# Florida Department of Transportation (FDOT) Express Toll Lane Modeling Workshop Peer Review Report

September 2013


TMIP

Better Methods. Better Outcomes.


U.S. Department of Transportation
Federal Highway Administration

FHWA-HEP-14-014

TMIP

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# List of Acronyms

| | |
|---|---|
| ABM | Activity-Based Model |
| ConOps | Concept of Operations |
| CPS | Corridor Planning Study |
| DRCOG | Denver Regional Council of Governments |
| DTA | Dynamic Traffic Assignment |
| ETDM | Efficient Transportation Decision Making |
| FDOT | Florida Department of Transportation |
| FHWA | Federal Highway Administration |
| FSUTMS | Florida Standard Urban Transportation Model Structure |
| FTE | Florida's Turnpike Enterprise |
| HCM | Highway Capacity Manual |
| HCS | Highway Capacity Manual Software |
| HOV | High-Occupancy Vehicle |
| HOT | High-Occupancy Toll |
| IOAR | Interchange Operational Analysis Report |
| ITS | Intelligent Transportation Systems |
| LRTP | Long-Range Transportation Plan |
| MOE | Measure of Effectiveness |
| MPO | Metropolitan Planning Organization |
| O&M | Operations and Maintenance |
| PD&E | Project Development and Environment |
| PET | Project Evaluation Toolkit |
| PSRC | Puget Sound Regional Commission |
| RPS | Revealed Preference Survey |
| SHS | State Highway System |
| SPS | Stated Preference Survey |
| T&R | Traffic and Revenue |
| TAT | FHWA Traffic Analysis Toolbox |
| TMIP | Travel Model Improvement Program |
| TMU | Transit Model Update |
| VMT | Vehicle Miles Traveled |
| VPH | Vehicles per Hours |

# 1.0 Introduction

## 1.1 Disclaimer

The views expressed in this document do not represent the opinions of the Federal Highway Administration (FHWA) and do not constitute an endorsement, recommendation, or specification by FHWA. The document is based solely on the discussions that took place during the Florida Department of Transportation (FDOT) Express Toll Lane Modeling Blue Ribbon Panel Workshop and supporting technical documentation provided by FDOT, workshop invited speakers and participants.

## 1.2 Acknowledgements

FHWA and FDOT wish to acknowledge and thank the ten Blue Ribbon Panel Workshop peer review panel members for volunteering their time to participate in the review of the FDOT express toll lane modeling practices and for sharing their valuable experience and expertise.

The Peer Review Panel Members were:

- Hugh Miller – CDM Smith – W*orkshop Moderator*
- Yi-Chang Chiu – University of Arizona
- Jim Ely – HNTB
- Matthew Kitchen – Puget Sound Regional Commission (PSRC)
- Kara Kockelman – University of Texas at Austin
- Bill Olsen – CDM Smith
- Eric Pihl – FHWA
- Scott Ramming – Denver Regional Council of Governments (DRCOG)
- James Sturrock – FHWA
- Peter Vovsha – PB

Brief biographies for each of the peer review panel members are presented in Appendix C.

## 1.3 Report Purpose

This report summarizes the FDOT Express Toll Lane Modeling Blue Ribbon Panel Workshop that was held on May 22-23, 2013 at the Florida Turnpike Enterprise headquarters in Orlando, Florida. The workshop was supported in part by the Travel Model Improvement Program (TMIP) and sponsored by the FHWA.

Given the increasing complexities of travel forecasting practices and the growing demands by decision-makers for information about varying policy alternatives, it is essential that travel forecasting practitioners have the opportunity to share their experiences and insights. The TMIP-supported peer review program provides a forum for this important knowledge and information exchange.

A peer review and/or peer exchange workshop can serve multiple purposes. This review in particular focused on providing advice and recommended technical guidance for a new managed-lane model design, as well as specifications for a consistent modeling practice for express lane implementation resulting from an increased emphasis on managed lanes as a required alternative for analysis in major capacity improvement studies on existing limited access highways in the State of Florida. The Systems Planning Office has recently started a program for developing a planning-level managed lane modeling application for the Florida Standard Urban Transportation Model Structure[1] (FSUTMS). Therefore, FDOT convened the Blue Ribbon Panel Workshop in order to:

1) Seek assistance in specifying the required elements of a common travel model framework,
2) Identify parameters and sensitivities for demand modeling in both express toll lane planning and operations, and
3) Define the relationships between regional travel demand, tolling, and microsimulation modeling.

The panel spent the morning session of Day One of the workshop listening to presentations by FDOT planning staff, national experts, and other invited speakers, which culminated in a set of specific questions from FDOT and its planning partners. The second half of Day One of the workshop was spent discussing those questions in two separate break-out sessions (the Planning Session and the Operations Session) and asking the panel members to provide their recommendations. The results of that discussion, in the form of comments and observations from the panel, are presented in this workshop documentation report.

FDOT and its partner agencies will carefully assess the feedback from the workshop panel when prioritizing the final model development implementation plan. While the advice of the peers is invaluable, there are many factors to work through when considering a model improvement strategy. Therefore, the peer recommendations should be regarded as suggestions for FDOT and its partners to consider rather than prescriptions to be followed.

## *1.4 Report Organization*

This report is organized into the following sections:

1. *Introduction* – introduces the peer review workshop panel and this resulting report.
2. *Overview and Background* – gives an introduction to FDOT's planning responsibilities and the agency's goals for the peer review.
3. *FDOT's Current Managed Lane Modeling Practice* – this section provides a historical context of express toll lane modeling at FDOT, including past and current modeling approaches.
4. *FDOT's Charge to Peer Review Panel* – the specific technical questions posed by the host agency to be considered and addressed by the panel.
5. *Issues and Key Concepts for Express Toll Lane Demand Forecasting* – a summary of issues to be considered in demand forecasting.
6. *Issues and Key Concepts for Express Toll Lane Operational Analysis* – a summary of issues to be considered in operational analysis.
7. *Panel Discussion and Observations* – peer review panel responses to the FDOT questions posed during the workshop.

[1] http://www.fsutmsonline.net/

In addition, the report includes a Number of Appendices:

*Appendix A* – List of Workshop Participants

*Appendix B* – Workshop Meeting Agenda

*Appendix C* – Peer Review Panel Biographies

*Appendix D* – Presentation Summaries

# 2.0 Overview and Background

## *2.1 FDOT Overview*

FDOT is an executive agency, which means it reports directly to the Governor. FDOT's primary statutory responsibility is to coordinate the planning and development of a safe, viable, and balanced State transportation system serving all regions of the State, and to assure the compatibility of all components, including multimodal facilities. A multimodal transportation system combines two or more modes of movement of people or goods. Florida's transportation system includes roadway, air, rail (freight and transit), sea, spaceports, bus transit, and bicycle and pedestrian facilities.

FDOT is decentralized in accordance with legislative mandates. Each of the Districts is fairly autonomous and managed by a District Secretary. The Districts vary in organizational structure, but each has major divisions for Administration, Planning, Production, and Operations. Additionally, each district has a Public Information Office that reports to the District Secretary and a District Chief Counsel who reports to the FDOT General Counsel in Tallahassee. Table 1 provides a summary of the eight FDOT districts, as well as their respective associated counties, daily vehicle miles traveled (VMT), and State Highway lane-miles. Figure 1 provides a geographic representation of the seven FDOT districts.

**Table 1: Florida DOT Districts**

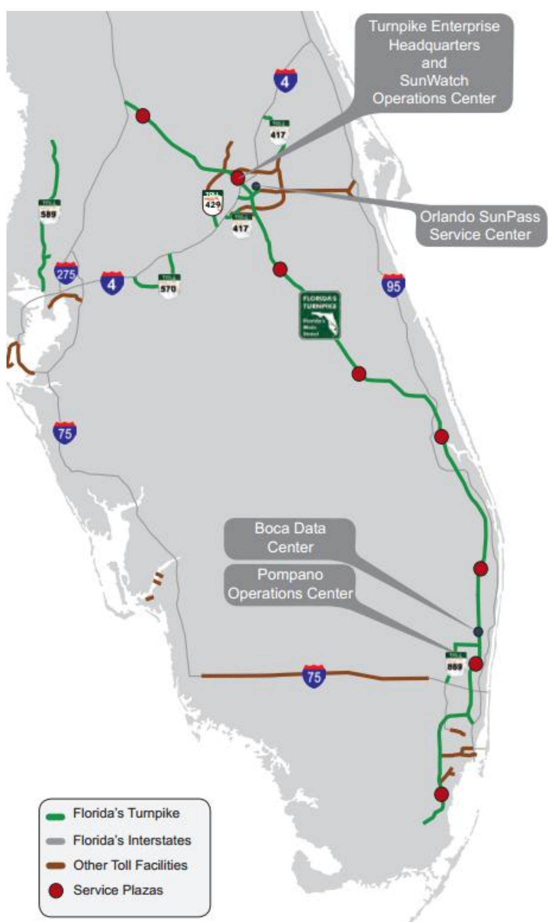
| FDOT District | Region | Counties | Daily VMT (millions) | State Highway Lane-Miles |
|---|---|---|---|---|
| District 1 | Southwest | Charlotte, Collier, De Soto, Glades, Hardee, Hendry, Highlands, Lee, Manatee, Okeechobee, Polk, and Sarasota | 34.7 | 5,842 |
| District 2 | Northeast | Alachua, Baker, Bradford, Clay, Columbia, Dixie, Duval, Gilchrist, Hamilton, Lafayette, Levy, Madison, Nassau, Putnam, St. Johns, Suwannee, Taylor, and Union | 43.2 | 8,197 |
| District 3 | Northwest | Bay, Calhoun, Escambia, Franklin, Gadsden, Gulf, Holmes, Jackson, Jefferson, Leon, Liberty, Okaloosa, Santa Rosa, Wakulla, Walton, and Washington | 26.1 | 6,464 |
| District 4 | Southeast | Broward, Indian River, Martin, Palm Beach, and St. Lucie | 52.4 | 6,016 |
| District 5 | Central | Brevard, Flagler, Lake, Marion, Orange, Osceola, Seminole, Sumter, and Volusia | 55.6 | 7,447 |
| District 6 | South | Miami-Dade and Monroe | 56.7 | 2,967 |
| District 7 | West Central | Citrus, Hernando, Hillsborough, Pasco, and Pinellas | 33.6 | 4,267 |
| District 8 | Florida's Turnpike Enterprise | Statewide | 6.2 | 2,210 |

**Figure 1: Florida DOT District Map**

The Florida Turnpike Enterprise[2] represents the eighth and final FDOT District and oversees a 460-mile system of limited-access toll highways, as listed below and illustrated in Figure 2:

- Florida's Turnpike Mainline (State Road 91), extending north from Florida City in Miami-Dade County to Wildwood in Sumter County;
- The Homestead Extension of Florida's Turnpike (Part of Mainline), between the Miami-Dade/Broward County line and the US 1 interchange (Exit 1) in Florida City;
- The Veterans Expressway/Suncoast Parkway in Hillsborough, Pasco, and Hernando counties (Toll 589);
- The Seminole Expressway/Central Florida GreenWay/Southern Connector Extension (Toll 417) in Seminole, Orange, and Osceola counties;
- The Martin Andersen Beachline Expressway West (Toll 528) serving Central Florida and the Space Coast;
- Polk Parkway (Toll 570) in Polk County;
- Sawgrass Expressway (Toll 869) in Broward County; and
- Daniel Webster Western Beltway (Toll 429) in Orange and Osceola Counties.

**Figure 2: Florida Turnpike System Map (2012 FY Report)**




2 http://www.floridasturnpike.com/

## *2.2 Planning Analysis Needs and Challenges*

The State's forecasting and analysis needs are being driven by stated FDOT policy objectives. Specifically, all new capacity for existing limited access State Highway System (SHS) facilities shall analyze a dynamically tolled alternative while maintaining existing non-tolled capacity. The Systems Planning Office is seeking ways to standardize the managed lane modeling practices in light of recent experience. Six new managed lane projects are now currently in construction or about to begin the construction phase. In each case, the analysis and modeling was conducted without a standardized project approach for the tools. While the analysis may not prove to be inaccurate, the current technical approach makes the process of prioritizing and especially comparing projects against one another a very difficult task for FDOT policy makers and planners.

Projects under construction or nearing construction include the following:

- I-75 Express – District 4/ District 6;
- I-4 Express - District 5;
- I-595 Express - District 4;
- I-95 Express Continued (Phase II, III) - District 4; and
- Palmetto Express - District 6.

## *2.3 Workshop Objectives*

In accordance with Florida SHS express lane policy guidance, dynamically tolled express lanes are a newly required factor of analysis in the study of major capacity improvements on limited-access facilities. With the increased emphasis on express lanes, there is now a critical need to adopt a standard travel demand forecasting practice in the State of Florida that is capable of analyzing these types of facilities.

In response to this need for a consistent Statewide modeling approach for evaluating express lanes, the Systems Planning Office was motivated to assemble a Blue Ribbon Expert Panel and to convene an Express Toll Lane Modeling Workshop. This workshop was intended to establish Statewide modeling practices in three focus areas:

- Public-Private Partnership (P3) Encouragement;
- Planning Feasibility Analysis; and
- Operational Feasibility Analysis.

The Blue Ribbon Expert Panel, consisting of national specialists, was assembled to provide advice and recommended directions for managed-lane model design, along with specifications for a consistent modeling practice for express lane implementation in Florida. FDOT staff conducted a presentation on Florida's current practices and FDOT-recommended guidelines. Workshop participants then took part in two breakout discussion groups within the following subject areas: Planning and Demand Forecasting and Operational Analysis.

The workshop's desired outcome was a set of specific recommendations regarding best-practice modeling strategies for express lanes throughout the State. The recommendations will address issues related to toll revenues, travel demands, and congestion/system performance, with an in-depth examination of the analytical tools available for direct or adapted use.

# 3.0 FDOT's Current Managed Lane Modeling Practice

The morning session featured an introduction to the FDOT overall process for project development followed by presentations discussing FDOT's experience in evaluating managed lanes. Presentation topics included: a briefing on Florida project development and evaluation processes, the evolution of the FSUTMS toll modeling application in the three phases of I-95 Express Lane development; approaches to traffic operational analysis; approaches to Traffic and Revenue (T&R) studies; and a briefing on risk analysis strategies applied in T&R studies. Together, these presentations provided a context for discussions later in the workshop regarding best practices and steps for moving forward.

