I-75/SR 826 Managed Lanes

Investment Grade Traffic and Revenue Study

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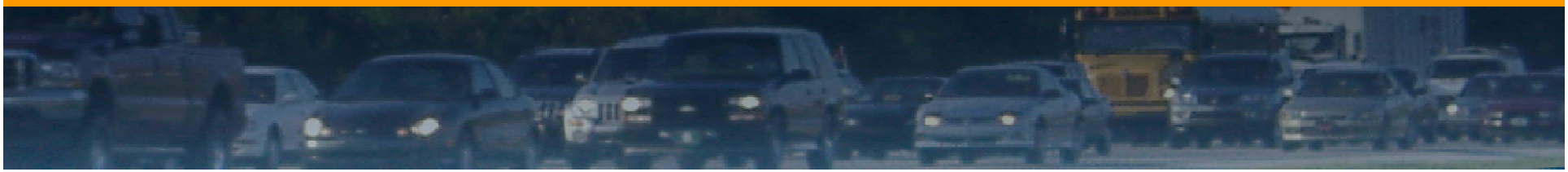
URS Corporation/Florida's Turnpike Enterprise



Traffic and Revenue Study

- Assessment of the viability of tolling a facility and expected toll revenue over a long-term time frame.
- Evaluates congestion relief potential of tolling options.
- Allows agencies to evaluate financing the options.
  - Cash Financing
  - Debt Financing
  - Public-Private Partnerships

Traffic and Revenue Study Levels

Top Down

- Comparative analysis of similar facilities

Sketch Level

- Involves analysis tools with generic input assumptions

Planning Level

- Involves some data collection and use of various modeling tools, including time of day diversion models.

Investment Grade

- Extensive data collection (O/D, value of time, socioeconomic) and refined modeling tools.

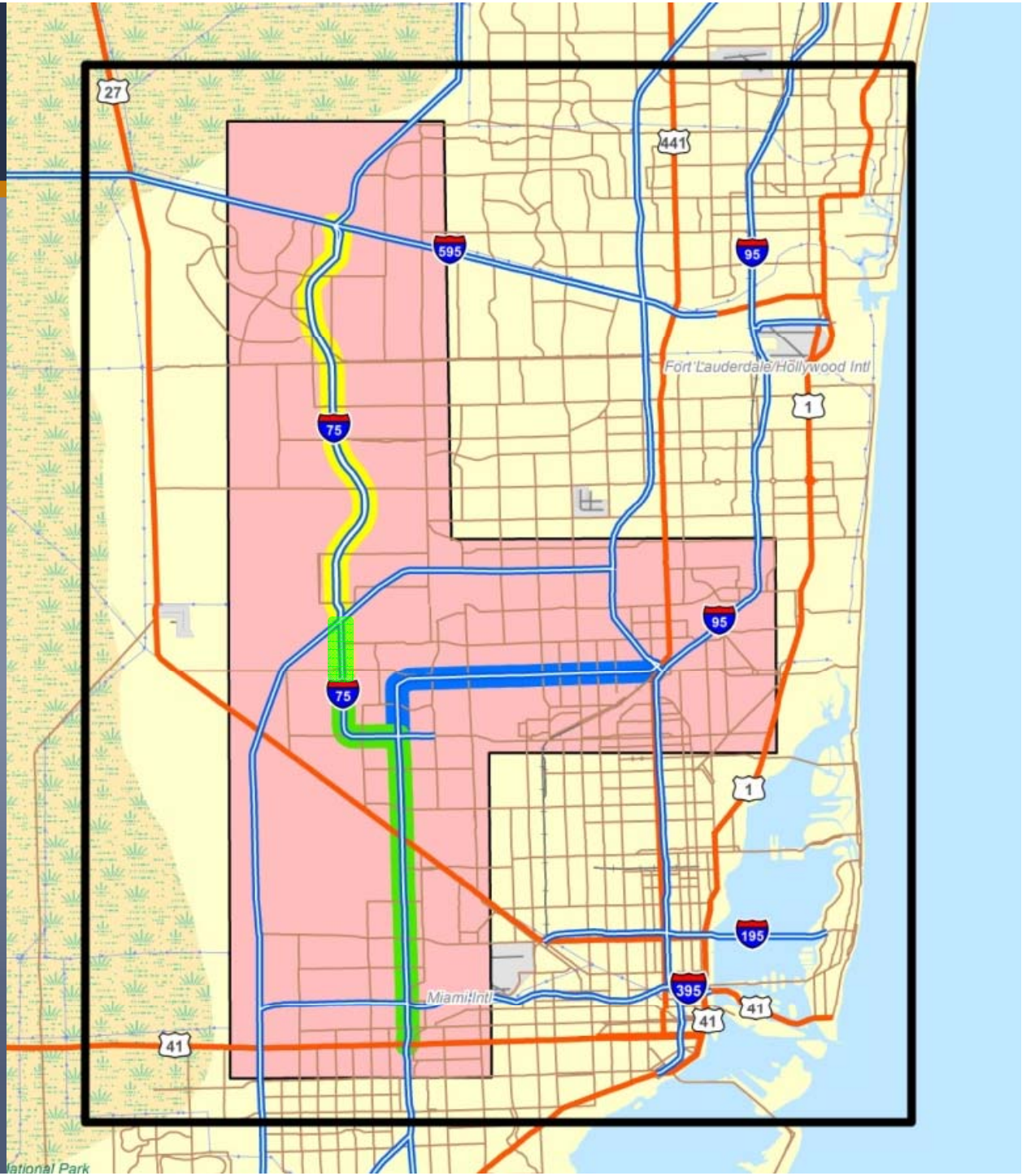
Study Area

District 4 Portion

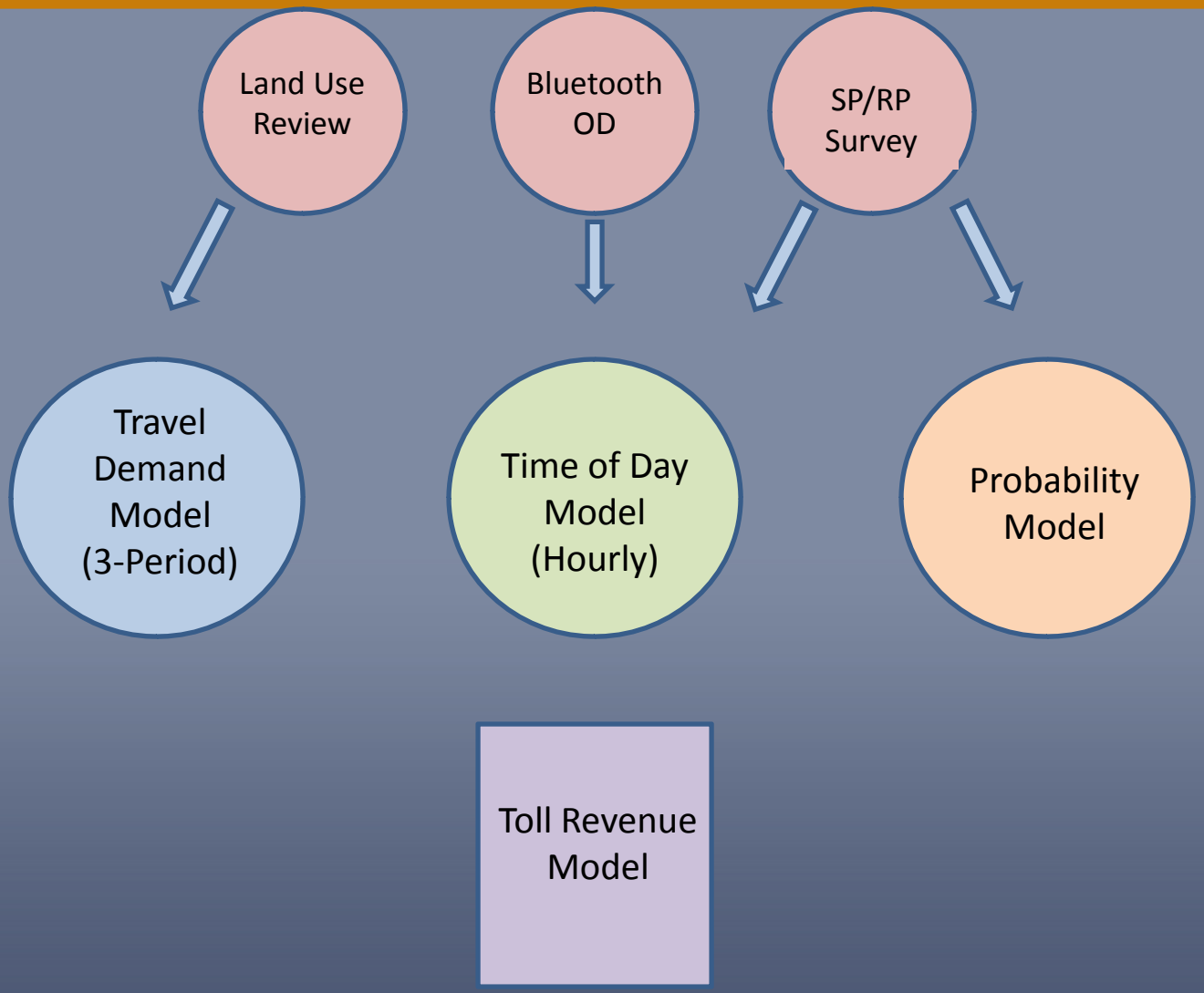
- 4 Managed Lanes on I-75 from NW 170th Street to I-595
- Reversible lane direct connection to I-595

District 6 Portion

- 4 Managed Lanes on I-75 from SR 826 to NW 170th Street
- Direct ramp connection from SR 826 to I-75 (two managed lanes)
- 4 Managed Lanes on SR 826 between SR 836 and SR 826

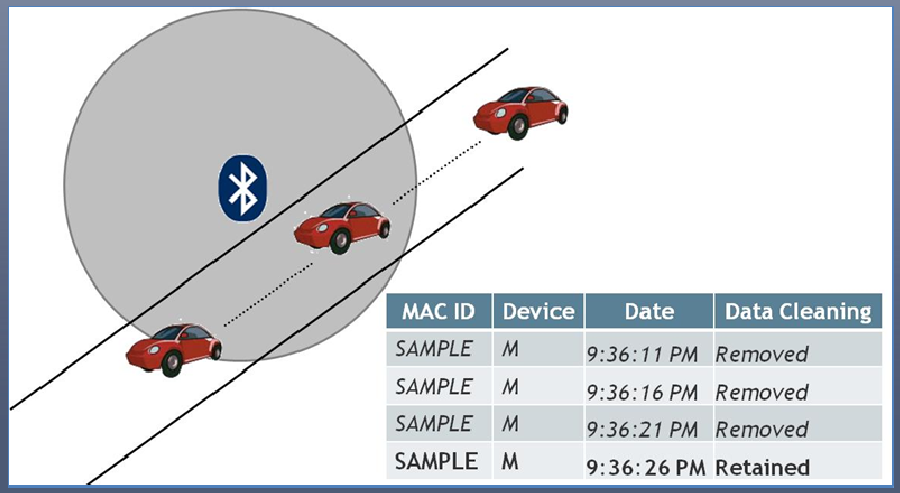


Traffic and Revenue Models



OD Estimation – Bluetooth Detection Technology

- Bluetooth Detector (Traffax) has 100-meter range and consecutive 5-second scan windows.
- “Discoverable” bluetooth devices are detected and timestamped.
- Bluetooth devices have a unique MAC ID.
- Chronological MAC IDs are linked together to form “trips”.
- Data analysis provides study area speed profiles and origin-destination estimates.



