Technical Memorandum No. 3.3

ITS Program Performance Measures:

ITS Corridor Master Plans for Florida's Principal FIHS Limited-Access Corridors

Prepared for:

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List of Acronyms

AADT ..... Average Annual Daily Traffic
ATIS..... Advanced Traveler Information System
CATS ..... Chicago Area Transportation Study
CVO ..... Commercial Vehicle Operations
EMC ..... Emergency Management Centers
ETC ..... Electronic Toll Collections
FCC ..... Federal Communications Commission
FDOT ..... Florida Department of Transportation
FIHS ..... Florida Intrastate Highway System
FMS..... Freeway Management System
GPS ..... Global Positioning Systems
HAZMAT ..... Hazardous Materials
HPMS..... Highway Performance Monitoring System
IMS ..... Incident Management System
ISP ..... Information Service Provider
ITS..... Intelligent Transportation System
IVR..... Interactive Voice Response
JPO ..... Joint Program Office
LOS ..... Level of Service
MPH ..... Miles Per Hour
MPO ..... Metropolitan Planning Organization
OOCEA ..... Orlando-Orange County Expressway Authority
OTO ..... Office of Toll Operations
PRR ..... Portable Roadside Reader
PTMS ..... Portable Traffic Monitoring Sites
RCI ..... Roadway Characteristics Inventory
ROO ..... Regional Operating Organization
RR Service Patrols ..... Road Ranger Service Patrols
RTMC ..... Regional Traffic Management Center
SEMP ..... System Engineering Management Plan
SITSA ..... *Statewide ITS Architecture*
SMIS ..... Surveillance Motorist Information System
SUL ..... Special-Use Lane
TMC ..... Traffic Management Centers
TTMS ..... Telemetered Traffic Monitoring Sites
USDOT ..... United States Department of Transportation
VMT ..... Vehicle-Miles Traveled
WIM ..... Weigh-in-Motion

1. Introduction

1.1 Why Do We Need Performance Measures?

> ***We measure ourselves for two reasons - to make sure we are spending the taxpayers' money as efficiently as possible, and to try to improve how we provide transportation to the people of Florida.***
>
> Secretary Tom Barry

Performance measures are "yardsticks" that transportation agencies use to measure their operating results and to assess investment options. Performance measures can be used by the Florida Department of Transportation (FDOT) to help focus its limited resources to better serve customer needs. By defining specific measures, FDOT will be able to better define the goals and objectives and measure the effectiveness of their programs in meeting these objectives.[1] The measures will help FDOT staff to be more effective and more accountable to citizens of Florida. The ability to focus on and measure results will also assist FDOT in allocating resources more consistently with its objectives and to identify needs in a more consistent manner. Secretary Tom Barry recently stated, "We measure ourselves for two reasons - to make sure we are spending the taxpayers' money as efficiently as possible and to try to improve how we provide transportation to the people of Florida." Performance measures are becoming an important part of the way government works in Florida and by proactively approaching the development and recommendation of these measures, FDOT is ensuring its long-term sustainability by having measures that reflect their mission statement.

FDOT's mission is to:

"Provide a safe transportation system that ensures the mobility of people and goods, while enhancing economic prosperity and sustaining the quality of our environment."

FDOT establishes the goals and objectives for the state transportation system from its mission statement. The *Florida Transportation Plan* includes a long-range component that establishes goals and objectives for twenty years and a short-range component that establishes objectives for the next ten years. The long-range component is updated every three to five years and the short-range component is updated annually. Progress toward the accomplishment of FDOT's objectives is reported on an annual basis in the *Annual Performance Report*. In this context, intelligent transportation system (ITS) performance measures are just one type of performance measure FDOT uses to evaluate agency performance. Other performance measures used by FDOT include mobility, safety, pavement condition, bridge condition, public transportation facility asset management, and environmental concerns.

[1] The measurement of transportation system performance is a complex problem and many externalities, such as the economy and resulting changes in driver behavior, can have profound impacts on system performance. These external factors are outside FDOT's control and, therefore, the use of performance measures only in the assessment of agency performance may not accurately reflect the full effectiveness of FDOT.

Similar to the FDOT's other major programs, ITS performance measures are needed to assess the agency's performance in supporting the *Florida Transportation Plan* through ITS deployments. These measures are of two types: mobility- and safety-related performance measures and agency oriented-measures.

1.2 Purpose

The purpose of this document is to summarize existing performance measures practiced nationally for ITS and recommend performance measures for the *ITS Program Plan*.

1.3 Organization of Document

This document provides a review of existing ITS-related performance measures in Section 2 and recommends ITS performance measures for the *ITS Program Plan* in Section 3.

2. Review of Existing ITS-Related Performance Measures

2.1 Principles of Performance Measures

When establishing performance measures, several principals have come to be accepted as guidelines for "best practices". These principles are as follows:

- The measures should be compatible with national methods.
- The measures should be based on a consensus of opinion.
- The measures should reflect the users' experience on the system.
- The measures should address the movement of both people and goods.
- The measures should address multimodal considerations.
- Fewer mobility performance measures are desirable.
- The measures should be quantifiable.
- Selection of measures should not be driven by existing data availability alone.
- The measures should not be too costly to estimate or collect.
- The measures should be understandable to the general public.
- The measures can be used throughout FDOT activities.
- The measures can be forecast into the future.

These principles were used when evaluating and recommending performance measures for the *ITS Program Plan*.

2.2 National ITS Performance Measures

The Joint Program Office (JPO) of the United States Department of Transportation (USDOT) is very active in testing and evaluating a number of performance measures. The primary measures that are recommended at a national level are used in the program review of major metropolitan ITS and benefits evaluation of system deployments. The measures employed in these analyses include:

Safety
- Reduction in crash rates - total fatalities and injuries

Mobility
- Reduction in travel time delay
- Reduction in travel time variability
- Improvement in customer satisfaction

Efficiency
- Increase throughput
- Productivity
- Reduce travel costs

Energy and Environment
- Reduce emissions
- Reduce energy consumption

Each of these measures have been deployed and tested in major metropolitan ITS. National statistics for many of the measures have been extrapolated to summarize the estimated benefits of ITS.

