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A Tour of ELToD4 Model

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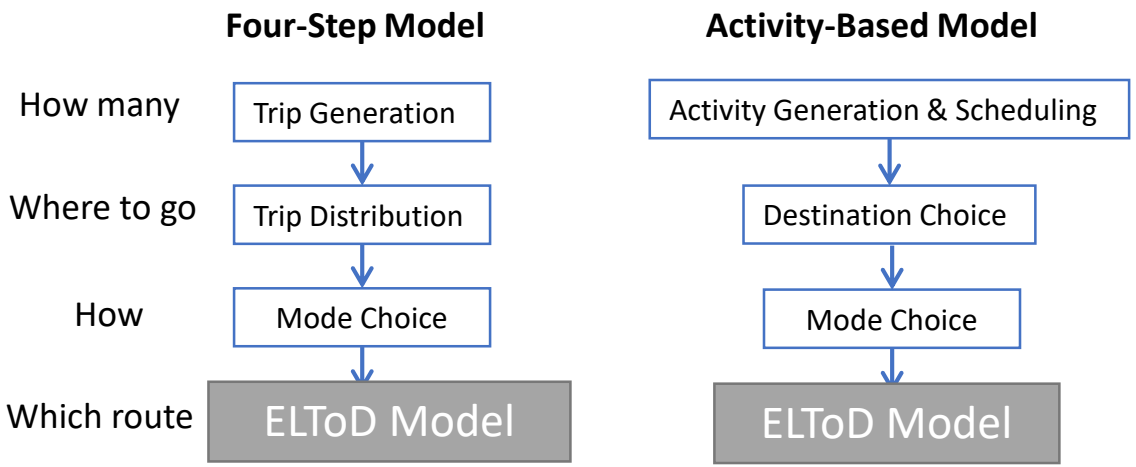
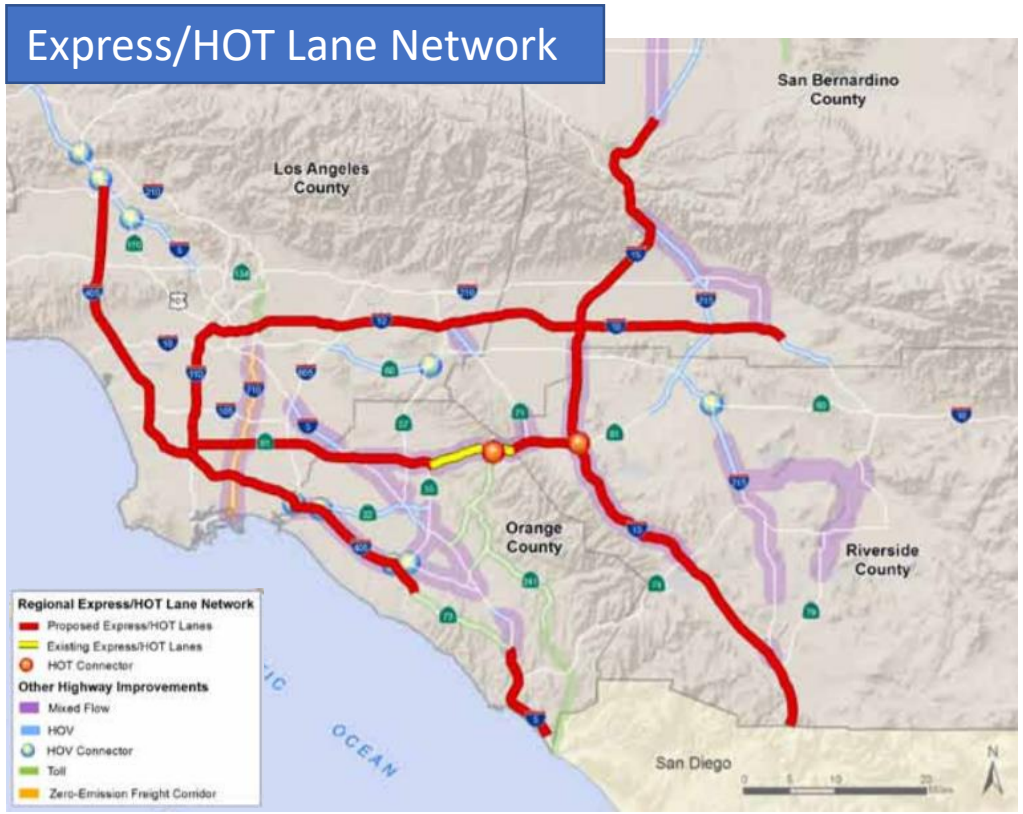
What is ELToD4?

- ELToD4 stands for Express Lanes Time of Day Model version 4
- It is a Dynamic Traffic Assignment (DTA) model to forecast traffic and revenue for complex express lane networks in large metropolitan area





Source: SCAG 2012-2035 RTP

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Development Timeline

Developed by: AECOM and RSG the science of insight for FLORIDA'S TURNPIKE

	ELToD1			ELToD2	ELToD3				ELToD4		
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Software	Excel			Cube	VB.net				C++		
Type	Static			Static	DTA				DTA		
Area	Corridor			Corridor	Subarea				Regional		
Resolution	Hourly			Hourly	15-min				15-min		

In collaboration with:

CITILABS, WSP | PARSONS BRINCKERHOFF, THE CORRADINO GROUP, HNTB, CDM Smith, bcc engineering

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Benefits of Using ELToD4 Model

Consistency in methodology and results

- Consultants
- Projects
- Over time

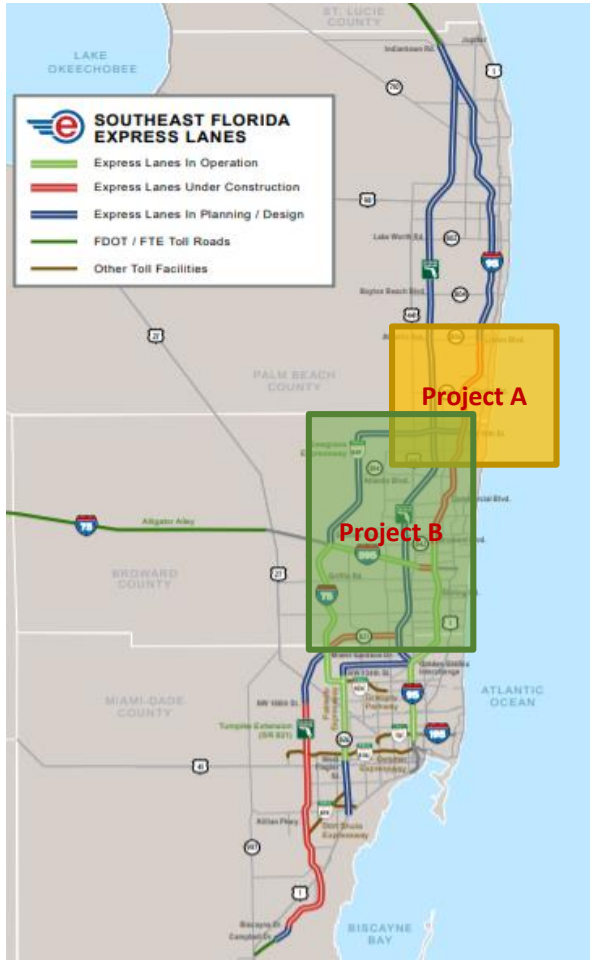
Savings in project time and budget

Easy quality control

Practice-ready for project needs

Open Source

Continuous support and improvement



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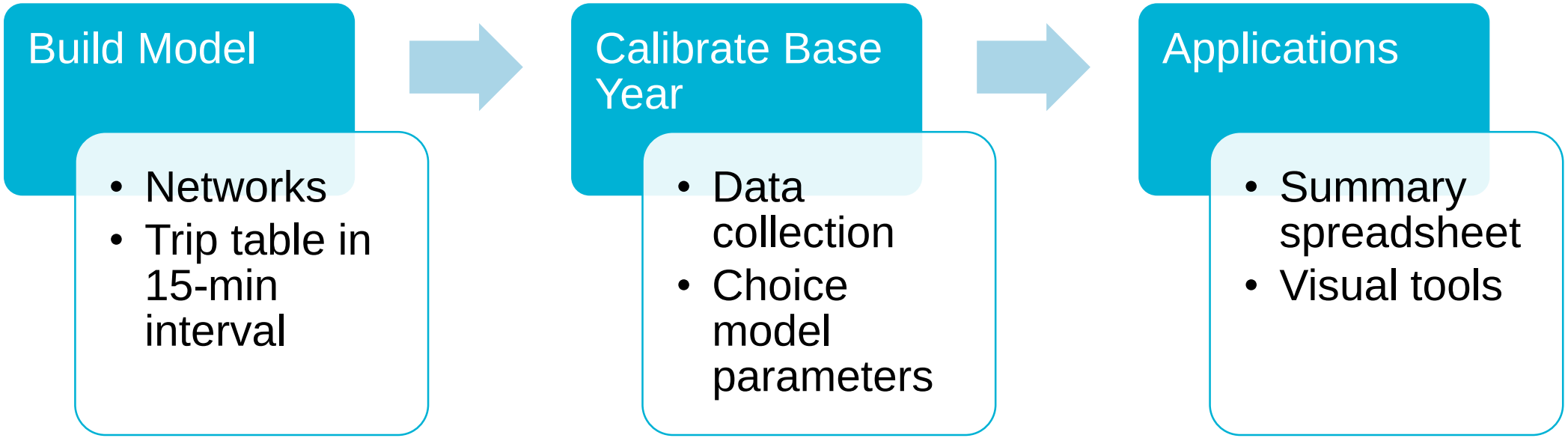
Model Transferability

