolitan area decided to use a systematic analysis of the situation and a strong estimate of future requirements as the basis for ITS deployment. Although the steering committee set a 20-year planning horizon, the work was divided into several steps. The ITS deployment plan was carried out in conjunction with the reconstruction of I-235. This might indicate that in a relatively uncongested urban area, the strategy should be proactive rather than reactive. The deployment of ITS in metropolitan areas that are inclined to support large construction investments requires strong leadership from the concerned authorities. Fortunately, Des Moines achieved such leadership (Kane, Maze and Pearce, 1999). This case study might be a good reference for ITS deployment in smaller urban areas, like those in the State of Alabama.

2.8.5 Europe

The literature review included ITS-related developments in Europe. The following paragraphs synthesize this review.

An American team visited Europe to study innovations in traffic control on that continent (ITS Handbook, 2000). The researchers noted a number of differences between American and European systems. These contrasts were both cultural and engineering in nature (ITS Handbook, 2000). Of importance to ITS was the observation that Europeans generally appeared to have greater respect for authority. This resulted in a higher level of compliance with traffic control regulations and devices.

From an engineering perspective, Europeans were utilizing new technologies faster than their counterparts in the United States. Additionally, European transportation agencies appeared to be more progressive in testing and implementing new technologies and applications of traffic control devices. In the ITS field, the use of advanced technology was more readily accepted by

European engineers. For example, Swedish engineers often integrated ITS solutions directly into their operations and did not call special attention to their use. This policy seems to reduce the likelihood that the innovative practices would be questioned for budgetary or non-technical reasons.

One of the primary innovations in Europe was "variable speed control." This system allowed transportation authorities to optimize traffic flow and safety in real time by dynamically changing the speed limit. This practice has been closely integrated with congestion detection and incident detection programs. Using loop detectors and video cameras, Sweden's motorway traffic management program has been employed in the Lundby Tunnel. The system measures traffic volumes and speeds; classifies vehicles; and detects incidents, wrong-way vehicles, disabled vehicles, and pedestrians. It resulted in a 23 percent reduction in overall accident rates and a 35 percent reduction in serious accidents.

Section 3.0
Examination of Issues Related to Alabama's ITS Initiative

The second task in this project was the identification of issues related to Alabama's ITS initiative, using two major groupings: technical and institutional/political. These groupings are described in this section of this report.

3.1 Technical Issues and Alabama ITS Initiatives

Identification of transportation needs was the first step. Matching appropriate ITS technologies to these needs was the second step. The following sections describe the methodology for this assessment, and identifies the ITS technologies that could enhance Alabama transportation infrastructure needs.

3.1.1 Evaluation of General Traffic Crash Trends in Alabama

The two criteria used to improve Alabama's transportation infrastructure using ITS were safety and congestion. These criteria are consistent with the UTCA theme and are the primary benefits of most ITS technologies. Four urban areas within the state have implemented ITS to reduce congestion and improve safety (see section 2 of this report). The safety analysis in this project was performed from a macroscopic perspective. The authors recognize that this type of analysis may mask some contributory factors related to crashes; however, the scope of this project was an overall system-wide needs assessment, not a case-by-case study.

Table 3-1 contains detailed crash data for Alabama from 1991 to 2000 (Alabama Traffic Crash Facts, 2000). Improvements in traffic safety are evident from 1998 until 2000. For example, the total number of crashes in Alabama increased steadily from 1991 through 1997 (24 percent), but from 1998 through 2000 there was a 4.8 percent reduction. Injury crashes followed a similar pattern as total crashes; from 1991 through 1997 there was an 18.5 percent increase in injury crashes, but from 1998 through 2000 there was an 11.7 percent reduction in injury crashes. The trend of increasing fatalities from 1992 through 1997 (15 percent increase) reversed to a 17 percent reduction from 1998 through 2000 (1190 fatalities in 1997 to 986 in 2000).

Vehicle miles traveled (VMT) increased at a 3.1 percent annual rate over this time period. Fortunately, the fatality rate per VMT dropped from 2.59 deaths per 100 million VMT in 1991 to 1.74 deaths per 100 million VMT in 2000. The following sections illustrate the results of a more detailed look into these crash statistics to identify specific crash characteristics that might be addressed through ITS treatment.

Crash type is one diagnostic tool to help identify contributory factors. Table 3-2 breaks down the types of crashes in Alabama in 2000. The most common crash was a vehicle-vehicle collision, which accounted for almost three quarters of all crashes. Other crash types of interest to this project include crashes with fixed objects (other object), crashes with animals, crashes with pedestrians, and crashes with trains.

Table 3-1 Alabama Crash Data, 1991 Through 2000 (Alabama Traffic Crash Facts, 2000)

Year	Total crashes (thousands)	Property-damage only crashes (thousands)	Injury crashes (thousands)	Fatalities	Vehicle miles traveled (VMT) (billions)	Mileage death rate *
1991	112.4	69.7	41.6	1110	42.92	2.59
1992	119.0	75.3	42.7	1033	45.76	2.26
1993	122.3	77.1	44.2	1040	47.34	2.20
1994	130.3	81.2	48.0	1082	48.96	2.21
1995	133.4	84.2	48.1	1113	49.02	2.21
1996	136.6	87.3	48.2	1142	51.29	2.23
1997	139.3	88.1	49.3	1190	53.40	2.23
1998	137.5	89.1	47.3	1071	55.20	1.94
1999	137.7	89.5	47.1	1148	56.41	2.04
2000	132.6	88.1	43.5	986	56.57	1.74

* Mileage Death Rate = Deaths per 100 million VMT.

Table 3-2 Types of Crashes for 2000 Alabama Traffic Crash Data (Alabama Traffic Crash Facts, 2000)

Type of Crash	Fatalities	Injuries	Crashes	Percent Crashes
Hit other vehicle	418	29,785	97,349	73.4
Hit fixed or other object	282	6,295	14,659	11.1
Overturning	78	1,702	2,333	1.8
Other non-collision	5	194	1,508	1.1
Hit animal	4	326	3,037	2.3
Hit pedestrian	51	426	540	0.4
Hit bicyclist	3	172	208	0.2
Hit railway train	9	46	89	0.1
Hit parked vehicle	4	374	3,818	2.9
All other	132	4,115	9,086	6.9
Total	**986**	**43,499**	**132,627**	**100**

A more-detailed analysis was required to identify factors that could be addressed via ITS technologies. Crash data was reviewed to determine location of the crashes. This review showed that 77,793 (58.6 percent) of all crashes occurred on the roadway, 31,609 (23.8 percent) occurred at intersections, 21,707 (16.4 percent) occurred off the roadway, 1,030 (0.8 percent) occurred at the median, and 89 (0.1 percent) occurred at railway tracks (Alabama Traffic Crash Facts, 2000). Over half of the total crashes (67,369) occurred on two-lane roadways. About 49 percent of rural crashes and 43 percent of rural fatalities occurred on county roadways, while 49 percent of urban crashes and 30 percent of urban fatalities occurred on city streets.

An additional review of crash data was related to driver causation factors. The primary causes of crashes are outlined in Table 3-3. Failure to yield right-of-way was the largest driver causation factor at 16.2 percent of all crashes.

Table 3-3 Primary Cause of Crash (Alabama Traffic Crash Facts, 2000)

Primary Cause	Number Crashes	Percent Crashes
Failed to yield right of way	21,452	16.2
Driver not in control	16,870	12.7
Misjudged stopping distance	15,017	11.3
Driving under the influence	4,649	3.5
Improper backing	2,477	1.9
Failure to heed sign	6,765	5.1
Tailgating	12,301	9.3
Excessive speed	3,046	2.3
Avoiding object or person	5,778	4.4
All other	44,272	33.4

3.1.2 Summary of Alabama Safety Trends and ITS Resources

As a result of traffic safety data analyses, the research team drew several conclusions pertinent to possible future ITS safety applications:

- VMT increased 31.8 percent between 1991 and 2000,
- mileage death rate decreased 32.8 percent from 1991 through 2000,
- total crashes increased 18 percent from 1991 through 2000, and
- total fatalities decreased 11.2 percent from 1991 through 2000.

From 2000 crash data (Alabama Traffic Crash Facts, 2000), additional interesting conclusions were drawn:

- vehicles striking other vehicles account for about three-quarters of total crashes,
- vehicles striking fixed objects accounted for 11 percent of total crashes,
- 70.5 percent of crashes in Alabama occurred in urban areas,
- 69.9 percent of all fatal crashes occurred in rural areas,
- 25.5 percent of all crashes involved drivers under the age of 25,
- 61 pedestrians were killed,
- 78.8 percent of all fatalities were not using seat belts, and
- failure to yield was the primary cause of 16 percent of crashes.