2.3 ITS-Related Performance Measures Currently Used in Florida

2.3.1 Florida Statewide ITS Strategic Plan Performance Measures

FDOT's *ITS Strategic Plan* outlines the recommended development of an ITS Plan, deployment priorities for ITS goals and objectives, and performance measures to be reported. These measures are summarized as follows:

Safety
- Minimize response times to incidents
- Reduce commercial vehicle safety violations
- Reduce weather related traffic incidents
- Minimize rail grade crossing incidents
- Improve security for highway and transit
- Improve security, safety, and convenience for bikes/pedestrians

Protection of Public Investment
- Reduce vehicular delay
- Improve peak period speed
- Reduce commercial vehicle operations (CVO) operating costs

Interconnected Transportation System
- Reduce cost and delay on intermodal connections
- Minimize shipping and delivery delays
- Improve predictability of travel times
- Improve the efficiency of fleet operations
- Improve tourist access and convenience
- Increase employment in ITS

Travel Choices
- Improve mobility and choices for transit
- Improve tourist access
- Reduce the need to travel
- Reduce energy use and environmental degradation
- Improve multimodal travel
- Reduce delay from incidents
- Improve efficiency of toll operations
- Enhance ride-sharing opportunities

Although these measures are provided in the *ITS Strategic Plan*, little direction is provided as to how the measures will be estimated, quantified, or reported and at what interval they should be reported. It is also difficult to understand the relationship of many of the measures to the goals and objectives for which they are associated. For example, how does an increase in employment in ITS support the goal of providing an interconnected transportation system. The general areas of the performance measures are also not directly tied to a goal of the *Florida Transportation Plan* as it exists today or the current *ITS Program Plan*, which is under development. (The goal areas in the existing *ITS Strategic Plan* reflect the goals of the *Florida Transportation Plan* in 1998.) As a result of the lack of progress in the implementation of these performance measures and the lack of a rational nexus between some of the measures and the goals reported, a fresh look at the statewide performance measures were made in this effort.

2.3.2 Performance Measures in ITS Corridor Plans

The *I-4 ITS Corridor Study*, which developed a system architecture and implementation strategy for deployment of ITS services along I-4, proposes several performance measures in connection with the goals and objectives for the project. These measures are as follows:

Reduce Travel Times and Costs
- Reduce travel times
- Improve reliability (day-to-day travel times)
- Improve predictability of travel times

Improve Highway Safety
- Reduce frequency, severity, and costs
- Improve incident response times
- Improve evacuation times
- Improve traveler security (CVO)

Improve Environmental Quality
- Reduce emissions costs

Support Economic Development
- Improve trucking operations
- Improve travel convenience for tourists

- Improve intermodal access

Improve Agency Operations
- Reduce public agency operating costs

Each of these measures are tied to specific objectives; however, no estimation or quantification of these measures is being performed along the corridor at this time.

2.3.3 Survey of ITS Operators

An informal telephone survey was conducted with the ITS operators for Florida metropolitan ITS services. The general result of the survey was that there is no implementation of performance measurements in their operations. There is a recognized need for performance measures and availability of the measures in the statewide and other system plans; however, there is no institutional use for the measures at this time. During normal operations, speeds and travel times are monitored in near real-time on the systems; however, these data typically are not stored or archived for future evaluation (beyond research application external to the operations). District 5, through a partnership with the University of Central Florida, has established a website and data archive of ITS data collected along I-4 for public use and evaluation. Incident response time is currently the most widely implemented measure and is viewed as a key indicator of success. The ITS personnel also recognized the need for before and after studies on the benefits of ITS services but only limited studies have been conducted to provide the baseline of data needed for analysis of their system. District 5 conducted safety evaluation following phases 1 and 2 of the I-4 Surveillance Motorist Information System (SMIS). However, the results of the evaluation were not as positive as hoped. Additionally, in District 6, a user survey was previously conducted to assess the travelers' perception of the freeway management system (FMS) developed in the Miami-Dade area.

2.4 Mobility Performance Measures Program

2.4.1 Overview

FDOT has been actively developing mobility performance measures since 1996. This effort has culminated in the successful definition of mobility performance measures for highways and transit and the implementation of a program for the regular reporting of trends for the state highway system and metropolitan transit systems.

Table 2.1 summarizes the mobility performance measures included in this program and the sources of data used to estimate these measures. This is one of the most advanced programs in the nation, but relies primarily on the use of estimated data rather than measured data. These estimated data are a result of the scale (12,000-mile system) and scope of the measures reported. Appendix A provides a summary of the ITS data needs to support performance measures.

Table 2.1 – Florida's Mobility Performance Measures and Data Sources

Dimension of Mobility	Mobility Performance Measures	Data Requirements	Source
Quantity of Travel	Person-Miles Traveled	Average Annual Daily Traffic (AADT)	Roadway Characteristics Inventory (RCI)
		Hourly K	Estimated from telemetered traffic monitoring sites (TTMS) system raw data files grouped by level of service (LOS) facility types
		Hourly Volume	Hourly K * AADT
		Length	RCI
		Vehicle Occupancy	1990 National Personal Transportation Survey county-wide average journey to work data
	Truck-Miles Traveled	AADT	RCI
		Hourly Volume	Hourly K * AADT
		Length	RCI
		% Trucks Daily	RCI
		% Trucks Peak Hour	Estimated from TTMS system raw data files grouped by LOS facility types
	VMT	AADT	RCI
		Hourly Volume	Hourly K * AADT
		Length	RCI
	Person Trips	Total Person Trips	Florida Standard Model (travel demand forecasting) output files
Quality of Travel	Average Speed	Average Segment Speed	Estimated using planning applications from the Highway Capacity Manual adapted for Florida and extended for saturated conditions
		Person-Miles Traveled	See above.
	Delay	Average Segment Speed	See above.
		Free-Flow Speed	Estimated using posted speed limits in RCI
	Average Travel Time	Distance	RCI
		Speed	See above.
	Average Trip Time	Door-to-Door Trip Travel Time	Florida Standard Model (travel demand forecasting) output files
	Reliability	Median Travel Times	Six-week field studies
		Travel Time Distribution	Six-week field studies
	Maneuverability	Hourly Volume	Hourly K * AADT
		Length	RCI

Table 2.1 (Continued)