- ELToD4 is flexible and customizable to work with any existing regional models
  - Traditional four-step or ABM
  - Cube or TransCAD



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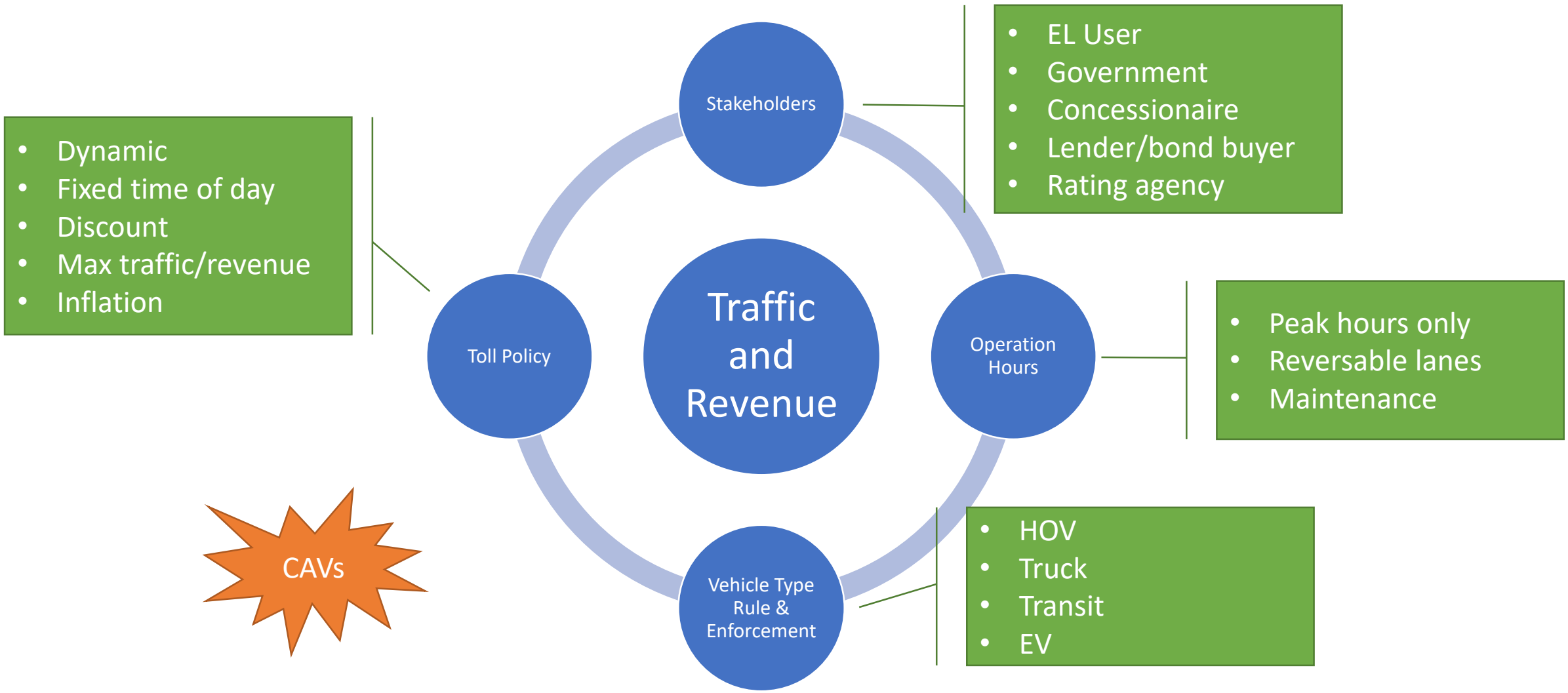
Express Lanes Model Considerations



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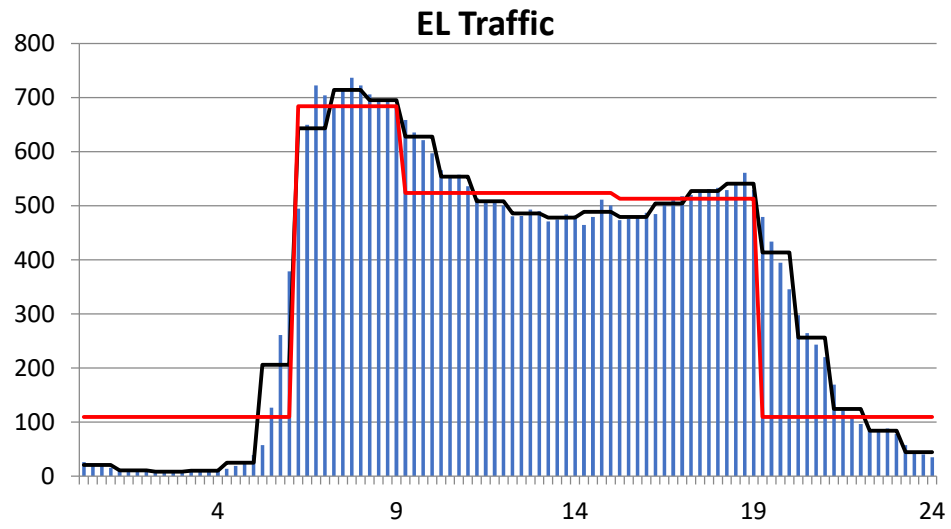
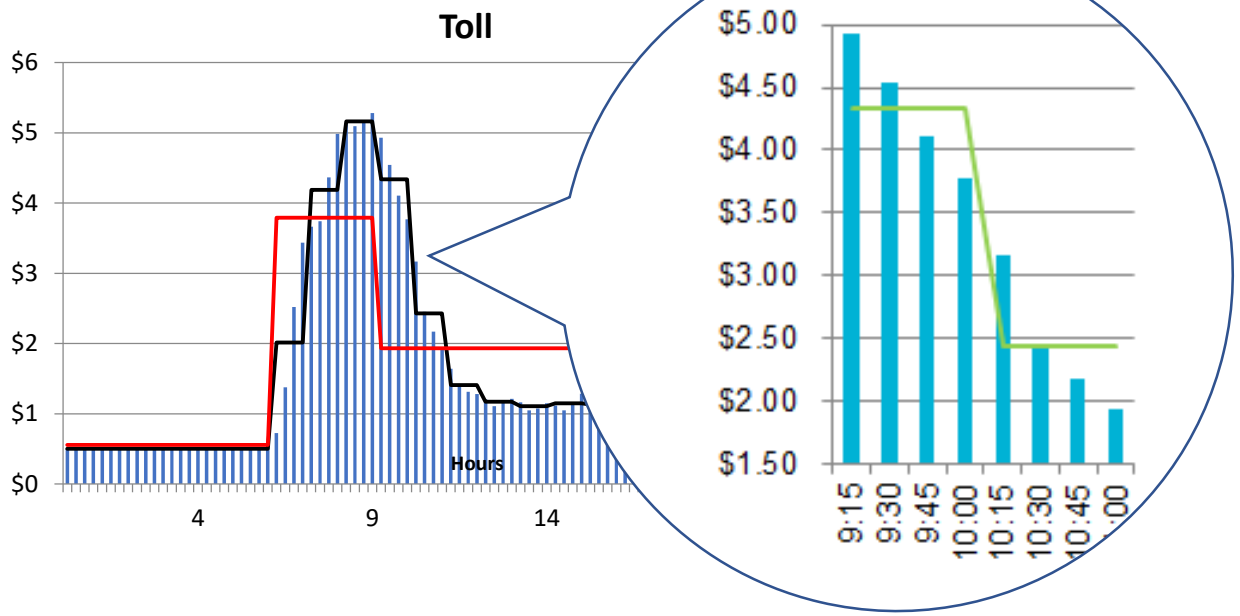
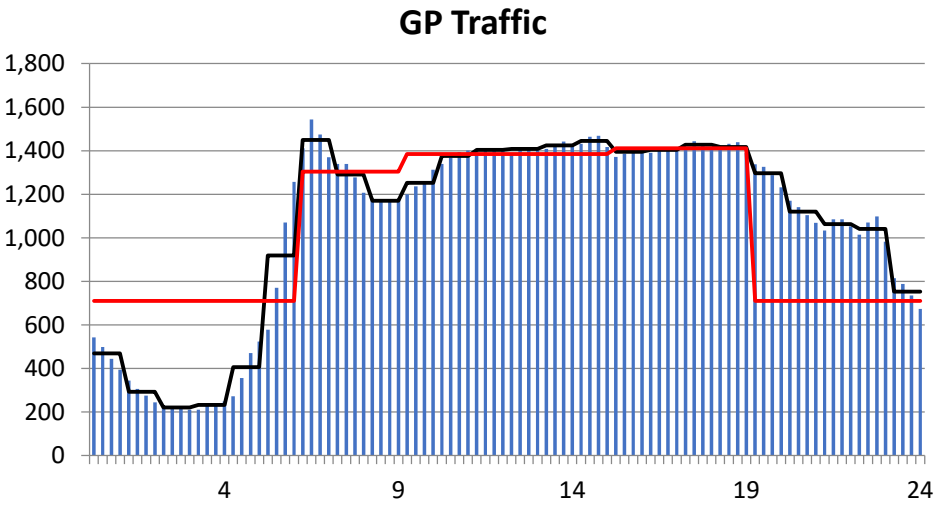
Observed Traffic and Toll Rate