3.1.3 Urban Area ITS Opportunities in Alabama

Four urban areas within Alabama have an ITS infrastructure in place: Birmingham (Jefferson County), Mobile (Mobile County), Montgomery (Montgomery County) and Tuscaloosa (Tuscaloosa County). About 42 percent (55,030) of the total crashes in Alabama occurred in these counties in 2000. Since 70 percent of all crashes in Alabama occur in urban areas, it is understandable that these cities were the primary focus of Alabama ITS safety initiatives. Specific crash information for these four counties is compiled in Table 3-4.

A review was conducted to find ITS infrastructure technologies used in other locations to reduce typical urban crash types. Examples included automated enforcement of speeding, railroad crossings and signalized intersections. A good source of information on automated enforcement technologies was UTCA Report 00102, "Potential Applications of Video for Traffic Management and Safety." ITS applications can be used to address these accident types by carefully identifying the root problem, usually done best by integrating stakeholders into the planning process for ITS and TMC programs.

Table 3-4 Crashes in Four Alabama Urban Areas with ITS Programs (Alabama Traffic Crash Facts, 2000)

Accident Type	Jefferson	Mobile	Montgomery	Tuscaloosa
All Crashes	18.38	10.53	7.67	5.16
Fatalities	11.72	6.59	4.08	3.66
Over Speed Limit	9.95	4.78	1.71	4.59
Railroad Trains	13.33	9.17	0.83	12.5
Roadway Defect	15.3	8.09	2.08	3.25
Speeding	9.04	5.02	2.36	4.48
Work zone	12.05	11.26	5.53	12.6
Alcohol Related	9.62	9.24	4.44	5.16
School Bus	9.61	15.76	7.64	4.43
Bicycle	13.92	13.07	11.93	3.13

3.1.4 Rural ITS Opportunities in Alabama

There is also a need to implement ITS programs in rural areas, because 70 percent of fatal crashes occur there. Based on the review of crash data, it is believed that the most common crashes in rural areas are run-off-road, striking-fixed-object. There are low cost improvements to address this type of crash (HSIP, 2000), including edge of pavement and centerline rumble strips, removal of objects in the clear zone, and improvements to shoulders. Minnesota's rural ITS program, discussed in section 2 of this report, is a useful guide for potential Alabama applications in rural areas.

Variable message signs have been installed in some locations to address crashes: roadway segments that are prone to accidents due to excessive speeds, roadway segments that have challenging horizontal and vertical alignment, areas with frequent ice build-up, and areas with poor visibility due to fog, etc. Advance-warning signs at intersections are used to alert drivers of potential conflicts where there is drastic change in speed, lane widths, or land-use conditions (rural to urban) to reduce congestion and accident problems. Animal/vehicle collision warning systems are used in some areas with high animal migration patterns. Pedestrian/bicycle crossing signs are also used to provide warnings.

Motorist-aide call boxes can reduce emergency notification time and reduce traffic congestion caused by an incident for roadway segments with minimal services between communities. Emergency service response can be made more efficient through the use of the Global Positioning System (GPS) to pinpoint locations. A regional incident management plan can be prepared to help improve coordination between transportation and management agencies, which allows them to provide better emergency services.

3.2 Institutional Issues and Alabama ITS Initiatives

A review was performed of the four ITS programs in Alabama (illustrated in section 2) to identify situations when institutional barriers affected implementation. Institutional barriers can take many forms, but the focus areas for this study were the organizational arrangement and coordination of stakeholders associated with the ITS program.

3.2.1 Background

This project focused on the inter-relationships of stakeholders of ITS programs. The various stakeholders associated with ITS deployment are highly specialized and accustomed to focusing on their own area of either traffic or safety management (Bunn et al, 2001). A typical stakeholder mix includes both public and private sector players who sometimes appear to have conflicting objectives. Moreover, the stakeholders must "market" the concept to senior government officials, internally within their own organizations, and to the public. For these reasons, it is helpful to develop an institutional model of stakeholder relationships to: a) understand the motivations of each stakeholder; b) provide a framework for facilitating cooperation; and c) educate others on the importance and value of the system (Bunn et al, 2001).

3.2.2 Stakeholder Identification

Stakeholders are those groups, organizations, or other entities that have an influence upon the deployment of an ITS technology. Key stakeholders could include (but are not limited to) local and state DOTs, traffic management centers, medical centers and EMS providers, wireless service providers, device manufacturers, and vehicle manufacturers. Stakeholder analysis should be used for the following actions (Bunn et al, 2001):

- identify and map key stakeholders,
- classify these key stakeholders in terms of their salience, and
- establish the incentives for alliances and joint ventures.

In short, strategic stakeholder analysis provides the theoretical tools for identifying, differentiating among, and drawing together the most relevant set of stakeholders for the deployment of an ITS technology.

The stakeholders involved in ITS program deployment must make critical decisions that have important implications for their organizations. Many of these decisions involve significant investments. In addition to the strategic stakeholder analysis research discussed above, the area of industrial marketing or "business to business" marketing was analyzed for the Birmingham area (Bunn et al, 2001). Bunn's project examined organizational buying behavior of both firms and government entities because ITS technology requires investments on the part of stakeholders. In particular, research shows that organizational members may approach decisions differently and will rely on various information sources to make their decisions (Bunn et al, 2001). Understanding the decision-making process and the organizational members' perceptions of risk sheds light on the motivations of stakeholders to invest in an ITS program (Bunn et al, 2001).

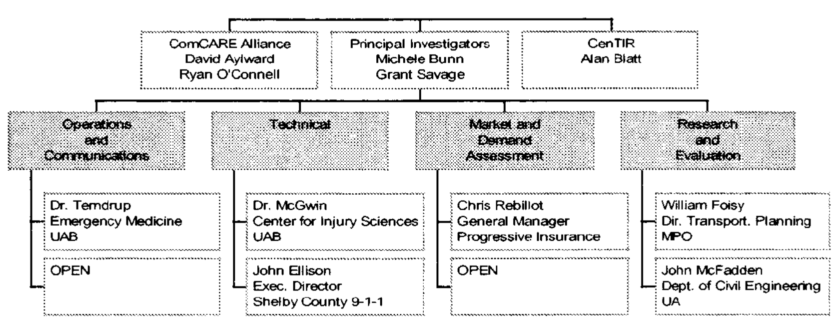
3.2.3 Case Study

The findings from UTCA project 00101 entitled "Development of an Integrated Traffic Management Center" are closely related to this topic, and provided an example procedure to overcome institutional barriers (Bunn et al, 2000). Bunn's study used the City of Birmingham as a pilot location to plan an integrated traffic management and emergency communication system based primarily on wireless technologies. The following stakeholders were identified:

- 9-1-1 operators,
- commercial end-users and suppliers,
- ALDOT,
- education/research community,
- industry trade associations,
- medical providers,
- non-profit organizations,
- police/fire,
- pre-hospital (EMS, trauma),
- regional planning organizations, and
- traffic management.

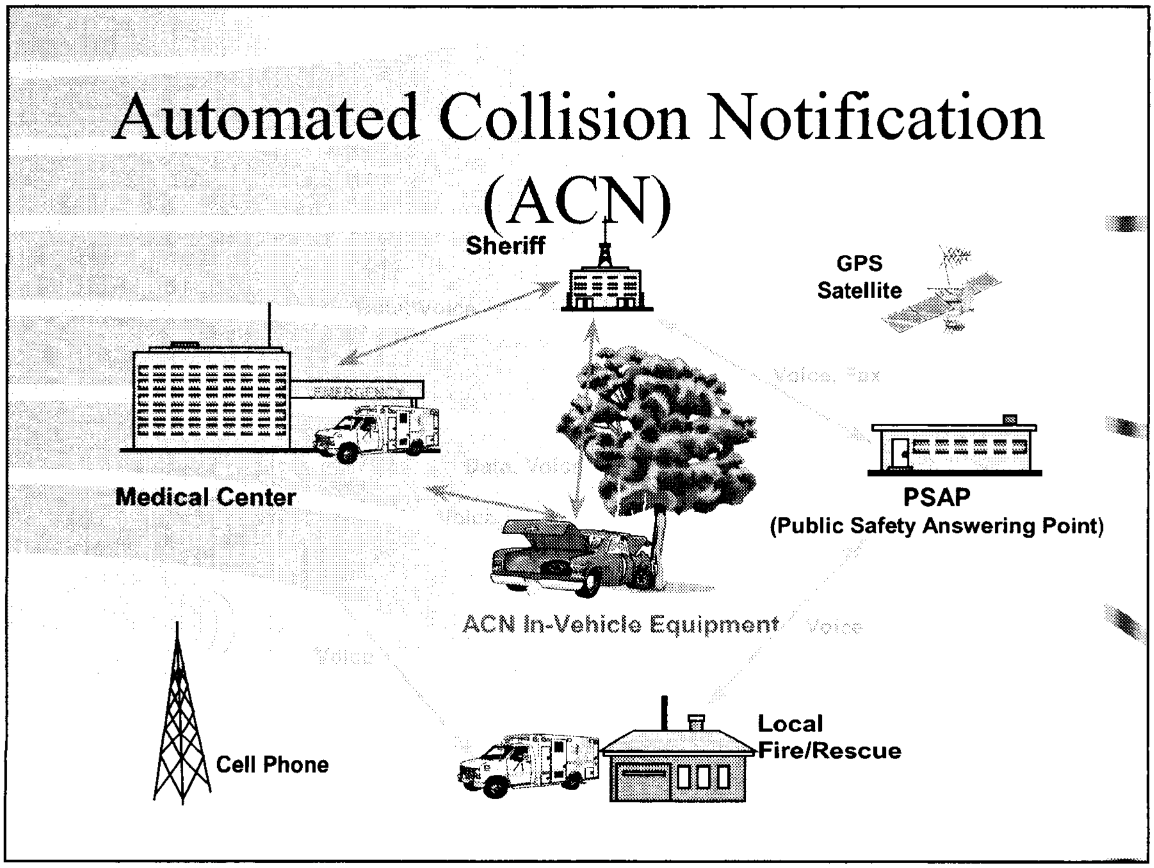
Effective coordination of interests of this wide variety of stakeholders is needed for implementation of the project. A work group was formed to ensure that communication was efficient among stakeholders. This group was dubbed the "Tiger Team," and had the organizational structure illustrated in Figure 3-1 (Bunn et al, 2000). The Tiger Team provided a forum so that stakeholders involved in the project could voice their opinions and learn the opinions and concerns of others.