## *3.1 Project Development Process and Evaluation*

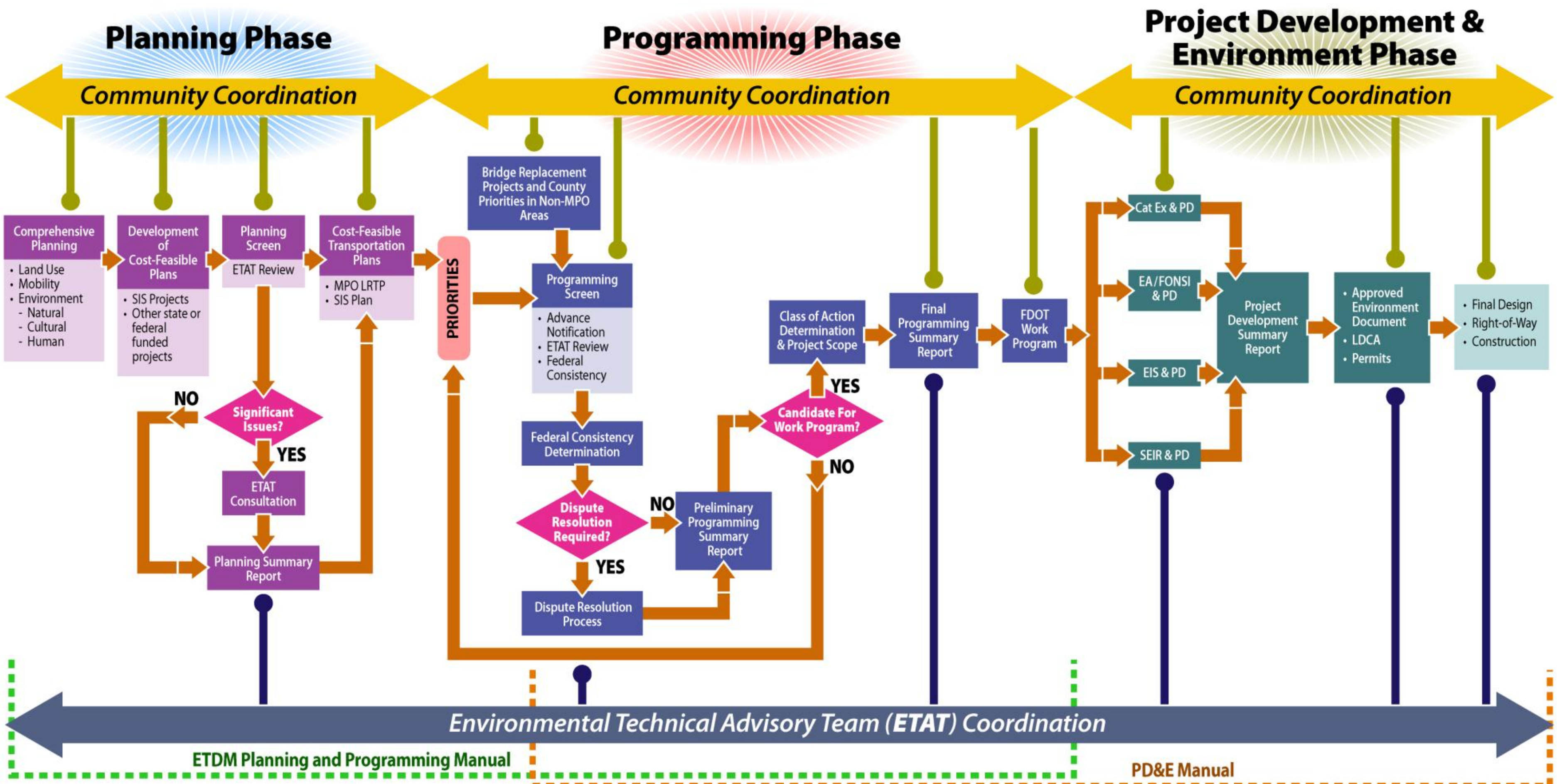
Florida follows the federal planning process, which begins with the Metropolitan Planning Organization's (MPO's) preparing a long-range transportation plan (LRTP) following the 3-C planning process. Each LRTP covers a span of 20 years. In Florida the LRTP list of needed improvement projects is prioritized considering benefits and cost feasibility. The LRTP improvements list is used by the MPO and FDOT to develop the Transportation Improvement Program (TIP), which consists of a five-year program of projects of which one year is current and four are proposed. Each year, the TIP is modified by adding a new fifth year and advancing the first of its future years to current status.

As stated in the MPO Program Management Handbook (2012), "(each) MPO carries out three major work activities:

1. The development and maintenance of the LRTP which addresses no less than a 20-year planning horizon.
2. The update and approval of the Transportation Improvement Program (TIP), a five-year program for highway and transit improvements.
3. The development and adoption of the Unified Planning Work Program (UPWP)"

The FDOT has also established an Efficient Transportation Decision Making (ETDM) process that includes planning, programming, development, and environmental phases of project implementation. These phases of project implementation are illustrated in the Figure 3.

Figure 3: FDOT ETMD Process



These traditional activities were placed in a matrix, shown in Table 2, and presented by Hugh Miller during the workshop's introductory presentation. The issues involved in Florida's project development process are well known by the FDOT staff and supporting consultants. Product deliverables have specific names, and milestones are well established for completing the projects. For traditional roadway projects, the demand models used for project forecasts and traffic operational analysis procedures have been well-established and are updated regularly. In adding express lane projects, FDOT Districts have dealt with more complex demand modeling procedures and more complex traffic analysis procedures (like microsimulation), as well as financial feasibility calculations that require T&R studies.

**Table 2: FDOT Project Development Process**

| | Traditional Activities | | | |
|---|---|---|---|---|
| | Name | Issues | Products | TDM Model |
| **MPO** | Regional Planning Studies | Needs & Cost Feasible | LRTP/TIP/UPWP | MPO Model Update |
| **FDOT** | Project Planning Studies | Project need and purpose; funding sources and priority; | Concept Report with tentative project features and planning level cost estimates | Latest version of MPO Model |
| | Project Development and Environmental Studies | Environmental feasibility; public acceptance; project location, funding and design features | EIS; permits; refined design with cost estimate and schedule | Project validated version of the MPO model |
| | Design Studies | Detailed design features | Design Package, R/W | Same model |

## *3.2 Use of SERPM for I-95 Express Lanes*

The travel demand modeling conducted to date for express lane projects has been completed as part of the FDOT project development process. Each project makes enhancements to the latest version of the MPO regional travel demand model. The decision of what enhancements to make has been left to the discretion of the consultant performing the work with input from the District modeling staff.

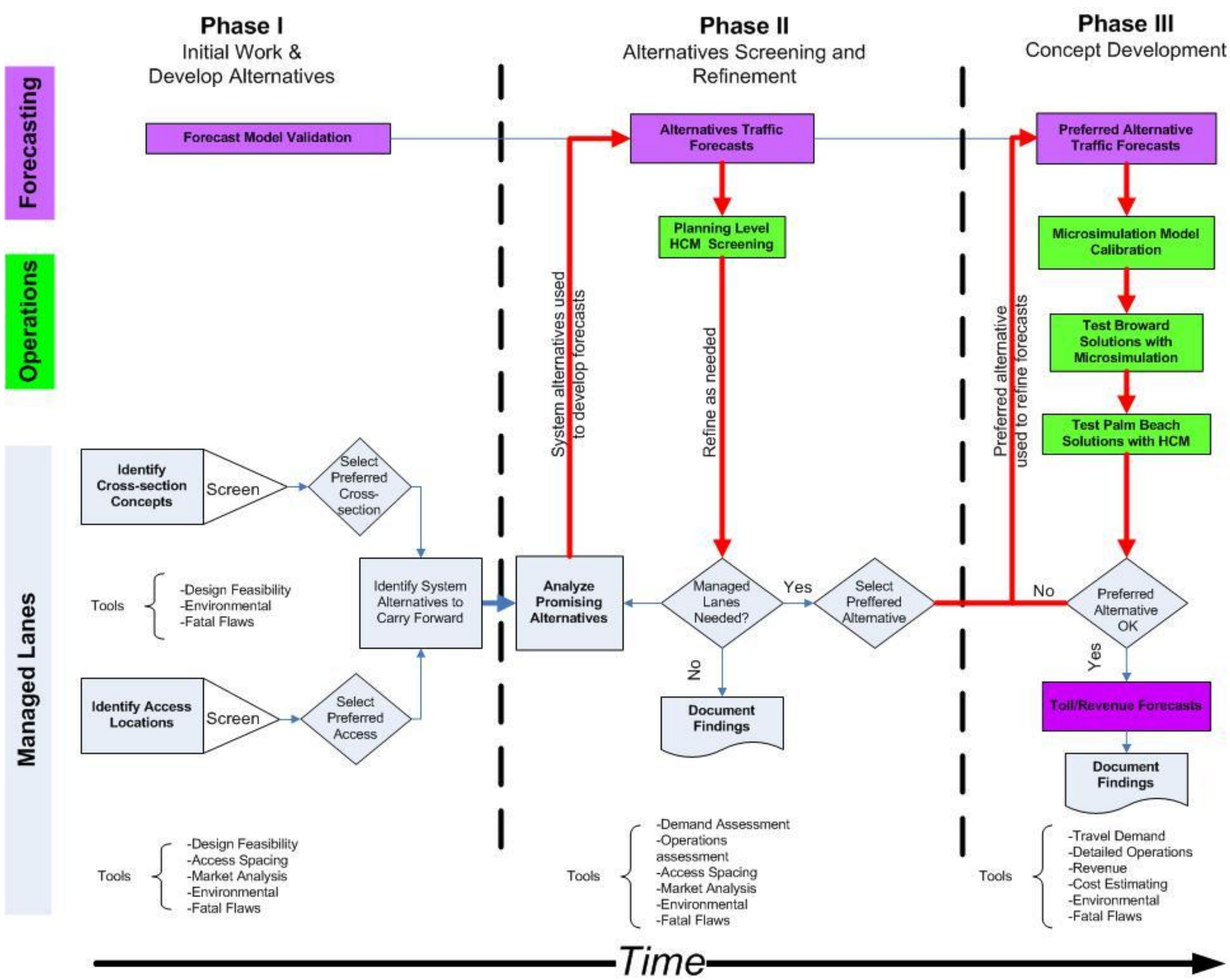
In the case of the I-95 Express Lanes Study, Ken Kaltenbach described the evolution of modeling approaches used as the project advanced from the initial Phase I to the Phase II and Phase III extensions of the express lanes. During Phase I, an analysis of the demand for the I-95 Express was performed using the traditional CTOLL parameter within the standard FSUTMS assignment process. This was done due to severe time constraints, and it used a dynamic toll function based on the express lane volume-to-capacity value to determine the toll.

In Phase II, the I-95 Corridor Planning Study, a binary logit choice model for tolled route/non-tolled-route choice was implemented during highway assignment. This was combined with more extensive feedback and the use of a subarea model to reduce the network size. This study examined the feasibility of high-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes for 63 miles between Griffin Road and Indiantown Road.

Finally, in Phase III's I-95 Project Development and Environment (PD&E) Study, an enhanced version of the previous study's model was used, retaining the binary choice model implemented in the assignment phase but refining the model parameters to increase sensitivity to changes in tolls and travel times.

Figure 4 illustrates the three phases of the I-95 Express Analysis.

**Figure 4: I-95 Express Analysis Flow Chart**




*Source: I-95 Corridor Planning Study: Managed Lane Feasibility, FDOT District 4, July 2012*

## *3.3 I-95 Express Operational Analysis*

With respect to traffic analysis for I-95 Express Phase I and II, David Stroud described how traffic analysis based on Highway Capacity Manual Software (HCS) in the PD&E and Interchange Operational Analysis Report (IOAR) did not provide a sufficient assessment of the complex traffic weaving maneuvers associated with managed lanes. He explained that the selection of a microsimulation approach (using CORSIM) as the traffic analysis tool was based on the need to assess transportation system complexities associated with adding a system of tolled managed lanes to the currently congested and geometrically constrained interstate system.

A team of technical experts from FHWA Florida Division, FDOT Central Office, and FDOT District Office met regularly to discuss the application of the FHWA Traffic Analysis Toolbox (TAT) Volume IV microsimulation guidelines and procedures to the project and to resolve technical issues. Key challenges addressed during these meetings included: the proper selection of temporal and spatial limits; accurate and consistent coding of 24 centerline-miles of freeway, 18 miles of service roads, and four system-to-system interchanges; gathering input data from available sources; and calibrating the model to produce outputs that were verifiable and reproducible. Speed, volume, density, and queuing were the primary measures of effectiveness (MOEs) for model calibration. The microsimulation model's operational analysis resulted in design changes that improved safety and operations.

For the I-95 Express Phase III traffic analysis, both planning and PD&E studies were conducted. The I-95 Corridor Planning Study (CPS) included a rigorous process to develop a methodology to integrate travel demand, traffic operations, and managed lane design into the project development process. The methodology includes a multi-resolution analysis of freeway traffic operations, where Highway Capacity Manual (HCM) tools are used in the initial planning stages and microsimulation is used during the conceptual development or PD&E stage of the project development process. The intent is to focus the planning study efforts on verifying the need to implement tolled managed lanes to reduce congestion and improve interstate mainline operations. Once the need is established by the planning study, the PD&E study uses HCM software and microsimulation to assess the complex traffic maneuvers created by the implementation of tolled managed lanes with placement of ingress and egress access points. The CPS verified the need for implementing tolled managed lanes and recommended the location of ingress and egress access points based on multimodal considerations and market demands between interchanges in the study area.

The PD&E for I-95 Express Phase III was divided into three segments with separate PD&E studies pursued simultaneously. A rigorous process for developing the Traffic Methodology Memorandum for tolled managed lanes was undertaken at the beginning of the studies. The memorandum applied to each of the studies, specifying the details of data collection; travel demand modeling and forecasting; and traffic operational analysis methods using HCM software and microsimulation with VISSIM) which followed the guidelines of FHWA TAT Volume III.

Additionally, the memorandum specified the use of diurnal factors to convert the travel demand model peak-period volumes to peak-hour volumes and calibration targets for hourly traffic flows, travel times, and queuing. The pricing and route choice elements of the microsimulation software's managed lane module were applied to the build conditions to determine the traffic demand for the tolled managed lanes. MOEs included volumes and speeds of both the general purpose and managed lanes, network-wide assessment of no-build and build conditions, and managed lane revenues.

### 3.4 Summary of Managed Lane Program

In a discussion of current Florida modeling practice in relation to tolled facilities, Steve Ruegg described the recent history of toll modeling incorporation in the FSUTMS framework. Since the start of the FSUTMS model design, there has been some accommodation of tolled facilities, with the Turnpike's fixed toll highways in mind. The model structure has used an assignment-based fixed-toll algorithm, with the toll itself being converted to a value-of-time based on the "CTOLL" value. In addition, toll collection facilities are modeled explicitly, with deceleration, toll service time, and acceleration times explicitly modeled through the use of specialized toll links. Service times are estimated based on a multi-server queuing model embedded into the traffic assignment's volume-delay functions. Later improvements have included ramp-to-ramp tolling structures to better represent the Turnpike pricing system.

