Final Report*
EXECUTIVE SUMMARY

Reporting Period: January 2000 – January 2002

Reference: *Executed contract - Research Project Work Order #4 -- Federal Aid Project CFDA-20.205 / Contract No. BC352, "Advanced Traffic Engineering and ITS Technologies."*

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This project has involved a total of **13** student assistants over the reporting period.

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* The complete final report is in the attached CD. (Hardcopy is available upon request.)

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1. BACKGROUND

1.1 ITS – Intelligent Transportation Systems

The ultimate mission of a public transportation agency is to provide safe, efficient, effective, and environmentally sound transit services. Such mission is becoming more and more difficult to accomplish because of the exponentially increasing demand for mobility with the growth of population. The inability to cope with this skyrocketing demand will, unfortunately, translate into serious potential for congestion, unsafe conditions, and the deterioration of the natural environment. It has been recognized that to expand the existing thoroughfares is not an attractive solution mainly because of (1) lack of readily available land for additional roadways; (2) mounting construction costs; and (3) environmental concerns.

In recent years, the transportation professionals have come to the realization that an attractive and yet logical approach for improving the capacity of a transportation system is to optimize the use of resources as well as the existing facilities.

The vision of *intelligent transportation systems* (*ITS*) is a conceptual framework committed to utilizing advanced communications technologies throughout the multi-modal transportation system. It represents a paradigm shift to the transportation-information infrastructure. The goal is to improve safety, reduce congestion, enhance mobility, minimize environmental impact, save energy, and promote economic productivity in the U.S. transportation system and abroad.

ITS programs are evolving rapidly and gaining momentum in the United States and other industrialized nations. Currently, the ITS efforts are focused on: (1) Improvement to highway infrastructure. (2) Adaptations to both private and mass-transit vehicles in order to increase the capacity of the present transportation network and improve traffic safety.

The key component that is required in virtually all ITS programs is the communications technology. In essence, ITS projects demand: (1) Communications with moving vehicles. (2) Communications links with remote control devices such as the changeable message signs and traffic signals. (3) Continuous status reports in all types of weather from roadway sensors installed throughout the transportation network.

1.2 FDOT Traffic Engineering Research Laboratory

With the advent of ITS incentives and ISTEA resources for the advancement of transportation systems in the United States, coupled with the rapid advances made in the microelectronics and communications industries, there has been very significant improvement and development in traffic control devices and systems. These new and improved technologies will ultimately provide operational and safety enhancement to the existing roadways across the country.

Over five years ago, the FDOT traffic engineers recognized the need to maintain the current knowledge of new equipment system and software advancements in order to attain the most effective and efficient highway system operation in Florida. In particular, they envisioned the combined efforts of research and testing should assure that FDOT maintains a strong technical support for the current ITS initiatives.

In May of 1997, the Traffic Engineering Research Laboratory (TERL) was established to develop the state-of-the-art traffic engineering evaluation and testing facilities. The core mission of TERL is twofold:

- To conduct and nurture applied research pertaining to traffic engineering technologies.
- To provide technical support for Florida ITS initiatives so as to ensure Florida stay competitive and poised for the emerging information and ITS age.

This research laboratory is managed by the FDOT State Traffic Operations (formerly Engineering) Office. The strength of the TERL stems from the unique composition of its staff, which consists of FDOT personnel and a research team consisting of faculty and students from the Department of Electrical and Computer Engineering at the FAMU-FSU College of Engineering (FSU-ECE). This unique arrangement facilitates an interactive but coordinated problem-solving process in which the urgent and important research issues identified by FDOT engineers are addressed by the FSU-ECE research team in a timely manner. The direct benefit is the FSU-ECE researchers are able to focus its expertise on relevant problems to produce results that FDOT can use immediately.

2. RESEARCH OBJECTIVES

The principal objective of virtually all projects at the TERL is to conduct and support applied research, testing, standards, and specification development. The main research efforts include the evaluation and testing of components involved in the operation of the *Traffic Control Signal Device Certification Program* and the implementation of *Advanced Traffic Engineering and ITS Systems.* By working closely with the FDOT Traffic Operations Office over an extended period, the FSU-ECE investigators have come to understand and identify the near-term as well as the long-term objectives envisioned by FDOT. These objectives subsequently define the framework for various TERL research programs.

2.1 Near-Term Objectives

The current and near-term objectives are identified as follows:

- To advance the *Traffic Control Signal Device Certification Program* initiated by the Traffic Operations Office.
- To update and develop standards and specifications to keep pace with the rapidly advancing fields pertinent to traffic engineering.
- To establish guidelines for testing and evaluating ITS and traffic engineering technologies.
- To develop computer-based automated testing and evaluation systems.