Figure 3-1 Tiger Team Organizational Structure



3.2.3.1 Project Results
An integrated traffic management and safety system model is illustrated in Figure 3-2 (Bunn et al, 2000). Even though the conceptual model has been developed, the actual deployment of such a system has yet to take place (Bunn et al, 2001). There is a pressing need for a deployment demonstration to verify the strengths of the integrated approach and to identify unforeseen problem areas. At present no location has implemented a traffic management and safety system as described in Bunn's research (Bunn et al, 2000).

Figure 3-2 Conceptual Model of Integrated Management and Safety System (Bunn et al, 2000)



While there have been numerous efforts to improve the efficiency and safety of our highway transportation system, these efforts typically focus attention on a single area – such as improved highway construction, better management of traffic flow, or enhanced response to trauma incidents (Bunn et al, 2001). Little or no effort has been directed at coordinating these different aspects or to considering how efficiencies and safety can be leveraged for better use of public and private funds.

The proposed Birmingham project took advantage of eight developments in national and state circumstances (Bunn et al, 2001):

1) concern for highway safety is intensifying among Alabama citizens,
2) the number of wireless subscribers in the Birmingham area is increasing rapidly,
3) crash response and traffic management systems are increasingly justified because of their social and economic benefits,
4) UAB is successfully operating a six-county trauma response network,
5) the City of Birmingham Traffic Engineering Department has begun an ambitious enhancement of its traffic management system,
6) the FCC has mandated that wireless carriers upgrade their networks to provide Enhanced 9-1-1 (E9-1-1) by the year 2001,
7) ITS applications increasingly focus on integrating rich data from a multitude of sources, communications applications, information processing, and in-vehicle systems information, and
8) US DOT is encouraging both research and deployment of integrated ITS applications.

This confluence of events and trends created an opportunity to pursue an ITS vision for the State of Alabama. That vision included improved traffic flow, better management of incidents, fewer crahses, improved survival rates from crashes, and lower severity of injuries (Bunn et al, 2001). To seize this opportunity will require an unprecedented level of cooperation among public and private stakeholders. Unfortunately, many barriers must be overcome. For example, in the rush to take advantage of new technologies for intelligent transportation applications, institutional and business issues have been largely overshadowed. The future success of ITS initiatives rests on the assumption that the private sector is willing to invest in the deployment of new technologies (Bunn et al, 2001).

Numerous companies are researching commercial applications that could be offered to public and private entities, but the applications have not been marketed because the public sector has not yet deployed integrated systems. Few firms are willing to take the next step because of insufficient coordination and weak public funding for the infrastructure. Lack of high-level state support for these programs has further inhibited these efforts. Thus, the major stakeholders have little guidance to assist in the analysis and evaluation of these opportunities from a system-wide perspective.

This unique situation has no clear precedent in Alabama history. Yet, even while there is no direct analogy for this problem, there are two major research areas that have the potential for developing an institutional model for success. The first of these concerns the technical and institutional issues related to wireless location platforms and the applications made possible with wireless technologies. Two national partners, ComCARE Alliance and the Center for Transportation Injury Research, provided important information and contacts in this topic area. The second area concerns management and marketing theories that provide a framework for successful deployment of the technologies. The project conducted by UTCA helped with this (Bunn et al, 2001).

3.3 Methodology for Successful Implementation of ITS Programs

In reviewing the case study and relevant literature, strategies for successful implementation and evaluation of ITS programs were identified. The World Council for ITS identified a three point strategy for successful development and implementation of ITS programs--conceptual plan, implementation plan, and project management. The steps associated with these stages are illustrated in Table 3-6. This strategy is recommended to for the future ITS initiative in Alabama.

Table 3-6 ITS Program Development Strategy

Planning Stage	Steps
Stage A: Conceptual Planning	1. Identify stakeholders 2. Inventory existing ITS systems 3. Analyze regional transportation needs 4. Assess the potential for ITS 5. Specify the requirements for ITS Architecture 6. Documentation
Stage B: The ITS Implementation Plan	1. Develop an ITS regional architecture 2. Secure an organizational framework 3. Develop effective coordination techniques 4. Securing interagency operational agreements 5. Program planning
Stage C: Project Management	1. Set the goals 2. Timetables 3. Managerial factors 4. Public sector commitment 5. Communications plan

Another example is the plan developed by the USDOT Joint Program Office (JPO) for evaluating and implementing ITS programs. The steps in the JPO plan are listed below:

- form evaluation team--a team should be composed of representation from all stakeholders and project partners,
- develop evaluation strategy--the major focus should be on the prioritization of goals, based on the opinions of all the stakeholders,
- develop the evaluation plan--the evaluation plan formulates hypotheses on expected outcomes of the project, and refines the evaluation approach. Non-technical issues like procurement practices, contracting policy, and organizational structure also require attention,
- develop one or more test plans--a test plan lays out details of procedures and resources required for each test,
- collect and analyze data and information--cooperation among implementing partners and the evaluators is essential for saving time and money. By careful planning, an automated data collection can be built into the implementation plan, and
- prepare the final report--document the evaluation strategy, plans, results, conclusions, and recommendations. The information needs to be disseminated to all the members of the team and the local partners.

Section 4.0
ITS Technical and Management Support Services Provided to Alabama

This task involved providing expert support services to state and local transportation officials for ITS technologies and management strategies. An outreach effort was conducted to assist transportation professionals in identifying technical aspects of ITS applicable to their organizations. Based on these contacts, the following ITS topic areas were identified for further research:

- highway advisory radio,
- dynamic/variable message signs, and
- transportation management center operation.

The following sections of this report review and amplify the findings from this portion of the project.

4.1 Highway Advisory Radio (HAR)

HAR is a real-time tool used to update travelers on travel information through a radio broadcast. The FCC licenses HAR as a Travelers Information Station (TIS). Its main applications include maintenance/construction zones, traffic advisories, route diversions, special events, weather advisories, and tourist information. HAR stations are operated with low-power transmitters placed along the roadside. Advisory signs are used to inform the driver of the existence of HAR. These signs also provide the station's frequency so drivers can tune their radios to receive traffic information. Figure 4-1 is an example of a HAR notification sign.

Figure 4-1 Message Board Indicating HAR Radio
(Source: www.co.rowan.nc.us)

HAR is a non-commercial broadcast that plays short messages (usually lasting less than 60 seconds) of travel-related information. It can be very helpful to drivers who are not familiar with the location and who are trying to make driving decisions (in the vicinity of air, train, and bus transportation terminals, public parks, historical sites, bridges, tunnels, and highways). HAR is regulated by FCC guidelines, and the agency in charge of operating the station is required to update all posted information as the prevailing conditions change (HISP, 1998). HAR typically provides the following types information (HAR, 1982):

- current traffic conditions,
- travel restrictions,
- notices of events,
- directions to popular tourist attractions, and
- general safety information,

Several helpful findings were noted during a review of HAR programs. For example, a HAR system was implemented on the New Jersey Turnpike in July 1992 (HISP, 1998). Different frequencies were used to give instructions to motorists traveling in opposite directions (1610 AM for south bound and 590 AM for northbound). The station provided motorists with up-to-the-minute reports on road and traffic conditions, and was a good example of successful HAR application.

Minnesota DOT performed a project on usage of HAR that showed that over 80% of drivers took an alternate route after they received instructions recommending a diversion, and as few as 2% indicated that they did not know about the information broadcast on the radio station (HISP, 1998).

Another study in New Braunfels, Texas showed that as high as 91% of the drivers who were new to the area diverted to another route after tuning to a local HAR (HISP, 1998). The study showed that the continuous traffic information HAR offers is more useful than conventional radio traffic broadcasts.