Dimension of Mobility	Mobility Performance Measures	Data Requirements	Source
Accessibility	Connectivity to Intermodal Facilities	Intermodal Facilities of Significance	Public Transportation Office
		Intermodal Connectors	Public Transportation Office
	Dwelling Unit Proximity	System Location	State highway system base map
		Dwelling Units	1990 Census' statewide transportation planning package
	Employment Proximity	System Location	State highway system base map
		Employment Location	1990 Census' statewide transportation planning package
	Industrial/Warehouse Facility Proximity	System Location	State highway system base map
		Industrial Warehouse Facility Location	1990 Census' statewide transportation planning package
	Percent-Miles Bicycle Accommodations	Miles of Roadway with Bicycle Accommodations	FDOT bicycle coordinator
		Total System Miles	RCI
	Percent-Miles Pedestrian Accommodations	Miles of Roadway with Pedestrian Accommodations	FDOT bicycle coordinator
		Total System Miles	RCI
Utilization	Percent-System Heavily Congested	Hourly Volume	Hourly K * AADT
		Segments Operating at LOS E or F	Use of FDOT's generalized LOS tables
		Segment Length	RCI
		System Miles	RCI
	Percent-Travel Heavily Congested	Hourly Volume	Hourly K * AADT
		Segments Operating at LOS E or F	Use of FDOT's generalized LOS tables
		Segment Volume * Length	See above.
		System VMT	See ablve.
	Vehicles Per Lane Mile	AADT	RCI
		Length	RCI
		Lane-Miles	RCI
	Duration of Congestion	Hourly Volume	Hourly K * AADT
		Hours of the Day that Segments Operate at LOS E or F	Use of FDOT's generalized LOS tables.
		Lane-Miles	RCI lanes * RCI length

3. ITS Performance Measures

3.1 Introduction

When evaluating candidate performance measures for ITS deployments, two basic considerations must be applied:

- How does ITS support FDOT's goals and objectives to improve how we provide transportation services to the citizens of Florida?

- What is FDOT's success/progress in deploying ITS services and are we spending our limited resources as efficiently as possible?

To answer both of these questions, two distinctive sets of performance measures are needed.

The first set of performance measures responds directly to the *ITS Program Plan's* goals and objectives as documented in *Technical Memorandum No. 2 – ITS Needs Model*. This issue paper proposes a set of goals and objectives for the *ITS Corridor Master Plans* and derives performance measures and benchmarks for the *ITS Program Plan*. These agency-oriented goals and objectives form the basis of the ITS business plan for the *ITS Program Plan*.

The second set of performance measures supports national performance measures and is proposed to accomplish the following:

- The national ITS performance measures documented in Section 2 can be derived from the ITS performance measures in Florida.

- The ITS performance measures support FDOT's Mobility Performance Measures Program.

- The *ITS Program Plan's* performance measures support FDOT's overall performance measures as documented in their *Annual Performance Report* and the *FTP* goals and objectives.

This structure and hierarchy of requirements result in ITS performance measures that must be at least as detailed as the requirements of the national program, but do not limit the provision of more detailed measures or more measures in general to support the *ITS Program Plan* goals and objectives.

3.2 Recommended Measures

The following summarizes the recommended ITS performance measures for the *ITS Program Plan*. Table 3.1 (pages 12-15) organizes the performance measures related to the goals and objectives for the *ITS Program Plan* as documented in *Technical Memorandum No. 2 – ITS Needs Model* and recommends benchmarks for tracking the measures.

These measures were identified based on measures previously established by FDOT for the *ITS Strategic Plan* and are consistent, where possible, with other measures from the *Agency Strategic Plan/Short-Range Component* of the *FTP*.

Mobility- and Safety-Related Measures

Derived from the ITS Program Plan Goals and Objectives

- Total delay in vehicle-minutes
- Predictability of travel times
- Reliability of travel times
- Accident rate per million vehicle-miles traveled (VMT) by severity type
- Queue length and frequency of queue formation annually
- Throughput in passenger car equivalents per lane per hour

Needed to Support National ITS Performance Measure Objectives

- Improvement in customer satisfaction
- Reduce travel costs (can be derived from delay)
- Reduce emissions (can be derived from delay)
- Reduce energy consumption (can be derived from delay)

Note: The only additional performance measure that is not directly derived from the measures based on the goals and objectives statement is improvement in customer satisfaction. To implement this measure for ITS, it is recommended that the ITS Office evaluate the current customer satisfaction survey performed by FDOT to determine if additional items can be added that directly relate to customer satisfaction with ITS deployments.

Agency Performance Measures

- Advanced traveler information system (ATIS) coverage
- Overweight vehicle enforcement coverage
- Incident management system (IMS) coverage
- FMS and IMS coverage of special-use lanes (SULs)
- Data collection system coverage
- Data collection system functionality
- Percent of ITS deployments with before and after studies
- Publish guidelines on how to mainstream ITS in transportation planning
- Branding of major services
- Hazardous materials (HAZMAT) response team coverage

- Designation and signing of detour routes
- Continue research and development at existing or greater funding levels
- Publish statewide standards and specifications for ITS field devices and implement
- Publish statewide standards for traffic management center (TMC) software and implement
- Publish a statewide communications architecture and implement
- Communications backbone coverage
- Publish standard operating procedures and implement
- Publish statewide information exchange network standards and criteria
- Publish performance measures and archive data requirements and implement
- Publish a Systems Engineering Management Plan (SEMP)
- Establish a statewide-managed funds program for ITS
- Implement ITS funding targets for FDOT
- Publish work program instructions
- Complete training program assessment and implement
- Percent of project costs funded (total cost) by other agencies through public-public partnerships
- Number of regions that implement regional operating organization (ROO) partnerships
- Percent of project costs funded (total cost) through public-private partnerships

Table 3.1 – Recommended *Ten-Year ITS Cost-Feasible Plan* Performance Measures (Goal Area 1)