Model Type	Resolution
Time of Day	4 Time Periods
ELToD2	Hourly
ELToD4	15 minutes

Source: Florida I-95 Phase 1 southbound 2017 average weekday

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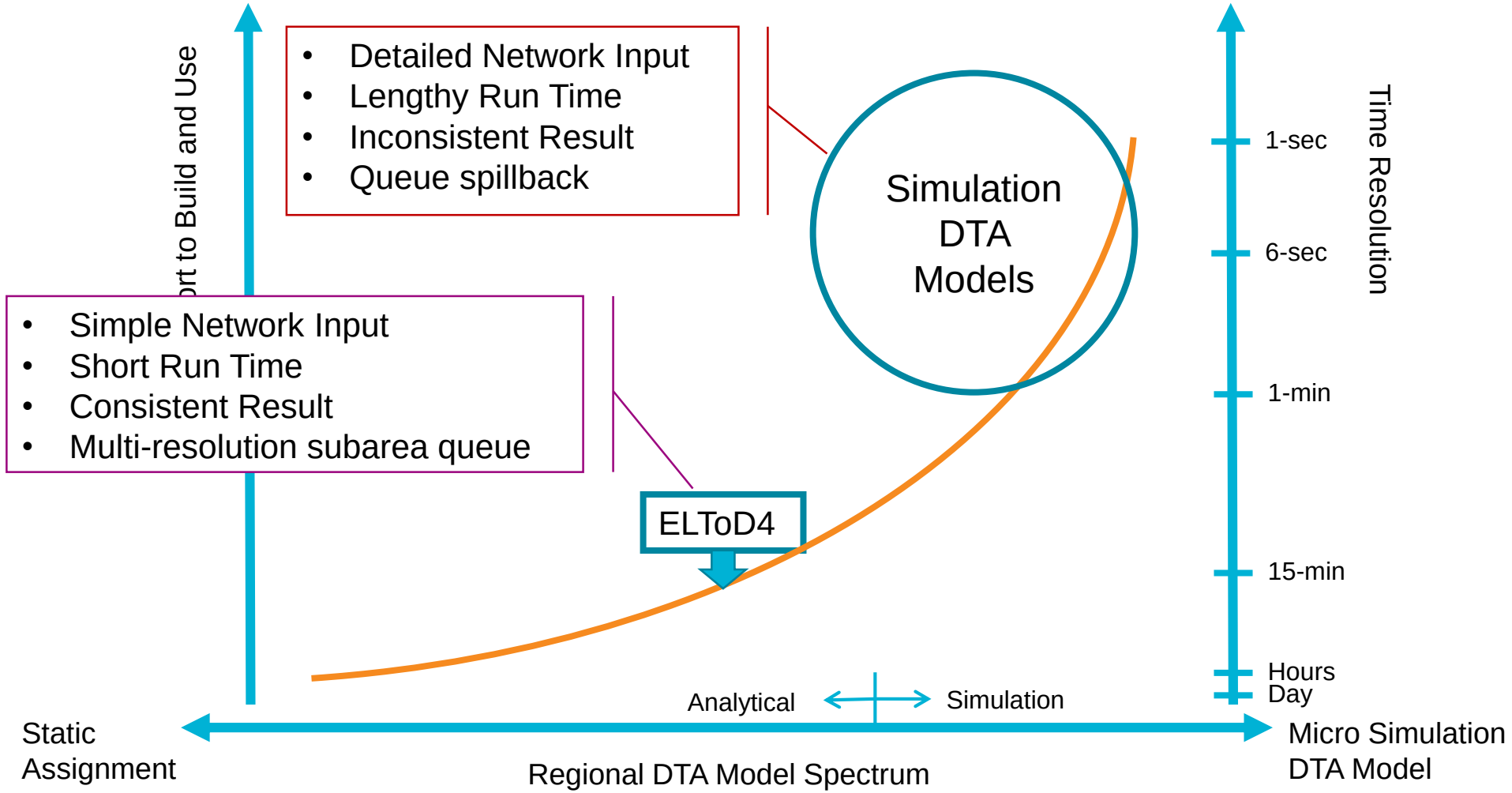
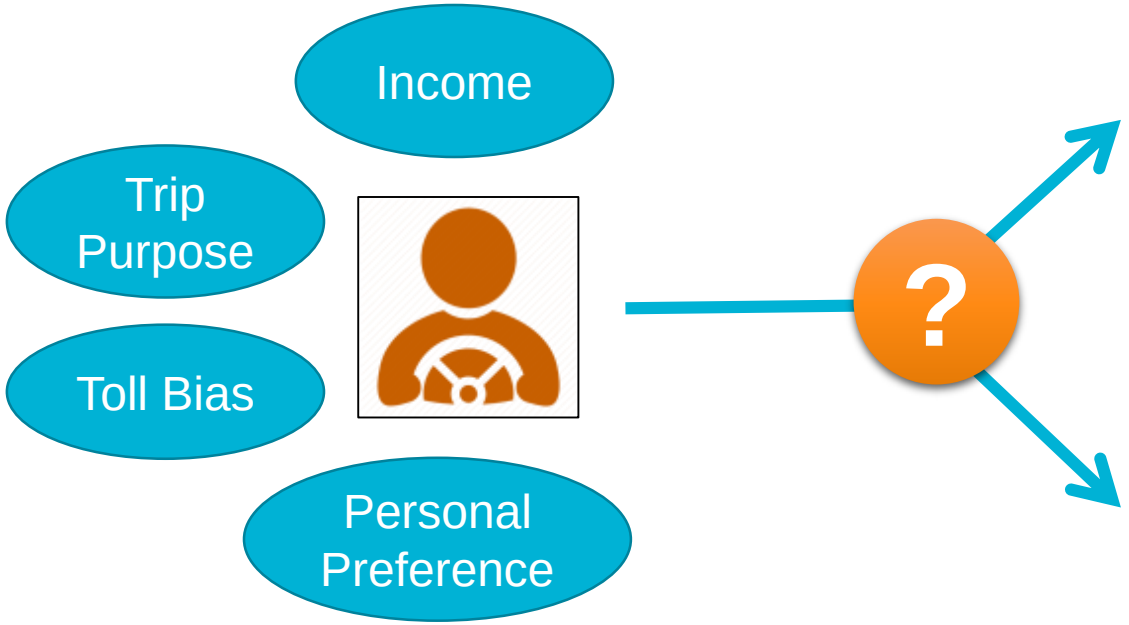
Time and Effort Requirement



Express Lanes Choice

- Willingness to pay is measured by Value of Time (VOT) and Value of Reliability (VOR)
- VOT and VOR vary by person and trip



Free General Use Lane

Cost	Benefit
• Toll	• Time Savings • More Reliable • Less weaving • No Heavy Trucks