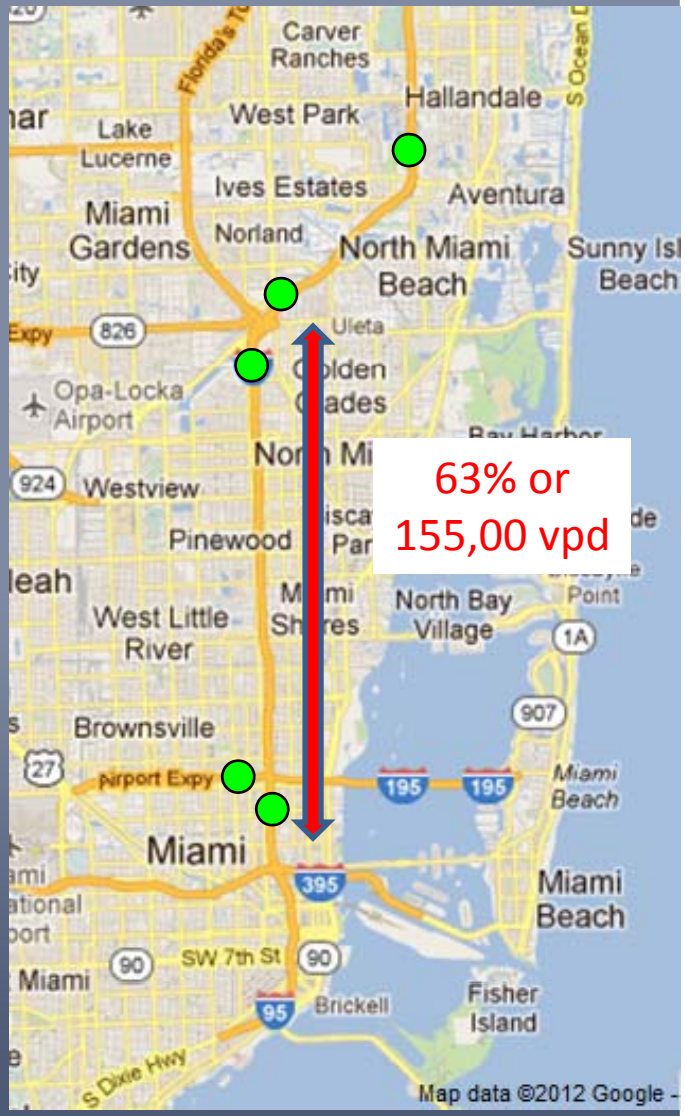
MAC ID	Device	Date	Data Cleaning
SAMPLE	M	9:36:11 PM	Removed
SAMPLE	M	9:36:16 PM	Removed
SAMPLE	M	9:36:21 PM	Removed
SAMPLE	M	9:36:26 PM	Retained

Bluetooth Data Collection Effort

- 46 detectors deployed in the study area
- Deployment designed primarily to sequester interchanges
- Data collection occurred October 12-20, 2011
- Penetration rate ranges from 3%-9%, 5% mean
- 2010 O-D table by period (AM, PM, OP)

Bluetooth Data Collection Effort

- 5 detectors deployed in the I-95
- Data collection occurred February 23 – March 1, 2012
- Purpose to understand vehicle movements eligible to use 95 Express
- O-D critical for accurate model calibration

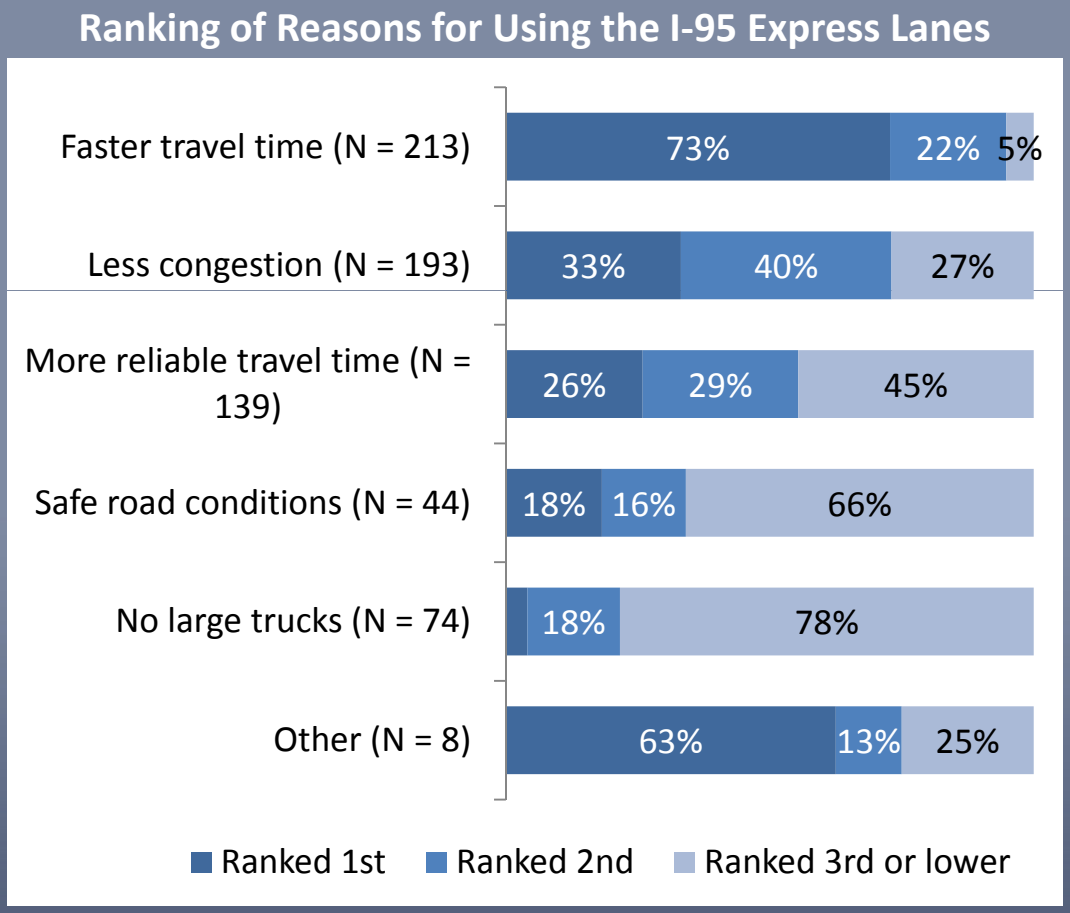


Stated/Revealed Preference Surveys

- Stated Preference Survey:
  - Hypothetical choice scenarios to understand response to future conditions
  - What would you do if...?
- Revealed Preference Survey:
  - Observed choice behavior given existing conditions
  - What did you do...?
- I-75/SR 826 Stated Preference Survey
  - Estimate Values of Time (VTTS) for drivers in the I-75 and SR 826 corridors
  - Input for traffic and revenue forecast for Express Lanes expansion
- I-95 Stated/Revealed Preference Survey
  - Estimate VOT for drivers in the I-95 corridor
  - Understand why drivers choose to use the I-95 Express Lanes without a large travel time benefit
  - Validate/calibrate travel demand model

I-95 Trip Characteristics

- Reasons for using I-95 Express Lanes
  - Faster travel time cited most frequently
  - Faster travel time ranked highest
  - Less congestion and travel time reliability ranked 2nd and 3rd
  - Only 1 respondent reported fuel savings as a reason



Discrete Choice Modeling Overview

- Stated and Revealed Preference data used to estimate coefficients of a discrete choice model
- Coefficients provide information about sensitivity to:
  - Travel time
  - Toll cost
  - Travel Time uncertainty
- Used to feed the ELTOD model

SP/RP Model Calibration

Time and Cost Savings | **Reliability** | **Other Variables**

Utility for alternative (i): U(i) = βtime * travelTime(i) + βcost * tollCost(i) + βentropyLate * entropy (i) + CalibratedTollConstant

Entropy for alternative (i): Entropy(i) = 2.15*EXP(-11.8183 + VC(i)*17.7816)/(1+EXP(-11.8183+VC(i)*17.7816))

Where: βtime = travel time coefficient

βcost = toll cost coefficient

βentropyLate = entropy coefficient for travelers arriving late

CalibratedTollConstant = Calibrated toll constant for appropriate travel direction and time period

travelTime(i) = Travel time for alternative(i)

tollCost(i) = Toll cost for alternative(i)

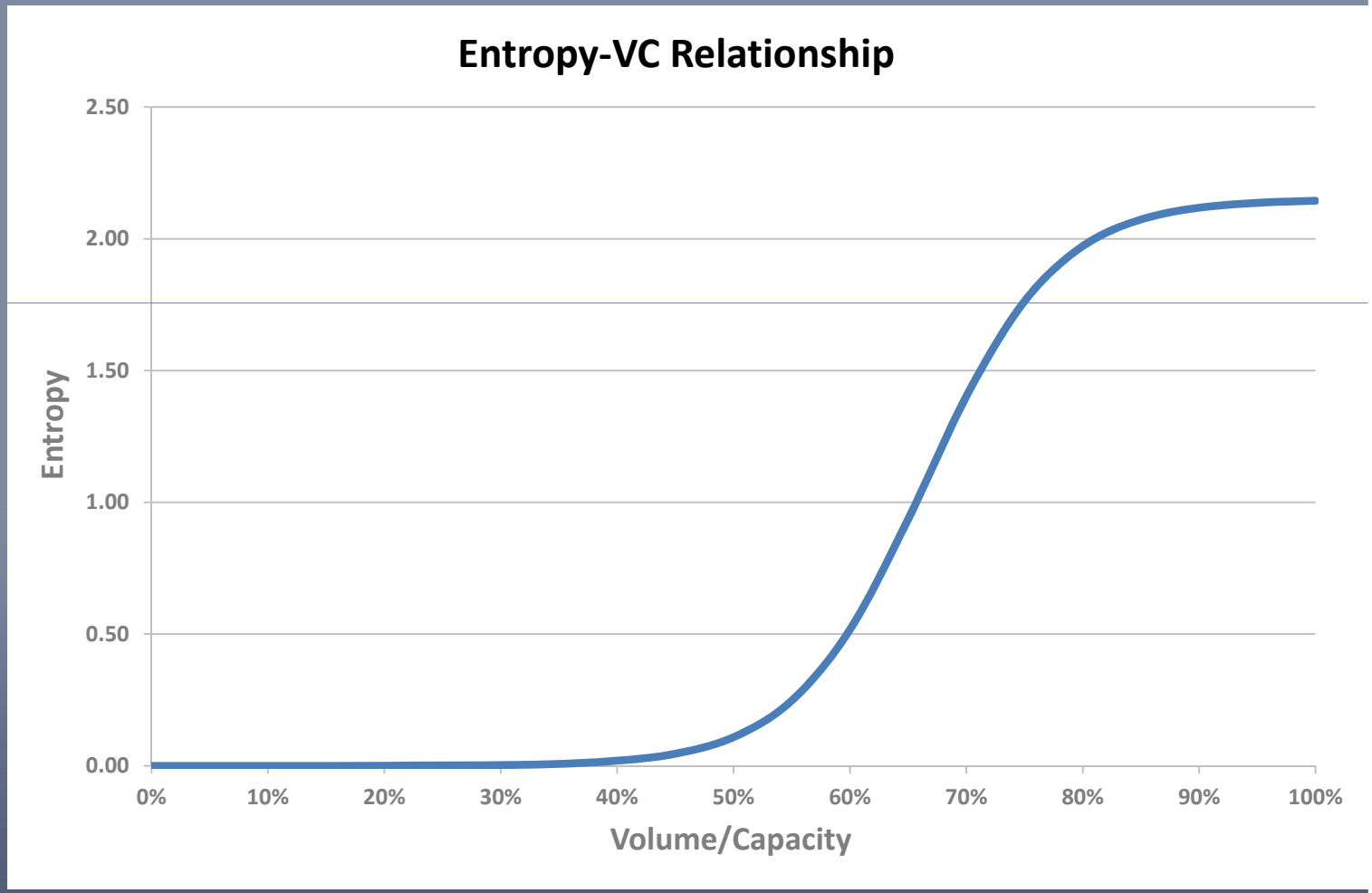
VC(i) = Volume/Capacity ratio for alternative(i)