HAR is gaining popularity as a tool to address congestion and to improve safety. The latest improvements in HAR systems (e.g., mobile and portable HAR) are helpful in situations of chemical or hazmat spills, detours, construction and work zones, weather related incidents, lane closures, and other special circumstances.

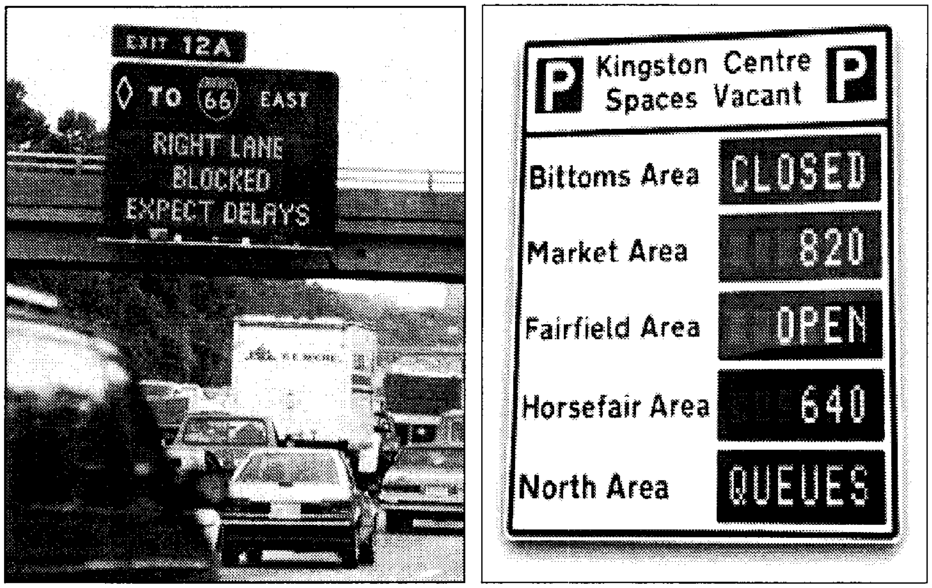
4.2 Variable Message Signs (VMS)

The use of VMSs to provide traffic-related information, route guidance, and similar information is another step in the evolution of ITS. VMSs are programmable traffic control devices that display messages composed of letters, symbols or both. VMSs can provide information about recurring congestion, non-recurring congestion, weather-related hindrances, alternate routes, speed restrictions, and other traffic-related problems. The source of this information is often a traffic surveillance system. The VMS concept is well received by motorists, and is usually preferred over static signs.

VMS letter height and location affect performance of the system, and are designed to match site requirements using information provided in the Manual on Uniform Traffic Control Devices

(MUTCD). The MUTCD states that the driver should be able to read the message at least twice while traveling (MUTCD, 1989). The VMS should be within the driver's cone of vision to be identifiable. The use of fiber optic technology, fuel cells, light emission diodes , and other emerging technology will continue to enhance VMS. Two examples of VMS are shown in Figure 4-2.

Figure 4-2 Example Variable Message Signs
(Source: www.tfhrc.gov and tcsu.org.uk)



4.3. Transportation Management Centers (TMCs)

A transportation management center (TMC) is the nerve center of a transportation management system. The TMC is the location where information is collected and processed. Applicable portions of this information can then be sent to drivers using the Internet, highway advisory radio, variable message signs, and news media. There are three main types of transportation management centers. They include freeway management centers, traffic signal system centers, and transit management centers (ITS Handbook, 1999). All three combine ITS user services to provide safe and effective traffic management.

TMC's are usually focal points for monitoring and communications with local agencies, and they are also used to disseminate information to drivers and pedestrians. These centers focus on traffic management during peak periods. TMC's allow early incident identification. This reduces response times, resulting in reduced vehicular delay and carbon monoxide emissions. The theoretical approach to TMCs allows each jurisdiction to maintain its own center, while at the same time all centers are networked together in case of an incident (ITS Homepage, 2001).

4.3.1 Case Study—Anaheim, California TMC

The TMS in Anaheim, California was reviewed because of its success. Anaheim has an overwhelming number of tourists, and handling special events is very important to this area.

Anaheim's TMC has been in operation since 1988; however, the facility was updated in 1992. The new center was designed to meet the following criteria:

- monitor the traffic network once per second,
- provide an easy upgrade path as new technologies and requirements evolve,
- reduce in-the-field law enforcement personnel managing traffic during special events by systematically managing the traffic network, and
- promote integrated control of the surface streets and freeways by providing an electronic interface with California Department of Transportation for exchanging traffic management information.

The City used video camera technology with VMS technology to move information to and from drivers. A motorist information system was established, incorporating information kiosks, HAR, highway advisory telephone, and a local CCTV feed (ITS Benefits, 2000).

4.3.2 Case Study—NAVIGATOR, Atlanta, Georgia

The NAVIGATOR system was introduced previously. This portion of the report addresses the effectiveness of NAVIGATOR as a TMC for incident detection and traffic management using HAR and VMS. Once NAVIGATOR detects an incident, highway emergency response operators (HEROs) are dispatched to respond to the accident. The primary goal of HEROs is to minimize the disruption of normal traffic flow at an incident site. They minimize response times by assigning patrol shifts to designated routes during peak hours. During peak hours, the HEROs patrol approximately 170 miles of metro-Atlanta highway. As indicated by Table 4-1, the number of assists and accident responses incidents climbed dramatically from 1996 to 1998. In addition, the table shows that response times were reduced by two minutes, which is very important because saving time makes a difference in saving lives of critically injured motorists (HISP, 1998).

Table 4-1. 1996-1998 Response Times Using NAVIGATOR

PROGRAM	1996 Totals	1997 Totals	1998 Totals
Assists	15,630	15,158	28,708
Accidents	2,084	2,748	5,029
Total	17,714	17,906	33,737
Average Response Time		12 minutes	10 minutes

NAVIGATOR utilizes VMS at key decision-making points on area interstates, where operators can inform motorists of travel times and display incident messages. These messages are updated every two to three minutes to allow motorists to make informed decisions about alternate routes. NAVIGATOR reaches the cities of Atlanta, Athens, and Savannah, and will be expanded to other cities (Atlanta NAVIGATOR, 1998). Figure 4-3 shows a NAVIGATOR traffic management center and a HERO response vehicle.

Figure 4-3 Photos of NAVIGATOR Center and HERO Vehicle
(Source: http://www.georgia-navigator.com)

Section 5.0
Alabama's ITS Initiative Opportunities and Safety

Safety analyses (beyond those mentioned in Section 3) were conducted to identify ITS applications appropriate for traffic safety treatments in Alabama. The study was conducted on crash data from the years 1996-98, and was performed using the Critical Analysis Reporting Environment software (Brown et al, 2000). The findings from this study are presented in the following paragraphs.

5.1 Data Acquisition

Crash data for the years 1996-1998 was obtained from *Alabama Traffic Crash Facts* (ALDOT Crash Facts), and from data embedded in the Critical Analysis Reporting Environment (CARE) system. CARE is "designed to provide individual decision-makers within the traffic and aviation safety communities direct access to accident and incident information." CARE was developed at The University of Alabama to provide a simple tool to access vast databases of crash information, and is readily accessible via the Internet (Brown et al, 2000).

5.2 General Crash Facts and Trends

General crash data for Alabama during the study period is summarized in Table 5-1. Variables included in this summary are vehicle miles traveled (VMT) for each year and the rates for accidents, injuries, and deaths per million VMT.

Table 5-1 General Alabama Crash Data

	1996	1997	1998
Accidents	136,456	139,344	137,509
Injuries	48,200	49,202	47,310
Fatalities	1,142	1,190	1,071
Vehicle Miles Traveled (VMT) in Billions	51.3	53.4	55.2
Accidents / million VMT	2.66	2.61	2.49
Injuries / million VMT	0.94	0.92	0.86
Deaths / million VMT	0.022	0.022	0.019

Several conclusions can be drawn from the table. First, the number of crashes each year is very high, almost 400 per day. And, there are 130 injuries from crashes each day. These are big numbers! Fortunately, the data indicates that crashes, injuries and fatalities all fell during the three-year study period despite a steady increase in VMT. The other good news is that rates for all three categories declined. However, there is still a great deal of work to do on this serious problem.

Another general analysis was conducted to obtain the number of accidents, persons injured, and persons killed for Alabama on a county-by-county basis. This information is presented in Table 5-2. The authors have provided it to allow individual counties to perform safety analyses as part of their ITS planning and implementation activities.