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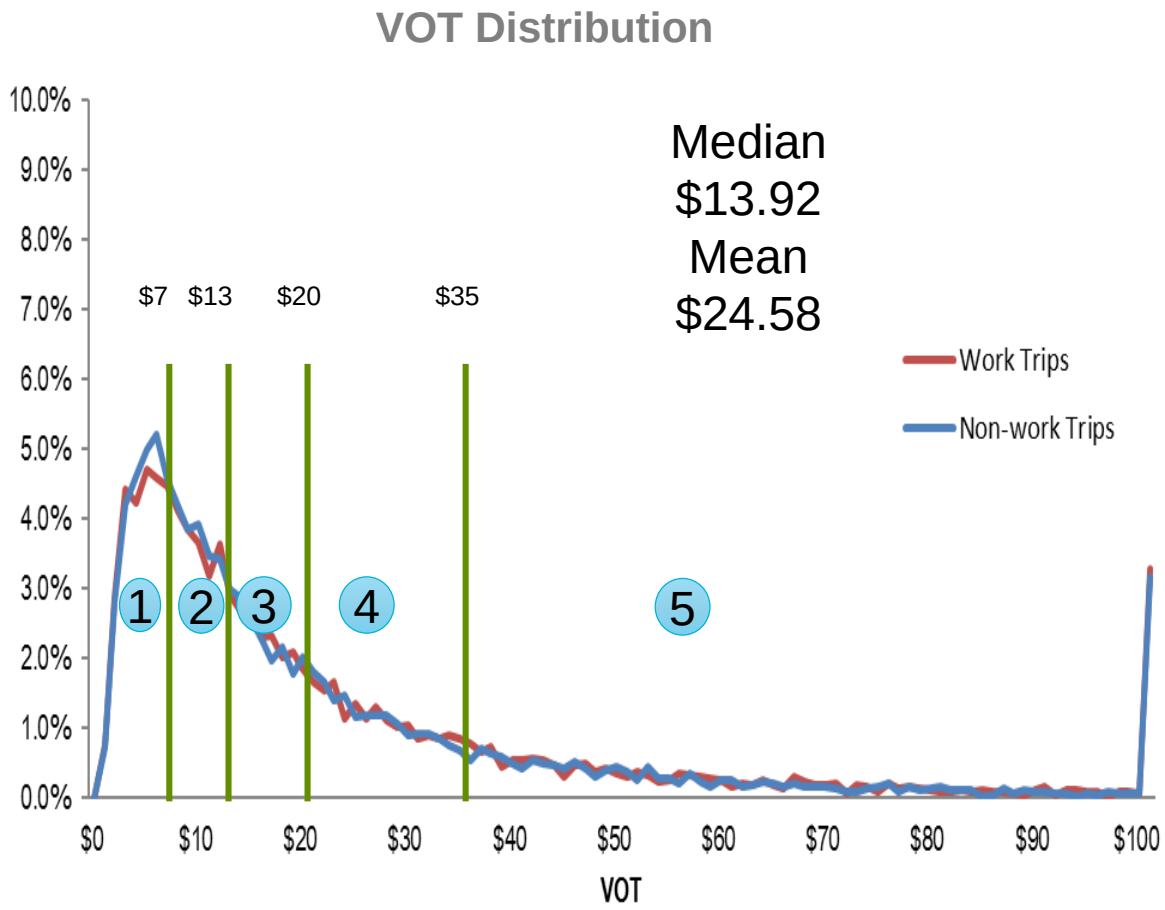
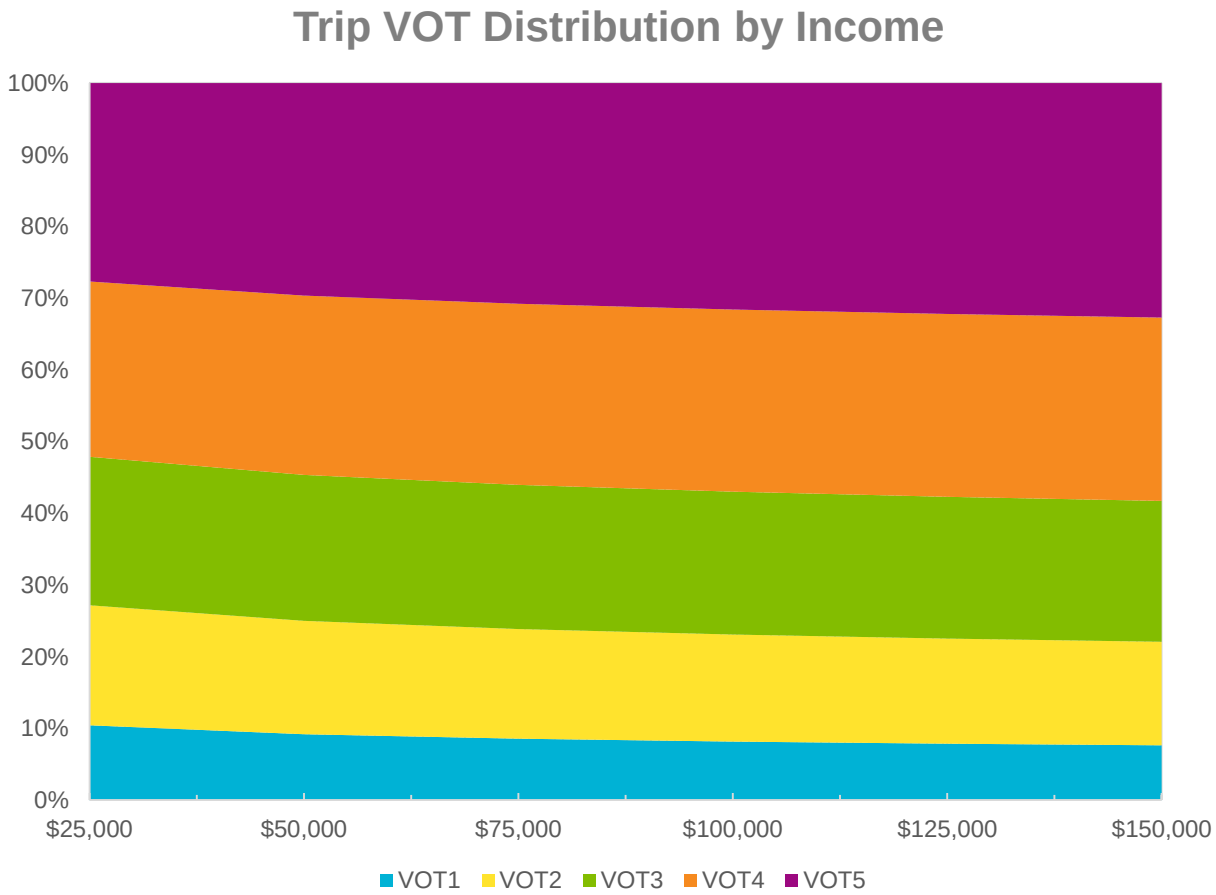
Distributed Value of Time (VOT)





Work Trip

Value of Reliability

- Value of Reliability (VOR) is the willingness to spend money to reduce the standard deviation of travel time

