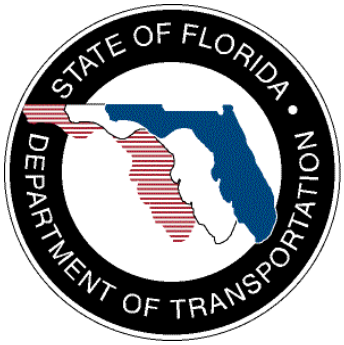
White Paper

Intelligent Transportation System Maintenance — A Key Component to the Future of an Intelligent Transportation System

May 2, 2008
Final Version



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DOCUMENT CONTROL PANEL		
File Name:	*White Paper – Florida Department of Transportation – Intelligent Transportation Systems Maintenance – A Key Component to the Future of an ITS*	
File Location:	W:\C8I75\Assign 1 - Special Projects\ITS Maintenance\080502 ITS Maintenance_V1-6_final.doc	
Deliverable Number:		
Version Number:	Final Version 1.6	
	Name	**Date**
Created By:	Tahira Faquir, PBS&J	May 21, 2007
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Reviewed By:	Paul Watson, PBS&J	June 12, 2007
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Completed By:	TJ Hapney, PBS&J	May 2, 2008

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List of Acronyms

AMBER ..... America's Missing: Broadcast Emergency Response
CCTV ..... Closed-circuit Television
CFP ..... Cost Feasible Plan
DMS ..... Dynamic Message Sign
DOT ..... Department of Transportation
EDL ..... Electronic Document Library
FDOT ..... Florida Department of Transportation
FHWA ..... Federal Highway Administration
FMS ..... Freeway Management System
ITS ..... Intelligent Transportation System
MTBF ..... Mean Time between Failure
NJDOT ..... New Jersey Department of Transportation
RCI ..... Roadway Characteristics Inventory
RTMC ..... Regional Transportation Management Center
TMC ..... Transportation Management Center
TMS ..... Transportation Management System
TOC ..... Transportation Operations Center
TTS ..... Travel Time System

1. Introduction

The Florida Department of Transportation (FDOT) has made a long-term commitment to the deployment of an intelligent transportation system (ITS), and the operations and replacement of that system. As a result, it is only logical for the FDOT to make the same commitment towards adequate maintenance for the ITS.

While the FDOT has been deploying freeway management systems (FMS) throughout the state for several years, a dedicated *Ten-Year ITS Cost Feasible Plan (CFP)*[1] was established in 2002 for continued deployment that was valued at approximately $724 million dollars, including the funding supplied by the Districts. As well as this initial plan, funding is added to the *Ten-Year ITS CFP* each year in the out lying tenth year to ensure continued deployments for ITS. In 2004, the FDOT took the additional step of recognizing that the ITS is a system that must be operated properly and replaced at the end of its life for its benefits to be fully achieved; therefore, the FDOT developed a dedicated 10-year funding program for the operations and replacement of the ITS. The dedicated funding program is called the *Operations and Replacement CFP*.[2] This *Operations and Replacement CFP* totaled over $142 million and additional funding is added for each new tenth year to ensure continued operations. Having established these two critical funding sources for ITS in Florida, the FDOT is now positioned to turn its attention to the final component for ensuring that the ITS functions properly with a high level of reliability (i.e., maintenance).

To ensure that a highly sophisticated systems such as the ITS operates with strong reliability, system maintenance must be planned and budgeted. Failure of the ITS on any level can negatively affect the traveling public and overall public opinion on the need for ITS. When any component of the ITS fails, the benefits and features of failed system are completely lost until the component is repaired. This issue is compounded by the fact that some ITS components are dependent on others potentially increasing the severity of a single component failure, as indicated in the following excerpt from the *Guidelines for Transportation Management Systems Maintenance Concept and Plans Final Report*.[3]

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[1] Florida Department of Transportation, *Ten-Year ITS Cost Feasible Plan (CFP) — Fiscal Year 2004 / 2005* (Revised May 2005). Available online at http://www.dot.state.fl.us/TrafficOperations/ITS/Projects_Deploy/Ten-Year_CFP.htm.