Goals and Objectives		Performance Measures	Benchmark (for 2012 unless otherwise noted)
1.	**Move People and Goods Safely**		
1.1	**Reduce accident rates.**		
1.1.1	Reduce accident rates caused by driver errors and the severity of accidents.[2]	Accident rate per million vehicle-miles traveled annually.	Reduce accident rates by 15% where freeway and incident management systems are deployed and reduce the severity of accidents by 15% (a reduction of fatality and injury accident rate in proportion to the total rate)
1.1.2	Reduce accident rates and severities in construction work zones.	Accident rate per million vehicle-miles traveled annually.	Reduce accident rates by 15% where smart work zone management systems are deployed
1.1.3	Reduce accident rates at highway-rail grade crossings.	Accident rate per million vehicle-miles traveled annually.	Reduce accident rates by 15% where advanced highway-rail grade crossing systems are deployed.
1.2	**Reduce queuing on interstate mainlines.[3]**		
1.2.1	Reduce queues on limited-access roadways from highway-rail grade crossings.	Queue length (feet) on mainline and the frequency of queue formation (times per year)	Reduce queue length and frequency of queue formation by 15% where advanced highway-rail grade crossing systems are deployed.
1.2.2	Reduce queues at weigh and inspection stations along the corridors.	Queue length (feet) on mainline and the frequency of queue formation (times per year)	Reduce queue length and frequency of queue formation by 15% at weigh and inspection systems where electronic clearance and credentialing is deployed.
1.2.3	Reduce queues at intermodal facilities that impact corridor operations.	Queue length (feet) on mainline and the frequency of queue formation (times per year).	Reduce queue length and frequency of queue formation by 15% at intermodal facilities where inspection systems, electronic clearance, and credentialing are deployed.
1.3	**Improve the safety of commercial vehicle operators in rest areas.**	The number of crimes against commercial vehicle operators in rest areas.	Reduce the number of crimes committed against commercial vehicle operators where surveillance and public safety systems are deployed.
1.4	**Provide evacuation coordination services and emergency management.**		
1.4.1	Provide pre-trip planning information for evacuation coordination.	ATIS coverage.	Dissemination of pre-trip traveler information for evacuations through Information Service Providers (ISP's) to Florida coastal counties.
1.4.2	Provide traffic management during evacuation conditions.	Traffic management services coverage during evacuations.	Management of Traffic information on Florida's five principal FIHS corridors for evacuations.
1.4.3	Manage demand through communication with shelters and other safe harbors.	Communication links to county emergency management centers (EMCs) and shelter management personnel.	Provide communication links from all regional traffic management centers (RTMC') to county emergency operation centers and shelter management personnel and provide shelter information in statewide 511 services.
1.4.4	Provide route guidance information and information on traffic/travel conditions and weather including winds, rainfalls, and storm surges.	Route guidance coverage.	Provide route guidance information during evacuations on Florida's five principal FIHS corridors for evacuations.
1.4.5	Support remote configuration management of highways during evacuation conditions or other emergencies.	Remote configuration deployment coverage.	Provide remote configuration technology deployments along all candidate corridors for contra-flow operations during evacuations.
1.4.6	Provide accurate and timely traveler information regarding incidents on evacuation routes and updated weather information.	ATIS coverage.	Provide ATIS coverage along Florida's five principal FIHS corridors.
1.4.7	Share emergency information among local and regional TMCs and emergency management facilities.	Communication links to county EMCs and shelter management personnel.	Provide a communications link from all RTMCs and links to local county emergency operation centers and shelter management personnel and provide shelter information in statewide 511 services.
1.4.8	Detect, verify, respond to, and clear incidents and manage traffic around accidents, emergencies, and other incidents	Incident response and clearance times.	Minimize the incident response and clearance times during evacuation conditions.
1.4.9	Support infrastructure security through surveillance at critical structures and interchanges.	Percent of critical structures, interchanges with surveillance, and at RTMCs.	Provide coverage at 75% of critical structures on limited-access facilities and at 100% of RTMCs.

[2] The severity of accidents is commonly divided into three strata: accidents involving fatalities, accidents involving injuries (but no fatalities), and accidents involving property damage only.

[3] This objective is intended to promote measures that reduce queuing that forms on mainlines from surface street elements formed by exiting vehicles.

Table 3.1 – Recommended *Ten-Year ITS Cost-Feasible Plan* Performance Measures (Goal Area 2)

Goals and Objectives		Performance Measures	Benchmark (for 2012 unless otherwise noted)
2.	**Preserve and Manage the System**		
2.1	**Enhance mobility and efficiency.**		
2.1.1	Improve travel times along the corridors.	Total delay in vehicle-minutes.	Reduce delays by 15% where freeway and incident management services are deployed.
2.1.2	Improve predictability and reliability of travel times.	Predictability of travel times in minutes.	Provide travel time prediction models for ATIS capable of predicting actual travel times within 5% of trip duration for 95% of all trips along the five principal FIHS corridors.
		Reliability of travel times measured as the percent of trips that are achieved less than the predicted travel time plus a 20% margin.	Operate and manage the system to provide at least 85% reliability for a 20% margin of trip travel time along the five principal FIHS corridors.
2.1.3	Reduce accidents and other incidents during normal flows that result from congestion and delays that are caused by "rubber-necking" during incidents.	Accident rate per million vehicle-miles traveled annually.	Reduce accident rates by 15% where freeway and incident management services are deployed.
2.1.4	Reduce congestion-related delays by reducing queues and spillback from other facilities.	Queue length (feet) on mainline and the frequency of queue formation (times per year).	Reduce queue length and frequency of queue formation at ramp interchanges where ramp metering and surface street control is deployed.
2.1.5	Reduce delays caused by congestion in construction work zones.	Total delay in vehicle-minutes.	Reduce delay by 15% where smart work zone management systems are deployed.
2.1.6	Manage traffic accessing these major corridors at interchanges to improve mainline throughput and traffic flow.	Total delay in vehicle-minutes	Reduce delays by 15% where freeway and incident management services are deployed.
		Throughput in passenger car equivalents per lane per hour.	Increase throughput in interchange areas by 10% where freeway and incident management services are deployed.
2.1.7	Reduce unnecessary delays at tollbooths	Total delay in vehicle-minutes.	Reduce delay at tollbooths by 10% where electronic payment services are deployed.
2.1.8	Reduce unnecessary delays at the gates of intermodal facilities.	Total delay in vehicle-minutes.	Reduce delay at intermodal terminals by 10% where electronic clearance and credentialing services are deployed.
2.1.9	Provide traveler information services with route and mode choice information.	Advanced traveler information service coverage.	Provide advanced traveler information services along Florida's five principal FIHS corridors.
2.2	**System Preservation**		
2.2.1	Improve enforcement of illegally overweight vehicles.	Overweight enforcement coverage.	Increase the use of portable overweight vehicle enforcement technologies such as seismic weigh-in-motion (WIM).
2.3	**Incident Management**		
2.3.1	Improve abilities to detect, verify, respond to, and clear incidents.	Incident management service coverage.	Provide incident management services on at least 85% of Florida's five principal FIHS corridors in urbanized areas and at high accident locations in other areas.
		Road Rangers Service Patrol coverage.	Provide incident management services on at least 85% of Florida's five principal FIHS corridors in urbanized areas and at high accident locations in other areas.
2.3.2	Improve incident-related traveler information.	Advanced traveler information service (ATIS) coverage.[4]	Provide advanced traveler information services along Florida's five principal FIHS corridors.
2.3.2.1	Predict delays and clearance times.	Predictability of travel times in minutes.	Provide travel time prediction models for ATIS capable of predicting actual travel times within 5% of trip duration of 95% of all trips along the five principal FIHS corridors.
2.4	**Manage Special-Use Lanes (SULs)**	Freeway and IMS coverage of special-use lanes.	Provide incident management services on at least 85% of special-use lanes along Florida's five principal FIHS corridors in urbanized areas and at high accident locations in other areas.
2.5	**Provide Data Archiving and Warehousing**		
2.5.1	System evaluation and alternative analysis.	Data collection system spatial coverage.	Provide data collection system coverage for all freeway and IMS's deployed.
2.5.2	Support and supplement other statewide data collection programs.	Data collection system functionality.	Document requirements and provide archived data to other statewide data collection programs.
2.5.3	Support highway operational performance reporting, modeling simulation, and other techniques for operations and management of the system.	Data collection system functionality.	Document requirements and provide archived data to highway operational performance reporting, et. al.
2.5.4	Providing before and after studies for ITS deployments	Percent of ITS deployments with before and after data.	Implement before and after studies to document benefits of statewide ITS deployments for at least 10% of all deployments.