$$Reliability\ Ratio = \frac{\text{VOR}}{\text{VOT}}$$

- Reliability values range from 0.5 to 2.5 in the SHRP2 Reliability Report

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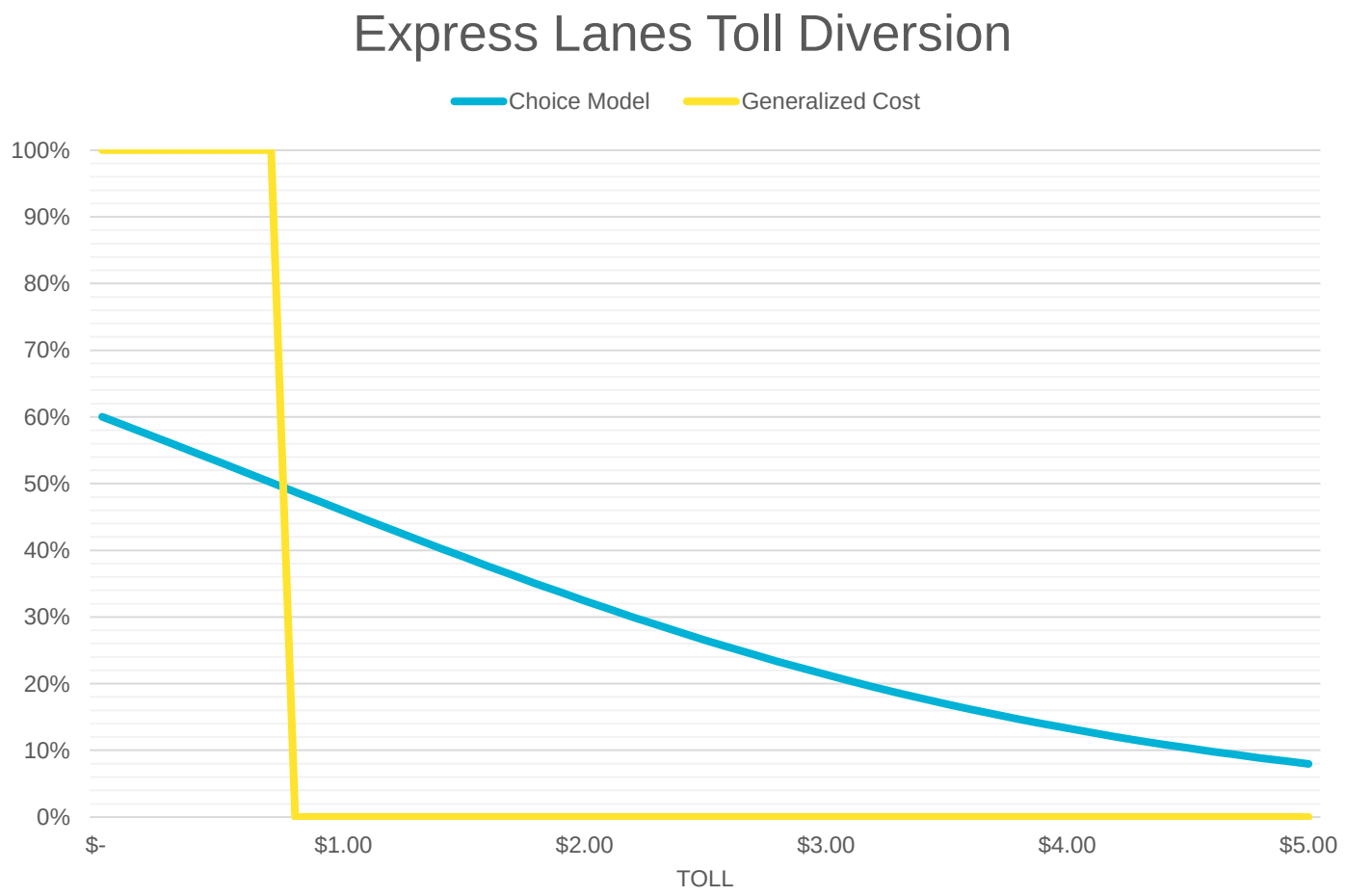
Binary Toll Choice Model

$$P_{EL} = \frac{1}{1+e^{(Utility)}}$$

- Predict the probability of choosing two choices
- Produce “smooth” instead of “abrupt” responses to toll changes



Mixed Multinomial Logit Toll Choice Model

Toll Share = $\frac{1}{1+e^{(Utility)}}$

where

$$Utility = -1 * (\beta\_Constant + \beta\_Time * Time + \beta\_Toll * Toll + \beta\_Reliability * Reliability)$$

$$Reliability = \gamma_r \times \left(Time_{Congested} - Time_{FreeFlow}\right) \times (Distance)^{-\eta_r}$$

$$VOT = \frac{60 * \beta\_Time}{\beta\_Toll}$$

$$VOR = \frac{60 * \beta\_Reliability}{\beta\_Toll}$$

*Reliability formula is base on TRB SHRP2 Report S2-L04-RR-1, Incorporating Reliability Measures into Operation and Planning Model Tools, 2014, page 37

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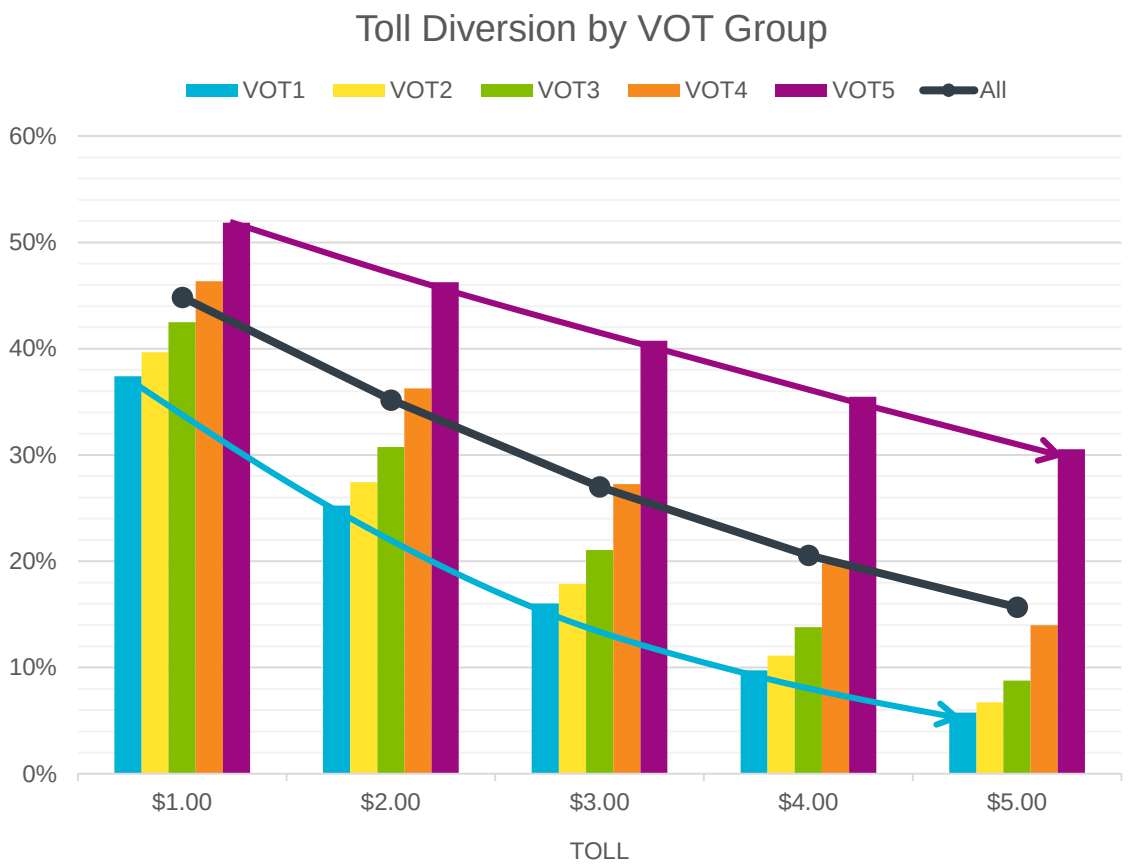
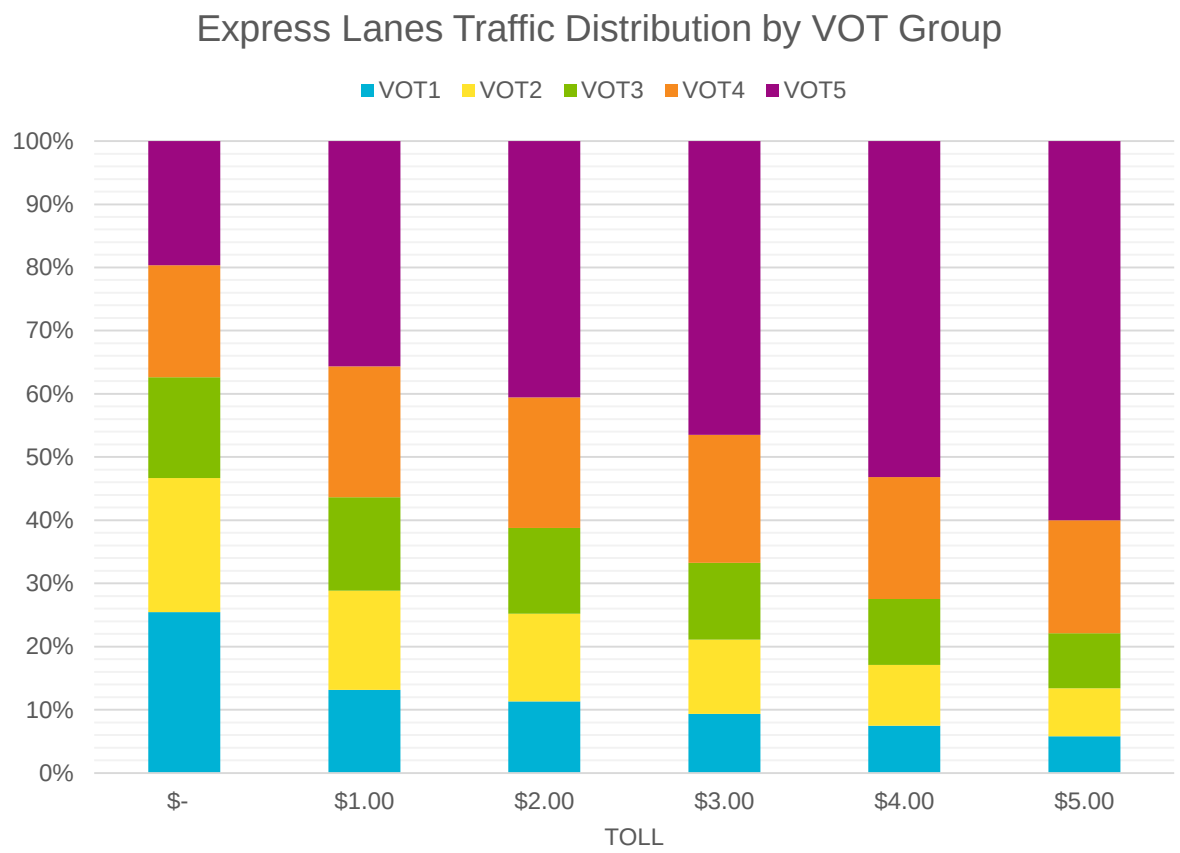
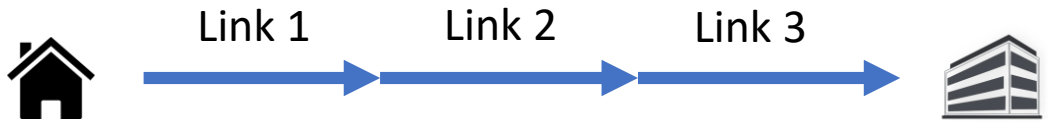
Choice Model Toll Sensitivity