Table 5-2 County-by-County Crash Data (Part 1)

County	Number of Accidents			Persons Killed			Persons Injured		
	1996	1997	1998	1996	1997	1998	1996	1997	1998
Jefferson	26102	24963	25278	95	116	121	7342	6908	6824
Mobile	14213	14812	14484	98	79	67	4380	4452	4520
Montgomery	11157	10869	10545	40	35	45	3375	3413	3232
Autauga	1200	1280	1190	11	17	13	431	525	395
Baldwin	3144	3550	3560	36	32	45	1192	1283	1194
Barbour	706	688	643	5	9	8	281	257	249
Bibb	315	306	231	11	13	6	135	184	119
Blount	1027	1122	1042	11	15	10	425	479	477
Bullock	179	165	157	5	3	3	88	89	91
Butler	708	784	647	22	13	13	328	326	308
Calhoun	3969	3655	3492	29	25	28	1399	1317	1202
Chamber	1035	1066	1075	10	18	10	388	377	412
Cherokee	422	478	446	5	5	9	211	245	263
Chilton	1019	1020	1021	19	18	16	379	412	404
Choctaw	222	223	223	8	7	6	150	142	104
Clarke	513	594	579	11	12	5	278	272	304
Clay	189	188	182	5	4	4	118	152	99
Cleburne	419	465	450	8	20	12	180	181	162
Coffee	1081	1096	990	16	14	12	506	464	356
Colbert	1760	1644	1599	6	21	10	671	604	558
Conecuh	387	385	394	24	5	11	176	208	202
Coosa	250	256	280	7	6	6	167	167	142
Covington	766	887	728	4	14	11	351	371	308
Crenshaw	302	276	249	8	6	3	102	130	116
Cullman	2085	2160	2343	15	28	20	739	837	744
Dale	992	998	946	10	11	3	385	389	328
Dallas	1510	1587	1491	12	12	15	550	535	621
DeKalb	1625	1655	1679	21	14	17	749	633	663
Elmore	1424	1495	1487	24	20	14	588	630	616
Escambia	921	807	881	18	11	11	449	358	427
Etowah	3302	3356	3277	26	30	22	1323	1303	1272
Fayette	386	389	407	9	5	11	184	234	206
Franklin	687	675	721	5	3	9	300	322	299
Geneva	447	464	444	11	2	8	238	248	240
Greene	312	283	306	6	7	8	156	146	146
Hale	261	309	282	6	5	4	136	168	112
Henry	327	281	330	3	6	4	141	119	134
Houston	3471	3594	3532	20	22	20	1493	1639	1595
Jackson	1112	1049	1038	23	26	18	499	470	406

Additional data for (Part 1) counties may be found on the next page

Table 5-2 County-by-County Crash Data (Part 1) (continued from previous page)						
	Vehicle Miles Traveled (VMT)			Accidents per Million VMT		
County	1996	1997	1998	1996	1997	1998
Jefferson	7.43E+09	7.72E+09	8.03E+09	3.51	3.23	3.15
Mobile	3.55E+09	3.69E+09	3.84E+09	4.00	4.01	3.77
Montgomery	2.25E+09	2.34E+09	2.43E+09	4.96	4.64	4.33
Autauga	4.35E+08	4.52E+08	4.70E+08	2.76	2.83	2.53
Baldwin	1.45E+09	1.51E+09	1.57E+09	2.17	2.35	2.27
Barbour	4.19E+08	4.36E+08	4.53E+08	1.69	1.58	1.42
Bibb	2.05E+08	2.13E+08	2.21E+08	1.54	1.44	1.04
Blount	5.05E+08	5.25E+08	5.46E+08	2.03	2.14	1.91
Bullock	1.40E+08	1.46E+08	1.51E+08	1.28	1.13	1.04
Butler	4.15E+08	4.31E+08	4.48E+08	1.71	1.82	1.44
Calhoun	1.50E+09	1.56E+09	1.62E+09	2.65	2.34	2.15
Chamber	3.44E+08	3.58E+08	3.73E+08	3.00	2.98	2.89
Cherokee	2.54E+08	2.65E+08	2.75E+08	1.66	1.81	1.62
Chilton	5.62E+08	5.85E+08	6.08E+08	1.81	1.74	1.68
Choctaw	1.82E+08	1.89E+08	1.97E+08	1.22	1.18	1.13
Clarke	2.78E+08	2.89E+08	3.00E+08	1.85	2.06	1.93
Clay	1.60E+08	1.66E+08	1.73E+08	1.18	1.13	1.05
Cleburne	2.77E+08	2.89E+08	3.00E+08	1.51	1.61	1.50
Coffee	4.01E+08	4.17E+08	4.34E+08	2.69	2.63	2.28
Colbert	6.01E+08	6.25E+08	6.50E+08	2.93	2.63	2.46
Conecuh	3.17E+08	3.30E+08	3.43E+08	1.22	1.17	1.15
Coosa	1.82E+08	1.90E+08	1.97E+08	1.37	1.35	1.42
Covington	4.32E+08	4.49E+08	4.67E+08	1.77	1.98	1.56
Crenshaw	1.88E+08	1.96E+08	2.03E+08	1.61	1.41	1.22
Cullman	7.67E+08	7.98E+08	8.30E+08	2.72	2.71	2.82
Dale	5.82E+08	6.06E+08	6.30E+08	1.70	1.65	1.50
Dallas	3.67E+08	3.81E+08	3.97E+08	4.12	4.16	3.76
DeKalb	6.79E+08	7.06E+08	7.34E+08	2.39	2.34	2.29
Elmore	5.17E+08	5.38E+08	5.60E+08	2.75	2.78	2.66
Escambia	4.62E+08	4.81E+08	5.00E+08	1.99	1.68	1.76
Etowah	1.13E+09	1.17E+09	1.22E+09	2.93	2.86	2.68
Fayette	2.21E+08	2.30E+08	2.39E+08	1.75	1.69	1.70
Franklin	4.29E+08	4.46E+08	4.64E+08	1.60	1.51	1.56
Geneva	2.79E+08	2.90E+08	3.02E+08	1.60	1.60	1.47
Greene	2.30E+08	2.40E+08	2.49E+08	1.35	1.18	1.23
Hale	1.68E+08	1.75E+08	1.82E+08	1.55	1.77	1.55
Henry	2.50E+08	2.60E+08	2.70E+08	1.31	1.08	1.22
Houston	1.01E+09	1.05E+09	1.09E+09	3.43	3.41	3.23
Jackson	7.18E+08	7.46E+08	7.76E+08	1.55	1.41	1.34
Additional counties may be found in Part 2, on the next page						

Table 5-2 County-by-County Crash Data (Part 2)

	Number Accidents			**Persons Killed**			**Persons Injured**		
County	1996	1997	1998	1996	1997	1998	1996	1997	1998
Lamar	118	124	144	3	5	1	83	75	87
Lauderdale	2580	2510	2532	31	19	17	832	827	791
Lawrence	629	641	724	9	8	14	306	285	345
Lee	3606	3983	3687	24	26	18	1245	1255	1196
Limestone	1629	1750	1813	18	31	22	685	692	674
Lowndes	298	324	288	8	10	7	150	172	117
Macon	713	808	701	9	9	10	321	359	306
Madison	8167	8411	8810	29	44	45	2665	2703	2849
Marengo	492	463	366	13	9	8	222	219	199
Marion	800	788	705	16	11	10	335	402	300
Marshall	2492	2643	2581	24	27	27	883	981	937
Monroe	448	462	493	7	1	6	180	226	260
Morgan	3556	3652	3573	21	33	22	1216	1296	1158
Perry	221	200	201	5	8	2	122	104	110
Pickens	272	326	277	8	10	6	135	175	142
Pike	808	773	824	16	15	11	338	271	222
Randolph	358	374	365	8	6	9	130	179	150
Russell	1859	2019	2105	23	13	20	843	984	936
St. Clair	1351	1587	1520	9	22	15	533	627	599
Shelby	3439	3663	3715	20	34	18	1079	1057	1025
Sumter	402	363	338	7	8	7	181	182	162
Talladega	1911	2088	1978	29	28	27	769	830	833
Tallapoosa	875	1138	993	11	17	11	377	512	441
Tuscaloosa	6496	7246	7097	37	37	41	2204	2496	2366
Walker	2093	2202	2119	33	26	18	802	897	775
Washington	209	238	248	6	7	5	145	143	134
Wilcox	247	237	252	4	7	4	181	142	174
Winston	450	458	411	11	10	13	216	191	172

Additional data for (Part 2) counties may be found on the next page

Table 5-2 County-by-County Crash Data (Part 2)
(continued from previous page)