Coefficient	Before Calibration	After Calibration
Time	-0.112	-0.112
Cost	-0.609	-0.609
Entropy	0.179	0.95
Toll Constant	-1.79	-0.900 (Peak) -1.50 (Off-Peak)

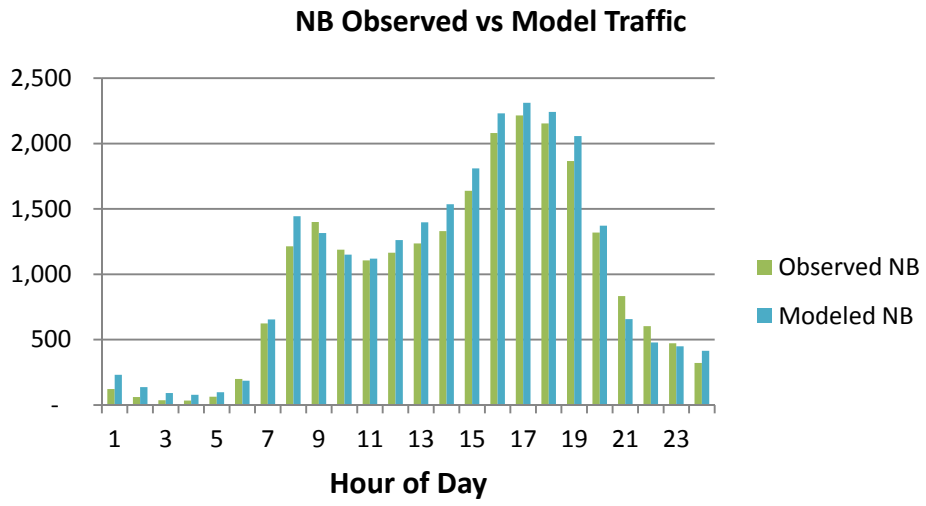
VTTS = $11.03

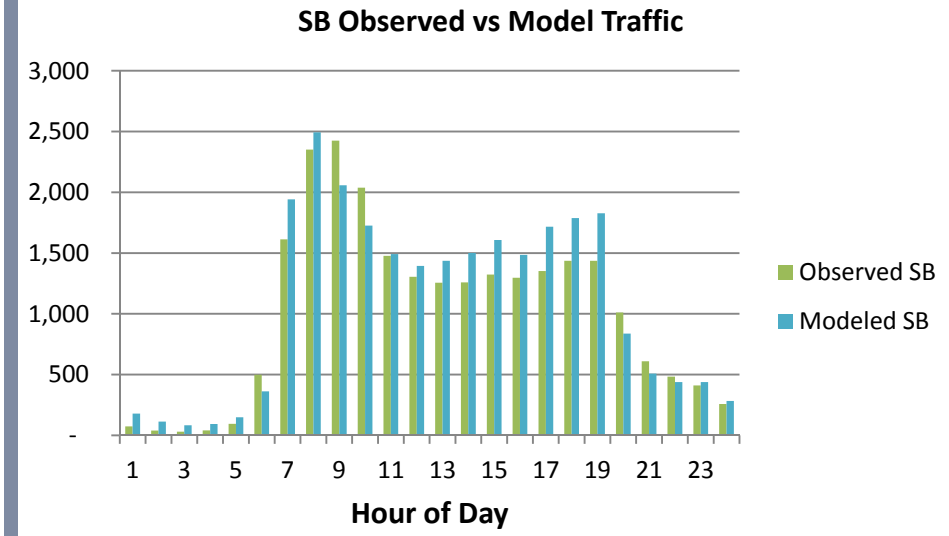
SP/RP Model Calibration

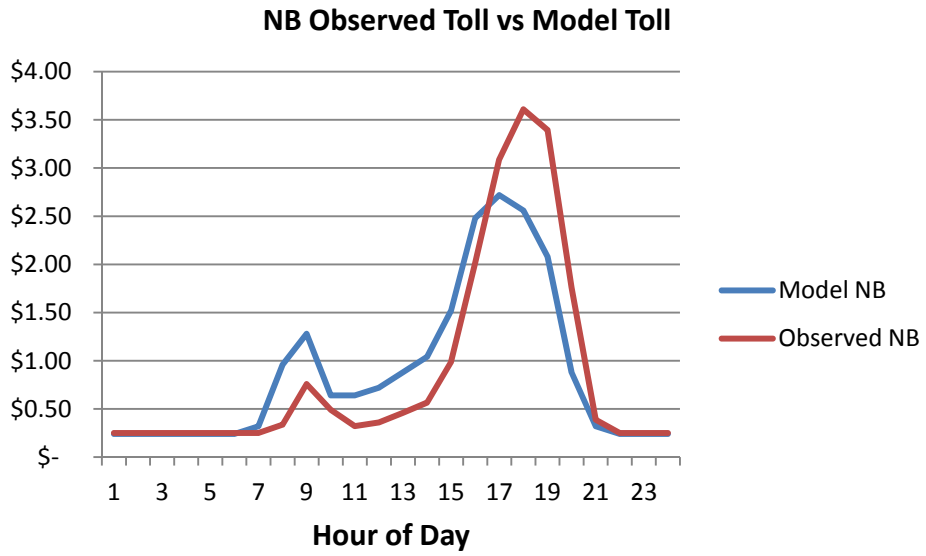
V/C	Entropy
0%	0.00
5%	0.00
10%	0.00
15%	0.00
20%	0.00
25%	0.00
30%	0.00
35%	0.01
40%	0.02
45%	0.05
50%	0.11
55%	0.25
60%	0.52
65%	0.94
70%	1.40
75%	1.76
80%	1.97
85%	2.07
90%	2.12
95%	2.14
100%	2.14

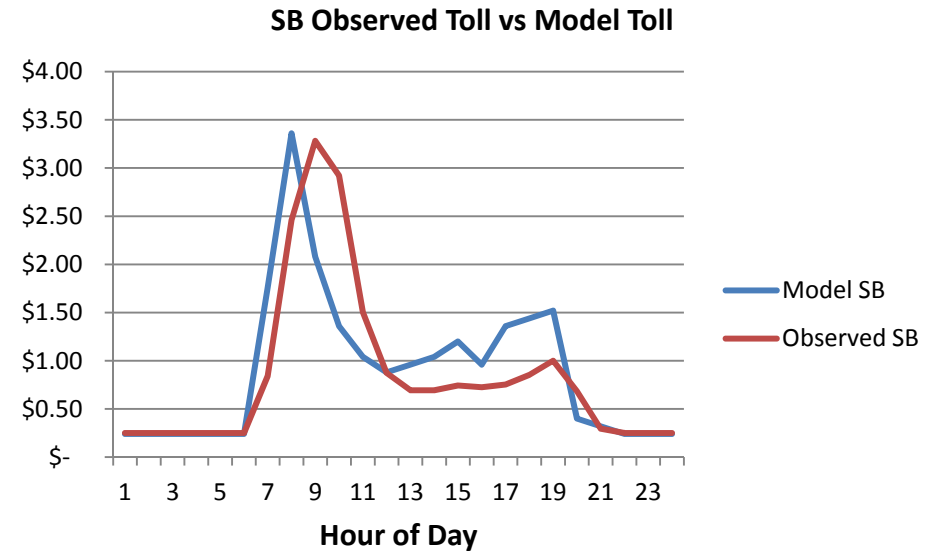


95 Express Calibration Results





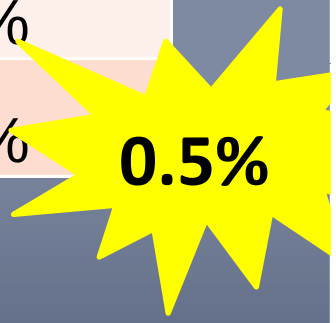




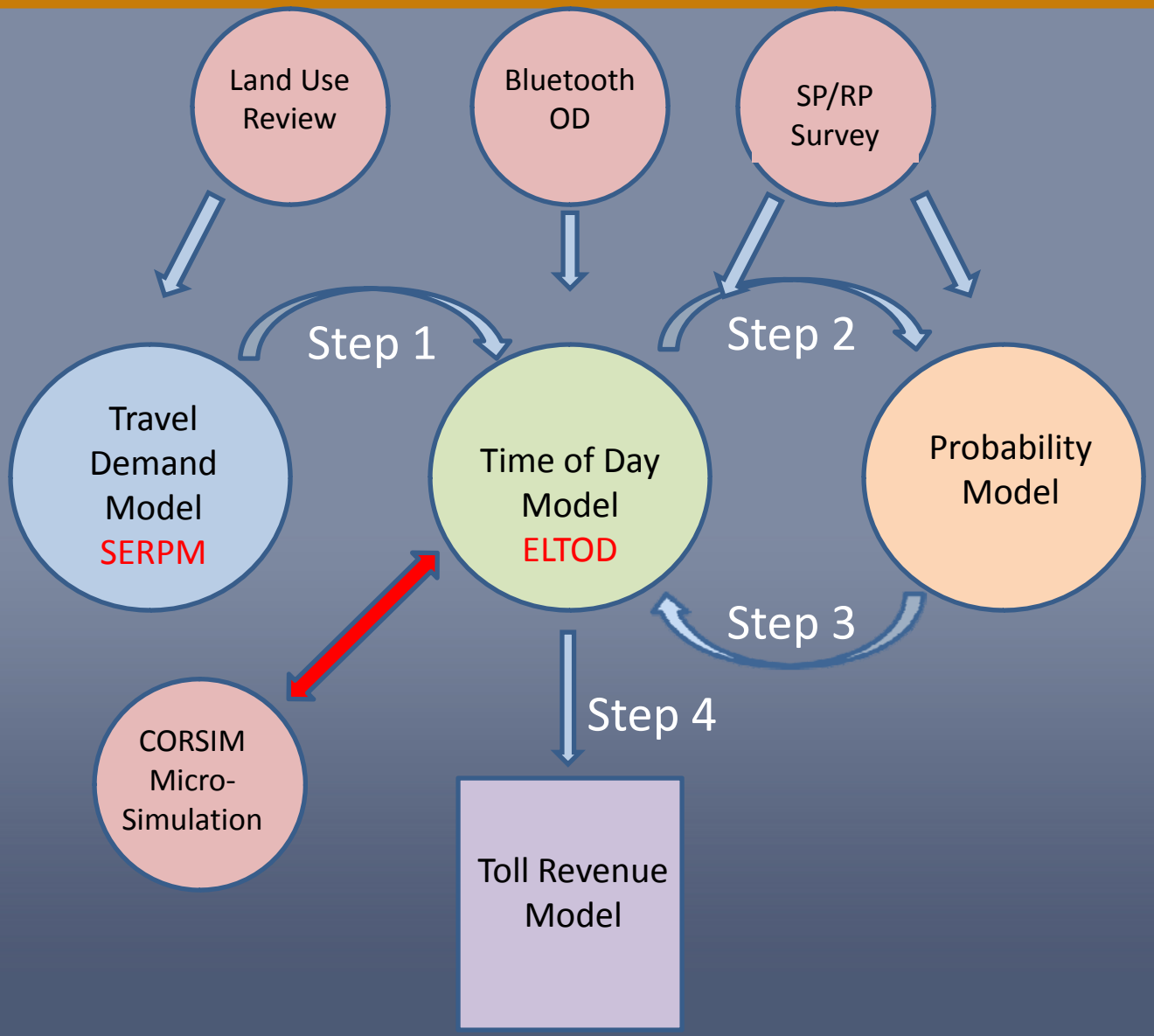
95 Express Calibration Results

Calibration Results			
Average Weekday	**Observed**	**Model**	**% Difference**
Transactions	47,404	50,668	6.9%
Revenue	$67,314	$67,624	0.5%