In the past three years, FDOT Central Office has undertaken two major projects, which will improve the ability to model express lanes in Florida. The first is a major review and upgrade of standard modeling practices, as reflected in the FSUTMS. This improvement program, known as the Transit Model Update (TMU) made several improvements to the four-step model procedure, including the following:

1. Expanded trip purposes;
2. Time-of-day stratification;
3. Use of feedback to trip distribution;
4. Use of a destination-choice distribution model formulation;
5. Expanded mode choice nesting structure and mode options; and
6. Tighter assignment closure criteria.

These model improvements enhance express lane modeling by improving overall model sensitivities and capabilities. For example, time-of-day modeling will allow for more precise estimation of variable tolls and the effect of them on distribution and mode choice.

A second initiative by the FDOT Central Office was specifically directed at improving managed lanes modeling. This program included a "toolbox" of three model approaches that address modeling dynamic open-road tolling in Florida as shown in Table 3.

**Table 3: FDOT Managed Lane Modeling Concept Plan**

| | Phase I | Phase II | Phase III |
|---|---|---|---|
| Type | Assignment-Based Integrated Toll Choice | Mode Choice + Assignment | Discrete Choice |
| Model Type | Trip-Based, Static | Trip-Based, Static | AB and DTA |
| Features | Dynamic toll Estimation, Willingness to pay Curve, Toll Policy | Feedback of toll LOS skims to mode choice. Sensitive to multi-modal shifts | Incorporates detailed HHLD characteristics for toll choice |
| Uses | LRTP & Corridor Planning | Multi-modal corridor evaluation | Policy Sensitivity Testing, and TP Planning |
| Data Requirements | SP/RP survey for WTP curve or logit estimation | SP+RP survey to estimation & calibrate MC parameters | HIS supportive of AB models |
| Availability | Summer, 2012 | 2013 | 2014-2015 |

The development plan consists of three phases, with the intent to generate a robust toolbox of managed lane modeling applications that can meet the planning needs of all agencies based on their modeling capabilities and the required level of detail and model sophistication. In the three-phase program, Phase I consists of developing an assignment-based dynamic toll model, featuring dynamic toll estimation and shift in toll paying demand, willingness to pay curves, and sensitivity to various toll policies. Phase I development work was completed in the summer of 2012.

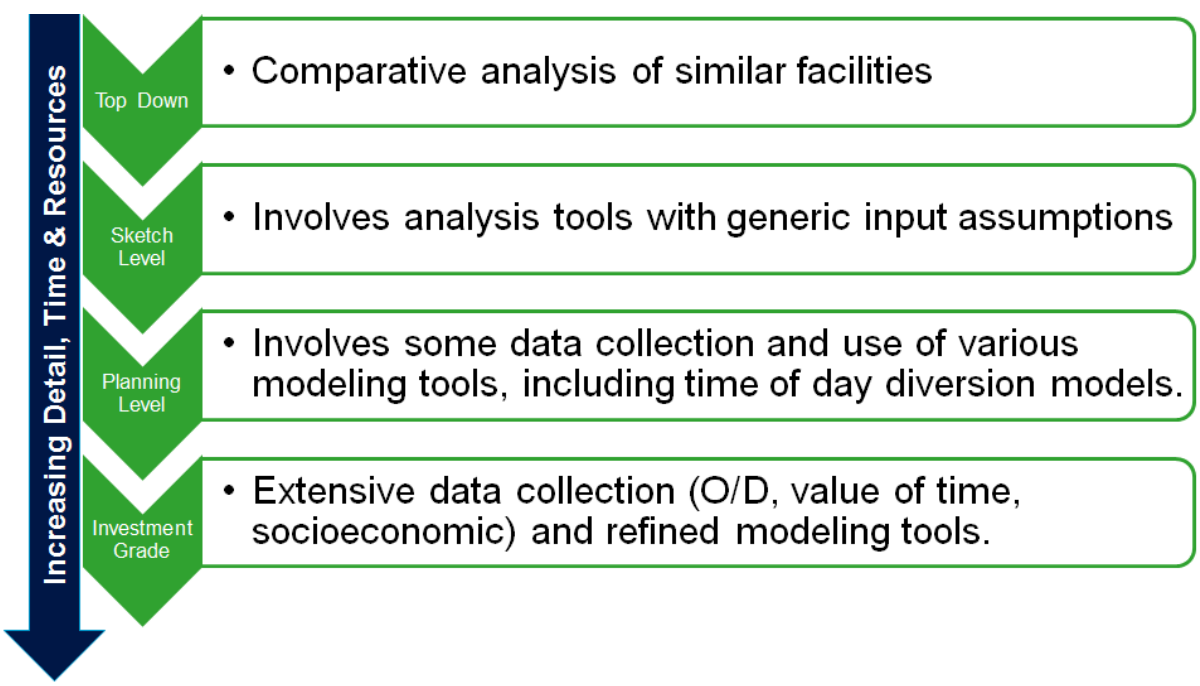
Phase II of the program extends the toll effects to the mode choice level and focuses on implementing toll choice within the mode choice model. This mode choice model with toll paying alternatives was then integrated with the assignment-based dynamic toll model of Phase I, using a feedback structure. The Phase II model provides the ability to forecast occupancy level shifts and mode shifts, and a more comprehensive representation of the utility of a toll facility than is possible in the static highway assignment model. The development of Phase II prototype models is also complete, and final documentation was published in April of 2013.

Finally, Phase III focuses on implementing managed lanes within an activity-based model (ABM) framework. The intent is to take advantage of the detailed person and household attributes available in an ABM to better represent the factors that affect the choice of managed lanes. Activity-based models have been extensively used to support road pricing projects and should be more appropriate for policy sensitivity testing of managed lanes. Phase III is expected to commence in the summer of 2013.

## *3.5 Florida Turnpike Experience*

Josiah Banet of URS/FTE presented on the Turnpike's experience with modeling express lanes in Florida and identified four types of T&R studies, as shown in Figure 5. From the top to the bottom of the figure, the types of studies imply an increasing level of detail, time, and resources to generate the desired output information. For each type of study, there is a modeling approach suited to provide the needed information for each study.

**Figure 5: Types of Traffic & Revenue Studies**



In a "Top Down" T&R study, the focus is to collect general design and performance information on the proposed facility, including lanes, traffic volumes (existing and future), and access design. Operational assumptions, such as types of vehicles allowed, will also be defined. The analyst then compares these features to known performance of other, similar facilities to determine initial feasibility or screening for further studies.

A "Sketch Level" T&R Study (Level 1) is used to determine the high-level financial feasibility of an express lane project using limited data sources. The results of a "Sketch Level" study would assist an agency in determining the need/desire to commit additional resources to further assess a project's feasibility as part of an express lane system. This approach to evaluating an express lanes project within a limited-access facility utilizes existing modeling tools that rely on available data. This approach does not include refinement to the traffic forecast models or additional data collection. Unavailable forecast years for traffic are developed based on reasonable assumptions regarding growth rates. Post-model adjustments to forecasts may be performed based on historical traffic data. In some cases, a stand-alone corridor time-of-day model is used to produce toll rates based on the level of congestion throughout the day. The T&R results are corridor-level and considered to be average estimates with a positive or negative deviation, which are refined with more detailed analyses from a "Planning Level" study.

A "Planning Level" T&R Study (Level 2) results in a more detailed revenue forecast for a project that the agency can then use for developing a project funding plan. This "Planning Level" approach would refine the traffic forecast models to better reflect the selected project corridor's traffic patterns with updated roadway network and improved land use assumptions for existing and future years. A minimum of two forecast years would be developed based on the latest socioeconomic data (e.g., population and employment estimates). Refinement to the validation of the traffic models would be undertaken in order to improve model accuracy and provide more confidence in the forecast results. A time-of-day toll diversion model is used to define traffic and toll rates by hour. Additional data collection efforts would be undertaken to ensure the most recent traffic patterns for the project study area are accurately reflected in the traffic models. This could include, but is not limited to, an origin-destination (O/D) study, speed study, or stated preference survey (SPS). Statistical probability analyses are employed to assess project risk.

An "Investment Grade" study (Level 3) is required when the financing mechanisms use bonds to leverage against anticipated project revenues and the project is ready to go to market. In this case, FDOT has a high confidence that the project will be implemented and would like certainty in the accuracy of the revenue projections. At the "Investment Grade" level, primary data collection of O/D patterns and value of travel time savings (using SPS results) is often required. An independent assessment of the socioeconomic data affecting project traffic is undertaken. The travel demand model is also highly specialized and adapted specifically for the project corridor. Efforts to improve the model forecasting by incorporating reliability are imbedded into the modeling process, and microsimulation models are also employed to provide a more accurate assessment of corridor travel times.

## *3.6 Quantifying Forecasting Risks*

Risk can be defined as the ability of a project to achieve an objective; whereas, uncertainty deals with potential fluctuations in circumstance that may or may not yield significant impact on the project's ability to reach an objective. Tom Adler of RSG first discussed methods of identifying and quantifying the uncertainties and risks associated with model forecasts and then presented an example from work conducted for the Orlando I-4 T&R Study managed lane project.

Dr. Adler began by identifying three main sources of uncertainty associated with travel forecast models that will subsequently impact project risk, including:

1. Model Structure and Data;
2. Analysis Bias; and
3. Inherent Uncertainties about the Future.

The objective of his presentation was to describe methods to quantify these inherent uncertainties within models. While it is recognized that computational methods, statistical methods, and qualitative analysis of uncertainty in models might be used to produce measures of uncertainties from model execution directly, practical problems, including run times, may prevent this approach.

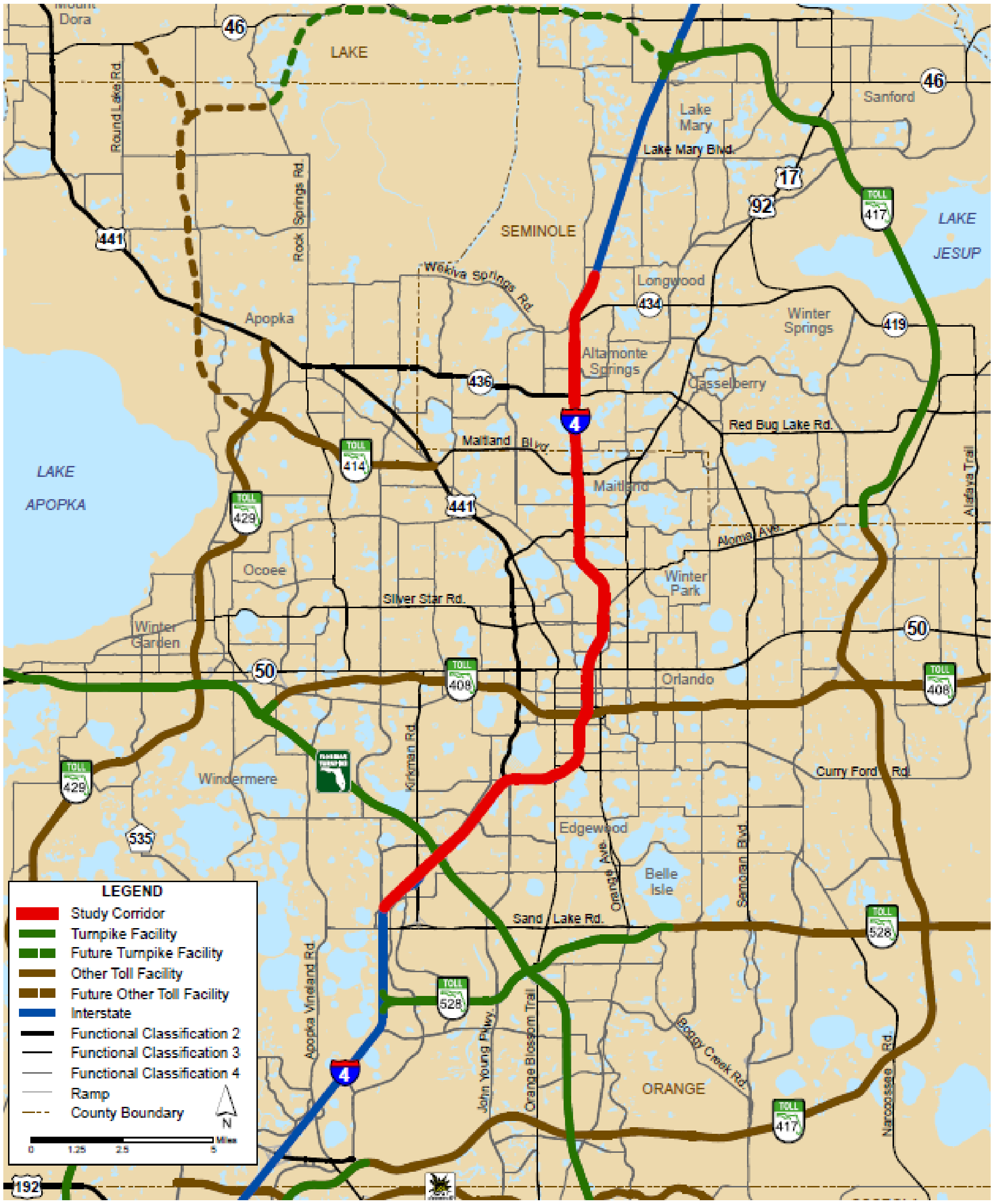
Dr. Adler stated that corridor traffic alternative results generated by a series of travel demand model runs may be subsequently represented using a multivariate closed-form function of model inputs. Application of this type of function allows for a rapid calculation of alternatives represented by variations in key inputs and can therefore generate a response surface which can be used to evaluate the probability of risk associated with the probability uncertainties in input value ranges.

In the Orlando I-4 T&R Study, illustrated in

Figure 6, a 21-mile managed lane project, adding two priced lanes in each direction was evaluated using this approach. Nine “experimental” sensitivity tests were performed in which travel times, toll rates, economic forecasts, and network structures were varied. From these results, a synthesized model for T&R estimation was developed that was able to match model results with an r-squared value of 0.98. Using this synthesized model, probability distributions of revenue and traffic were generated, representing one million random draws from input distributions.

The presentation concluded that response surface models can be developed with accuracy and can be used to effectively simulate risks associated even with more complex travel demand models.

**Figure 6: I-4 Managed Lanes Corridor Map**



# 4.0 Florida DOT's Charge to Peer Review Panel

The Blue Ribbon Expert Panel was charged with providing advice and recommending technical guidance for a new managed lane model design, including specifications for a consistent modeling practice for express lane implementation. The need for this new managed lane model design was a direct result of the recent shift to requiring managed lanes as an alternative for analysis in the study of major capacity improvements on existing limited access facilities in the State of Florida.

FDOT developed a workshop agenda that first provided an overview of Florida's current modeling practices and procedures for analyzing managed and express toll lanes. Following a number of presentations on the specific experience to date in Florida, a handful of invited speakers expanded the discussion to identify current practices and emerging trends being employed nationally across the country.