	Vehicle Miles Traveled (VMT)			**Accidents/ Million VMT**		
County	1996	1997	1998	1996	1997	1998
Lamar	2.04E+08	2.12E+08	2.20E+08	5.79	5.85	6.53
Lauderdale	8.77E+08	9.12E+08	9.49E+08	2.94	2.75	2.67
Lawrence	3.39E+08	3.52E+08	3.66E+08	1.86	1.82	1.98
Lee	9.42E+08	9.80E+08	1.02E+09	3.83	4.06	3.62
Limestone	7.35E+08	7.64E+08	7.95E+08	2.22	2.29	2.28
Lowndes	2.56E+08	2.66E+08	2.77E+08	1.16	1.22	1.04
Macon	4.03E+08	4.19E+08	4.36E+08	1.77	1.93	1.61
Madison	2.21E+09	2.30E+09	2.39E+09	3.70	3.66	3.69
Marengo	2.55E+08	2.65E+08	2.76E+08	1.93	1.75	1.33
Marion	5.15E+08	5.36E+08	5.57E+08	1.55	1.47	1.26
Marshall	6.87E+08	7.15E+08	7.44E+08	3.62	3.70	3.47
Monroe	2.44E+08	2.54E+08	2.64E+08	1.84	1.82	1.87
Morgan	1.17E+09	1.21E+09	1.26E+09	3.05	3.01	2.83
Perry	1.31E+08	1.37E+08	1.42E+08	1.68	1.46	1.42
Pickens	2.32E+08	2.41E+08	2.51E+08	1.17	1.35	1.11
Pike	3.49E+08	3.63E+08	3.78E+08	2.31	2.13	2.18
Randolph	1.94E+08	2.02E+08	2.10E+08	1.84	1.85	1.74
Russell	6.12E+08	6.36E+08	6.61E+08	3.04	3.17	3.18
St. Clair	7.84E+08	8.15E+08	8.48E+08	1.72	1.95	1.79
Shelby	1.20E+09	1.25E+09	1.30E+09	2.87	2.94	2.86
Sumter	2.66E+08	2.76E+08	2.87E+08	1.51	1.31	1.18
Talladega	6.61E+08	6.88E+08	7.15E+08	2.89	3.04	2.77
Tallapoosa	4.79E+08	4.98E+08	5.18E+08	1.83	2.29	1.92
Tuscaloosa	2.03E+09	2.11E+09	2.19E+09	3.21	3.44	3.24
Walker	6.99E+08	7.27E+08	7.56E+08	2.99	3.03	2.80
Washington	2.12E+08	2.20E+08	2.29E+08	9.87	1.08	1.08
Wilcox	1.88E+08	1.96E+08	2.04E+08	1.31	1.21	1.24
Winston	2.67E+08	2.77E+08	2.88E+08	1.69	1.65	1.43

To gauge the potential impact of technology-based applications (traffic management and automated enforcement systems), data was obtained for specific crash types including speed-related, red-light running, and fog-related crashes. These were selected (in part) because of the popularity and effectiveness of ITS applications currently being used across the country to address these problems. For this research project, data analyses were conducted to determine whether these applications might be useful for Alabama.

5.3 Alabama Speed-Related Crashes and Trends

For the purposes of this research a speed-related crash is one for which the investigating law enforcement officer listed the prime contributing circumstance as "speeding" while completing the accident report form. This places it in the State crash database, so that it is variable available in the CARE database. Table 5-3 presents a general summary of speed-related crashes for the years 1996-1998. The data presented in Table 5-3 suggests a consistent, recurring incidence of speed-related crashes over the three-year period. The variance in accidents, injuries, and deaths per million vehicles is relatively insignificant.

More importantly, the rates for crashes, injuries and fatalities are higher than the general crash data shown in Table 5-1. In fact, the crash rate is more than 60% higher, the injury rate is 25% higher, and the fatality rate is over 300% higher. Thus, the problem of speed-related accidents is persistent from year to year, and it is much more severe than general crashes.

Table 5-3 Alabama Speed-Related Crash Statistics

	1996	1997	1998
Speed-related crashes	7,173	7,968	7,908
Resulting injuries	5,522	6,053	6,079
Resulting fatalities	338	335	335
Crashes/1,000,000 miles	1.40	1.49	1.43
Injuries/1,000,000 miles	1.08	1.13	1.10
Deaths/1,000,000 miles	0.07	0.06	0.06

5.4 Alabama Red-Light Running Crashes and Trends

The CARE database identified red-light running crashes and analyzed trends related to these accidents. Traditionally, red-light running crashes are hard to identify in a crash database. This was also true of the Alabama situation. Prior studies had utilized the CARE variable "Fail to Yield Right of Way" to identify red-light running crashes. When this variable was utilized with the "Traffic Control Unit" data filter, it was possible to identify crashes during which a driver failed to yield the right of way at a traffic signal. Using this definition, CARE data for Alabama for the years 1996-1998 was obtained, analyzed, and summarized in Table 5-4.

Table 5-4 Alabama Red-Light Running Crash Data

	1996	1997	1998
Red-Light Running Crashes	4,386	5,706	4,451
Resulting Injuries	1,357	1,387	1,390
Resulting Fatalities	10	51	15
Crashes/1,000,000 VMT	0.086	0.107	0.081
Injuries/1,000,000 VMT	0.026	0,110	0.025
Deaths/1,000,000 VMT	0.000	0.001	0.000

A high percentage of these accidents caused injuries. The primary reason is that they are right-angle collisions. One vehicle is hit from the side, where there is very little protection for the occupant. Consequently, almost 1400 people are injured each year in red-light running crashes. Fortunately, application of ITS technology like photo enforcement in other portions of the country has made significant reductions in these types of crashes.

5.5 Alabama Fog Crashes and Trends

The CARE system was used to examine fog accidents, and identified several counties for "alert" status, using 1996-1998 data. Alert status indicated that there was an overall increase in fog-related accidents during the three-year time period. In this study, Baldwin and Lee counties were given alert status because they had crash values more than 10 percent higher than the expected value. This does not automatically impute that fog is a serious problem in these counties, but it might indicate that they are candidates for further investigation and possible ITS treatments.

5.6 Recommendations for Video Technology Applications in Alabama

This report has documented that certain measures must be taken for transportation officials to efficiently implement video technologies. First, the problem or need has to be identified. Then the stakeholders must be identified to develop ITS partnerships. These are often agencies that might be able to utilize video technologies (i.e. traffic engineering, police, fire, EMS, etc.). As the video deployment architecture is being developed, it is important to ensure that deployment remains nonproprietary in nature.

Next, future compatibility with existing local systems must be addressed. As metropolitan areas continue to grow, there is a possibility of overlapping or merging with adjacent traffic management systems. For compatibility with future video technologies, the systems should remain as open-ended as possible to ensure that they are fully upgradeable.

The State of Alabama has yet to approve legislation that will allow the operation of automated enforcement technologies. Until such legislation is passed, the implementation of these enforcement tools remains stalled. If such legislation is enacted in the future, transportation agencies should identify problem areas, perform pilot testing of enforcement technologies, and then deploy on a full-scale basis. If video technology is used as an enforcement tool, the primary purpose of the system should be to improve safety, not to generate additional finances.

5.6.1 Red-Light Running Enforcement

Red-light running enforcement through the use of video technology has been an effective deterrent in other states. This technology, however, has not been implemented in Alabama. Further research should be conducted in order to determine possible locations for future pilot projects, and existing manual programs should updated by purchasing equipment that utilizes new technologies such as fiber optic cables and cameras capable of digital imaging.

5.6.2 Speed Violations

Video technology to curb speeding violations is not currently used in Alabama. As in the case of red-light running technology, further research should be conducted to determine suitable locations for future pilot projects. The installation of equipment capable of handling speed violations would allow law enforcement personnel to concentrate on other duties. The greatest challenges in this area are the legal issues and earning public support.

5.6.3 Video Enforcement at Grade Crossings

While the use of video technology at railroad-grade crossings has not yet been implemented in the State of Alabama, it is been discussed in this report for two reasons. First, since enforcement can be used for both heavy and light-rail systems, it may be deployed in both rural and urban settings. Although Alabama is a growing state it is still predominantly rural, and utilizing video technology for both enforcement and safety purposes should be explored.

If video technology were to be implemented in such a capacity, this would add Alabama to a growing list of other states investing in the Advanced Rural Transportation Systems (ARTS). The second reason for discussing the use of video enforcement for grade crossings is because the State of Alabama (as of 1998) ranks eleventh nationally in railroad grade crossing crashes according to Operation Lifesaver. A CARE analysis for counties throughout Alabama found that seven counties deserve to be placed on "alert" status for high incidents of railroad crashes. Each of these counties could have rural-specific or urban-specific grade crossing problems.

5.6.4 ITS Applications for Fog Alert Systems

Fog alert systems use video images to provide transportation officials with an immediate visual confirmation of the current driving conditions and level of traffic flow. As was discussed earlier in the report, a fog alert system was first implemented in the City of Mobile after a tragic multiple car-crash in 1995. As a result of a CARE Analysis it was determined that Baldwin and Lee Counties could be placed on "alert" status as potential candidates for the use of video technology to address fog-related accidents. A comprehensive study would be necessary to determine the role and extent of fog in causing crashes, and whether or not the crash types are responsive to ITS treatment.

5.7 Conclusions and Recommendations

Based on the findings from analyses previously discussed in this report and the analyses conducted in UTCA project 99107, entitled "Potential Applications of Video for Traffic Management and Safety," the following areas were identified as promising for ITS advancements in Alabama:

- traffic management and incident response using traffic management centers,
- automated enforcement applications to address speeding crashes
- automated enforcement applications to address red-light running crashes
- automated enforcement applications to address rail-highway grade crossing crashes, and
- fog detection and notification systems.