For the period November 1, 2011 to December 16, 2011

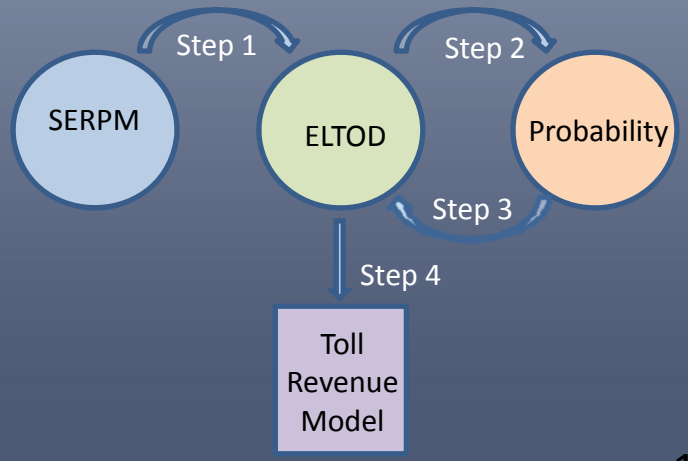


Model Interactions



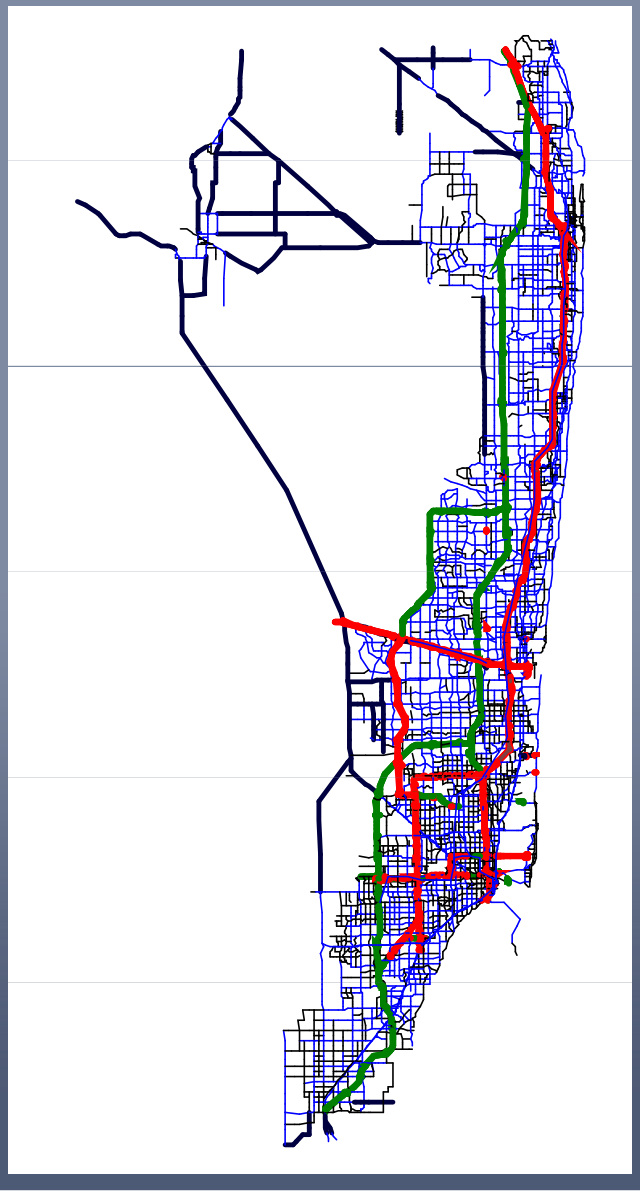
Traffic and Revenue Process

- Step 1
  - Initial feed from the SERPM into the ELTOD model
- Step 2
  - Run ELTOD for full experimental design into probability model. Probability model provides target revenue values.



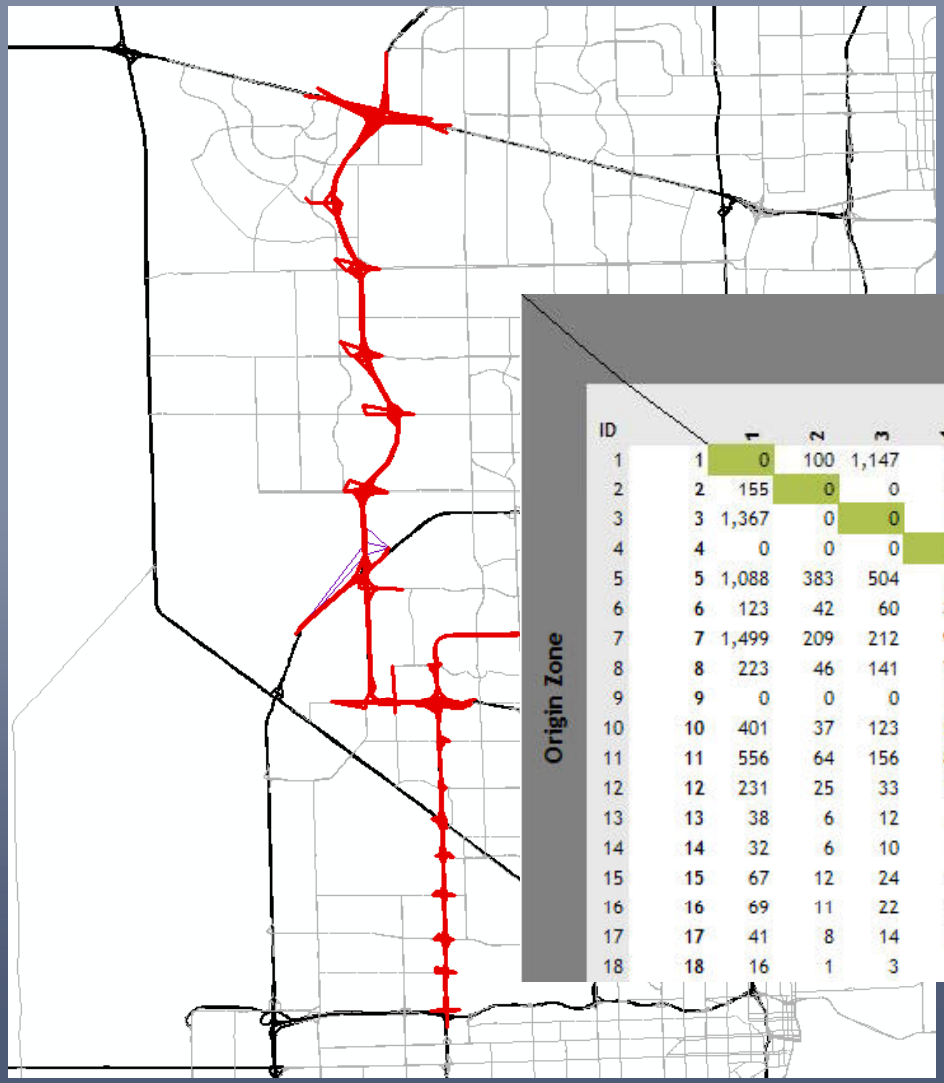
Southeast Regional Planning Model (SERPM)

- 3 Counties – Miami-Dade, Broward and Palm Beach County
- Project Level Validation
  - Updated Highway Network to 2010
  - Benchmarked Population to 2010 Census
  - Updated 3,700 links with counts by time of day