After an intermission for lunch two technical breakout workshop sessions were convened: "Planning and Demand Forecasting" and "Operational Analysis." Roughly ninety participants in total attended the two-day workshop. Participants elected which of the breakout sessions to attend based on their own interests, background, and expertise. As a result, there was approximately a 70/30 split of total participants in the "Planning and Demand Forecasting" and "Operational Analysis" breakout sessions, respectively.

## *4.1 Planning & Demand Forecasting Breakout Session*

This session was moderated by the following four individuals:

- Jennifer Fortunas (FDOT Central Office);
- Steve Ruegg (PB);
- Jack Klodzinski (URS/Florida Turnpike); and
- Amy Perez (FDOT District 1).

The expert panel members invited to serve during this session included:

- Scott Ramming (DRCOG);
- Matthew Kitchen (PSRC);
- Kara Kockelman (University of Texas);
- Hugh Miller (CDM Smith);
- Bill Olsen (CDM Smith);
- Eric Pihl (FHWA); and
- Jim Ely (HNTB).

The moderators led a series of discussions focusing on questions related to three different topic areas that included: Express Lanes: Planning, Policy, and Process; Model Capabilities and FSUTMS Applications; and Screening and Planning Phase Considerations.

The specific questions posed by the moderators to the expert panel and breakout session participants are listed below. There were five questions regarding Topic Area #1, five questions regarding Topic Area #2, and twelve questions regarding Topic Area #3.

**Topic Area #1 = Express Lanes: Planning, Policy and Process**

1) Which criteria should be applied in determining when a capacity improvement may be needed within the planning horizon (i.e., the next 20 to 40 years)?
2) How can the feasibility of express lanes as a strategy for capacity improvement be determined?
3) Which key features and capabilities are necessary in a travel forecast model to provide a case for the feasibility of express lanes?
4) If express lanes are not feasible, which other non-priced managed lane strategies may be evaluated as suitable alternatives?
5) If express lanes are feasible:
    a) How can lane requirements be established?
    b) Which dynamic tolling scheme provides maximum throughput?
    c) Which dynamic tolling scheme provides the optimal financial solution?
    d) What important considerations must be evaluated to determine an Internal Rate of Return over 50 years?

**Topic Area #2 = Model Capabilities and FSUTMS Applications**

1) Which model sensitivities and capabilities must be focused on during each stage of project development and LRTP development?
    a) Demand Sensitivity to Price
    b) Price and Demand Equilibrium
    c) Time- of-Day Travel Sensitivities
    d) Distributed Value-of-Time
    e) Income Market Segmentation
    f) Purpose Market Segmentation
    g) Reliability
    h) Transit Demand Sensitivities
    i) Multi-class Assignment
2) What guidelines should be established for model application?
3) Should these guidelines vary by phase and, if so, how would they vary?
    a) Fixed Person Demand across All Alternatives
    b) Assignment Closure Criteria
    c) Forecast Years
    d) Quality Assurance Procedures and Technical Review
    e) Network/zone Level of Detail
    f) Level of Detail of Reported Results
    g) Subarea Isolation or “Windowing” of Regional Model (size of detailed network area)

4) Identify data needs at each of the phases below to support the development and maintenance of demand forecasting tools for express lanes:
    a) Development Phases
    b) Initial Screening
    c) Feasibility
    d) T&R
5) How should the development and application of modeling tools be coordinated from initial screening through T&R forecasts to ensure consistency?

**Topic Area #3 = Screening and Planning Phase Considerations**

1) What modeling efforts should be undertaken for “Sketch Level” studies?
    a) Should the data available define the model tools?
    b) Define potential modeling approaches/tasks (e.g., utilize and run an existing travel demand model).
    c) Which applications should be utilized in conjunction with travel demand models (e.g., ability to model managed express lanes)? Consider both model run times and structural complexity.
    d) Should additional modeling be conducted (e.g., time-of-day)?
    e) Is it possible for a demand model to be supplemented with an additional modeling tool (e.g., time-of-day) to meet the defined goal(s) of the project scope?
2) How much consideration should be given to modeling capabilities for “Sketch Level” studies in the initial stages of project definition?
    a) How are project limits and access locations identified?
    b) What considerations should be taken when defining a potential project?
    c) Should there be two stages of model capability review: one for project definition and one for feasibility analysis?
3) What input data should be required for a “Sketch Level” study?
    a) Traffic counts, capacity (e.g., general use and express lanes), speed (e.g., posted, free flow), etc.?
4) What output data should be required for “Sketch Level” project feasibility determination?
    a) Should multiple projects in a defined network of limited access facilities be considered?
    b) Which considerations should be taken in defining output? Examples include: the defined goal(s) of the managed lanes project(s), administrative directives (i.e., all new capacity should consider tolling), congestion management, filling funding shortfalls, covering operations and maintenance (O&M), schedules, etc.?
    c) Which output aside from toll rates and traffic volumes are necessary?
5) What should function as the determining factor for whether a project should graduate to the next phase of analysis?
    a) Which considerations should be taken in determining the phase of analysis? Examples include: the defined goal(s) of the managed lanes project(s), administrative directives (all new capacity should consider tolling), congestion management, filling funding shortfalls, covering O&M, schedules, etc.?

   b) How can project feasibility be determined from a "Sketch Level" evaluation?
6) What modeling efforts should be undertaken for "Planning Level" analysis?
   a) Define potential modeling approaches/tasks (e.g., project level validation of demand model, refinement of access points).
   b) Should available model tools define data requirements? (e.g., if more than one model is available and one particular model requires more data than the others due to complexity, which should be selected for application?)
   c) Which applications should be included with demand modeling (e.g., toll mode choice), considering model run times and complexity?
   d) What additional modeling tools (e.g., time-of-day) could be utilized to meet the defined goal(s) of the project scope?
7) What model input data should be required for a "Planning Level" study?
   a) What can be considered in addition to traffic counts by time-of-day, travel surveys, and O/D surveys?
8) What model output data should be required for a "Planning Level" study?
   a) What can be considered in addition to traffic volumes by time-of-day, toll rates by time-of-day, and revenue estimates based on time-of-day data?
9) What model results make a successful "Planning Level" project?
   a) What can be considered in addition to the implications of alternatives and ability to select a preferred alternative?
10) When and to what degree of detail should statistical probability/risk analysis be introduced in the "Planning Level" process?
11) Should Dynamic Traffic Assignment (DTA) be introduced as part of the modeling process and, if so, when?
12) Identify any additional factors/concerns:
   a) Should full model redevelopment be required for producing bonding capacity results for "Investment Grade" studies?
   b) Should intensive microsimulation be implemented for "Investment Grade" studies?

The panel's discussion of these questions is presented in Section 5.0 of this report.

## *4.2 Operational Analysis Breakout Session*

The Operational Analysis Breakout Session was moderated by the following three individuals:

- James Sturrock (FHWA);
- Andrew Velasquez (URS/Florida Turnpike); and
- David Stroud (PB).

The expert panel members invited to participate in this session included:

- James Sturrock (FHWA);
- Yi-Chang Chiu (University of Arizona); and
- Peter Vovsha (PB).

The moderators led a series of discussions focusing on questions related to three different topic areas that included: Process and Policy, Dynamic Traffic Assignment, and Microsimulation.

The specific questions posed by the moderators to the expert panel and the breakout session participants are listed below. There were eleven questions regarding Topic Area #1, eight questions regarding Topic Area #2, and six questions regarding Topic Area #3.

**Topic Area #1 = Process and Policy**

1) At what point should operations be involved in the determination of feasible access points?
2) What are the required analysis procedures for an Interstate System Access Request? When is a PD&E or Design required?
3) In what project development phase is O/D survey data and/or SPS data needed?
4) What should function as the source for express lane demand for operational analysis? Potential sources include, but are not limited to: regional demand models, corridor time-of-day models, DTA models, or microsimulation choice models.
5) What is included in a concept of operations, and at what point in a study should a concept of operations (ConOps) be executed?
6) Which pricing policy should be modeled at the PD&E and Design levels: revenue maximization or traffic maximization?
7) When should the operational models be integrated with the T&R output for PD&E and Design evaluation?
8) How does FDOT address pricing policy changes from an operations perspective?
9) Would you recommend that FDOT establish a life-cycle travel demand model/ microsimulation model philosophy? For example: should models created for tolled-managed lanes in the project development planning step be passed forward for enhancement and applied in subsequent project development steps?
10) What MOEs and values should be used to confirm the feasibility/viability of tolled managed lanes to subsequently move a project forward to development?
11) What MOEs and values should be used to confirm the express lanes' feasibility/viability? If not viable, how can future implementation of tolled managed lanes be preserved? For example, should HOV lanes could be implemented.

**Topic Area #2 = Dynamic Traffic Assignment**

1) Is DTA current in use for PD&E (NEPA)/Design analysis in other regions?
2) What level of acceptance/education is necessary for the incorporation of DTA at the institutional level?
3) What standard scoping templates and guidelines are needed for managing a DTA project?
4) What are the implications of NCHRP 255 or the FDOT Project Traffic Forecasting Handbook in the application of DTA?
5) What are appropriate DTA validation standards?
6) Identify data shortcomings of DTA.
7) How can toll choice model expressions be incorporated in DTA?
8) Can DTA be used to calculate an equilibrium toll?

**Topic Area #3 = Microsimulation**

1) What should be the source of the decision and pricing model inputs for the VISSIM and CORSIM managed lane modules?
2) How can VISSIM or CORSIM be modified to model reliability?
3) What is the basis for adjusting the intercept values in VISSIM?
4) Should preference be giving to multiple segment travelers in VISSIM?
5) What microsimulation MOE's are acceptable in oversaturated conditions?
6) What modeling time-slice is preferred: 15 minutes or 1 hour? What are the shortcomings of a lower time-slice?

The panel's discussion of these questions is presented in Section 6.0 of this report.

# 5.0 Issues and Key Concepts for Express Toll Lane Demand Forecasting

The afternoon discussion with the panel members in the planning and demand forecasting session was used to address many of the questions listed in Section 4.0 of this report. The three areas of discussion included: Policy Guidance, Model Sensitivities, and Model Design and Application.

## 5.1 Policy Guidance

The responses from the panelists regarding policy guidance for express lanes centered on two topic areas: guidance on identifying and screening potential express lane projects and guidance for defining a consistent set of MOEs.

Identifying potential express lane projects is the first and highest level of screening analysis in the project development process. The panel encouraged the use of the regional planning process to identify potential express lane corridors, making this a part of each region's LRTP process. They also suggested the use of available sketch-plan models that might offer a way to prioritize and/or screen potential projects, without investing the time and effort required to conduct a more formal analysis with a regional model.

In terms of how to rank projects, a quick measure of Density, Distance of congestion, and Duration of delay (termed "3-D" measures) was suggested by an attendee and was well received by the panel. Another measure that was discussed was the evaluation of the ability to cover O&M costs of the proposed project, a potential minimum-threshold criterion. Other related criteria might be the ability to cover all toll-related infrastructure costs, or even the ability to cover overall maintenance or some portion of the general purpose-related construction costs. Finally, given the policy minimum toll and assuming reasonable value-of-time and speed advantage, a minimum feasible express lane length can be established.

The second main topic was identifying a consistent set of MOEs for evaluation and comparison of competing express lane projects. The panel felt that defining benefits and costs even at the early stages of a project was important in order to maintain consistency of evaluation and clarify to decision-makers early on what criteria will be used. User benefits minus generalized costs for users based on time and monetary costs should be used in some form in the evaluation, as this value provides a very basic measure of public benefit. Both toll and non-toll users should be evaluated when assessing total social/user benefits. Travel time savings and reliability are also important metrics with which to measure the effectiveness of a proposed express lane. In any measure, a risk analysis should be conducted to give proper perspective of the relative merits of each proposed project.

## 5.2 Model Sensitivities

The panel also discussed key features of managed lane models that they felt were necessary for proper and effective traffic forecasting. In the initial discussion, the panel recognized the importance of several state-of-the-practice model features that should be included to support managed lane modeling activities. These included:

1. *Use of feedback in the model* – to ensure that the level of service, time cost, and convenience-related variables are consistent between those generated from assignment and those used for distribution and mode choice. This practice takes on an added importance when considering variable tolling and the time-toll cost influences on demand.
2. *Use of a destination-choice model formulation for trip distributions* – to allow a multi-modal consideration of accessibility which, in the case of toll facilities, may be used to influence trip table (O/D) patterns.
3. *Time-of-day stratification* – important when toll rates change throughout the day, affecting travel patterns in terms of O/D pairs, trip purposes, and travel times.
4. *Market stratification* – which may be employed by trip purpose, socioeconomic measures (income groups), and/or vehicle occupancy type, all of which can affect toll eligibility and toll rates.
5. *Multi-class assignment* –to identify tolled versus non-tolled paths and demand. Classes may also be established by trip purpose and/or traveler income for integrated toll choice and assignment methods.
6. *Rigorous assignment closure criteria* – in order for proper comparison of alternatives, the equilibrium assignments must be executed to satisfy tight closure criteria. One panelist suggested a gap criterion of at least 0.0001.

All these features were identified as necessary but not sufficient conditions for proper express lane evaluation. They are included in the FSUTMS Transit Model Update recommendations.

Beyond these model features, the panel suggested several other model sensitivities critical to effectively model priced managed lane operations. Of these, reliability measures are considered very important, and they can be estimated even within a static assignment framework.

Studies have shown that reliability may represent up to 40 percent of the attractiveness of a managed lane. Shifts in travel by time-of-day are also a common response to tolling, so a time-of-day choice model may be a desirable feature in a managed lane model. It was agreed that the use of a range or distribution of values of travel time, in mode choice and/or assignment, is necessary to more closely represent actual behavior.

A specific algorithm to balance toll level and demand was also suggested. This balance is particularly important when modeling variable tolls and is an issue not found in other costs in a model, which are typically not demand-based.

Finally, the use of smaller time slices for trip assignment was suggested to provide for greater sensitivity to changes in both demand and toll rates throughout the day. Greater time-of-day detail will also aid in providing time-specific flows for mesoscale simulation models.

## 5.3 Model Design and Application

The third major topic was basic model design and application. In this discussion, the focus was on how the analyst should make use of the model most effectively. The panel had several important points on this topic.

First, the panel encouraged early evaluation of data and survey requirements. Though they may not be needed in the early screening phases, surveys and other data collection activities take time. Analysts should anticipate data collection needs and plan accordingly so that the necessary data are available when the more advanced modeling is required.

Similarly, a continuity of model design or specification should be maintained throughout the development process. While different models of various levels of detail may be used, these models can still share common parameters such as values-of-time, capacities, and operation policies. The panel felt that we should see the model use through project development as a continuum, rather than a series of distinct model applications.

In response to a question from an attendee, the panel affirmed that transit demand was important in evaluation of express lanes. The models used should be sensitive to changing transit levels of service as a result of an express lane project.

Finally, the question of whether toll choice should be implemented in the mode choice stage or integrated with assignment was discussed. Both methods have advantages, and subsequently, the panel did not reach a consensus regarding a clear preference to either design.