[4] Implementation of ATIS requires instrumentation of our highways to provide accurate and reliable travel times in near real-time.

Table 3.1 – Recommended *Ten-Year ITS Cost-Feasible Plan* Performance Measures (Goal Areas 3 and 4)

Goals and Objectives		Performance Measures	Benchmark (for 2012 unless otherwise noted)
3.	**Enhance Economic Competitiveness**		
3.1	**Ensure efficient landside access to intermodal, port, airport, and truck terminal facilities.**	See items 1.1.3, 1.2.1, 1.2.2, 1.2.3, 2.1.8, and 2.2.1.	See items 1.1.3, 1.2.1, 1.2.2, 1.2.3, 1.2.8, and 2.2.1.
3.2	**Ensure efficient intermodal transfer of people and goods.**	See items 1.1.3, 1.2.1, 1.2.2, 1.2.3, 2.1.8, and 2.2.1.	See items 1.1.3, 1.2.1, 1.2.2, 1.2.3, 2.1.8, and 2.2.1
3.3	**Promote safe and efficient access of vehicles to markets.**	See all above.[5]	See all above.
3.4	**Expedite permitting and clearance of commercial vehicles at weigh and agricultural inspection sites to keep commerce moving.**	See items 1.1.3, 1.2.1, 1.2.2, 1.2.3, 2.1.8, and 2.2.1.	See items 1.1.3, 1.2.1, 1.2.2, 1.2.3, 2.1.8, and 2.2.1.
3.5	**Ensure efficient access to major activity centers such as tourist attractions, state parks, and other areas of interest.**	See all above.	See all above.
3.6	**Provide safe and efficient tourist travel and reduce VMT through the provision of accurate and timely traveler information.**	See items 1.4.1, 1.4.6, 2.1.9, and 2.3.2.	See items 1.4.1, 1.4.6, 2.1.9, and 2.3.2.
3.7	**Support designation of corridors as strategic intermodal corridors and funding for ITS deployments.**	See item 2.5.	See item 2.5.
4.	**Enhance Quality of Life and the Environment**		
4.1	**Provide efficient statewide ITS services with autonomy for decision-making to support local needs and regional cooperation to promote efficiency and support regional and statewide goals.**	See all above.	See all above.
4.2	**Improve interoperability of ITS services through the development of statewide uniform device standards and specifications.**	See Goal Area 5.	See Goal Area 5.
4.3	**Support integration of ITS into local planning processes, programs, and capacity projects.**	Publish guidelines on how to mainstream ITS in transportation planning.	Complete Rule 940 Implementation Plan by the end of 2002 and provide regular support of metropolitan planning organizations (MPO's) on ITS planning integration.
4.4	**Provide name recognition of key ITS-related services through branding that will instill trust and confidence in traveler information services, roadside assistance, electronic payment services, and other strategic services.**	Branding of major services.	Adopt statewide brands for (1) traveler information services, (2) roadside assistance and (3) electronic payment services by the end of 2001 and others as needed.
4.5	**Provide easy access and data mining capabilities for transportation planning and design for all partners to support decision-making.**	See item 2.5.	See item 2.5.
4.6	**Provide accurate real-time data to technology, business, and operational users for effective and responsive transportation operations.**	See item 2.5.	See item 2.5.
4.7	**Reduce air-quality emissions from mobile sources.**	See items 2.1.1, 2.1.5, 2.1.6, 2.1.7, 2.1.8, and 2.4.	See items 2.1.1, 2.1.5, 2.1.6, 2.1.7, 2.1.8, and 2.4.
4.8	**Reduce the potential for impacts from HAZMAT incidents.**	See items 1.1.1, 1.1.2, and 1.1.3.	See items 1.1.1, 1.1.2, and 1.1.3.
4.8.1	Improve HAZMAT response systems.	HAZMAT response system coverage.	Provide HAZMAT response coverage on 85% of Florida's principal FIHS corridors in urbanized areas and at high-accident locations in other areas.
4.8.2	Improve the availability of traveler, weather, and shelter information during man-made and natural disasters.	See items 1.4.1 and 1.4.6.	See items 1.4.1 and 1.4.6.
4.8.3	Provide safe routes for HAZMAT that avoid densely populated areas.	Designation and signing of detour routes.	Designate and sign detour routes for Florida's five principal FIHS corridors.

[5] All of the measures identified for ITS support this objective.