Time savings = 1 minute; Distance = 4 miles; Income = $85,000

Time Dependent Shortest Path (TDSP)



Time Interval	Link 1	Link 2	Link 3	
7:00	10	11	10	
7:15	12	16	12	=33 min
7:30	14	15	20	=48 min
Average	12	14	14	=40 min

- Static Shortest Path uses average link travel time of a time period (several hours)
- TDSP uses the travel time when the vehicle is going through the link

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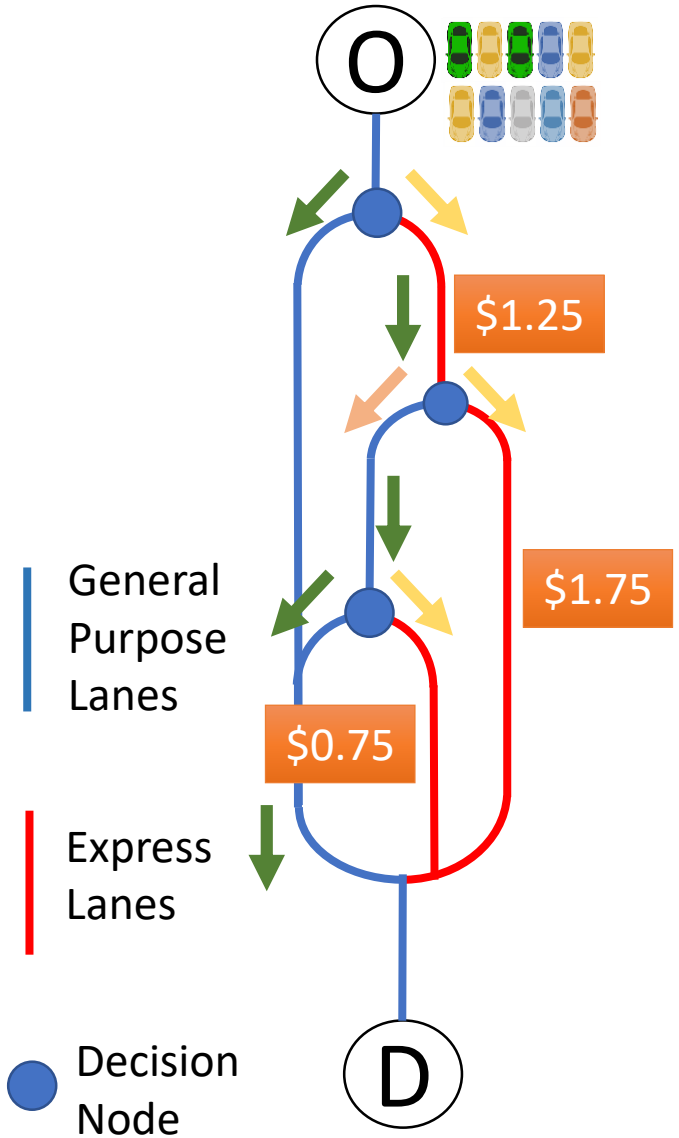
En-route Toll Choice Making

To simulate driver's behavior:

- Other models assign all trips to one shortest time path
  - Toll converted to time penalty
- ELToD4 splits the trips at each decision node using an en-route toll choice model
  - Reflect heterogeneity in the population
  - Drivers only know the toll when they are at the entrances and exits



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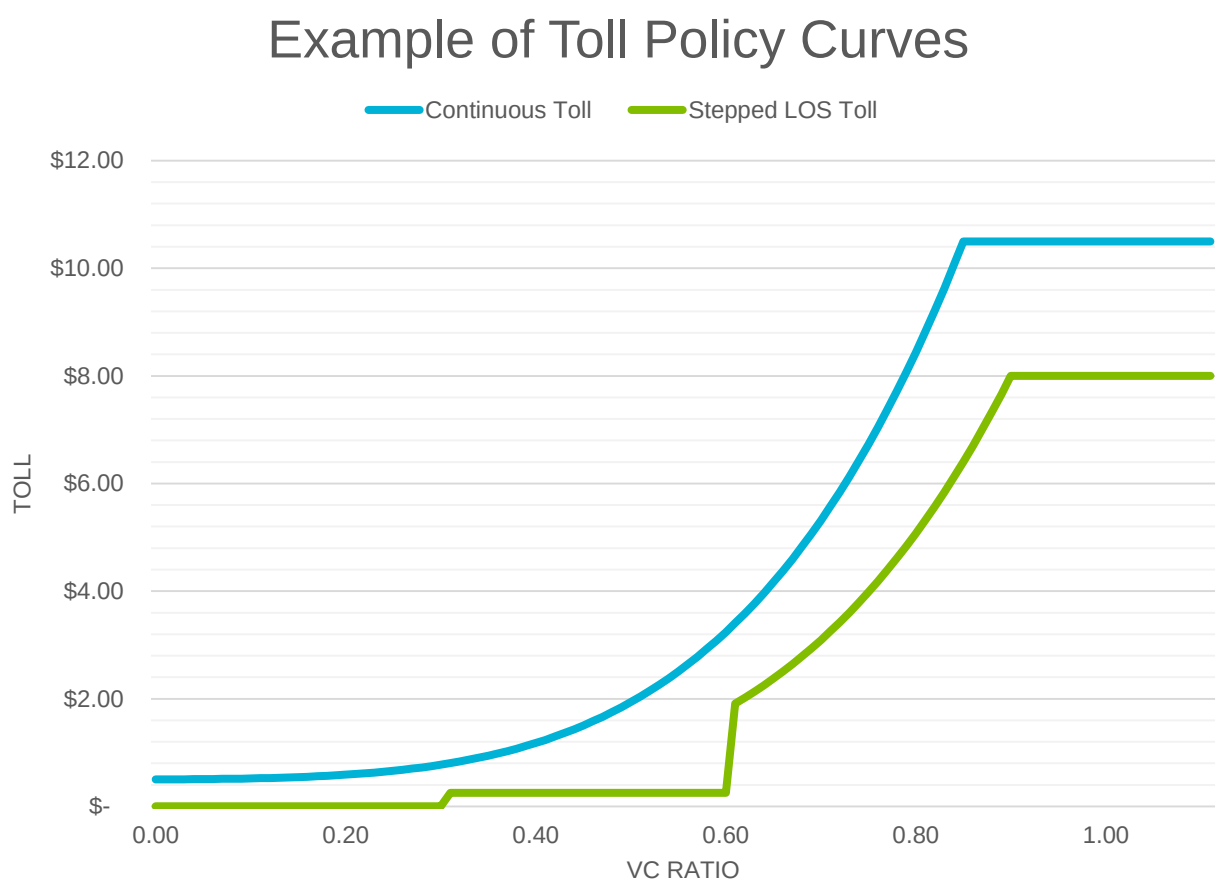
Toll Policy Curves

$$Toll = Min + (Max - Min) \times (VC\ Ratio - Offset)^{Exp}$$



- Adjust toll rate based on V/C Ratio at 15 minutes interval
- Flexible to be applied by facilities and time of day
- A toll policy example: Dynamic toll during peak hours and static toll rates during off-peak hours