## 5.4 Summary

The following bullet points summarize additional discussion points either presented or elicited by the afternoon session on demand forecasting:

- Reliability measures are very important and can be measured even with static assignments.
- Travel time savings are primary benefits to managed lanes in early project life. Reliability benefits increase as the project matures.
- Revenues, user benefits, toll rates, and traffic demand estimates should all be provided by screening analyses.
- Consumer surplus measures should also be considered critical measures for evaluation.
- The open-source and comprehensive Project Evaluation Toolkit (PET) provides rapid demand modeling and traffic estimates across abstracted networks, multiple times of day and multiple traveler classes. PET provides estimates of revenues, reliability measures, consumer surplus, crash counts, emissions, and long-run benefit-cost ratios for competing projects for such abstracted networks or more detailed networks whose trip tables and cost and time skims have already been estimated using large-scale demand models. PET is designed to be well suited for tolled settings, including variably priced express lane applications. The open-source PET can be accessed via the following web address: http://www.caee.utexas.edu/prof/kockelman/PET_Website/homepage.htm.

# 6.0 Issues and Key Concepts for Express Toll Lane Operational Analysis

The afternoon discussion with the panel members in the operations group was used to address questions listed in Section 4.0 of this report. The moderators intended on discussing three major topics: Process and Policy, Microsimulation, and Dynamic Traffic Assignment. Due to time constraints, however, the moderators could not specifically address the questions related to microsimulation and DTA. There was some discussion, however, on microsimulation and DTA within the framework of the overall discussion on Process and Policy.

Major discussion themes and key issues discussed by the moderators, panel members and participants are described below.

## *6.1 Survey Data Collection*

The group identified the need for earlier scheduling, collection, and warehousing of survey data. This includes O/D Surveys, SPS, and Revealed Preference Surveys (RPS). It was noted that data collection should be conducted around six to nine months prior to the initiation of the PD&E Study.

O/D surveys may be categorized as either “behavioral” or “non-behavioral.” Behavioral O/D data are preferred to non-behavioral O/D data, because they provide more robust insights on trip and traveler characteristics (such as trip purpose, trip frequency, and income). Non-behavioral O/D examples are GPS route-based data, cell phone probe data, or Bluetooth reader data. Behavioral O/D data are found to be valid for many years, while non-behavioral O/D data are valid contingent to changes to the roadway network. Non-behavioral O/D data generally have a shelf life of five to ten years. A new SPS is generally required for investment-grade T&R studies to satisfy bond holders.

Some panel members stated that it is better to conduct travel surveys more frequently with smaller sample sizes than larger, less frequent surveys. Panel members stated that there are numerous SPSs available and the data from them can be adjusted to reflect socioeconomic conditions of different areas. The Florida’s Turnpike Enterprise (FTE) has a repository of SPS data. It was recommended the FDOT Central Office create one using the data from FTE as a starting point. All SPS data and instruments should be made available for future express lane projects.

## *6.2 Measures of Effectiveness*

Questions were raised regarding MOEs that justify an express lanes project. The justification depends of the purpose and need of the project. The purpose and need should be communicated early in the project life-cycle. It should be clarified whether congestion relief or revenue generation is the primary goal. If congestion relief is a primary goal, the project should have a clear operational benefit in travel time savings, which could be improved corridor reliability, speed, or vehicle throughput. If the project’s purpose and need identify reliability at the primary MOE for project evaluation, FHWA would prefer to be presented with results indicating facility or wider network reliability, not only express lane reliability. PET, discussed in Section 5.0, offers many similar MOEs.

Finance criteria should include revenue and toll rates. If revenue generation is the primary goal, the project should provide the ability to fund O&M costs at a minimum. If possible, the project may be able to fund a portion of the capital construction cost or provide new funding for public transit on the corridor. In terms of revenue generation, the availability of the excess demand to use the express lanes should also be considered.

The panel members referenced *NCHRP 722 Decision-Making Framework for Assessing Highway Tolling and Pricing* as resource that can assist project selection and MOE determination. It was also recommended that goals of the project should be specific, such as to reduce delay at Ramps A, B, C and D from 360 seconds to under 120 seconds. Another example is to reduce the queues at Lake, Randolph and Monroe Streets from over 300 feet to less than 125 feet on northbound and southbound approaches.

## *6.3 Operational Assessment of Access Points*

The group was asked to discuss when an operational analysis should be conducted for evaluating the express lane ingress/egress points. Many agreed that the analysis should be identified in the early planning stages and that a vehicle O/D trip table is critical for the assessment. The panel members recommended using a route choice mesoscopic DTA model to assess ingress and egress traffic. One audience member stated that a DTA model has been developed for the I-95 Corridor in Palm Beach County, and it could be used to evaluate access points.

From an operations perspective, the access points should add value to the users and not create traffic congestion at merges/diverges areas or express lane terminal locations. The identification of access points should consider origin-destination patterns, average trip length, access to park-n-ride lots, and access to major destinations. Locations of the ingress and egress points should be consistent with user experience. Depending on demand variations, O/D patterns, and overall capacity utilization, more access points may not necessarily provide better congestion management. In dense urban areas without a by-pass around the core urban region, an express lane with limited-access could be a very effective congestion management tool.

## *6.4 Demand Input for Operations*

The panel members were asked about the demand model inputs for operational analysis in a microsimulation model. A travel demand model is necessary for operational analysis while there are then multiple methods/resolutions for traffic assignment (i.e., macro, meso, and micro). The issue becomes which robust lane choice model should to be used to estimate the demand.

One panel member stated that the VISSIM lane choice model is reactive (to en route information), as compared to the mesoscopic DTA demand model, which is based on a longer-term (less instantaneous) driver learning process. The panel agreed that demand inputs depend on the robustness of the model for the region. The priority ordering of model setups, as recommended by the panel, proceeds as follows:

- Develop an ABM with DTA.
- If an ABM is not possible, develop a trip-based demand model with DTA, which would entail improving the route choice component of the demand model and applying static demand inside a DTA setting.
- If ABM and DTA are not feasible, use of a trip-based demand model along with a non-DTA corridor-focused time-of-day model and microsimulation for lane choices in the corridor would be preferred.

The panel recommended that modelers describe why either lane choice or DTA was selected, and a matrix be prepared to identify the appropriated tool for each evaluation stage.

Subsequent to the working session, one software vendor recommended that low-cost, dynamic microsimulation be the primary approach for examining the desirability of express lanes both in a planning mode and also in a more refined manner for operations analysis. As a second choice, a static time and cost assignment methodology cited in NCHRP 722 could be used. The third choice could be a standard, multi-class assignment with an appropriate distribution of value-of-time.

## *6.5 Pricing Policies*

A discussion was held on which pricing policy should be used for operational analysis: revenue maximization or traffic optimization/maximization. The traditional approach is to evaluate operations under a traffic maximization strategy where the express lane demand is capped at a maximum service volume of 1,650 vehicles per hour (vph) per lane. Under a revenue maximization approach, volumes will not reach this level. Each approach has different impact on mainline operations, weaving operations, and safety. The approach will also play a role in determining access points.

The recommendation from the panel members is to run the microsimulation model with both extremes (maximum revenue and maximum traffic). FDOT District Two has performed a microsimulation analysis that considers the extremes for the I-295 express lane analysis. Express lane volumes were modeled at 1,650 vph and 825 vph. The T&R consultant should be able to provide the appropriate express lane volume under a revenue maximization approach. If the T&R study performs a revenue maximization scenario, FHWA may request to see the results in the Interchange System Access Request.

## *6.6 Concept of Operations*

The panel members were asked about the preparation of a ConOps and how it integrates with the project development process. The ConOps can dictate pricing and operational strategies that would affect the operational analysis. At each level in the project development process, recommendations were made as to what would need to be included in the ConOps document.

At the planning-level, no robust or high-level details are required. General project statements include regional express lane context, operating policies, pricing policy, incident management, business rules, exempt vehicles, multimodal/BRT, and short distance versus long distance trips.

At the PD&E level, the ConOps will include all of the details from the planning level. In addition, the ConOps should include coordinating elements with traffic operations and Intelligent Transportation Systems (ITS) for integration of the express lane operations and toll collection systems.

At the Design-level, the ConOps should include all details from the PD&E level. In addition, the document should include coordinating elements with Systems Engineering for ITS supporting structure. The document should address incident management and work zone procedures. It may be necessary to perform microsimulation under these event-related traffic conditions. There should be detailed clarification on the pricing structure including the tolling algorithm that sets the price in the express lanes. Also, en-route travel time information through dynamic message signs shall be evaluated since this information impacts to operations and revenues.

## *6.7 Life-Cycle Modeling*

The panel was asked whether they would recommend that FDOT establish a life-cycle demand model and microsimulation model philosophy. An example would be a microsimulation model that was created in the PD&E phase and enhanced for use in the Design phase. The FHWA Traffic Analysis Toolbox does consider life-cycle modeling a good management practice. The panel agreed that life-cycle modeling is good practice where appropriate. However, the agency should also consider the need for consistency, model development costs, data demands, increasing accuracy and time spans for express lane projects. It was noted that each FDOT District functions differently, so no single template can easily be applied to all Districts in terms of warehousing the models. No single position or department can be designated, so this issue should be discussed and decided at the District-level.

# 7.0 Panel Discussion and Observations

## *7.1 Demand Modeling Recommendations*

The panel's responses to questions and subsequent discussions did not include a specific set of recommendations for FDOT's express lane demand model forecasting practice. However, as described in Section 5.0, panel members did discuss several basic modeling principles on which there was general agreement. These were reiterated on the morning of the second day of the workshop and form the guiding principles of a recommended practice for modeling express lanes in Florida to help insure the development of high quality and consistent forecasts. (Note that these recommendations do not specifically address simulation modeling.) These principles are discussed as follows.

1. **Consistency of Forecasts:** The development of express lane forecasts is an evolutionary process, starting from a high-level screening process, continuing through more detailed corridor studies, and ending in detailed T&R forecasts that may support acquisition of private financing, investment-grade forecasts. Progressing from the early to final stages, each step requires a greater sophistication and rigor in the forecasting procedure, and a progressively greater need for detailed flow and observed behavioral data to support the model algorithms. The models used in each stage should, however, share common behavioral assumptions (e.g., value-of-time and toll policy) and, to the extent possible, differ in terms of level of detail and market segmentation. The models should build upon the earlier stages and not represent independent modeling approaches.

2. **Standard Evaluation Criteria:** MOEs and evaluation criteria should be established and documented early in the project development phase. Ideally, these MOEs should be established for all FDOT projects to allow for objective evaluation of projects. Potential MOEs that models should be capable of reporting include, but are not limited to:
    a. Travel time savings
    b. Reliability
    c. Ability to meet express lane operations costs from tolls
    d. Congestion relief for general purpose and express lane users
    e. Transit impacts
    f. Other methods of quantifying user benefits for both general purpose and express lane users

3. **Use of State-of-the-Practice Model Features:** A necessary, but not sufficient, requirement for models used to estimate express lane demand should be the inclusion of several state-of-the-practice features now incorporated in the latest FSUTMS "transit" model update, which include the following:

a. Travel time and cost feedback, including trip distribution, mode choice and assignment steps.
b. Use of destination-choice formulation for the distribution model.
c. Expanded mode choice nesting structure, including a toll/non-toll choice for auto modes.
d. Expanded time-of-day stratification in both distribution and mode choice and more detailed time-of-day stratification for trip assignment.
e. Expanded trip purposes.
f. Market segmentation involving income and auto sufficiency.
g. Multi-class traffic assignment, by hour or period.

4. **Use of a Toolbox Approach to Model Design:** A selection of managed lane modeling approaches, such as those described in the three-phase managed lane modeling structure developed at the FDOT Systems Planning Central Office, should be used to specify models for express lane evaluation. These tools include an integrated toll/non-toll binary choice and assignment model (Phase I); a toll choice nest within a mode choice model, potentially coupled with the Phase I assignment model; and an ABM using a daily activity scheduler and mode choice, coupled with a DTA model with at least 15-minute time intervals. As discussed in Item **Error! Reference source not found.** above, use of these models should, to the extent possible, share consistent assumptions with regard to traveler value-of-time, toll policy, and facility design, with the understanding that more detail is required as the analysis progresses to the final stage.

5. **Inclusion of Reliability and Time-of-Day Model Sensitivities:** To properly evaluate an express lane with open-road tolling variable pricing, forecast models should be sensitive to reliability and choice of time-of-day of travel, in addition to time savings and cost. These have been shown to be drivers of traveler responses to managed lanes. Both can be implemented even in traditional four-step models with static assignments. There should also be an explicit sub-model to balance demand and toll level.

6. **Robust Data Collection to Support Model Development:** Data collection should include traffic volumes, speeds, O/D data, and household/transit rider characteristic information. SPSs or RPSs that identify a distribution of value-of-time by income, time-of-day, and trip purpose should also be collected as necessary. Data sources and needs should be identified as early as possible in a study, as advanced express lane forecasts will be needed and should be used to inform all phases of the model forecasts.

7. **Risk Analysis:** In more advanced stages of project development, and essential to investment-grade forecasts, a risk analysis should be conducted. The risk analysis should reveal the project's particular sensitivities to variations in value-of-time, toll rates, future demand, fuel price, and economic development. This will allow decision-makers to properly evaluate the potential for success of each project.

More specific model features are discussed in NCHRP Report 722[3] which provides further guidance on model features and designs recommended for modeling priced managed lanes.

[3] NCHRP Report 722: Assessing Highway Tolling and Pricing Options and Impacts, Volume 2: Travel Demand Forecasting Tools. National Cooperative Highway Research Program, Transportation Research Board. 2012. Chapter 7 pp. 153-157. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_722v2.pdf

The first wave of tolled managed lanes in Florida has been studied and implemented over the past several years has been conducted during the FDOT project development process rather than being included as part of the long-range planning activities conducted by MPOs throughout the State. The unique demand modeling, traffic operation analysis, and toll revenue analysis aspects of these projects have been addressed by FDOT's Districts on a project-by-project basis.

In order to be prepared for the next wave of tolled managed lanes the following short-term and long-term recommendations are presented below. These recommendations cover demand modeling, traffic operations analysis, and T&R analysis.

## *7.2 Short-Term Operational Analysis Recommendations*

The following short-term traffic operations analysis recommendations were provided by the Blue Ribbon Panel:

- Standardized tolled managed lane study activities should be specified and made part of the LRTP process performed by MPOs.
- Adopt and implement the FDOT Managed Lane Modeling Applications for FSUTMS Phase 1 and Phase 2 procedures.
- Complete, adopt, and implement the FDOT Managed Lane Modeling Applications for FSUTMS Phase 3.
- Develop and distribute standardized traffic operations analysis and simulation guidelines and/or procedures that support express lane projects as documented in Figure 7.