Table 3.1 – Recommended *Ten-Year ITS Cost-Feasible Plan* Performance Measures (Goal Area 5)

Goals and Objectives		Performance Measures	Benchmark (for 2012 unless otherwise noted)
5.	**Deploy an Integrated, Effective System**		
5.1	**Provide research and development for technologies to support deployments.**	Continue research and development at existing or greater funding levels.	Promote continued research and development of emerging technologies and activities to support deployments.
5.2	**Develop statewide standards and specifications for ITS field devices.**	Publish statewide standards and specifications for ITS field devices and implement.	Complete by end of 2001.
5.3	**Develop statewide standards for TMC software.**	Publish statewide standards for TMC software.	Complete by end of 2001.
5.4	**Develop a communications architecture and backbone for statewide deployment.**	Publish statewide communication architecture and implement.	Complete by end of 2001.
		Communication backbone coverage.	Pursue private partnerships to advance deployment of statewide communication backbone to achieve 50% coverage of the five principal FIHS corridors.
5.5	**Develop standard procedures for operations and management.**	Publish standard operation procedures.	Complete by end of 2002.
5.6	**Develop statewide information exchange network standards and criteria.**	Publish statewide information exchange network standards and criteria and implement.	Complete by end of 2002.
5.7	**Brand all critical statewide services such as traveler information, interactive voice response (IVR) systems (511 or 1-800), RR Service Patrols, *SunPass*®, Pre-Pass, etc.**	Brand all critical statewide services such as traveler information, IVR systems (511 or 1-800), Road Rangers, ***SunPass***®, Pre-Pass, etc.	Complete by end of 2001.
5.8	**Standardize performance measures and archive data to produce a history of trends and establish benchmarks.**	Publish performance measures and archive data requirements and implement.	Complete by end of 2002.
5.9	**Develop statewide procurement guidelines.**	Publish procurement guidelines and implement.	Complete by end of 2002.
5.10	**Develop a statewide systems engineering process for design, integration, and testing that includes regular updates and enhancements of statewide architecture.**	Publish SEMP.	Complete by end of 2002.
5.11	**Develop statewide procurement contracts to leverage economies of scale.**	Develop statewide procurement contracts.	Complete by end of 2002.
5.12	**Develop an ITS asset management program to track and program replacement parts, migrate legacy systems, and manage the life-cycle of deployment.**	Deploy asset management program.	Complete by end of 2002.
5.13	**Establish a statewide-managed funding program for ITS with project decision recommendations made by the ITS Office.**	Establish statewide-managed funds program.	Complete by end of 2001.
5.14	**Dedicate a percentage of all FDOT funds, statewide-managed and district-allocated, for operations, management, and ITS deployment.**	Implement ITS funding targets for FDOT.	Complete by end of 2002.
5.15	**Update work program instructions to develop traceability with the *Statewide ITS Architecture (SITSA)*.**	Publish work program instruction changes.	Complete by end of 2002.
5.16	**Increase the professional capacity of the public and private sectors in Florida to support planned deployments.**	Publish training needs assessment and implement.	Complete training needs assessment by end of 2001 and implement structured training program by 2003.
5.17	**Promote public-public partnerships to leverage financial and human resources.**	Percent of project costs funded (total cost) by other agencies through public-public partnerships.	One percent of total project costs funded through partnerships on FIHS limited-access facilities.
		Number of regions that implement regional operating organization (ROOs) partnerships.	Establishment of ROO in Orlando, Miami, Jacksonville, and Tampa.
5.18	**Promote public-private partnerships to leverage financial and human resources.**	Percent of project costs funded (total cost) through public-private partnerships.	One percent of total project costs funded through partnerships on FIHS limited-access facilities.

3.3 Data Needs and Reporting Requirements

In general, it is recommended that annual reporting of these measures be done each fall in conjunction with FDOT's *Annual Performance Report* cycle. Adopting this cycle will allow the integration of the *ITS Program Plan* into FDOT's annual report to the Legislature and the Florida Transportation Commission resulting in full institutional integration. Similar to FDOT's *Annual Performance Report*, a brief report should be prepared each year to document the progress in achieving these goals and objectives. It is anticipated that during the early years of the program, 2001 and 2002, the ability to provide detailed documentation and reporting will be limited. However, as the *ITS Program Plan* reaches maturity, the ability of the ITS Office to document the progress should also mature.

The following discusses the data needs and potential tracking system requirements to support this reporting.

3.3.1 Mobility- and Safety-Related Measures

- Total delay in vehicle-minutes – derived from ITS vehicle detector systems. The basic data needed are travel times and free-flow travel times. Incident delays should be used in this analysis. The use of probe vehicle technology to support analysis of incident delays is recommended.
- Predictability of travel times – derived from ITS vehicle detector systems with additional algorithms to predict travel times along corridors based on historical data from delay computation.
- Reliability of travel times – derived from ITS vehicle detector systems with additional algorithms similar to the prediction of travel times.
- Accident rate per million VMT – additional functionality is needed with the data archiving system to track accident locations and frequency by type.
- Queue length and frequency of queue formation – can be derived from ITS vehicle detector systems if special consideration is given to the location of sites near interchange ramp terminals or other candidate sites.
- Throughput in passenger car equivalents per lane per hour – can be derived from ITS vehicle detector systems.
- Improvement in customer satisfaction – derived from FDOT's annual customer satisfaction survey.
- Reduce travel costs – can be derived from delay (delay * operating and user costs = undesirable travel costs).
- Reduce emissions – can be derived from delay (delay * emission factor).
- Reduce energy consumption – can be derived from delay (delay * fuel consumption rate = undesirable fuel consumption).

Of these basic performance measures, the availability of data to support the analysis of queue formation is of the greatest concern. Additional analysis is needed to determine the potential costs of implementing this performance measure.

3.3.2 Agency Performance Measures

In order to track and assess the success of the *ITS Program Plan*, many of these performance measures will be addressed through the SEMP program management area. It is anticipated that an asset management program and monitoring of the systems engineering process will result in most of the documentation of the progress in achieving the goals, objectives, and benchmarks established for these various performance measures.