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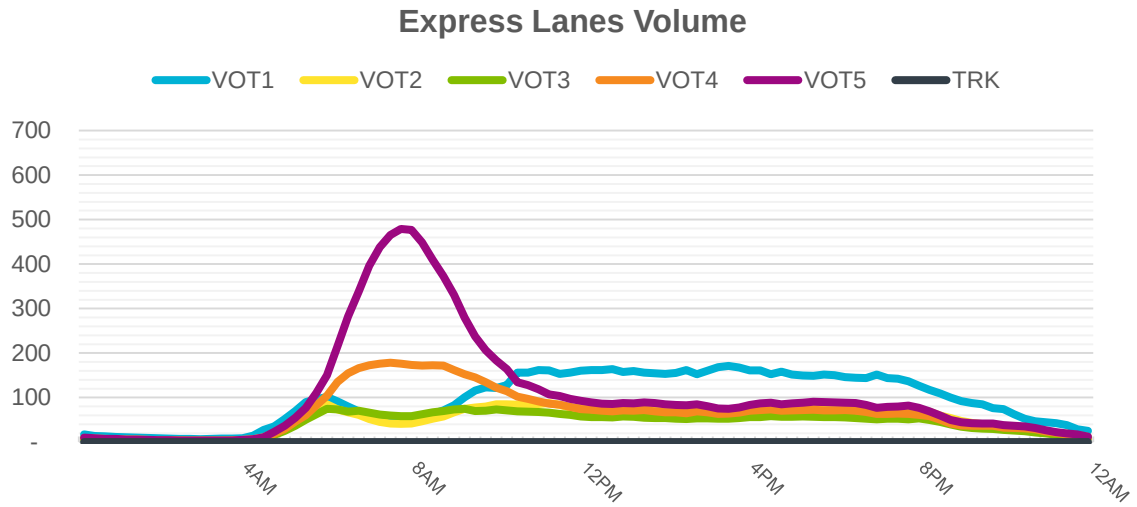
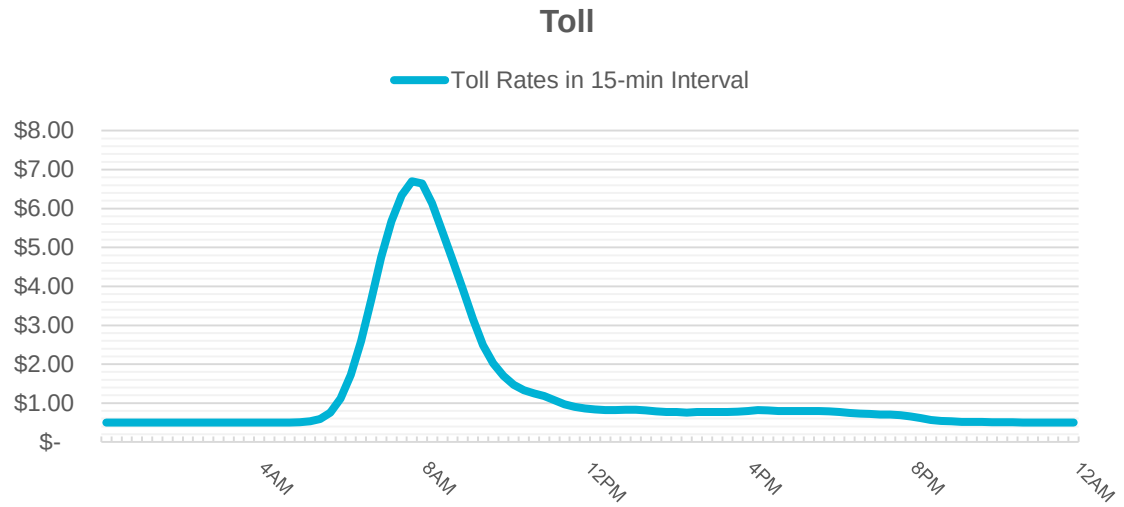
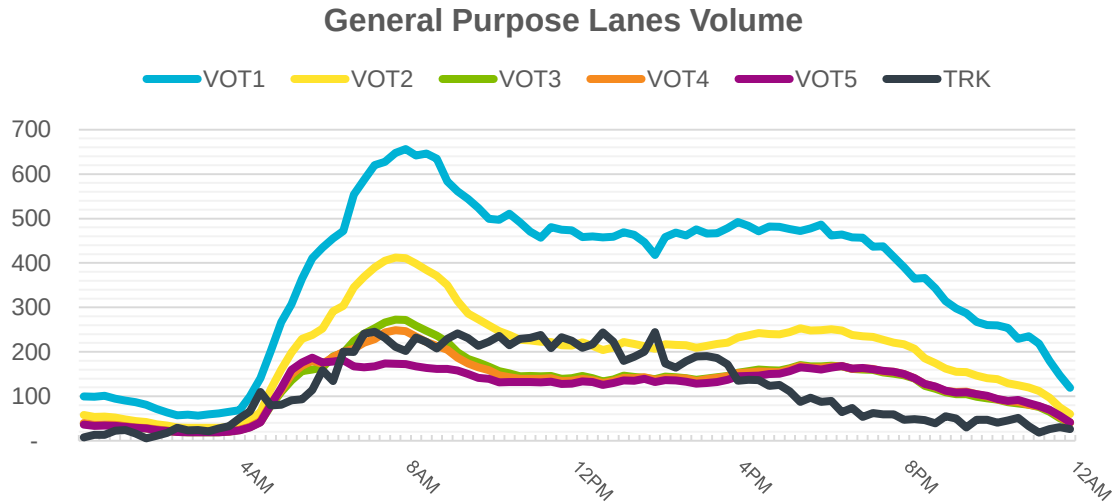
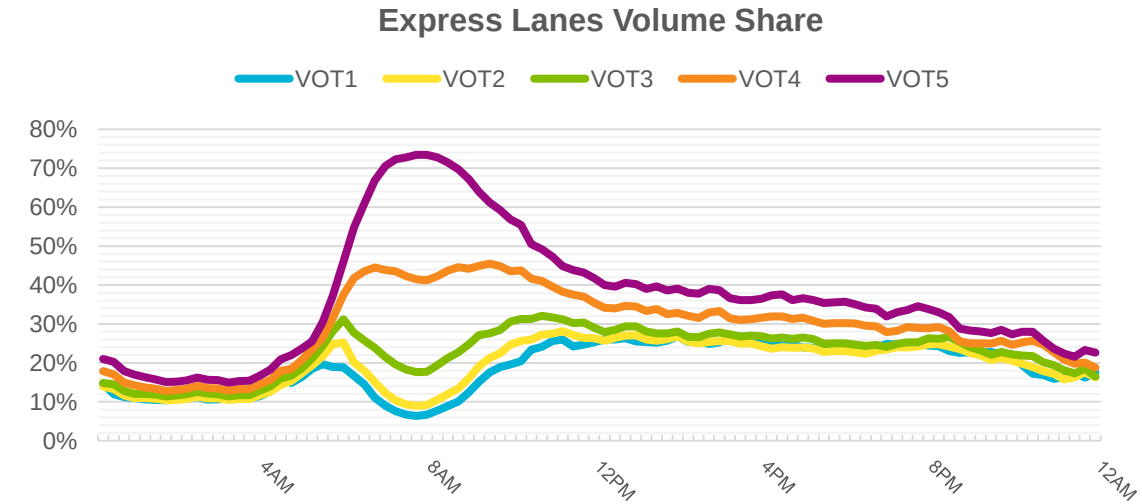
Model Result Example