## *7.3 Long-Term Operational Analysis Recommendations*

The following long-term traffic operations analysis recommendations were provided by the Blue Ribbon Panel:

- Develop a high-level standardized planning application tool that can be used to evaluate the need, feasibility, and impact of tolled managed lanes. One example of a high-level tool is the PET prepared by the University of Texas at Austin.
- Implement multi-resolution modeling for use in the study of tolled managed lanes. Ideally, mesoscopic demand modeling would be incorporated with FSUTMS.

**Figure 7: Recommended Traffic Operations Analysis Components**

| | Traditional Activities | Traffic Operations Analysis Supporting Express Lane Projects | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Activities** | **Issues** | **Products** | **Data** | **Demand Input** | **Operational Tools** |
| **MPO** | Regional Planning Studies | T&R Estimate | Lane call analysis for general purpose vs. express lanes; Location of ingress & egress points | Planning Study; Level of Service and V/C ratios; Express Feasibility Report | Regional ConOps; Access Locations, Traffic: Off Peak Pd, Peak Pd, Peak Hr Traffic | Regional MPO Model | Generalized Tables & Spreadsheets or Microsimuation if Available |
| **FDOT** | Project Planning Studies | Level 1 Traffic Study | Lane call analysis for general purpose & express lanes; Location of ingress & egress points | Concept Traffic Report; Level of Service and V/C ratios | Regional ConOps; Access Locations, Off Peak Pd, Peak Pd, Peak Hr Traffic, Origin-Destination Data, Speed Data | Regional MPO Model; Meso DTA Model | Regional: HCS-HCM Corridor: HCS-HCM, Microsimulation |
| **FDOT** | Project Development and Environmental Studies | Level 2 Traffic Study | Complete freeway facilities analysis including operating conditions at ingress/egress points | Traffic Technical Memorandum; Level of Service; Density, Travel Speed, System-wide Delay, Throughput, Reliability | Corridor ConOps;Traffic counts; Origin-Destination Data; Speed Data | Project Validated Demand Model; Meso DTA Model | Microsimulation |
| **FDOT** | Design Studies | Level 3 Traffic Study | Refined corridor analysis based on feedback from T&R study and design refinements | Interstate System Access Report; Level of Service; Density, Travel Speed, System-wide Delay, Throughput, Reliability | Corridor ConOps;Traffic counts; Origin-Destination Data; Speed Data | Project Validated Demand Model;Meso DTA Model; Corridor TOD Model | Microsimulation |

## *7.4 Short-Term Toll & Revenue Analysis Recommendations*

Historically, there is not a direct correlation between the FDOT's project development process and T&R studies. Additionally, there has been little effort to consider revenue for express lane projects at the MPO-level.

It is recommended that distinct T&R studies be conducted during each phase of the project development process. At the MPO-level, it would be acceptable for the MPO consultant to provide simplistic estimates of revenue for the purposes of using or recommending certain projects for advancement by the maintaining District. As a project advances into the FDOT project development process, the T&R studies should be completed by each District through the FTE. The FTE should work closely with the District program manager to determine whether the project is considered to be at planning-, PD&E-, or Design-level at every phase of the project development process.

Figure 8 shows the activities, issues, products, data and tools for T&R studies and how they should correlate to the FDOT's project development process.

**Figure 8: Recommended Traffic Revenue Analysis Components**

| | Traditional Activities | Traffic and Revenue Supporting Express Lane Projects | | | | |
|---|---|---|---|---|---|---|
| | | **Activities** | **Issues** | **Products** | **Data** | **Revenue Tools** |
| **MPO** | Regional Planning Studies | T&R Estimate | Needs & Cost Feasible | Revenue Estimate | Statewide or National Empirical, pricing policy | MPO Model with minor adjustments and updates & Spreadsheet |
| **FDOT** | Project Planning Studies | Level 1 T&R Study | Financial feasibility | Planning-Level T&R estimates, tolls and toll rates, bonding capacity and project alternatives | Traffic count, pricing policy, and any other readily available data | MPO Model with minor adjustments and updates |
| | Project Development and Environmental Studies (NEPA) | Level 2 T&R Study | T&R implications of various alternatives, leading to selection of a preferred alternative; some details for that alternative | Preliminary T&R estimates based on time-of-day characteristics and observed travel patterns | Traffic counts by time-of-day, travel surveys, pricing policy, and other model improvements | Project validated version of the MPO model with time-of-day and other features |
| | Design Studies | Level 3 T&R Study | Detailed analysis of the designed project | Comprehensive T&R suitable for investment decisions, (detailed forecast of toll, T&R); risk analysis | Traffic counts, travel survey, value-of-time, reliability, and independent SE forecasts | T&R model for the project with toll diversion |

## 7.5 Conclusion

The Peer Review Express Toll Lane Modeling workshop ended after almost twelve hours of presentations and discussion. The FDOT and members of the Florida modeling community showed high levels of enthusiasm based on the various opportunities and ideas for future activities conferred in workshop discussions and presented by the Blue Ribbon Panelists. There need for innovations and standard best practices for managed lane modeling in the State is highly transparent, and the Peer Review facilitated an ideal forum for discussion of Statewide implementation considerations.

# Appendix A List of Workshop Participants

This section contains a list of the workshop participants, including the panel members, workshop presenters (invited speakers), local agency staff, and TMIP documentation support staff.

## *A.1 Peer Review Panel Members*

| Panel Member | Affiliation |
|---|---|
| Scott Ramming (DRCOG) | Denver Regional Council of Governments |
| Matthew Kitchen (PSRC) | Puget Sound Regional Commission |
| Kara Kockelman | University of Texas at Austin |
| Yi-Chang Chiu | University of Arizona |
| Eric Pihl | Federal Highway Administration |
| James Sturrock | Federal Highway Administration |
| Hugh Miller | CDM Smith |
| Bill Olsen | CDM Smith |
| Peter Vovsha | PB |
| Jim Ely | NHTB |

## *A.2 Invited Guest Speakers and Presenters*

| Name | Affiliation |
|---|---|
| Vidya Mysore | Florida DOT |
| Ed Hutchinson | Florida DOT |
| Jennifer Fortunas | Florida DOT |
| Ken Kaltenbach | Corradino Group |
| David Stroud | PB |
| Steve Ruegg | PB |
| Josiah Banet | URS / Florida Turnpike |
| Tom Adler | RSG |
| Jim Ely | HNTB |
| Eric Pihl | FHWA |
| John Lewis | Cambridge Systematics |
| Tom Rossi | Cambridge Systematics |

| | |
|---|---|
| Yi-Chang Chiu | University of Arizona |
| Peter Vovsha | PB |

### *A.3 Local Agency Staff and Other Participants*

| Name | Affiliation |
|---|---|
| Jack Klodzinski | Florida Turnpike |
| Neelam Fatima | St. Lucie TPO |
| Denise Bunnewith | North Florida TPO |
| Robert Keeth | Volusia TPO |
| Milton Locklear | North Florida TPO |
| Vinod Sandanasamy | Palm Beach MPO |
| Vladimir Majano | FDOT CO |
| Ashish Kulshrestha | FDOT CO/PB |
| Diane Quigley | FDOT CO |
| Daniel Cashin | FDOT CO |
| Christa Dismuke | FDOT CO |
| Bob Crawley | FDOT District 1 |
| Amy Perez | FDOT District 1 |
| Rax Jung | FDOT District 1 |
| Thomas Hill | FDOT District 2 |
| Stephen Browning | FDOT District 2 |
| Michael Lewis | FDOT District 3 |
| Lyle Seigler | FDOT District 3 |
| Shi-Chiang Lee | FDOT District 4 |
| Tom Turberville | FDOT District 4 |
| Brian Stanger | FDOT District 5 |
| Jeremy Dilmore | FDOT District 5 |

| | |
|---|---|
| Ken Jeffries | FDOT District 6 |
| Alexandra Lopez | FDOT District 6 |
| Danny Lamb | FDOT District 7 |
| Waddah Farah | FDOT District 7 |
| Bill Davidson | PB |
| Dave Schmidt | AECOM |
| Jaimie Sloboden | Cambridge Systematics |
| Sung-Ryong Han | BCC Engineering |
| Bob Hamm | CDM Smith |
| Andrew Velasquez | URS |
| Saad Shbaklo | URS |
| Bill Nelsen | URS |
| Michael Doherty | URS |
| David Rae | URS |
| Emam Emam | URS |
| Imran Ghani | Osiris 9 |
| Li Jin | Kittelson & Associates |
| Kacia Monts | HNTB |
| Jeanette Berk | HNTB |
| Matthew Click | HNTB |
| Garth Lynch | HNTB |
| Mohammed Hadi | Florida International University |
| Yafeng Yin | University of Florida |
| Chunyu Lu | RS&H |
| Kapil Arya | Gannett Fleming |
| Hoyt Davis | Gannett Fleming |

| | |
|---|---|
| Jerry Graham | Trafodata |
| Dan Macmurphy | Trafodata |
| Sam Bohluli | C&M |
| Herbert Vargas | C&M |
| Carlos Contreras | C&M |
| Ana Elias | Jacobs |
| Daniel Beaty | ATKINS |
| Andres Rabinowicz | Caliper Corporation |
| Dan Morgan | Caliper Corporation |
| Heejoo Ham | Citilabs |
| Derek Miura | PTV America |
| Mike Florian | Inro |

### *A.4 TMIP Peer Review Support Staff*

| Name | Affiliation |
|---|---|
| Brian Grady | RSG |

# Appendix B Workshop Meeting Agenda

## *B.1 Day-One Meeting Agenda (May 22, 2013)*

# Managed-Lane Modeling Practice Workshop
# May 22, 2013
# Orlando, FL

**Wednesday, May 22, 2013**

| | |
|---|---|
| 8:30 AM – 8:45 AM | Welcome and Introductions – Ed Hutchinson |
| 8:45 AM – 9:00 AM | FDOT Requirements – Jennifer Fortunas<br>• Secretary's Directive on Florida Transportation Vision for the 21st Century<br>• Review of Draft Policy<br>• Short/Long Term Requirements |
| 9:00 AM – 9:15 AM | Workshop Background and Structure – Hugh Miller |
| 9:15 AM – 10:15 AM | Florida's Current Practice for Express Lane Modeling<br>• Use of SERPM for 95 Express – Ken Kaltenbach (10 min)<br>• 95 Express Operational Analysis – David Stroud (10 min)<br>• MTF Summary of Managed Lane Program Work - Steve Ruegg (10 min)<br>• Florida Experience - Josiah Banet (10 min)<br>• Quantifying Forecasting Risks - Tom Adler (10 min) |
| 10:15 AM – 10:30 AM | *Break* |
| 10:30 AM – 11:15 AM | National Current Practice<br>• National Overview of Priced Managed Lanes - Jim Ely (10min)<br>• Planning for Express Lanes - Eric Pihl (10 min)<br>• Operational Methods for Managed Lane Analysis – John Lewis (10 min) |
| 11:15 AM – 11:30 AM | Overview of Workshop Sessions - Hugh Miller |
| 11:30 AM – 1:00 PM | *Lunch* |

1:00 PM – 4:30 PM **Technical Workshop Sessions**

**Planning Workshop Session**

Demand Forecasting, Model capabilities and sensitivities, evaluation criteria, data requirements, project evaluation structure and sequence, coordination across evaluation phases, initial screening procedures

**Moderators:** Jennifer Fortunas, Steve Ruegg, Jack Klodzinski and Amy Perez

**Blue Ribbon Panel Members:** Scott Ramming, Matthew Kitchen, Hugh Miller, Bill Olsen, Eric Pihl, Jim Ely and Kara Kockelman

**Note Takers:** Ashish Kulshrestha and Josiah Banet

**Operations Workshop Session**

Microsimulation Discussion, Calibration, Introduction to Reliability Concepts, Dynamic Traffic Assignment

**Moderator:** James Sturrock, Andrew Velasquez and David Stroud

**Blue Ribbon Panel Members:** James Sturrock, Yi-Chang Chiu and Peter Vovsha

**Note Taker:** Emam Emam

## *B.2 Day-Two Meeting Agenda (May 23, 2013)*

# Managed-Lane Modeling Practice Workshop
# May 23, 2013
# Orlando, FL

**Thursday, May 23, 2013**

| | |
|---|---|
| 8:30 AM – 9:15 AM | How Managed Lanes Can Be Analyzed using Advanced Travel Demand Models – Tom Rossi (15 min) |
| | Dynamic Traffic Modeling – Yi-Chang Chiu (15 min) |
| | Impact of congestion and pricing on travel demand; Finding from the SHRP 2 C04 Project – Peter Vovsha (15 min) |
| 9:15 AM – 9:30 AM | *Break* |
| 9:30 AM – 10:00 AM | Workshop Summaries – Steve Ruegg and James Sturrock |
| 10:00 AM – 11:30 AM | Comments, Questions and Discussion – Hugh Miller |
| 11:30 AM – 12:00 PM | Closing Remarks – Vidya Mysore |

# Appendix C Peer Review Panel Biographies

## *C.1 Scott Ramming (DRCOG)*

Scott Ramming has over 20 years of experience developing and applying transportation models. He has experience estimating and using models in Saint Louis; the New York Metropolitan area; Boston; Hong Kong and Guangdong Province, China; as well as applications to high-speed airport access lines and privately-financed toll roads. His doctoral thesis at MIT developed the Path-Size Logit formulation for correcting for path overlap within a multinomial logit context. Path-Size Logit has been used for international applications to auto and transit paths, and is now a standard component of commercial transportation modeling software such as TransCAD. Scott developed a four-step trip-based model -- "from scratch" in some areas -- for the I-70 Mountain Corridor Programmatic EIS that covers roughly half the State of Colorado. The task included estimating mode choice models from stated-preference surveys for modes such as an Advanced Guideway System unlike anything currently in use in North America. Scott now works refining and adding functionality to DRCOG's activity-based model, Focus.

## *C.2 Matthew Kitchen (PSRC)*

Matthew Kitchen was formerly the Program Manager for Development at the Pudget Sound Regional Council.

## *C.3 Kara Kockelman (University of Texas)*

Professor of Civil, Architectural and Environmental Engineering at the University of Texas at Austin, Dr. Kockelman is a registered professional engineer and holds a PhD, MS, and BS in civil engineering, a Masters of City Planning, and a minor in economics from the University of California at Berkeley. She has received the NSF CAREER Award, U.C. Berkeley's University Medal, MIT's *Technology Review* Top 100 Innovators award, CUTC's inaugural Young Faculty Award, the Regional Science Association International's Hewings Award, and ASCE's Bartholomew Award and Huber Research Prize.

Dr. Kockelman's primary research interests include the statistical modeling of urban systems (including models of travel behavior, trade, and location choice), energy and climate issues (vis-à-vis transport and land use decisions), the economic impacts of transport policy, and crash occurrence and consequences. She has taught classes in transportation systems, transport economics, transport data acquisition and analysis, probability and statistics, design of ground-based transportation systems, and geometric design of roadways. She has chaired TRB's Travel Survey Methods committee for several years and served on TRB's Transportation and Land Development, Transportation Economics, and Statistical Methods committees.