- ATIS coverage – tracked in the ITS asset management database.
- Overweight vehicle enforcement coverage – tracked in the ITS asset management database.
- IMS coverage – tracked in the ITS asset management database.
- FMS and IMS coverage of SULs – tracked in the ITS asset management database.
- Data collection system coverage – tracked in the ITS asset management database.
- Data collection system functionality – tracked in the ITS asset management database and ITS architectures.
- Percent of ITS deployments with before and after studies – special studies needed and tracked as part of the systems engineering management program proposed.
- Mainstreaming of ITS planning – institutional success in the consideration of ITS in transportation plans throughout Florida.
- Branding of major services – document through narrative.
- HAZMAT response team coverage – tracking in the ITS asset management database.
- Designation and signing of detour routes – tracking in the ITS asset management database.
- Continued research and development – tracking of ITS Office's participation in FDOT's university research program.
- Publish statewide standards and specifications for ITS field devices and implement – document through narrative.
- Publish statewide standards for TMC software and implement – document through narrative.
- Publish statewide communications architecture and implement – document through narrative.
- Communications backbone coverage – tracking in the ITS asset management database.
- Publish standard operating procedures and implement – document through narrative.
- Publish statewide information exchange network standards and criteria – document through narrative.
- Publish performance measures and archive data requirements and implement – document through narrative and implement through central data warehousing and information exchange network.
- Publish SEMP – document through narrative.
- Establish statewide-managed funds program for ITS – tracking through FDOT's work program.
- Implement ITS funding targets for FDOT – tracking through FDOT's work program.
- Publish work program instructions – document through narrative.
- Complete training program assessment and implement – documents through narrative.
- Percent of project costs funded (total cost) through public-public partnerships – document through narrative.
- Number of regions that implement ROO partnerships
- Percent of project costs funded (total cost) through public-private partnerships – document through narrative.

4. Summary and Next Steps

This technical memorandum has recommended performance measures for the ITS Plan. These performance measures include mobility- and safety-related performance measures and agency performance measures. Each of these measures was derived from the goals and objectives' statements used to summarize the needs, issues, problems, and objectives for ITS deployments or to support a hierarchy of national performance measures.

The next steps in implementing the ITS Plan is for FDOT to engage in the successful completion of these goals and objectives and to implement the supporting data collection and tracking requirements as documented in Section 3.3.

Appendix A

ITS Data / Technology Needs to Support Mobility Performance Measures

A recent issue paper prepared by PBS&J for FDOT's TranStat Office identifies several opportunities for ITS to support FDOT's Mobility Performance Measures Program. The basic data sets needed for mobility performance measures are available from FDOT's RCI and highway performance monitoring system (HPMS). However, as the range and scope of mobility performance measures expand and evolve, ITS data sources are needed to provide the full range and robust data sets needed.

Data to Support Reliability Studies along Major Corridors
FDOT is currently planning to continue monitoring I-95 in Dade and Broward counties from I-395 to I-595; I-95 in Duval County from I-275 South to Emerson Street; and I-4 from U.S. 192 to Lake Mary Boulevard. Developing a trend of data over a period of at least three years will support the verification of the methods developed in 2000 for reliability and provide a baseline of data for future comparison and analysis.

In addition to these corridors, FDOT should explore the expansion of the reliability data sets as ITS services come "on-line" and work with each of the system managers to provide an ITS Data Warehouse Market Package that is suitable for the analysis of reliability within the system. In exchange for the storage of data needed for system-wide reporting, the method used to predict travel times and their reliability can be implemented in the TMC operation to support decision-making by system managers and dissemination to traveler information systems.

Transit System Data
Although a history of data suitable for mobility performance measurement for transit systems is available from the Public Transportation Office, new data collection studies are being conducted in conjunction with the MPOs for the major transit systems in Florida. This data needs to be compared with trend data available and evaluated for reasonableness. Recommendations for maintenance and updates of the data will need to be developed in cooperation with the Public Transportation Office. Annual updates of the data would be desirable. If this is not cost-effective, a three-year cycle may be a reasonable approach that is consistent with other FDOT data collection programs.

Data to Support Performance Measures for Freight and Goods Movement
One of the recommendations for expansion of the Mobility Performance Measures Program was to respond to the recent changes in FDOT's mission statement to reflect the importance of economic development. In order to implement these measures, data on freight volume, speed, classification, weight, and densities are required. This data is needed in stop-and-go conditions as well as free-flow conditions.

The data that is needed should be sufficient to provide average weight for heavy vehicles according to classification and in conjunction with volume according to classification along the major FIHS trade and tourism routes. Sampling techniques should be explored where data is not required along every segment of the corridor but provides a reasonable extrapolation to the facility level based on understandings of truck travel patterns and the relationship to distribution/warehousing facilities where loads change. The purpose of these data collection techniques is to be able to capture the ton-miles of goods carried on the major FIHS trade and tourism routes and then the remainder of the state highway system.

Options available to provide these data include a variety of WIM technologies. Quartz weight sensors are available that can measure vehicle weight in stop-and-go conditions. Seismic WIM sensors are also growing in their use, reliability, and affordability.

Data to Support Trip-Based Analysis and Measures

One of the recommendations of the *Mobility Performance Measures Handbook* (FDOT, 1998) was to explore the use of trip-based measures for reporting on metropolitan highway systems. The metropolitan highway systems are considered fundamentally different than reporting on the state highway system or FIHS since we are attempting to describe the total trip of travelers. For reporting on the major systems, the segment of trips off the state highway system or FIHS was not considered relevant in the analysis.

Measurement and aggregation of trip-based performance measures is a complex and challenging issue. Total-trip "traveler behavior" research has been conducted throughout the United States since the 1960's, beginning with the Chicago Area Transportation Study (CATS) used to support the development and refinement of travel demand forecasting models. However, the thirty years of history in the area have demonstrated that traditional methods of travel studies are costly and risky in terms of the use of samples for studies and the magnitude of errors possible (from a lecture by Dr. Peter Stopher, LSU, 1992).

A number of MPOs around the country have been collecting speed and/or travel time data as part of their travel monitoring or congestion management systems. Many of these areas use traditional travel time studies based on floating car techniques; however, some areas such as Hampton Roads, Washington, D.C., and Baltimore, Maryland, are beginning to use global positioning systems (GPS)-based probe vehicle technologies where volunteers are solicited to be probe vehicles and their travel behavior (trip length, frequency, speed, and travel times) are observed. The development of automated databases using large sample sets may be possible in the near future using a number of technologies including:

- Cellular/PCS location pattern matching technology;
- ***SunPass***® transponders for speed and travel time studies; and
- GPS technology as probe vehicles.

Based on the reported experience in some of the metropolitan systems that have been using this technology, there are tremendous long-term opportunities available for using probe vehicle data collection techniques for trip-based performance measures. Some of the obstacles and challenges that have been reported include costs of scaling the data collection to cover an entire region and privacy issues in the collection of cell phone data.