Subarea Feed from SERPM

Subarea Network

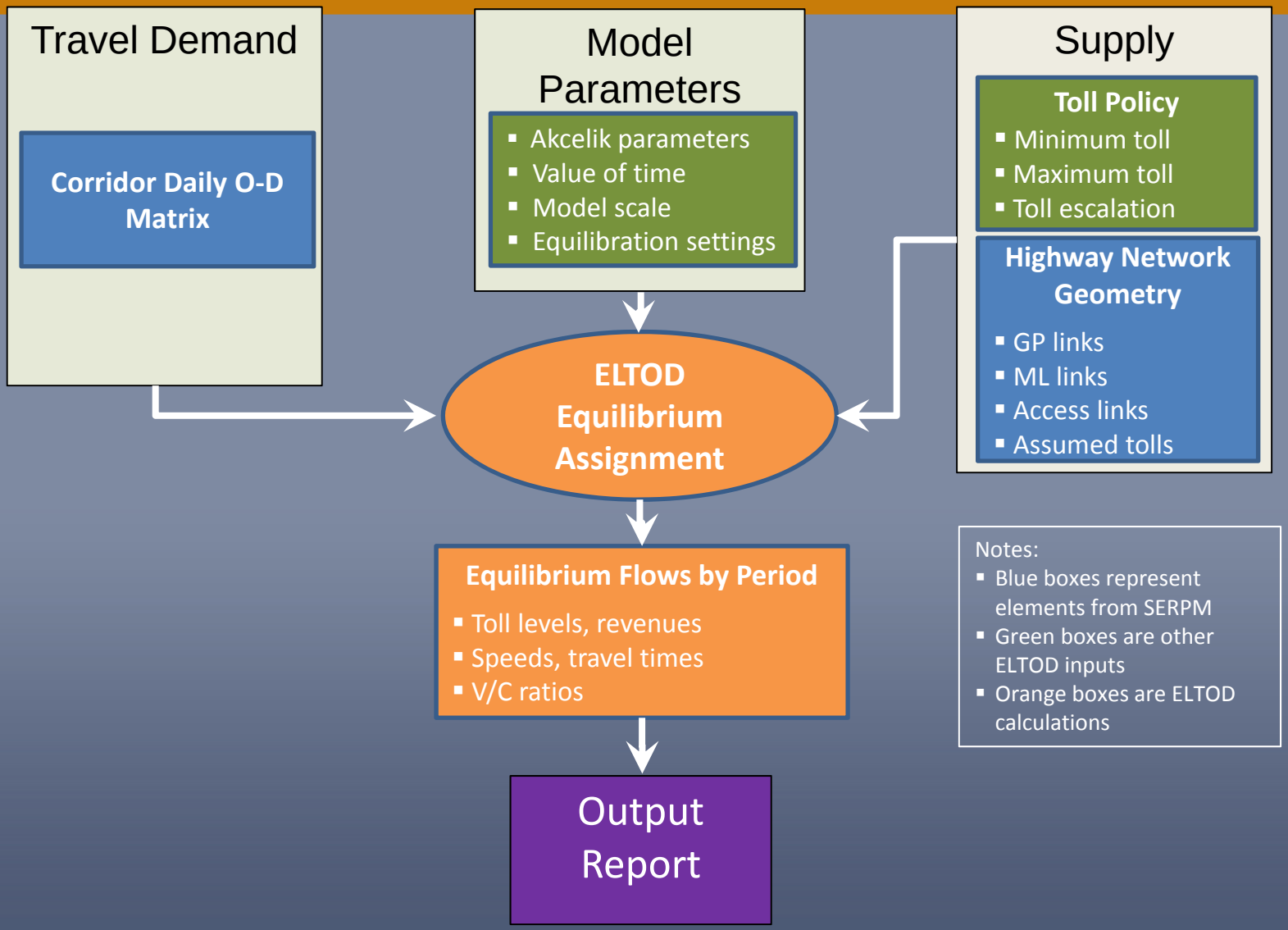


Origin-Destination Matrix for TOD Model

Destination Zone

Origin Zone ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0	100	1,147	0	1,732	354	2,266	302	0	469	861	322	23	11	57	56	33	4
2	155	0	0	0	318	58	213	54	0	39	92	34	4	2	12	6	8	0
3	1,367	0	0	0	745	104	292	210	0	174	301	60	8	4	23	16	17	1
4	0	0	0	0	0	19	73	70	0	41	76	22	3	1	8	5	4	0
5	1,088	383	504	0	0	279	536	394	0	232	417	130	15	8	50	26	29	2
6	123	42	60	32	588	0	944	855	0	677	365	129	18	26	50	26	27	2
7	1,499	209	212	90	528	763	0	1,496	0	728	622	222	38	43	123	48	48	6
8	223	46	141	76	301	616	1,478	0	0	1,064	825	324	38	54	127	48	57	7
9	0	0	0	0	0	0	0	0	0	120	48	159	8	7	17	12	11	3
10	401	37	123	54	215	290	839	804	9	0	996	659	27	28	94	40	46	3
11	556	64	156	84	291	282	598	563	124	495	0	191	30	5	147	17	15	1
12	231	25	33	15	82	68	142	204	109	561	343	0	453	24	51	23	23	26
13	38	6	12	6	30	27	77	48	7	80	59	177	0	19	15	28	8	8
14	32	6	10	5	23	22	52	46	6	36	2	137	23	0	82	61	10	5
15	67	12	24	12	54	47	135	116	8	118	126	130	27	28	0	305	22	12
16	69	11	22	11	43	38	91	71	9	107	45	234	30	32	249	0	17	11
17	41	8	14	8	33	26	63	49	9	64	72	61	22	23	117	19	0	179
18	16	1	3	1	5	3	7	6	1	2	19	41	16	15	44	7	15	0

TOD Model Flowchart



ELTOD

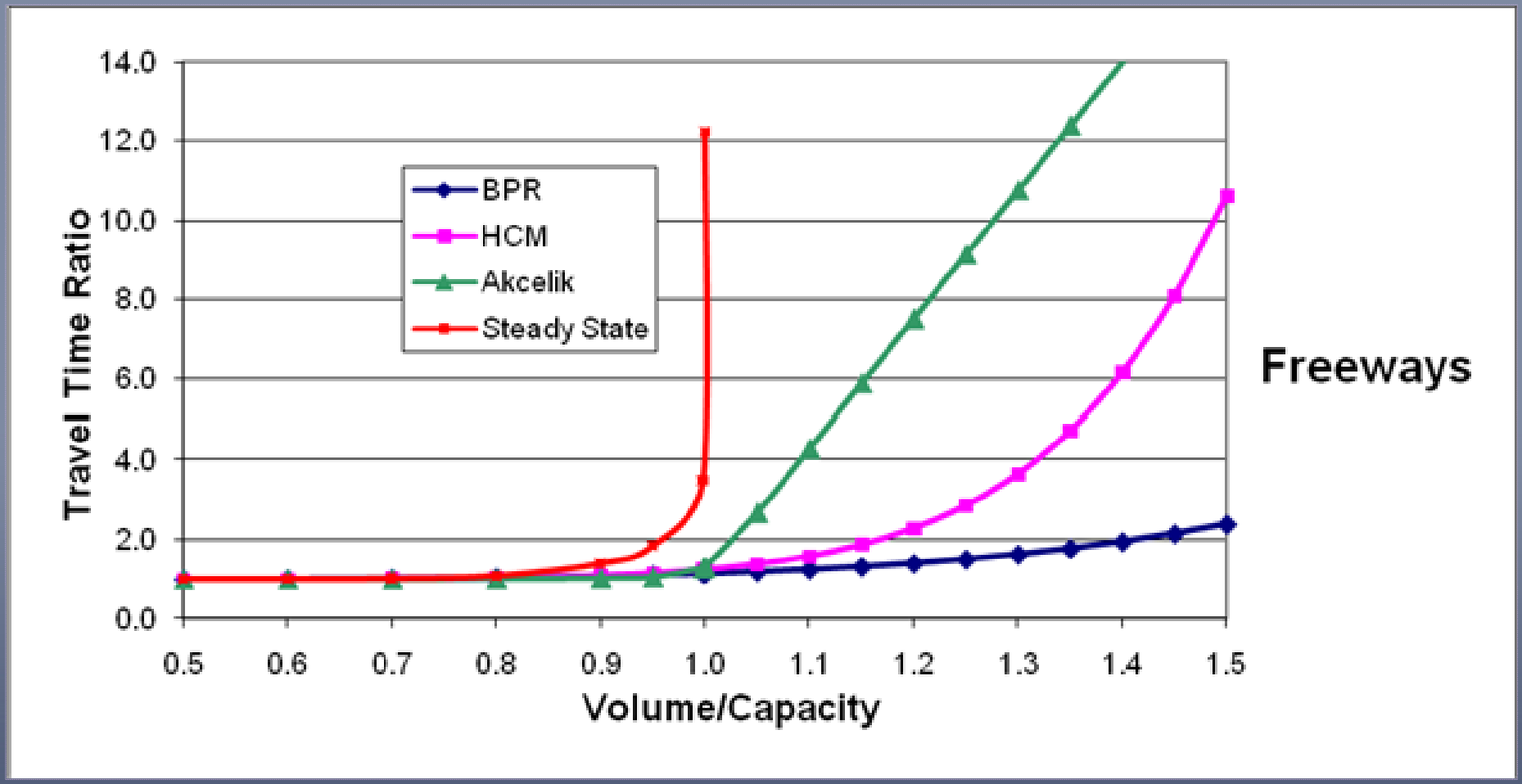
Express Lanes Time of Day Assignment Model

- Traffic allocation analysis for managed toll lanes projects
- Produces traffic forecast estimates in a pre-defined limited access corridor for general use and managed toll lanes
- Utilizes output from the SERPM
- Traffic estimates are by:
  - Direction, Project Section, Hour, Lane Type (GUL or ML)

ELTOD: Input Data

- VTTS & Choice Model Coefficients: $11.03
- Maximum Service Volume (Vehicles/Lane/Hour): 1740-2100 vph
- Free-Flow Speed: 60-75 mph
- Geometry (GP & ML)
  - Number of Lanes, Link Length (Distance)
- Sub area O-D matrix (AM, PM, Off-Peak)
- Hourly traffic distribution
- Volume-Delay Measure (Akcelik Function)

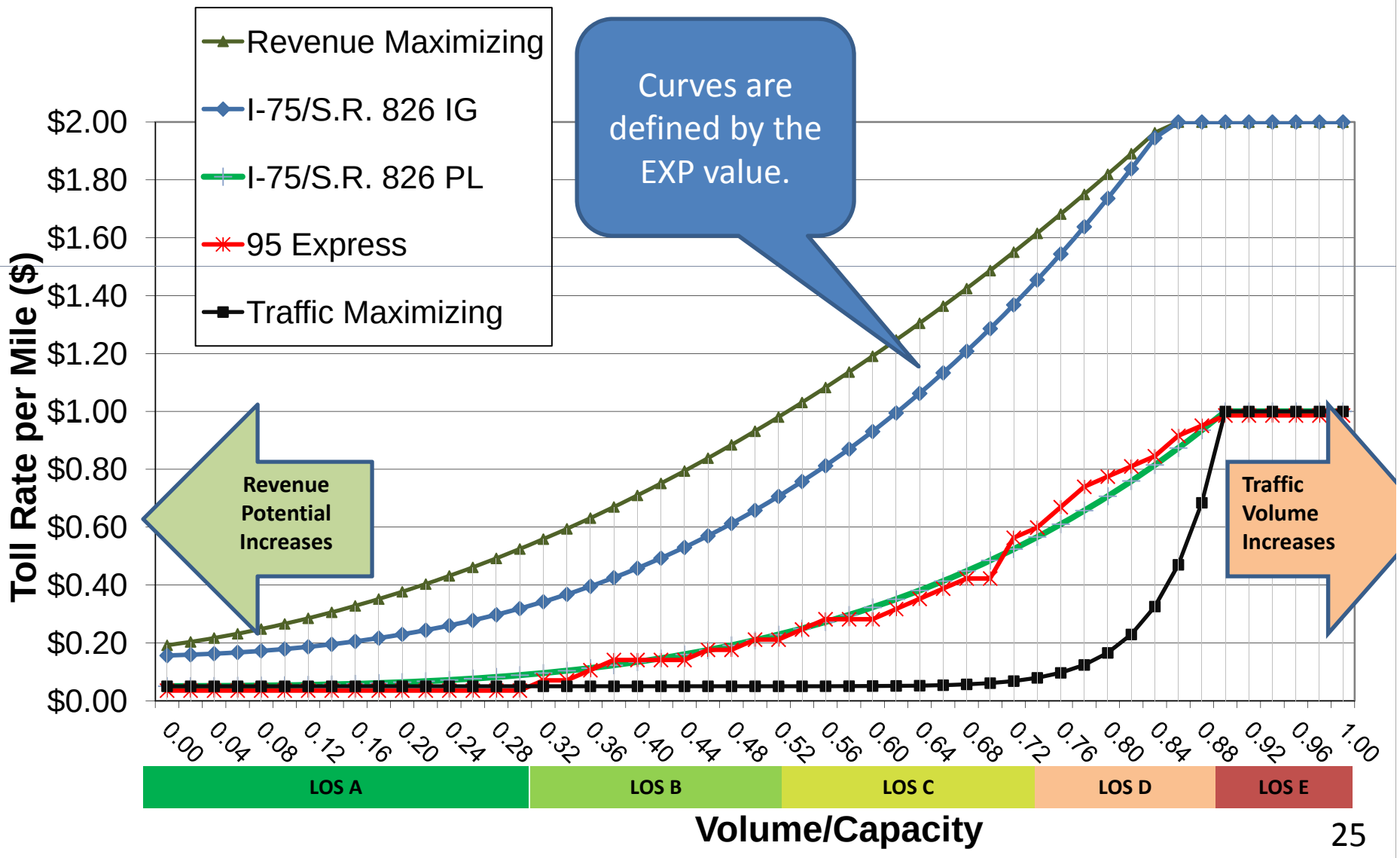
ELTOD: Volume-Delay Curve



ELTOD: Pricing Policy

- Input Data:
  - Minimum/Maximum Toll Rates
    - Min = $0.15/mile, Max = $2.00/mile
  - Pricing Curve Level (frequency of toll rate change)
    - Exponential curve (not a step function)
    - Higher exponential values represent more traffic serviced