## *C.4 Yi-Chang Chiu (University of Arizona)*

Yi-Chang Chiu, Ph.D., is an Associate Professor of Transportation at the University of Arizona. Dr. Chiu's research interests include dynamic traffic assignment, multi-resolution traffic assignment simulation modeling, mass evacuation network modeling, and urban system dynamic modeling, border security modeling, and intermodal transportation modeling. Additionally, Dr. Chiu is well-researched in critical infrastructure management and response, mesoscopic traffic flow theory, and telecommunication technologies in ITS applications. Dr. Chiu received his doctorate in Transportation Engineering from the University of Texas at Austin.

## C.5 Eric Pihl (FHWA)

Eric is a member of the FHWA Resource Center Planning team where he provides training and technical assistance to support the application of passenger and freight forecasting and analysis methods. A member of the TRB committee on Travel Behavior, he has contributed to national research projects focusing on technical methods for planning and project and instructs workshops on statewide, metropolitan, and operational planning methods. Eric holds an MS in transportation engineering and a Master of City Planning from Georgia Tech.

## C.6 James Sturrock (FHWA)

Bio can be found online at: http://www.fhwa.dot.gov/resourcecenter/staff/bios.cfm?id=340

## C.7 Hugh Miller (CDM Smith)

Hugh Miller has over 40 years of experience in transportation planning and engineering, working in a variety of consulting and academic positions. His experience as consultant ranges from project management to the supervision of large, diverse professional groups. Hugh is a recognized expert in T&R studies, specializing in travel demand modeling, traffic engineering and project planning. His experience covers toll feasibility studies through investment grade T&R studies. Hugh has presented findings to rating analysts, bond insurers, investors and the FHWA (as part of TIFIA loan applications). For more than 20 years, he led the T&R Consultant at Florida's Turnpike Enterprise. He is now Vice President of CDM Smith, where he serves as Lead Practitioner and Discipline Leader of the Toll Services Discipline.

## C.8 Bill Olsen (CDM Smith)

Bill Olsen has specialized in travel modeling using the Florida Standard Urban Transportation Model Structure since 1986. He was a contributor to the development of FSUTMS Data Update Project (Methodology for Using Data in Standard Models) and Model Update Phase V Project (Improvements to the Florida Standard Urban Transportation Model Structure). His most recent experience with the forecasting of toll facility traffic for projects in Florida has included the Veterans, Suncoast Parkway, and Daniel Webster Expressways. From 1969 to 1986 he served as Associate Professor with Florida State University's Department of Urban and Regional Planning and Director of the Transportation Planning Specialization. Dr. Olsen is a Registered Professional Engineer in Florida and his Master's and Doctoral Degrees in Transportation Engineering were earned at Northwestern University

## C.9 Peter Vovsha (PB)

Peter Vovsha has 28 years of experience in the development and application of transportation models. He has developed numerous models and computerized procedures for advanced discrete-choice models of travel behavior and integrated multi-modal network simulations. As a principal modeler, he has developed transport models for several large-scale regional model development projects in major cities such as Moscow, Tel-Aviv, Jerusalem, New York, Columbus, Montreal, and Ottawa. Peter is one of the leading experts in the development and application of the advanced tour-based and activity-based model systems in practice. He is pioneering in design of the new generation of advanced activity-based models that has been widely adopted in U.S. and worldwide (8 out of 12 activity-based models developed or being developed in practice in the U.S. were designed by him).

## *C.10 Jim Ely (HNTB)*

Jim Ely is chairman of HNTB's national toll practice. Ely is based in the firm's Tallahassee, Fla., office and joined HNTB in 2010. He served as vice chairman of the toll practice. Prior to joining the firm, he worked for the Florida Department of Transportation for 36 years. During that time he served as executive director of Florida's Turnpike Enterprise for 21 years, overseeing one of the largest toll programs in the nation. Ely is well known within the transportation market, having served as past president of the International Bridge, Tunnel and Turnpike Association in 2007. He remains active in the organization, chairing committees and organizing programs. Ely is a founding member and currently serves on the board of directors of the Transportation and Expressway Authority Membership of Florida, also known as TEAMFL. The organization includes statewide expressway and transit authorities, the Florida Department of Transportation, the Florida Transportation Commission and private-sector transportation partners, who discuss issues important to Florida in an effort to develop high-quality roadway systems throughout the state.

# Appendix D Presentation Summaries

As documented in Appendix B, presentations by FDOT staff, contracted consultant support staff and invited national experts dominated most of the workshop agenda. In total, thirteen (13) presentations were delivered to the workshop participants that described FDOT planning requirements, current express toll lane modeling practices in Florida and finally new emerging methods being applied nationally. This section will provide a brief overview of each presentation delivered during the two-day workshop. Note, the actual presentations can be requested by contacting TMIP (feedback@tmip.org).

## *D.1 FDOT Policy Requirements*

Jennifer Fortunas from the FDOT Systems Planning Office delivered the first presentation of the workshop. Ms. Fortunas described Florida's Transportation Vision for the 21st Century which includes an objective for mobility choices for their customers, with the choice representing either express lane or priced managed lanes. An earlier Managed Lanes Workshop convened in January 2013 was described along with the draft policy statements for feasibility, finance and tolling, concept of operations, TSM&O strategies, and design that resulted from the workshop. The presentation concluded with Ms. Fortunas describing why this Blue Ribbon Panel workshop was convened and FDOTs objectives moving forward:

- To develop a common travel demand model framework,
- To set parameters/sensitivities for demand modeling in planning and operations, and
- To define relationship between travel demand model, tolling, and microsimulation

Transportation Vision for the 21st Century

Creating Choices

| Objective | Activities | Performance Indicators | Targets | Responsible Party |
|---|---|---|---|---|
| The Department will develop and maintain a system of managed lanes in Florida. | Complete the FDOT Express Lanes Policy | Policy Attached | 4th Q FY 13 | Jennifer Fortunas |
| | Complete the FDOT Express Lanes Procedures/Standards | Procedure Attached/PPM Updated | 2nd Q FY 14 | Jennifer Fortunas |
| | Complete the FDOT Managed Lanes Policy | Policy Attached | 2nd Q FY 14 | Jennifer Fortunas |
| | Complete the FDOT Managed Lanes Procedures/Standards | Procedure Attached/PPM Updated | 4th Q FY 14 | Jennifer Fortunas |
| | Create and maintain an FDOT Managed Lanes Website/Intranet Site* | http://www.floridamanagedlanes.com/ | Active | Jennifer Fortunas |
| | Suggested information for the site | | | |
| | Best Practices | | | |
| | Lessons Learned | | | |
| | Sample Information | | | |
| | Policies, Procedures, links to project sites | | | |

* Additional activities should be developed associated with the website

*Provide links between key websites like the Vision 21 and Managed lanes with a goal of information being in one source to avoid duplication.

## D.2 Workshop Background & Structure

Hugh Miller from CDM Smith gave the next presentation. Mr. Miller described the FDOT project development activities which include a standard set of planning and engineering activities for a project called phases: Planning, PD&E, and Design. He also outlined the traditional planning process activities and the roles and responsibilities of the MPOs, FDOT district offices and the FDOT central office.

The remainder of Mr. Miller's presentation focused on express toll lane modeling projects and how they are different and more complex than regular roadway projects because toll rates change throughout the day to manage congestion, express lanes typically located in the median of expressway, and tolls rates influence overall corridor demand as well as the split in demand between the express lanes and the general purpose lanes. Finally, express lane projects require two additional threads of analysis not usually considered in traditional roadway projects: 1) traffic operations and 2) T&R projections.

Mr. Miller concluded his remarks by describing the agenda for the day and how the two-day workshop was to be organized, delivered and structured.

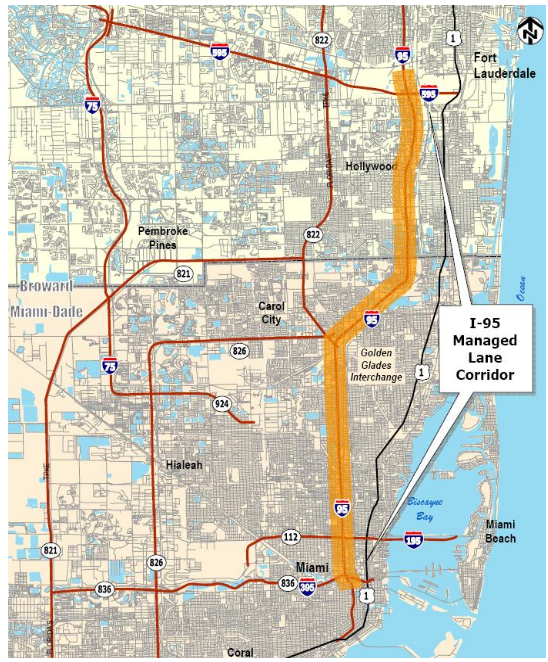
| | Traditional Activities | | | | Traffic Operations | Traffic and Revenue |
|---|---|---|---|---|---|---|
| | Name | Issues | Products | TDM Model | | |
| FDOT | Project Planning Studies | Project purpose and need; funding sources and priority; presence in TIP and LRTP | Concept Report with tentative project features and planning level cost estimates | Latest version of MPO Model | | |
| | Project Development and Environmental Studies | Environmental impacts; engineering issues and project location; public acceptance; and funding | Environmental documents; engineering report; and public hearing transcript | Project validated version of the MPO model | | |
| | Design | Detailed design features | Design package; right-of-way; and permits | Same model | | |

## *D.3 Use of SERPM for I-95 Express*

Ken Kaltenbach from The Corradino Group delivered the third presentation on day-one of the workshop. Mr. Kaltenbach described the modeling analysis and procedures relied upon to study the I-95 Express Lanes project using the Southeast Regional Planning Model (SERPM). Mr. Kaltenbach described the modeling approaches and the project in general which converted two HOV lanes to two HOT lanes in each direction on I-95 in Miami between I-395 and the Golden Glades interchange.

Mr. Kaltenbach indicated the I-95 Express project is generally considered a success and has resulted in FDOTs interest in converting more HOV to HOT facilities. He concluded with some important observations given the recent I-95 Express project experience:

- Modeling procedures were governed by schedule and resources at the time of the study.
- Modeling capabilities were improved to respond to study needs.
    - Quick planning study
    - Corridor feasibility study
    - PD&E with microsimulation
- Difficult to make big leaps in the modeling approach as part of a production engineering study. Engineers and management don't want to spend their resources on modeling.
- Big changes are better done "off-line" from production.




## *D.4 I-95 Express Operations Analysis*

David Stroud from Parsons Brinckerhoff presented another example of current FDOT practices using the I-95 Express project as a case study. Mr. Stroud described the analytical approaches relied on to study the operational impacts of the project. Specifically, he presented aspects of the Phase 1 and Phase 2 PD&E and Design phases that were conducted back in 2007. The microsimulation work performed using CORSIM was presented and the importance of express lane access points and weaving segments was emphasized.

Mr. Stourd also provided information on the Phase 3 Planning and PD&E that was performed in 2010. The microsimulation using VISSIM was described along with information about both the pricing model, lane decision model and the overall calibration process.

## *D.5 Summary of MTF Express Lane Modeling Work Plan*

Steve Ruegg from Parsons Brinckerhoff presented the next presentation focusing on current FDOT practices as identified by the Florida Model Task Force (MTF) involving the use of the Florida Standard Urban Transportation Model Structure (FSUTMS). Mr. Ruegg provided background on how FSUTMS has historically handled toll facilities modeling and ramp-to-ramp tolling. He then elaborated on planned FSUTMS model updates and the specific performance goals associated with those improvements which will be specifically tailored to improve toll modeling.

Mr. Ruegg used the remainder of his presentation to introduce the three-phase model improvement concept plan that will be implemented to improve and add new functionality to FSUTMS. Phase 1, 2 and 3 of the concept plan were then described in detail. Mr. Ruegg closed his remarks by posing a number of questions to the workshop panel and participants about policy and guidelines for the use of these improved models for analyzing managed lane projects in general.

## *D.6 Florida Traffic & Revenue Studies Experience*

Josiah Banet from URS and representing the Florida Turnpike Enterprise presented the sixth slideshow on the morning of day-one. Mr. Banet's presentation focused on the current T&R forecasting practices that are relied on within the State of Florida at present. He described the four distinct types of T&R studies: Top-Down, Sketch Level, Planning Level and Investment Grade. Mr. Banet then described each of the four T&R studies by illustrating the differences at each level and how progressing from one level to the next requires more detail, more time and more resources.

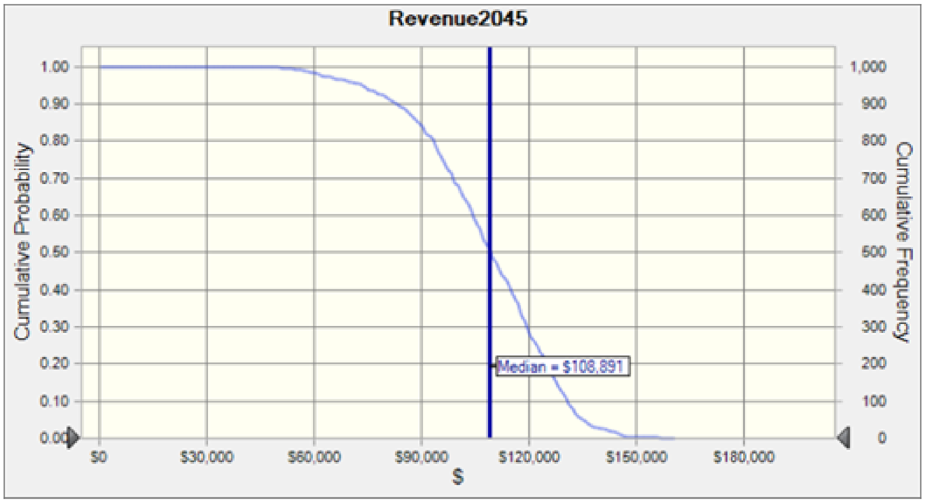
A Top-Down study can generally be performed in one month. A Sketch level study relies on the regional travel demand model and can take anywhere from three to six months. Planning level studies require additional data and some operational analyses and therefore can take six to nine months. Finally, Investment Grade level studies include a probability model and incorporate a risk assessment that may take twelve to fifteen months to complete.