These are recommended as potential ITS applications in Alabama, along with other applications that might be identified as the State's ITS program matures.

Section 6.0
Dissemination of Information

The final task associated with this project was the dissemination of information. In completing this task, the following items were developed and/or presented:

- The final report was prepared, approved by UTCA, posted on the UTCA web site, and distributed to transportation professionals in Alabama.

- Using the findings of this research (along with the findings of parallel research projects), the following papers were published in conference proceedings and presentations were made at the conferences:

    - McFadden, John, Andrew Graettinger, and Kilim Reddy. *Improving At-Grade Rail Road Crossing Safety Using Advanced Technologies in Alabama.* Presented at the 71st ITE Annual Meeting, Chicago, Illinois, August 2001, and accepted for publication in the proceedings.

    - Hill, Stephen, John McFadden, and Jay Lindly. *Evaluation of Automated Enforcement Technology and Programs.* Presented at the International Forum on Traffic Records and Highway Information Systems, New Orleans, Louisiana, August 1, 2001, and accepted for publication in the conference proceedings.

    - McFadden, John, Andrew Graettinger, and Nagendranath Pagadala. *Implication of Automated Enforcement of Red Light Running on Traffic Records and Law Enforcement.* Presented at the International Forum on Traffic Records and Highway Information Systems, Portland, Oregon, August 2000, and published in the conference proceedings.

    - McFadden, John, Stephen Hill, and Stephen Graham. *Considerations for Use of Video for Traffic Management and Safety.* Presented at the 70th ITE Annual Meeting, Nashville, Tennessee, August 6-9, 2000, and published in the conference proceedings.

- A short course entitled "Video for Traffic Management" was developed and presented in March 2000 at The University of Alabama, Tuscaloosa, Alabama.

- A short course was developed from the findings of this research and presented at the University of Alabama-Birmingham, Birmingham, Alabama in December 2000.

The instructional materials used in both ITS short courses were developed during the research covered in this report. Those instructional materials are on file at UTCA headquarters, and are available for use by others as needed, and as approved by the UTCA Executive Committee.

Section 7.0
Summary, Recommendations and Conclusions

The objective of this study was to review the past, assess the present and plan for the future of ITS initiatives in Alabama. This was completed through the following tasks:

- conducting an ITS literature/project review,
- examining institutional and political issues related to Alabama ITS initiatives,
- providing ITS technical and management support to public and private officials,
- conducting research studies and making recommendations for Alabama its programs, and
- disseminating findings.

These tasks were completed and documented in this report. Each of the report sections is briefly summarized in the following paragraphs.

7.1 Literature Review

A literature review was used to document how ITS technologies existing infrastructure safer and more efficient. Legislation was reviewed to trace the development of ITS, from Intelligent Highway Vehicle Systems, to ISTEA activities, to TEA-21 programs. The evolution of this legislation changed the nature of activities, improved funding levels, and revised allocation formulas for ITS technologies as goals and priorities changed.

The literature review provided valuable background information regarding ITS history, applications, projects and programs. This information will be useful for future ITS initiative because it provided clues to successful programs and technologies used by these programs to meet their needs.

7.2 Examination of Institutional Issues Related to Alabama's ITS Initiative

Based on various ITS projects throughout the country and current ITS projects in this State, a need for improvements was found for methodologies used in planning, design, implementation and evaluation of ITS technology applications in Alabama. Strategies for overcoming ITS institutional and technical issues were recommended.

It has been well documented throughout this report that certain measures are necessary before transportation officials will efficiently implement ITS technologies. First, after a problem or need has come to light, all potential stakeholders must be identified to develop ITS partnerships. Decisions must be made as to which agencies can to utilize ITS (traffic engineering, police, fire, EMS, etc.). As the architecture for ITS deployment is being developed, it is important to make sure that deployment is non-proprietary in nature. This will allow the maximum benefit and versatility from the implementation of ITS. Next, the issue of future compatibility with existing local systems must be addressed. As metropolitan areas continue to grow, the possibility arises that adjacent traffic management systems will overlap or merge. For compatibility with the future systems, they should remain as open-ended as possible so that they are fully upgradeable.

7.3 ITS Technical and Management Support to Public and Private Officials

A variety of transportation officials across the state were contacted and interviewed to identify research needs related to Alabama ITS initiatives. The focus areas of these studies include the following:

- video detection for traffic management and safety,
- highway advisory radio,
- dynamic message signs, and
- transportation management center operations.

These topics were investigated and reported upon within the scope of this project.

7.4 Research Studies/Recommendations for Alabama ITS

Based on a research investigation performed using the CARE software, the following areas were identified as promising future Alabama ITS initiatives:

- expansion of traffic management centers to combat delay, improve safety and reduce incident response times,
- utilization of existing ITS programs to implement automated enforcement programs to address red light running, speeding and rail road grade crossing violations, and
- development of additional fog detection systems.

7.5 Dissemination of Research Findings

This project helped to generate four papers at professional meetings, and to deliver two short courses. It also produced this final report, which will be disseminated to professionals throughout the state.

Section 8.0
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Appendix A

Table A-1: ITS User Services (Source ITS Handbook 2000)

Service Category	User service
Advanced Traffic Management Systems (ATMS)	Transportation planning support Traffic control Incident management Demand management Policing/enforcing traffic regulations Infrastructure maintenance/management
Advanced Traveler Information Systems (ATIS)	Pre-trip information On-trip driver information On-trip public transport information Personal information services Route guidance and navigation
Advanced Vehicle Control Systems (AVCS)	Vision enhancement Automated vehicle operation Longitudinal collision avoidance Lateral collision avoidance Safety readiness Pre-crash restraint deployment
Commercial Vehicles Operations (CVO)	Commercial vehicle pre clearance Commercial vehicle administrative processes Automated roadside safety inspection Commercial vehicle on-board safety monitoring Commercial vehicle fleet management
Advanced Public Transport Systems (APTS)	Public transport management Demand responsive transport management Shared transport management
Emergency Management Systems (EMS)	Emergency notification and personal security Emergency vehicle management Hazardous materials and incident notification
Electronic Payment Systems (EPS)	Electronic financial transactions
Safety	Public travel security Safety enhancement for vulnerable road users Intelligent junctions

A.1 Advanced Traffic Management Systems (ATMS)

ATMS ensures maximum network capacity by combining several services like coordination of traffic signals to minimize delays and control queues, ramp metering to control the traffic volume coming onto a roadway, and incident detection and management.

A.2. Advanced Traveler Information Systems (ATIS)

ATIS is the provision of travel information to enable drivers to make travel choices and prepare better. ATIS works on the principle of collecting traffic data, analyzing it, and disseminating accurate and real-time traffic information to drivers. The information can be pre-trip information like update news on the Internet or enroute information like displays on variable message signs (VMS), highway advisory radio (HAR), etc. The use of wireless communication is the latest revolution in this field.

A.3. Advanced Vehicle Control Systems (AVCS)

AVCS is any vehicle or road-based system that assists the driver in achieving increased safety and control either by improving the quality of traffic information or by providing driving support. Intelligent cruise control systems have arrived in the market. The next step in the process of achieving fully automated vehicles is the collision avoidance systems.

A.4. Commercial Vehicle Operations (CVO)

Regulations such as the license checks, toll collections, and permit checks at checkpoints on the border cause loss of time for commercial trucks. The CVO applications of ITS improves this situation by providing automatic vehicle identification, weigh-in motion (WIM) scales, and automatic toll collection. This system can be coupled with the automatic vehicle location (AVL) to improve fleet management.

A.5. Advanced Public Transport Systems (APTS)

Shared transport systems and public transport need to be promoted to mitigate severe congestion problems. Public transport information systems need huge investments in ITS infrastructure. AVL technology can be deployed to help maintain service punctuality and reliability.

A.6. Emergency Management Services (EMS)

Prompt emergency measures help save lives in serious automobile crashes. ITS achieves this by integrating emergency notification with management services. Whenever a crash occurs, the emergency management center (EMC) is notified, and it takes immediate action to deploy emergency response to the site. Automatic notifications of crashes, also called Mayday services, alerts authorities of the incident and its location.

Coordination is the key to effective emergency operations. This can be brought about by a change or modification of the infrastructure of the organization. Inter-organizational structure improvement through the use of advanced database and communication equipment is often the key to having a standard communications protocol.

A.7. Electronic Payment Services (EPS)

Electronic payment enables drivers to pay using a card. Information on the payments and the arrears is stored on a magnetic strip on the card. The card uses a microchip to perform computations, and also stores a huge amount of information, allowing more effective functionality.

Appendix B
Highlights of the 1991 ISTEA and 1998 TEA-21 Acts

ISTEA

ISTEA ushered in a new era of transportation planning. It provided the platform for innumerable programs and projects, statewide and nationwide. ISTEA was built on four policy cornerstones: economic development and competitiveness in global markets, maximizing system performance and return on investment, partnerships and flexibility in making transportation choices, and focusing on outcomes for people and communities. The following are some of the ITS highlights in ISTEA:

National Highway System and Surface Transportation Program eligibilities were clarified for ITS capital improvements. Congestion Mitigation Air Quality was clarified for funding programs and for projects that implemented ITS strategies.