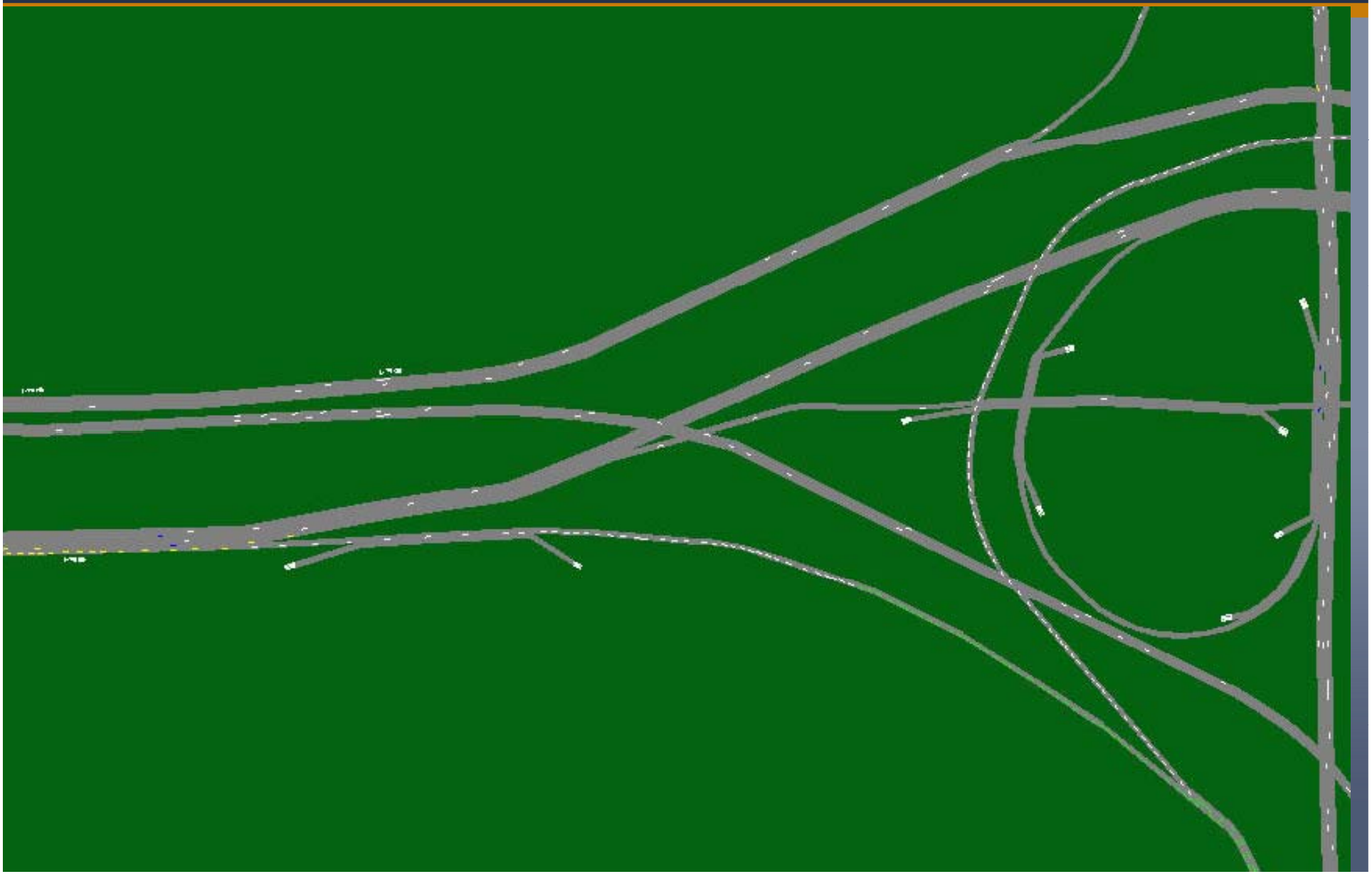
ELTOD: Pricing Policy Curve Comparison



ELTOD: Output

- Traffic volumes
- Preliminary revenue
- Toll rates
- Speeds
- Volume to capacity ratios
- Application: Used the ELTOD to generate hourly traffic and toll rates to feed the revenue model

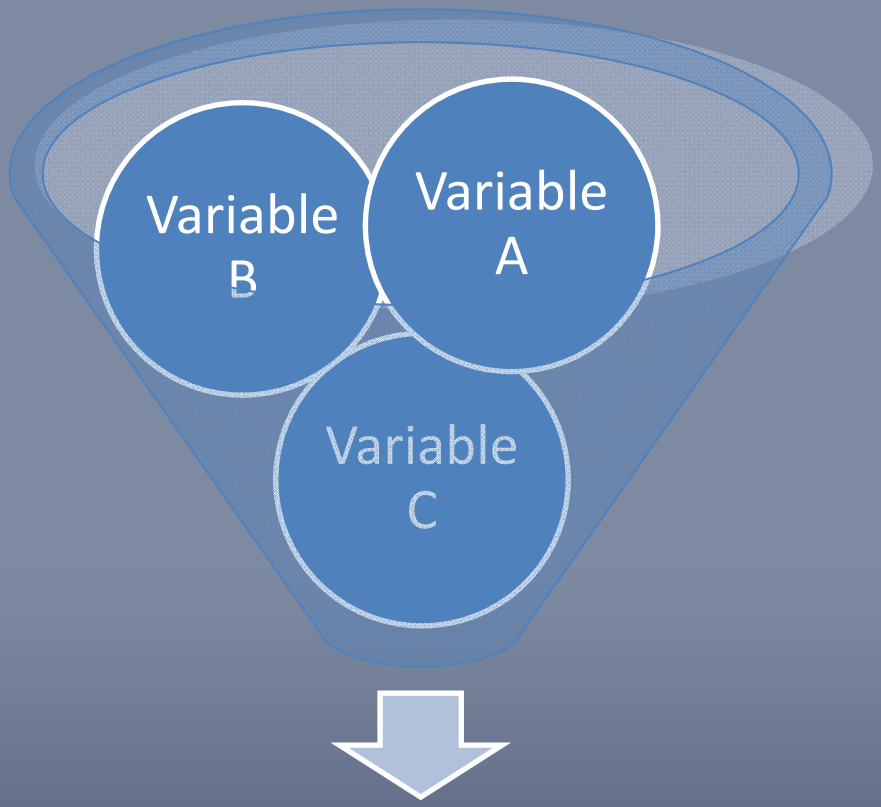
CORSIM Micro-Simulation



Existing Speed Comparison

Direction	Period	Bluetooth Avg. Speed	ELTOD Avg. Speed	BT vs ELTOD Diff	CORSIM Avg. Speed	Diff
I-75						
SB	AM	54.9	57.5	4.8%	47.7	-13.1%
	PM	68.5	69.9	2.0%	64.8	-5.4%
NB	AM	67.0	66.6	-3.2%	64.4	-3.9%
	PM	57.4	63.9	11.3%	59.0	-2.8%
SR 826						
SB	AM	37.6	38.1	1.5%	38.3	2.1%
	PM	37.7	44.5	17.8%	37.4	-0.8%
NB	AM	52.8	45.7	-13.3%	49.9	-5.5%
	PM	35.5	37.0	4.1%	40.0	12.5%

Probability Modeling



Probability distributions for traffic and revenue

Improving the Reliability of Traffic and Revenue Forecasts

There is broad recognition of issues with traffic forecasts and of ways of improving those forecasts.

- **Improve the models that are used for forecasting**
  - **Progress has been made along a number of fronts**
  - **Model structure**
  - **Model inputs**

- **Recognize and quantify inherent uncertainties and simplifications**
  - **Identify key uncertainties in model structure and inputs**
  - **Use quantified probability analysis**

Sensitivity Analyses are Essential…
…But Have Clear Limitations

- Typically run for each input separately, without accounting for interactions between inputs
- Generally need to evaluate effects of changes to more than one variable in combination; this cannot be accomplished without
  - A new model run…this can be time consuming given the number of possible combinations of possible uncertainties

How Are the Variables Assessed?

1. Estimate range of uncertainty associated with each significant variable
2. Outline scenarios involving combinations of factors
3. Determine sensitivity of traffic and revenue by:
   - Running travel demand model for those scenarios
   - Developing statistical model to approximate the travel demand model
4. Use simulation method to determine full distribution of traffic and revenue accounting for uncertainties in input factors

Key Forecast Variables of Possible Significance

Define key variables and their uncertainties, including:

- Values of time – distribution from survey
- Network changes
  - FDOT work program
  - Local road improvements
- Population, employment
  - BEBR scenarios
  - Employment projections

Experimental Design

2040	*Model Population*	*Roadway Network*	*VTTS*
1	6,263,300	Needs Plan	$ 8.08
2	6,263,300	CF Plan	$ 8.08
3	6,918,700	Needs Plan	$ 8.08
4	6,918,700	CF Plan	$ 8.08
5	6,918,700	E+C	$ 8.08
6	7,626,250	E+C	$ 8.08
7	6,263,3	eeds Plan	$
8	6,263	F Plan	$
9	6,263	E+C	$
10	6,918,	eeds Plan	$
11	6,918,700	CF Plan	$
12	6,918,700	E+C	$ 11.03
13	7,626,250	Needs Plan	$ 11.03
14	7,626,250	CF Plan	$ 11.03
15	7,626,250	E+C	$ 11.03
16	6,918,700	Needs Plan	$ 13.99
17	6,918,700	CF Plan	$ 13.99
18	6,918,700	E+C	$ 13.99
19	7,626,250	CF Plan	$ 13.99
20	7,626,250	E+C	$ 13.99