2.2 Long-Term Objectives

It is envisioned that the TERL will provide facilities and staff accessible to the federal and other state transportation agencies for characterization, testing, and evaluation of ITS equipment and components. These public transportation agencies will have open access to an ITS and traffic engineering database maintained by the TERL. Equally important is the educational and training component of the TERL development plan. It is anticipated that undergraduate and graduate education in transportation technologies and systems will be coordinated through the FSU Department of Electrical and Computer Engineering. To be specific, the main long-term objectives are described below:

- To strengthen the role of FDOT as a leader in providing comprehensive standards, specifications and technical documents on new traffic systems and devices.
- To educate a new breed of transportation engineers with specialized skill and knowledge in microelectronics, communications systems, control systems, and computer engineering to cope with the planning, design, selection, testing, and maintenance of various ITS technologies for the next generation of transportation systems in Florida and the United States as well.

3. AREAS OF WORK: 2000 - 2002

The work of this project was performed during the two-year period from 2000 to 2002. The key areas of work alongside their objectives are tabulated as follows (**Table 1**):

Table 1: *Areas of work and objectives*

Area of Work	Objectives
NTCIP: National Transportation Communications for Intelligent Transportation Systems Protocol	1.Develop the Florida Management Information Base (MIB) and obtain the capability, by using the NTCIP exerciser, to test manufacturer's controllers (DMS & Vehicle Controllers) for compliance to the Florida MIB. 2. Develop user-friendly test procedures for NTCIP compliance tests.
Signaling illumination technology: LED traffic signals	1. Make calibration more precise. 2. Purchase a commercial tester for comparison and field testing. 3. Install an environmental heat chamber for testing of signals. 4. Set standard for pedestrian signal intensity. (postponed till next phase) 5. Verify FDOT standard for dynamic message sign intensity. 6. Continue to test LED signals that have been up in the field for degradation. 7. Convert testing system to automatic. (in progress) 8. Develop a plan for pulling samples from the field or from stock and performing random testing and posting the results. (in progress)
Vehicle detection	1. Maintain completed standards for various detection technologies: Microwave, infrared, video, radar, etc. 2. Continue micro-loop testing. 3. Maintain real-time testing setup in the TERL lab area, including mast arm to lab detection system. 4. Continue the setup of a fully operational on-site test intersection. (on going)

Area of Work	Objectives
Device approval	To improve the FDOT Traffic Control Signal Device Certification Program by: 1. Maintain the national database of contacts (which was developed in Phase 1 of this project) such as (a) transportation agencies and device manufacturers and (b) maintaining agencies and signal contractors in the state of Florida. 2. Maintain the ***I***nteractive ***A***pproved ***P***roduct ***L***ist (***iAPL***), which was also developed in Phase 1 of this project. 3. To assist in evaluations of devices submitted for approval consideration.
Signaling illumination technology: Dynamic message signs	Research and identify the application and performance standards for DMS technologies, which consist of permanent mount, vehicle mount, and portable.
Traffic controllers	1. Develop knowledge concerning the operation of a vehicle traffic controller. 2. Develop knowledge concerning the basic operation of an isolated intersection. 3. Develop capability to set timings in a controller and perform a basic test of controller functions. 4. Develop capability to describe the operation of an isolated intersection. 5. Maintain specifications and standards database for the development of the Advanced Transportation Controller (ATC).
Technology transfer	1. Maintain the TERL web site located at http://rite.eng.fsu.edu/ 2. Distribute the "Technology Lab Notes" newsletter quarterly 3. Maintain the Technology Lab CD quarterly 4. Develop a CD that contains the research results and reports.
Communications technology	Develop a tutorial paper on each of the following communication technologies: 1. Spread Spectrum and how it relates to the DOT. 2. Fiber optics and how it relates to the DOT. (in progress) Each paper is to the basic issues: (a) Theory of operation. (b) Where and why would the FDOT use it? (c) Does it work? (d) Who is using it in the transportation industry?

4. RESULTS AND PRODUCTS

All the results and products of this research project conducted during in the two-year period, 2000 – 2002, are compiled and stored in the accompanying compact disc (CD). The summary of result and products is presented in **Table 2**.

Table 2: *Results and products*

Area of Work	Results and Products
NTCIP: National Transportation Communications for Intelligent Transportation Systems Protocol	Test procedures, presentations, documents, and reports
Signaling illumination technology: 1. *LED traffic signals* 2. *Dynamic message signs*	Presentations, documents, and reports
Vehicle detection	Documents and reports
Device approval	FDOT Approved Product List, certification handbook, and documents
Traffic controllers	Presentations and documents
Technology transfer	Lab newsletters and presentations Internet website: http://rite.eng.fsu.edu/
Communications technology	Tutorial papers and documents
FDOT Approved Product List: iAPL	The iAPL was the major development of this project and can be viewed at http://rite.eng.fsu.edu/ The iAPL is continuously maintained by the staff at the TERL.