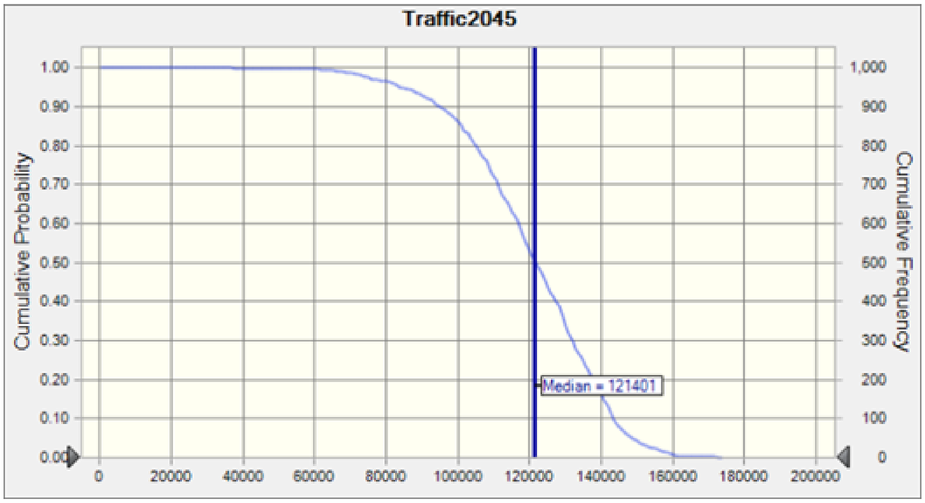
## *D.7 Quantifying Forecasting Risks*

Tom Adler from RSG addressed the workshop next and delivered a presentation focused on quantifying the risk associated with forecasting express toll lane utilization and resulting revenue forecasts. Dr. Adler indicated that the three most common sources of inaccuracy include: 1) model structure and data, 2) analysis bias, and 3) inherent uncertainties about the future.

Dr. Adler then described a quantified probability analysis approach that includes two steps: 1) estimating the probability distribution associated with each model uncertainty, and 2) estimating the resulting probability distribution of the model outputs. The key insight from Mr. Adler's work is that response surface methods can be used to develop closed-form models that very effectively estimate the effects of key model inputs on corridor T&R forecasts.

Dr. Adler concluded his presentation by describing how this analytical approach was implemented when performing the Orlando I-4 Traffic & Revenue Study for a twenty-one mile managed lane project that would add two dynamically priced lanes in each direction on I-4.

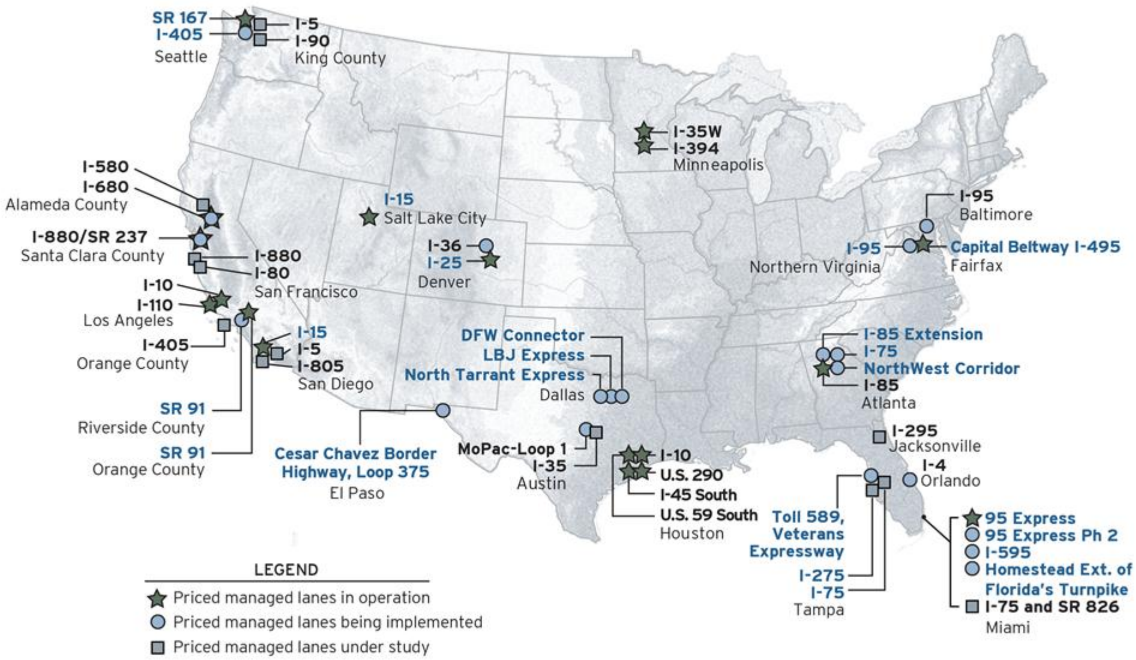



## *D.8 Priced Managed Lanes National Overview*

Jim Ely of HNTB delivered the next presentation which provided a national overview of priced managed lanes. Mr. Ely began by first covering some basic terminology since many different phrases and acronyms for priced managed lanes are often used interchangeably. He then performed a quick national scan and described a few of the most successful price managed lanes projects that have been completed to date including: I-85 in Atlanta, I-95 Express in Miami, I-15 Express in San Diego and I-495 HOT in Washington D.C.

Mr. Ely concluded his presentation by describing the important advantages of price managed lanes and how regions can benefit from their implementation. He also noted some important national lessons learned that should be considered and addressed when initiating any new price managed lane project.




## *D.9 Planning for Express Lanes*

Eric Pihl from the FHWA delivered the next presentation. Mr. Pihl used his time to discuss and provide an overview of *NCHRP Special Report #722 – Assessing Highway Pricing and Tolling*. Mr Pihl described the four-step model prototype which is presented in Special Report #722 as a suitable analytical tool and method for pricing studies.

Mr. Pihl used the remainder of his presentation to showcase two recent project case studies in Colorado: E470 and US36. In both cases the Denver Regional Council of Governments (DRCOG) activity-based regional travel model referred to as Focus was used to study the priced managed corridors. The advanced Focus model has a number of important strengths when used to analyze price managed lanes:

- Sophisticated time-of-day sub-model sensitive to travel times
- Trip distribution & mode choice sub-models sensitive to changes in travel times
- Highly disaggregate with many trip purposes
- Potential for trip rescheduling due to congestion dynamics

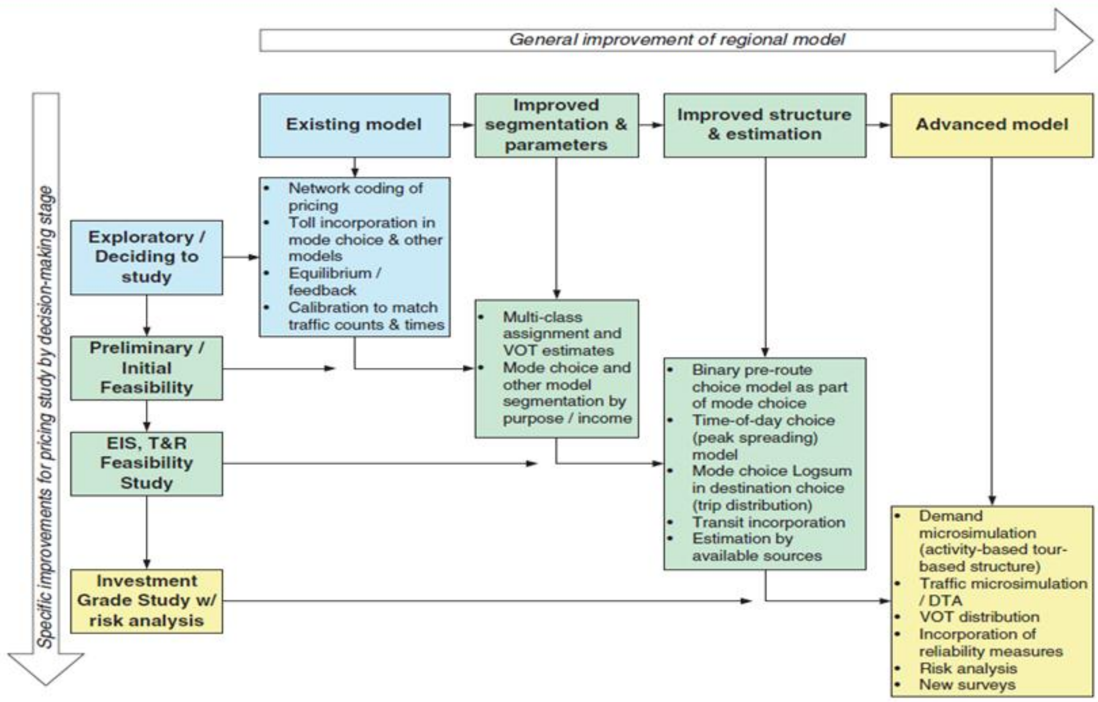
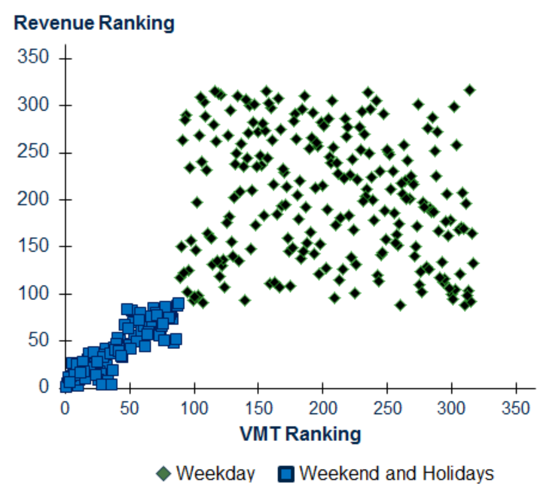



*Figure 1. Forecasting tools by stage of project development.*

## D.10 Operational Methods for Managed-Lane Toll Analysis

John Lewis of Cambridge Systematics delivered the final presentation of the workshop on day-one. Mr. Lewis began his presentation by introducing a generalized modeling framework for the operational analysis of managed toll lanes that includes macroscopic, mesoscopic and microscopic examinations. In general the modeling framework should include an iterative process between the demand model and the operational model with regional diversions represented in the demand model and dynamic route choice algorithms in the microsimulation model used to differentiate the express lane and general purpose lane utilization.

Mr. Lewis then described how this type of framework was used to study E-470 in Colorado and I-405 in Seattle. This part of the presentation included results and a number of visualizations from those particular case study examples.




Mr. Lewis concluded his remarks by noting that experience on SR167 reveals that highest VMT days do not correlate with highest revenue days. This adds uncertainty to calculating annual revenue from daily traffic forecasts and underscores the necessity of quantified risk analyses.

## *D.11 How Managed Lanes Can Be Analyzed Using Advanced Travel Demand Models*

Tom Rossi of Cambridge Systematics delivered the first presentation of the workshop on day-two. Mr. Rossi began his presentation by describing what traditional trip based regional travel models are capable of with respect to managed lane modeling. He then enumerated the ways in which advanced activity-based regional travel models offer a number of important advantages.

- Disaggregate application – reduces aggregation error
- More realistic behavioral basis than four-step trip-based models
- Modeling of entire tours (trip chaining)
- Ability to present results for any definable market segments

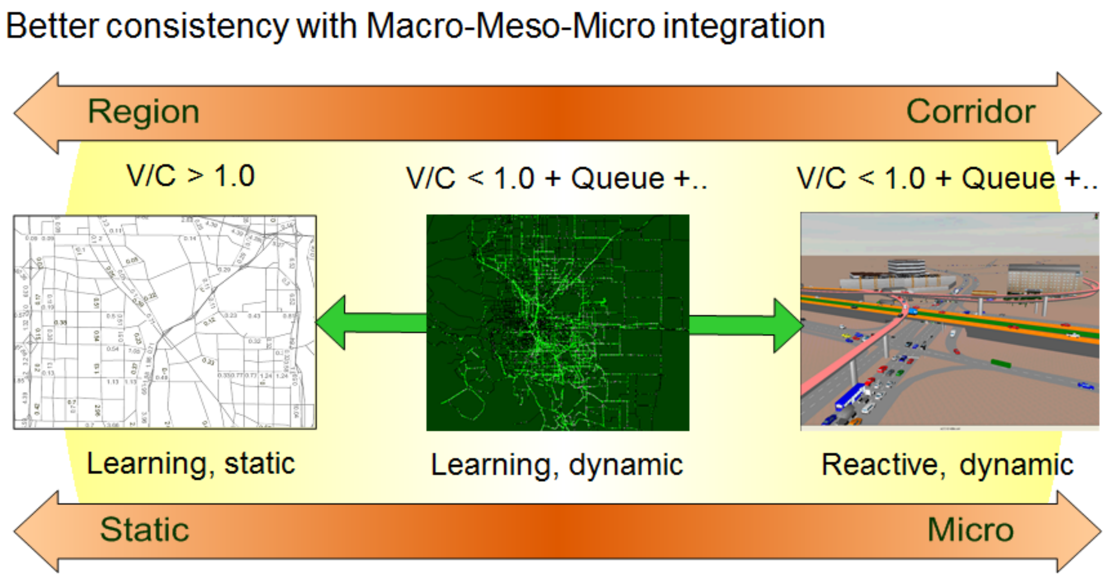
Mr. Rossi concluded his presentation by then describing the elements of activity-based regional travel models which make them particularly well-suited for analyzing express toll lane and price managed lanes.

- More complete consideration of carpool formation
- Time-of-day choice modeled explicitly
- Finer temporal resolution for time-varying pricing
- Ability to simulate individual values of time
- Ability to provide person characteristics (including VOT) into traffic simulation

## *D.12 Modeling Express Lanes Using Dynamic Traffic Assignment*

Yi-Chang Chiu of the University of Arizona delivered the second presentation on day-two of the workshop. To begin his presentation, Dr. Chiu indicated that by relying on dynamic traffic assignment methods to study express toll lanes one is inherently assuming the following: 1) estimating lane demand is a route/departure choice not a mode choice problem, and 2) learning and adaption is part of route choice decisions, instead of instantaneous or reactive route choice behavior.

In the remainder of his presentation Dr. Chiu described the DTA components relied upon for pricing analyses and again presented results and information from the US36 case study in Colorado and emphasized that DTA for express lane analysis provides a critical middle bridge between the macroscopic and microscopic models used to date and when feedback among the models is included. Dr. Chiu concluded his presentation by recommending that DTA offers the right combination of simulation realism and size of network to model many tolling scenarios effectively.




## D.13 Impact of Congestion Pricing & Travel Time Reliability

Peter Vovsha of Parsons Brinkerhoff presented the final presentation of the workshop. Mr. Vovsha presented the findings of his research team as part of the SHRP2 C04 research project sponsored by TRB. The objective of the project was to develop new mathematical descriptions of the full range of highway user behavioral responses to congestion, travel time reliability, and pricing. This included formatting the mathematical descriptions of behavior so that they could be incorporated into various travel demand modeling systems in use or now being developed. Another objective was to examine network assignment practices needed to support models that simulate behavioral responses to congestion, travel time reliability, and pricing.

Travel demand modeling systems can now reflect how travelers respond to congestion, travel time reliability, and pricing, so that decisions about operational improvements can be based on more realistic models. With better models agencies better understand how operations projects can improve the function of their highway networks.

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