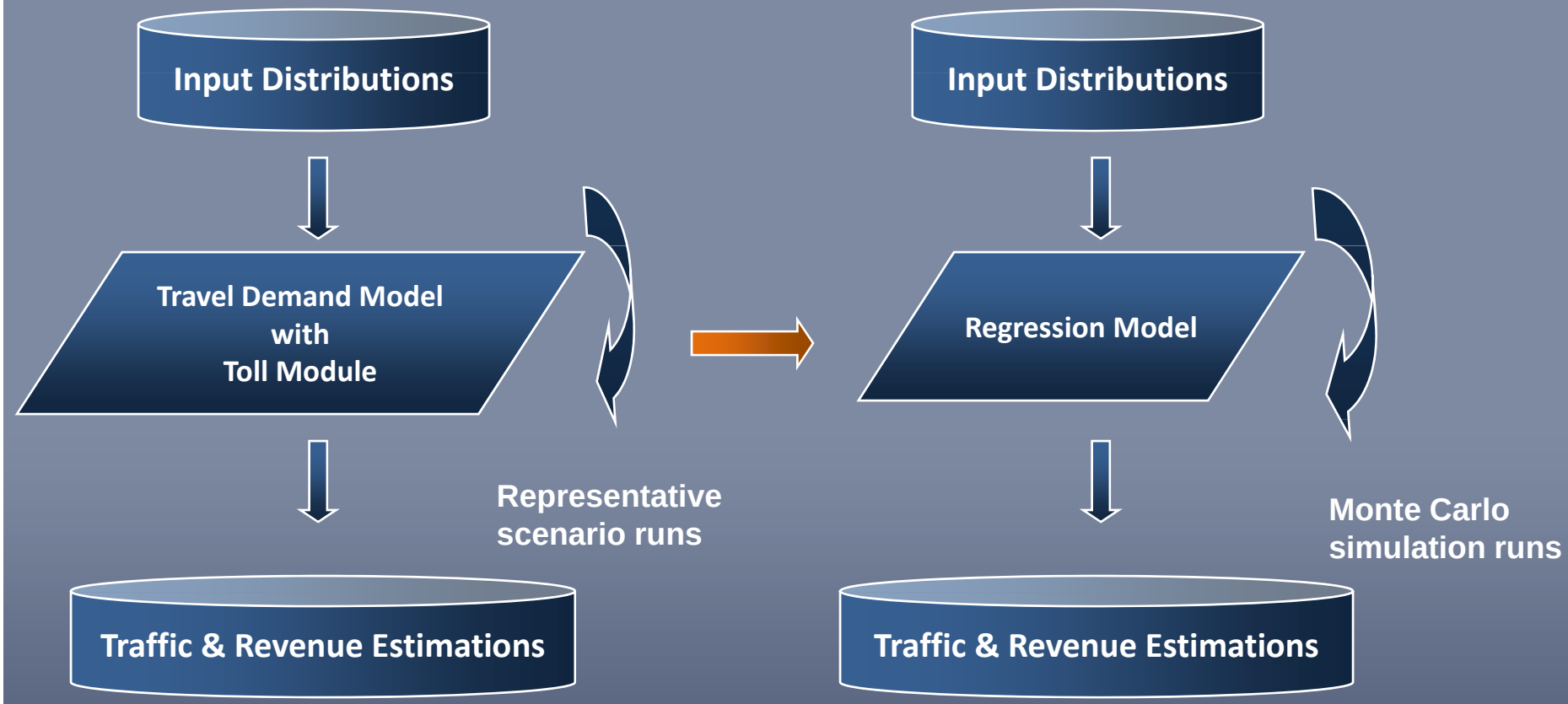
Travel Demand Model SERPM

Time of Day Model ELTOD

Probability Model Risk Factors

Variable	Case	Revenue Risk Factor
Demographics	Low	0.91
	High	1.10
Value of Time	Low	0.73
	High	1.27
Road Network	Low	1.00
	High	1.00
General Uncertainty	Low	0.75
	High	1.25

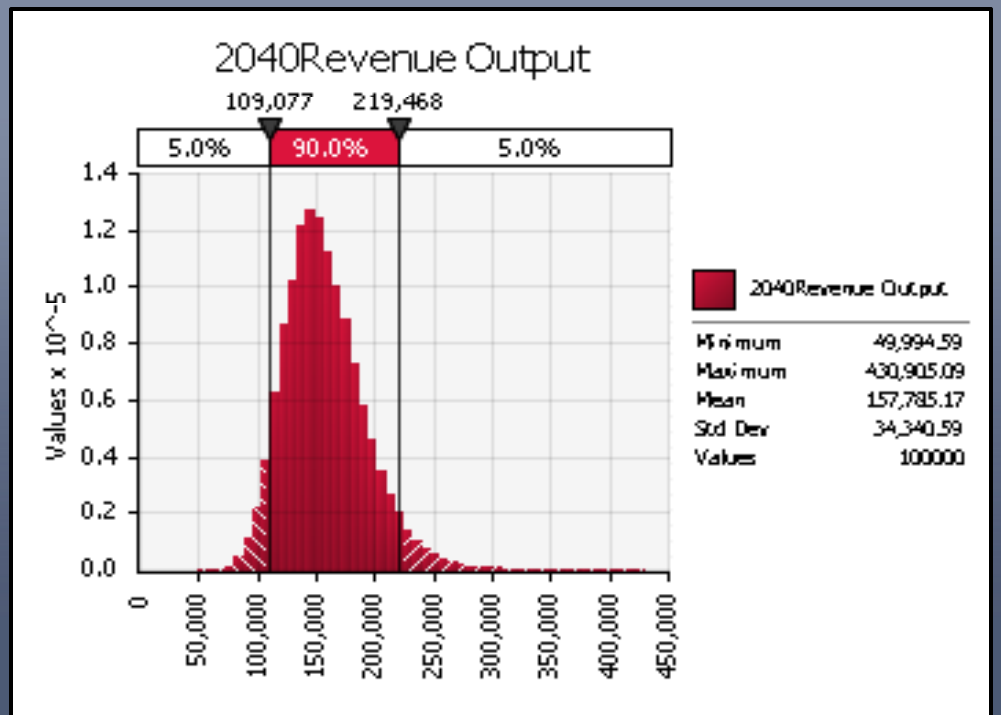
Probability Analysis Process



Application of Probability Model

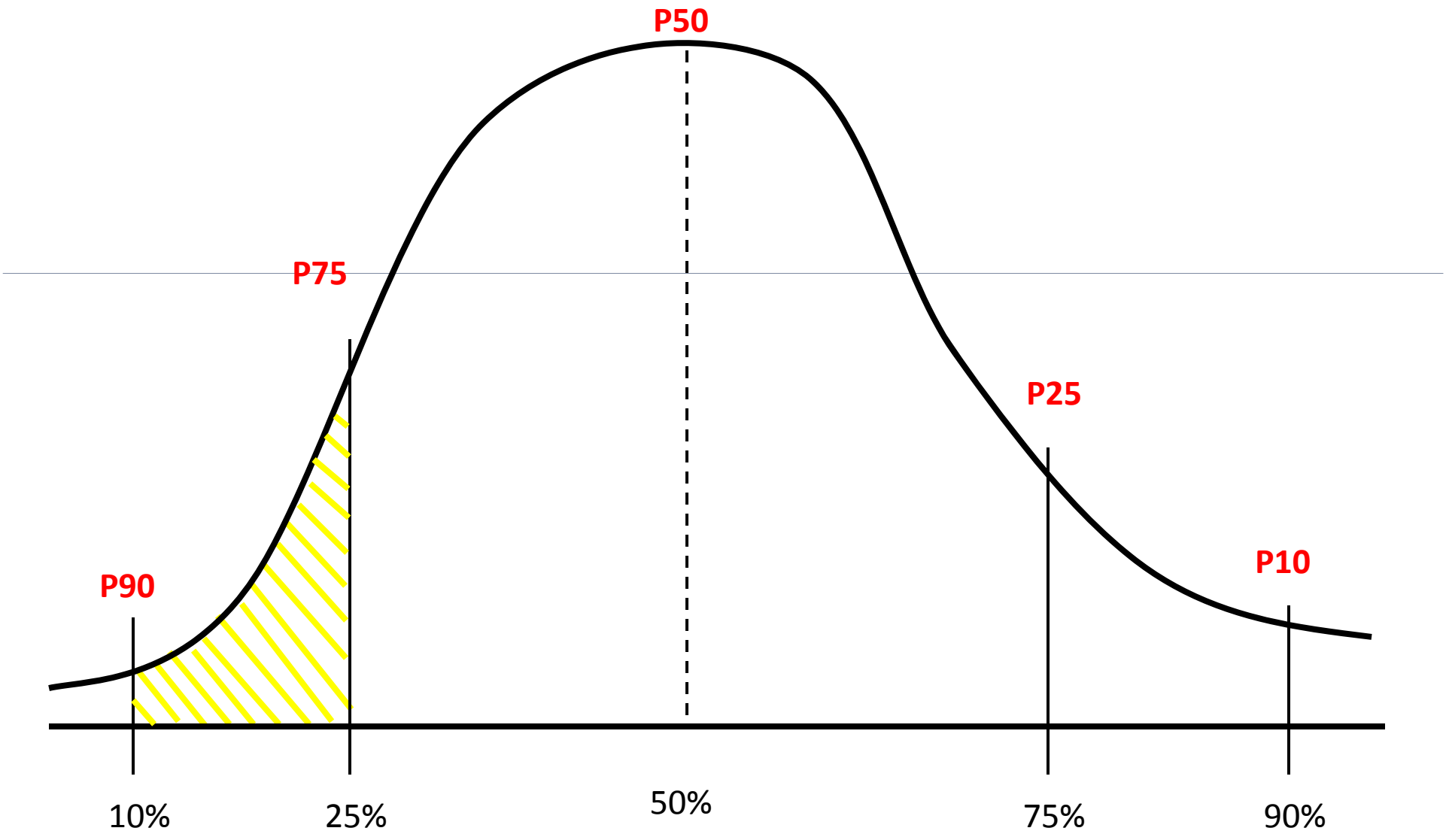
- Monte Carlo simulations used to determine distributions of traffic and revenue for each model year

Sample Output



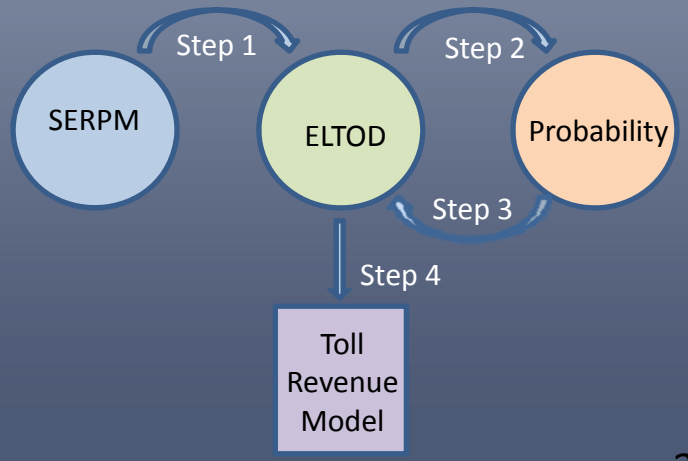
Summary Statistics for 2040Revenue Output			
Statistics		Percentile	
Minimum	-11,556	5%	134,389
Maximum	469,341	10%	153,698
Mean	224,187	15%	166,923
Std Dev	55,370	20%	177,198
Variance	3065868992	25%	186,179
Skewness	0.076657895	30%	194,430
Kurtosis	2.976380743	35%	202,082
Median	223,464	40%	209,569
Mode	228,480	45%	216,532
Left X	134,389	50%	223,464
Left P	5%	55%	230,503
Right X	316,555	60%	237,504
Right P	95%	65%	244,748
Diff X	182,167	70%	252,814
Diff P	90%	75%	261,241
#Errors	0	80%	270,675
Filter Min	Off	85%	281,918
Filter Max	Off	90%	295,618
#Filtered	0	95%	316,555