According to ISTEA, USDOT was to develop technical assistance and guidance on the evaluation and selection of appropriate procurement methods for state and local agencies. ITS software was to be used in accordance with the standards set by the Software Engineering Institute's Capability Maturity Model or a similar recognized standard risk assessment methodology. Guidelines for the evaluation of operational tests and deployment projects were to be developed by USDOT.

USDOT, working with ITS America, was to update the National ITS Program Plan. It was to maintain the Plan with definite goals and milestones for ITS research and development. It was to identify standards development activities and ensure national interoperability. Furthermore, USDOT was to coordinate with state and local governments to incorporate ITS into surface transportation plans.

USDOT was in charge of the implementation and maintenance of National Architecture and protocols. The Secretary of Transportation was to establish provisional standards if critical standards were not developed by January 1, 2001. Options for the waiver of this provision were discussed in the legislation. USDOT was to make sure that ITS projects funded from the Highway Trust Fund conformed to the national standards. USDOT and FCC were to work together to define needs. FCC was to complete a rulemaking process that considered the allocation of spectrum for ITS.

Not more than 80% of ITS project funding was to be provided by federal share from all sources. The maximum amount for a metropolitan area was $15 million, and not more than $2 million was to be used for ITS projects in a single rural area. No state could spend more than $35 million for projects. Metropolitan areas were to integrate ITS elements with other sources of funds, whereas rural areas were to install ITS infrastructure elements, with not less than 10% to be spent on integrating ITS in rural areas.

USDOT encouraged multi-state cooperative agreements on issues like corridor development. Wisconsin got $2 million per year to continue ITS deployment activities, and ITS activities in the I-95 corridor got $5 million per year.

USDOT promoted the deployment of ITS technologies on commercial vehicle operations with established priorities. The federal share of funding for this topic remained the same.

$1.5 million was provided for research on hazardous materials management systems. Urban Consortium's ITS outreach and technology transfer activities got $500,000 per year from the ITS Research and Development funds. The Translink program of the Texas Transportation Institute was allocated $1.3 million per year of ITS deployment funding.

Tea-21

TEA-21 was enacted June 9, 1998, as Public Law 105-178. It authorized the federal surface transportation programs for highways, highway safety, and transit for a six-year period. The following are sample highlights of TEA-21:

Research, development and deployment -- priority areas were outlined for a comprehensive program of research, development and operational tests of intelligent vehicles and intelligent infrastructure systems.

Deployment incentive -- acceleration of ITS integration and interoperability in metropolitan and rural areas was promoted. Projects were to be selected after competitive analysis of certain detailed criteria.

Rebuilding America -- the Act guaranteed $198 billion in surface transportation investment. This included a balanced investment in highways, transit, intermodal projects, and technologies such as ITS.

Improving safety -- the Act encouraged states to adopt a 0.08 blood alcohol concentration standard to fight drunk driving, and provided incentive grants to increase seat belt use. Funds were allocated for making rail-highway grade crossings safer and for improving truck safety.

Protecting the environment -- the Act expanded CMAQ with an increase of 35% in funding, provided $3 billion for transportation enhancement, set up $270 million to create and maintain recreational trails, provided $148 million for improvements to roads of scenic or historic value, dedicated $500 million to buy or lease buses that used low-polluting fuels, and expanded provisions for making bicycling and walking safer and more viable ways of travel.

Creating opportunity -- the Act created expanded job opportunities, and provided $228 million to support University Transportation Centers.

A total of $1.282 billion in contract authority was provided for the period 1998-2003 to fund the ITS program. $603 million of this funding went to research, training, and standards development, $482 million went to interoperability and integration in metropolitan areas, and $184 million went to rural areas. In addition to this funding, ITS activities were eligible for funding under other programs. The following additional provisions were included for ITS program in TEA-21:

- ITS funds no longer received limitation of 100% of available funding. They were to be based on a formula distribution and would receive a prorated share similar to federal-aid programs (Section 1102),
- ITS funds were no longer subjected to a limitation imposed on Research and Development obligations (Section 5002),
- National Highway System and Surface Transportation Program eligibilities were clarified to specifically allow funds for infrastructure-based ITS capital improvements,
- CMAQ funding eligibilities were clarified to include programs or projects that implemented ITS strategies, and
- The Software Engineering Institute's Capability Maturity Model or another similar recognized risk assessment methodology was to be used for software acquisition.

The 1996 Outreach Program

Prior to reauthorization of ISTEA in 1996, USDOT invited opinions from 13 regional forums and over 100 focus groups. The input helped shape President Clinton's ISTEA reauthorization proposal. The result was a DOT strategic plan 1997-2002 that tracked closely with ISTEA's goals, while focusing on safety, quality of life, and commitment to listen to customers. The following strategic plan goal pertained to ITS:

- promoting public safety and health by elimination of transportation-related injuries, fatalities, and property damage,
- achieving mobility,
- increasing economic growth and trade, nationally and internationally, and
- promoting the nation's security interests,

The 1998 Outreach Program

The 1996 input provided valuable insight into the reauthorization process. A similar outreach program in 1998 marked the termination of input and initiated the implementation of TEA-21. ISTEA observed that a new, better-managed infrastructure was the key to economic growth and competitiveness in the international market. TEA-21 emphasized topics like intermodal connections, and the National Corridors and Borders Programs.

ISTEA required the states and the metropolitan planning organizations to consider the impacts of transportation investment on safety, community quality-of-life and the environment. TEA-21 built upon the planning provisions and increased funding for CMAQ improvements and transportation enhancement programs. It encouraged environmental streamlining, and it integrated transportation and community planning

National ITS Program Plan

USDOT, working with ITS America, was required to update and maintain the National ITS Program Plan. The scope of this Plan included the goals and objectives for ITS research and development, standards development activities for promoting and ensuring interoperability, and a cooperative process to get state and local governments working together on incorporating ITS into surface transportation plans.

National Architecture and Standards

The national architecture was required to develop supporting standards and protocols to promote the widespread use of ITS technology and better interoperability. A report identifying the critical standards was to be completed by June 1, 1999, and a provisional standards report was to be prepared by the Secretary of Transportation in case the critical standards document was not completed by January 1, 2001. USDOT was to ensure that ITS projects funded from the Highway Trust Fund conformed to the national architecture, applicable standards, or provisional standards and protocols.

Spectrum

USDOT and the FCC were to work together to identify needs, including a spectrum for a dedicated short-range vehicle-to-wayside wireless standard. The FCC was to complete rulemaking for allocation of spectrum for ITS by January 1, 2000.

Emerging Issues

FCC's Ruling on Minnesota's Fiber-optic project
An important event that affected the transportation network and the deployment of ITS nationwide was the FCC ruling that refused to endorse Minnesota's "Connecting Minnesota" fiber-optic project. However, the FCC adopted a wait-and-see strategy to monitor the competitive aspects of the contract enforcement. The American Association of State Highway Transportation Officials quickly provided strong support for the Minnesota program and urged the FCC to issue a ruling in favor of the project. Observers were concerned about the effect the FCC ruling would have on shared-resource agreements, which were encouraged by the FHWA as a way to save millions of tax dollars in deploying ITS.

Mid-term Corrections to TEA-21
A mid-term corrections bill for TEA-21 was proposed in the 1999 Congressional session. But, this approach did not find the broad support necessary for adoption. Senate staffers were quick to point out that only S1144, the Surface Transportation Act of 1999, had even been reported by the Senate Environment and Public Works Committee. The Assistant Secretary for Budget and Programs at the USDOT said that there were no "must" corrections on the Administration's agenda, and that TEA-21 worked well as it was. Senators then put the Secretary of Transportation on notice that they opposed any proposals that would upset TEA-21's delicate funding balance at the midpoint of its six-year authorization. Consequently, the issue was dropped.

Reauthorization in 2003

AASHTO and other groups are now in the initial stages of organizing their approach to modifications to TEA-21. The AASHTO Reauthorization Steering Committee plans to refine issues like examination of regulatory burdens, determination of future trends, improvement of transportation research and safety, along with other important issues. Other professional and trade organizations are following suit.

Summary

Legislation plays a crucial part in the deployment of any high-budget program like ITS. So far, the federal government has fostered transportation infrastructure development through ISTEA, TEA-21, and other pertinent acts. Transportation is viewed as the backbone of the economic growth of any country, and it is important that legislation pertaining to transportation encourage better use of resources and better contributions to the country's economic growth.

University Transportation Center for Alabama

CONTACT INFORMATION

University Transportation Center for Alabama
271 H M Comer Mineral Industries Building
PO Box 870205
University of Alabama
Tuscaloosa, AL 35487-0205
(205) 348-9925
(205) 348-0783 fax
utca@coe.eng.ua.edu
http://bama.ua.edu/~utca/

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