[2] Florida Department of Transportation, *Operations and Replacement CFP* (June 2007).

[3] PB Farradyne, *Guidelines for Transportation Management Systems Maintenance Concept and Plans — Final Report* (December 2002). Federal Highway Administration (FHWA) Report No. FHWA-OP-04-011, Electronic Document Library (EDL) No. 13882. Available online at

Transportation Management Systems (TMS) are complex, integrated amalgamations of hardware, technologies, and processes for performing an array of functions, including data acquisition, command and control, computing, and communications. Disruptions or failures in the performance of these functions can impact traffic safety, reduce system capacity, and ultimately lead the traveling public to lose faith in the transportation network.

2. Intelligent Transportation System Maintenance

Since ITS are complex technology-based systems, maintaining these systems varies greatly from the maintenance services normally provided by departments of transportation (DOTs). While state DOTs and the FDOT in particular have years of experience in developing and executing highly successful maintenance programs, these are geared towards roadway maintenance and not the maintenance of technologically advanced systems.

Roadways, once constructed, while requiring maintenance do not need the continuous attention that an ITS must have in order to operate. For example, once constructed, a roadway can be basically left to operate unless damage has occurred, such as an incident that damages a guardrail or barrier; a problem in the pavement, base or sub-base occurs; or a roadside fixture fails in some manner. However, with ITS, the systems are made up of several moving, highly technical, software-based components that must be exercised, monitored, cleaned, and repaired on an almost daily basis to ensure that they are in working order. To accomplish these tasks, a separate ITS maintenance program must be established.

In a recent study to evaluate and upgrade transportation operations center (TOC) maintenance programs on an on-going basis, the New Jersey Department of Transportation (NJDOT) noted that they have "faced significant challenges in keeping intelligent transportation systems (ITS) at a high level of availability at their two TOCs." This resulted in them developing a report to assist in the development of an ITS operational support and contract implementation plan for their TOCs. One of the lessons learned from the study was that it is important to develop an on-going system for evaluating and upgrading their maintenance programs.[4]

Currently, ITS maintenance is funded as part of the general maintenance fund with funding based on four device categories under the FDOT's Roadway Characteristics Inventory (RCI) database.[5] These four categories are regional transportation management centers (RTMCs), dynamic message signs (DMSs), closed-circuit televisions (CCTVs), and detectors. The funding associated with each of these categories was developed several years ago. The funding has not been updated to reflect the actual dollars spent on ITS maintenance at the Districts, nor has it been reviewed to see if additional devices or categories should be added based on technology changes. In addition, the existing four categories are not clearly defined. This may result in non-uniform application of maintenance funds amongst the Districts.

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[4] United States Department of Transportation, Intelligent Transportation Systems Lessons Learned, *Strengthen existing maintenance and repair capabilities at Transportation Operation Centers (TOCs)* (January 2005). Lesson ID #2007-00358. Available online at http://www.itslessons.its.dot.gov/its/benecost.nsf/Lesson?OpenForm&EE99BDA032C755688525728900555502F^LLCats.

[5] More information regarding the FDOT's RCI is available online at http://www.dot.state.fl.us/planning/statistics/rci/default.htm#officebook.

Overall, it is necessary for the FDOT to establish a separate ITS maintenance program that allows a review of these items and creates standards. In general, ITS maintenance is divided into two main categories — General Response and Preventative Maintenance. The following sections provide an overview of these two types of maintenance.

2.1 Types of Maintenance

2.1.1 General Response Maintenance

General response maintenance is typically defined as the repair of a failed component and is performed when problems arise with any portion of the ITS for any reason. Typical causes of component malfunctions requiring immediate attention include, but are not limited to, component life expectancy failures; unknown component failures; vehicle crashes; theft; vandalism; hurricanes; and construction, lightning, and installation errors. The priority of the response is dependent on the severity of the component failure and it's affect on other ITS subsystems. The response can also be categorized as emergency maintenance work or nonemergency maintenance work with different associated response times for each. For instance, a fiber optic backbone that has been cut due to roadway construction will need to be fixed as soon as possible due to the number of other ITS subsystems directly dependent on the communication cable while the repair of a single CCTV failure can wait until the next business day since its affect on the ITS is relatively small.