Generic Probability Distribution

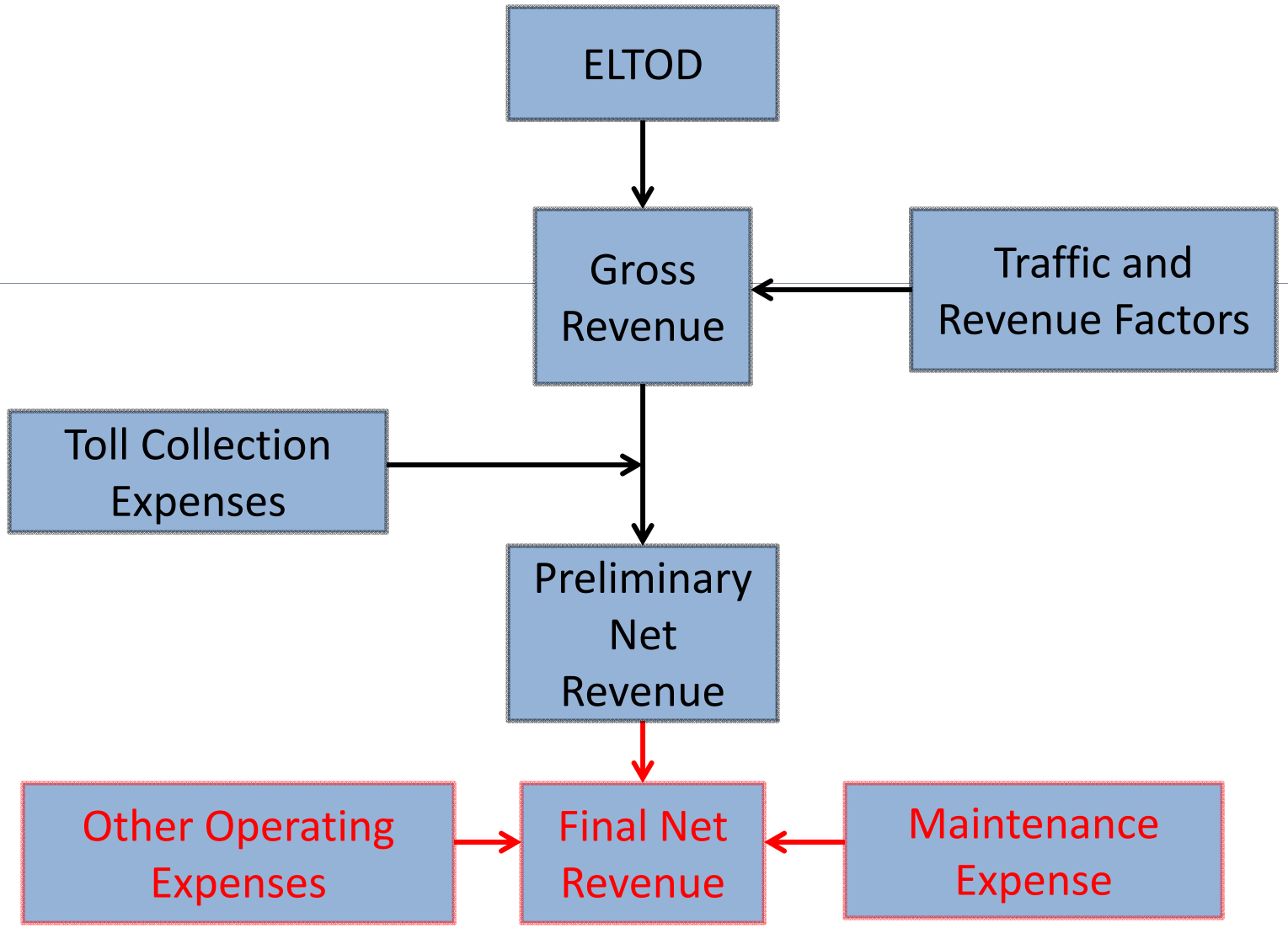


The Final Steps

- Step 3
  - Probability model supplies target revenue for P50 and P75 scenarios to ELTOD.
- Step 4
  - Final ELTOD runs to produce hourly refinement for the Toll Revenue Model



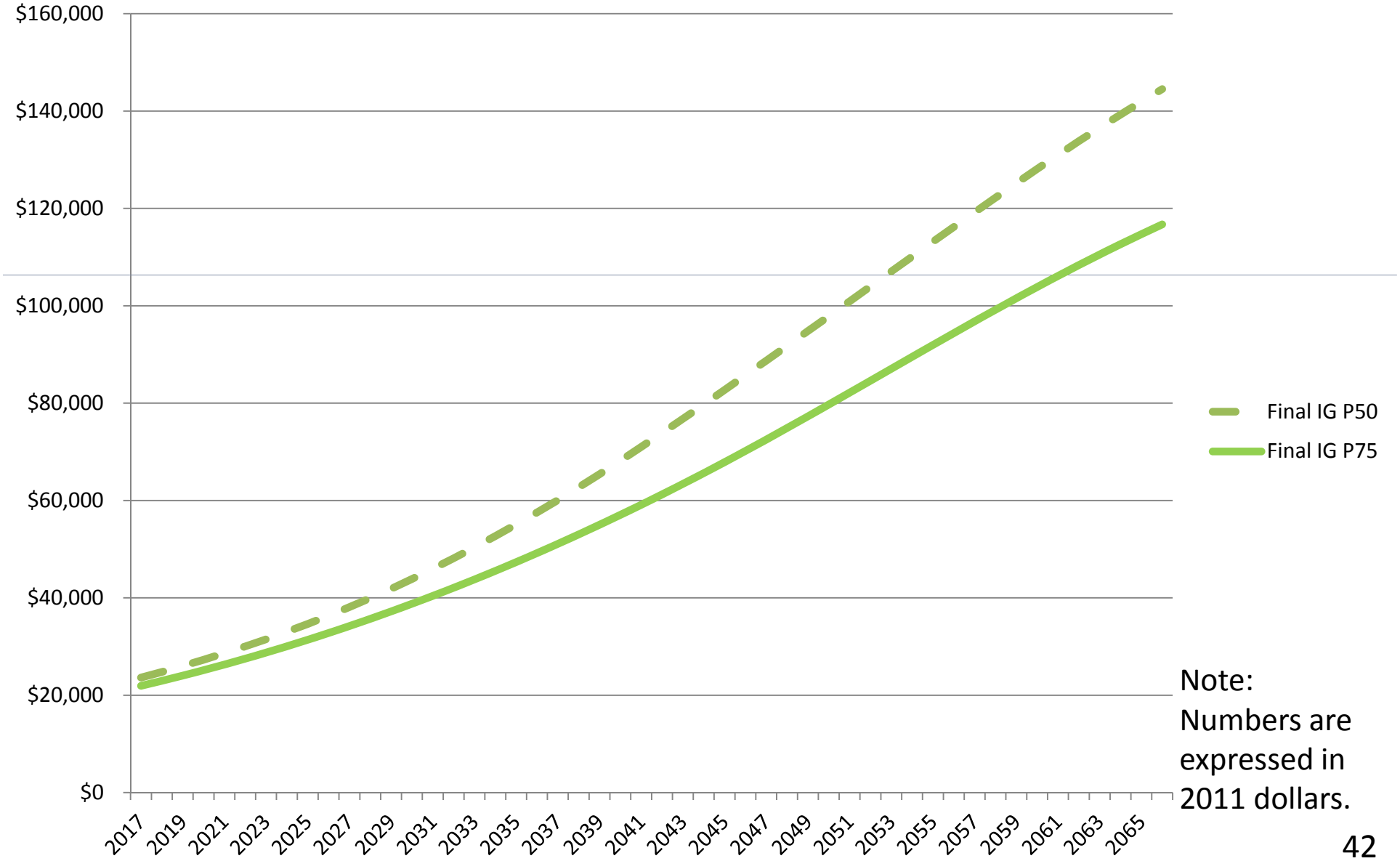
Revenue Forecasting Process



Traffic and Revenue Factors under FDOT Directive

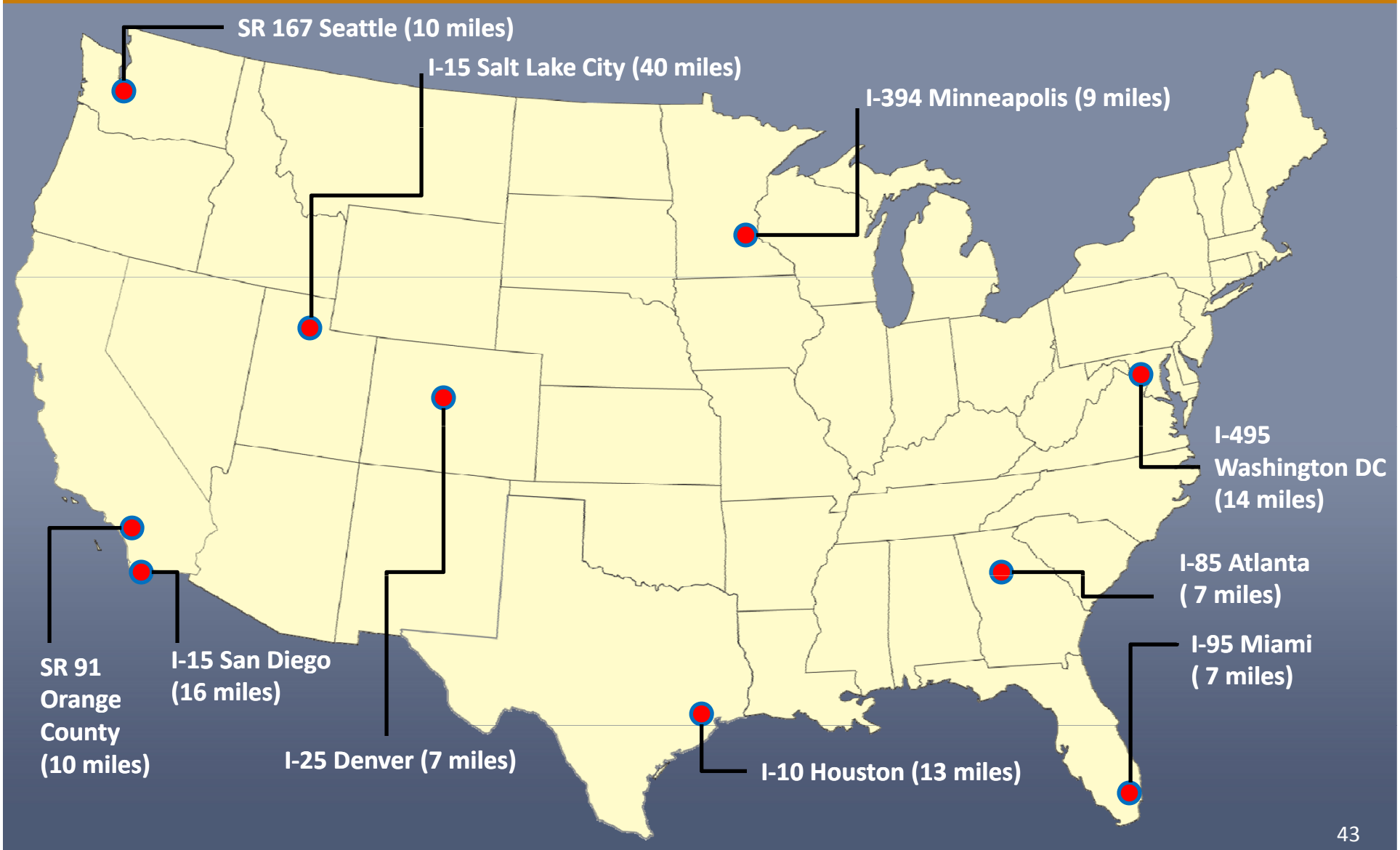
- Weekend Traffic
- Weekend Toll Rates
- Toll Evasion
- No Trucks
- No Toll-by-Plate
- Tolls Indexed annually

Annual Gross Revenue ($000)



Note: Numbers are expressed in 2011 dollars.

Managed Lanes in Operation



Managed Lanes Traffic and Revenue Stats

Facility	Length	General Use Lanes	Express Lanes	Annual Revenues (millions)	Average Daily Rate/Mile	Avg. Revenue/Lane-Mile
I-85 - GA	16	12	2	$4.0-5.0	$0.07	$160
S.R. 167 - WA	9	4	2	$0.4-0.5	$0.09	$28
I-394 - MN	11	4	2	$1.4-1.6	$0.13	$73
I-25 - CO	7	8	2	$2.0-2.5	$0.10	$179
I-10 - TX	12	10	4	$6.0-7.0	$0.04	$146
I-95 - FL	7	8	4	$15.0	$0.12	$564
S.R. 91 CA	10	8	4	$35.0-40.0	$0.30	$1,000
I-595 FL	10	8-10	3 Reversible	$5.0	$0.06	$167
I-75/SR 826 IG	25	8-10	4	$21.9	$0.24	$219

Questions & Answers