The proliferation of cellular/PCS phones provides significant opportunities for data collection in providing the coverage needed to measure an entire metropolitan area. The Federal Communication Commission (FCC) is requiring geo-locatable cell phone technology within 100 meters by October 2001 to improve response times in emergency calls. Test studies of the use of this data are currently being performed along I-95 in Washington, D.C., and Maryland. The communications infrastructure available with this technology and widespread acceptance of

cellular/PCS phones are very attractive as long-term potential sources of trip-based data. The challenges associated with this technology include a perception of loss of privacy and the requirement for any cellular/PCS phone involved in the study to be "powered-on". Japan has been using an enhanced form of GPS for several years now; however, for the United States, it would require more infrastructure.

In some areas of Florida, ***SunPass***® transponders provide a significant opportunity for data collection studies. More than 600,000 electronic toll collection (ETC) transponders are in use statewide today and this number is expected to double by 2005. Portable roadside readers (PRR) are currently available from the Office of Toll Operations (OTO) and the Orlando-Orange County Expressway Authority (OOCEA) that can be used to identify and match transponders to estimate speeds and travel times. This technology has tremendous potential for corridor and segment studies, but is limited for total-trip analysis until GPS capabilities are added to the ***SunPass***® system. GPS is being used by several foreign countries in virtual tolling systems where no tollbooths are used but telemetry is collected on vehicles for use by key facilities and tolls are charged based on the time of day and relative congestion on the facilities. It is estimated that GPS transponders may be available within Florida in the five- to ten-year timeframe.

Handheld GPS systems can also be used for probe vehicle data collection and are capable of estimating total-trip travel behavior. This technology is well known and has been applied on a limited basis in major metropolitan areas. As the costs associated with GPS services decline (some lower-end systems can be purchased for $15-$20 per set), the widespread availability of this technology may make data collection on a metropolitan system for total-trip analysis more affordable. As the technology becomes more mature, the general public is also likely to become more acceptable to serving as a probe vehicle for studies that can result in better traffic congestion management.

One of the recommendations of this technical memorandum was to explore use of these technologies for reporting trip-based performance measures. **A feasibility study is currently underway by the ITS Office to complete this effort.**

Data to Verify Speed Estimating Techniques Under Stop-and-Go Conditions

The modeling of average vehicle speeds in the mobility performance measures database underwent rigorous verification in 1998. Twenty-one sites were used to compare the estimating technique with measured data at TTMS that generally experience free-flow conditions. Additional verification may be needed where stop-and-go conditions occur. Several studies have been conducted in Florida that reveal the disadvantage of using inductive loop traffic detectors to collect traffic and speed data under stop-and-go conditions.

Data sources that may be used to support this analysis include the aerial volume and density speed studies performed by Skycomp during the spring of 2000 and existing portable traffic monitoring sites (PTMS) that utilize IDRIS technologies. For these sites, the software associated with the counters should be modified to consider speed bins as low as 2.5 miles per hour (MPH) (the lower boundary applied to the speed estimating technique).

Other non-intrusive technologies that may be used to assess stop-and-go conditions are radar and acoustic systems. **District 7 is currently partnering with Mobility Technologies to demonstrate radar and acoustic systems on I-275.**

Conclusions

There are many mobility-related performance measures identified in Florida that are associated with ITS. However, this application of performance measures during operations is limited to speed and travel time and incident response times. There are significant opportunities to integrate the Mobility Performance Measures Program with the ITS services throughout Florida. The robust data sets available from ITS services combined with the opportunity to add value to the data and support ITS evaluation and benefits is a logical partnership for effective use of resources within FDOT.

These needs for data can be fulfilled through standards for data quality and coverage. Table A.1 provides a summary of the desired data quality standards. Desirably, data at these levels of quality should be collected on all urban FIHS limited-access facilities.

Table A.1 – Summary of Desired Data Quality Standards

Freeways

Parameter	Units	Range Min	Range Max	Interval No.	Interval Units	Allowable Error
Incident Detection						
Flow Rate	vehicles per hour	0	2500	20	seconds	2.5% @ 500 VPH
Occupancy	percent	0	100	20	seconds	1 percent
Speed	miles per hour	0	100	20	seconds	1 MPH
Travel Time	minutes			20	seconds	5 percent
Ramp Demand	yes/no			0.1	seconds	no missed vehicles
Ramp Passage	yes/no			0.1	seconds	no missed vehicles
Ramp Queue Length	vehicles	0	40	20	seconds	1 vehicle
Incident Management						
Flow Rate	vehicles per hour	0	2500	5	minutes	2.5% @ 500 VPH
Occupancy	percent	0	100	5	minutes	1 percent
Speed	miles per hour	0	100	5	minutes	1 MPH
Travel Time	minutes			5	minutes	5 percent
Planning						
Flow Rate	vehicles per hour	0	2500	15	minutes	2.5% @ 500 VPH
Occupancy	percent	0	100	15	minutes	1 percent
Speed	miles per hour	0	100	15	minutes	1 MPH
Travel Time	minutes			15	minutes	5 percent
Origin-Destination Tracking	enter-exit location	0	500	15	minutes	10 percent

Other Roadways

Parameter	Units	Range Min	Range Max	Interval No.	Interval Units	Allowable Error
Approach Flow Profiles	vehicles	0	3	1	second	2 vehicles/signal cycle
Turning Movement Flow Rate	vehicles	0	200	1	cycle	2 vehicles/signal cycle
Average Link Travel Time	seconds	0	240	1	cycle	2 seconds
Average Approach Speed	miles per hour	0	100	1	cycle	2 MPH @ 0-55 MPH
Queue Length	vehicles per lane	0	100	1	second	2 vehicles
Demand Pressence	yes/no			10	MHz	no missed vehicles
Average Approach Delay	seconds per vehicle	0	240	1	cycle	2 seconds
Approach Stops	stops	0	200	1	cycle	5% of stops
Flow Rate	vehicles per hour	0	2500	5	minutes	2.5% @ 500 VPH
Occupancy	% per lane	0	100	5	minutes	5 percent
Average Speed	miles per hour	0	100	5	minutes	2 MPH @ 0-55 MPH
Average Delay	seconds per vehicle	0	240	5	minutes	2.5 seconds
Pedestrian Detection	yes/no					no missed presence
Bicycle Detection	yes/no					no missed presence