2.1.2 Preventative Maintenance

Studies have shown that periodic preventative maintenance can decrease required general response maintenance efforts. By taking the time and making the effort to properly maintain ITS components and its communications infrastructure, typical failures can be minimized, therefore reducing the effort required and costs associated for both emergency and nonemergency response maintenance as well as extending the life of the system. A good preventative maintenance plan includes daily, monthly, biannual, and annual maintenance procedures depending on the component or infrastructure and its associated mean time between failures' (MTBF) rating. All device MTBFs can be monitored and recorded as part of an effective preventative maintenance plan. Most ITS device manufacturers are able to provide an appropriate plan for preventative maintenance for their devices.

2.2 Intelligent Transportation System Downtime Effects

Intelligent transportation systems rely on both general response and preventative maintenance to decrease downtime of the ITS and/or any of its devices, communications infrastructure, or related systems. Systems and services that depend on ITS include: America's Missing: Broadcast Emergency Response (AMBER) alerts; 511 traveler information systems; travel-time systems (TTS); Traffic Incident Management; and, emergency detour information for situations such as hurricanes, forest fires, et cetera. Neither AMBER alerts nor average vehicle travel times can be displayed on a DMS that is not operational. Relating important detour information to the traveling public due to an accident or natural disaster would also be affected by DMS failures. Closed-circuit television failures along highly traveled roadways result in the local transportation management center's (TMC) inability to visually monitor roadway incidents capable of causing major traffic interruptions. A break in a fiber optic backbone could potentially disable an entire ITS depending on the available redundancy. All the advantages of an ITS and its ability to improve the traveling public's safety, reduce traffic congestion, and improve emergency vehicle response times are directly proportional to a fully functional ITS. The Kentucky Transportation Cabinet noted as a lesson learned in its *Maintenance and Operations Plan for Intelligent Transportation Systems in Kentucky* that, "System maintenance should be given a high priority to minimize liability risk."[6] The potential risks and loss of investment returns makes developing and funding an ITS maintenance program a critical goal for the FDOT.

[6] Kentucky Transportation Center, *Maintenance and Operations Plan for Intelligent Transportation Systems in Kentucky* (June 2004). Research Report No. KTC-04-14/SPR241-02-1F. Available online at http://www.ktc.uky.edu/Reports/KTC_04_14_SPR_241_02_1F.pdf.

3. Benefits

The FDOT has shown its strong support and belief in the benefits of ITS through its establishment of funding for the *Ten-Year ITS CFP* and the *Operations and Replacement CFP*. Now, the FDOT needs to continue that support by turning its attention to a dedicated ITS maintenance program. Currently, ITS maintenance is funded through the general maintenance program; however, as noted previously, ITS requires much more specialized attention to be truly effective and should be handled as it own entity.

In establishing a separate ITS maintenance program, the FDOT will be able to recognize several benefits. These benefits can be categorized as follows:

- ITS Reliability — The establishment of a separate ITS maintenance program will provide the FDOT with the ability to have greater control over the reliability of the ITS around the state. Performance measures and a baseline standard for the system could be established and tied to the funding.
- ITS Quality Assurance — The establishment of an ITS maintenance program will allow better tracking of device failures, MTBFs, identification of the cause of failures, and the amount of emergency response versus general maintenance being done.
- ITS Cost Benefit — The establishment of an ITS maintenance program will allow the long-term tracking of maintenance costs on a more detailed level than is currently available. It will also allow the FDOT to reduce the amount of money being spent on the replacement of devices by using preventative maintenance to extend the life of the devices.

4. Conclusions and Recommendations

A separate ITS maintenance program will benefit the FDOT by allowing them to establish a better understanding of what is currently being done for ITS maintenance and to get a handle on the actual dollars being spent. It will also allow better structuring of funding so that each District receives an accurate amount of funding for ITS maintenance based on their individual systems. The FDOT needs to take the next steps of reviewing their existing ITS maintenance costs and funding; establishing standards for ITS maintenance across the state; and establishing acceptable performance measures to assist in continuing its strong ITS program.