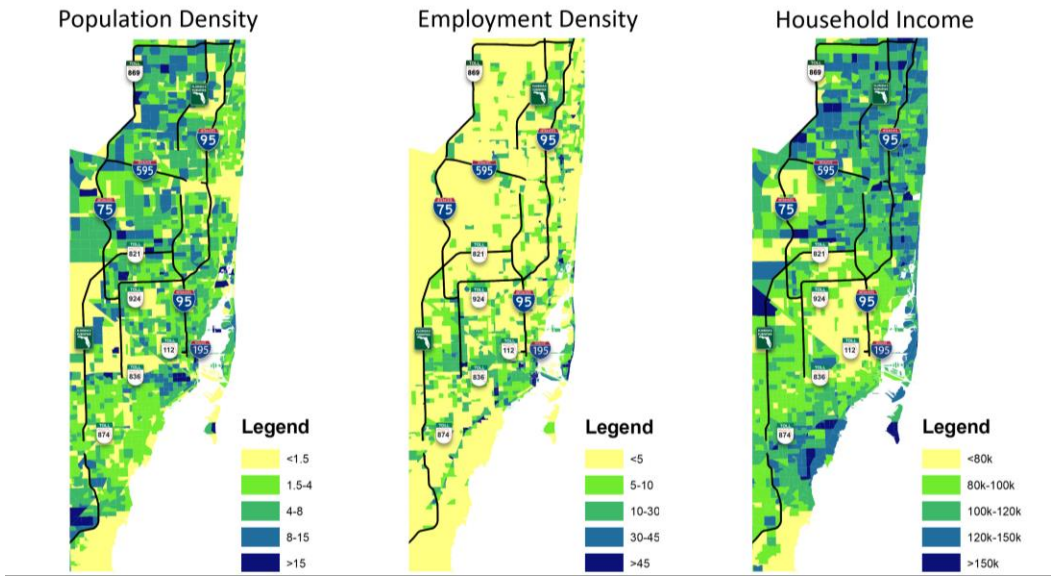




Florida I-95 express lanes segment 1 Southbound

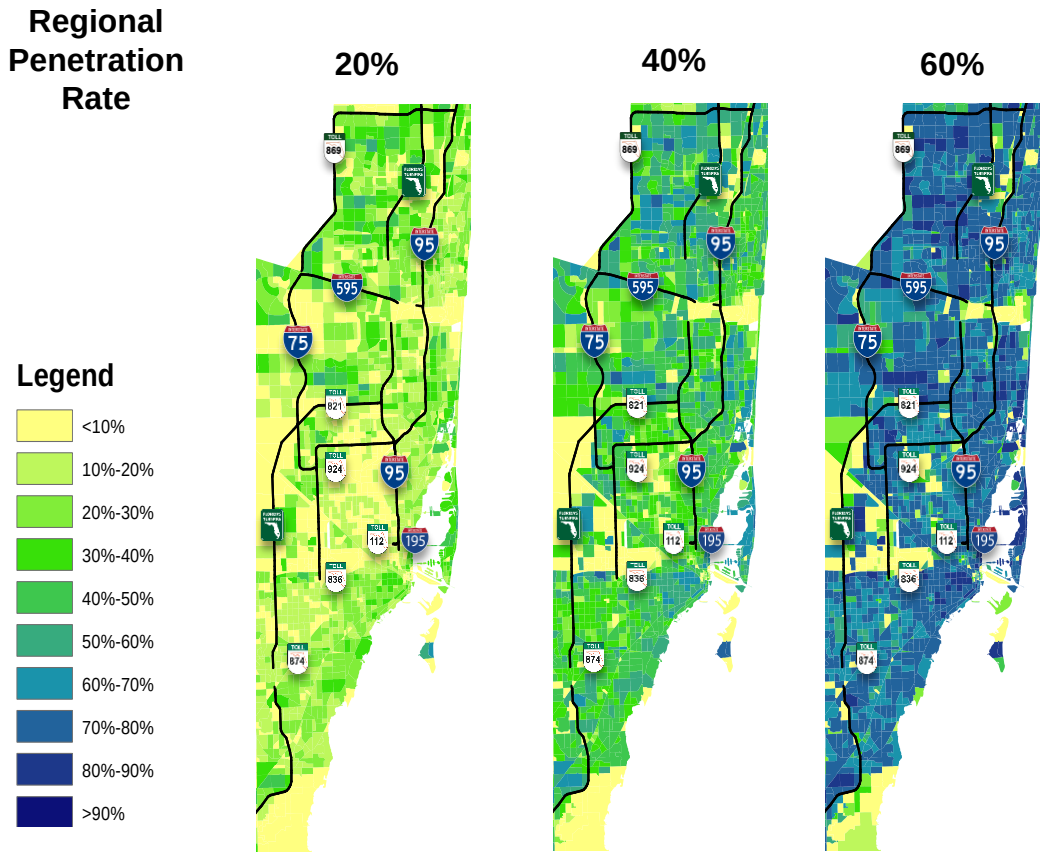
Connected and Autonomous Vehicle (CAV) Module

Socioeconomics Input

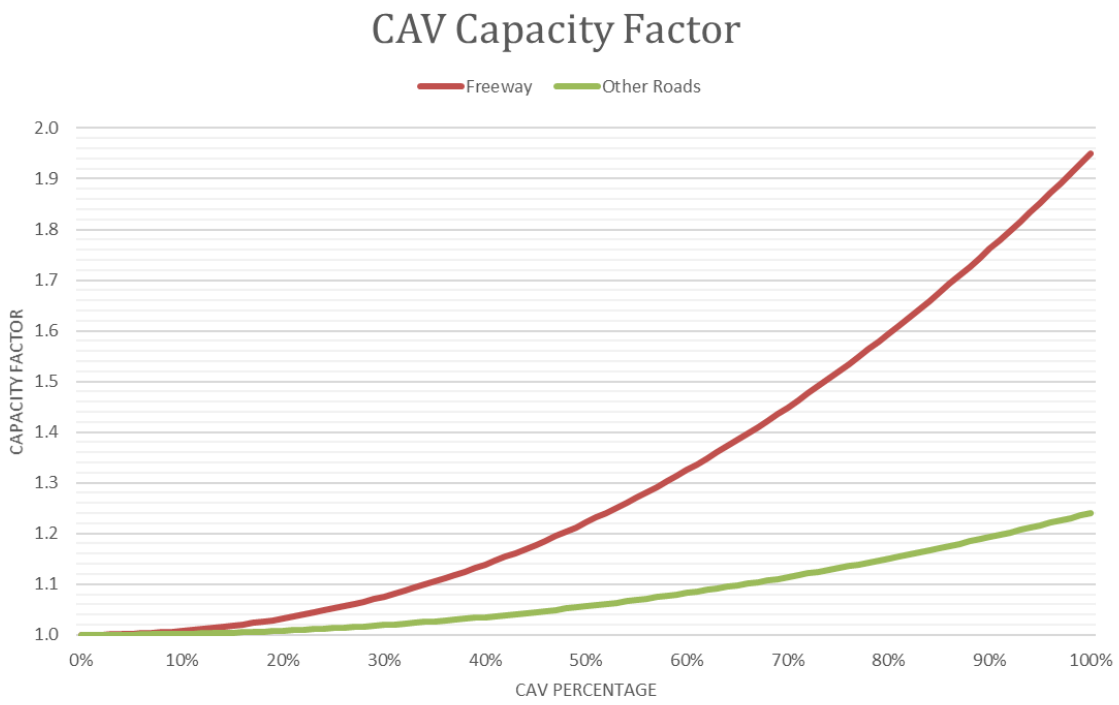


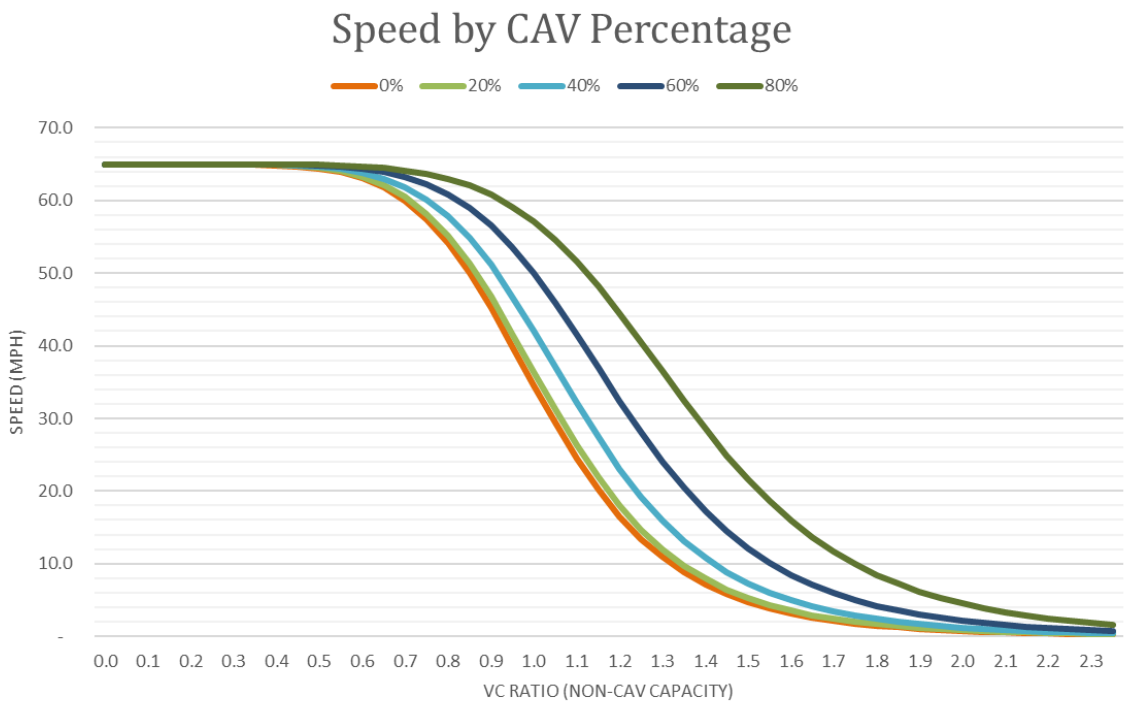
– High income family and urban areas will adopt CAVs first

Adoption Rate Variation by TAZ



Capacity with CAVs





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Example: CAV Model Outputs

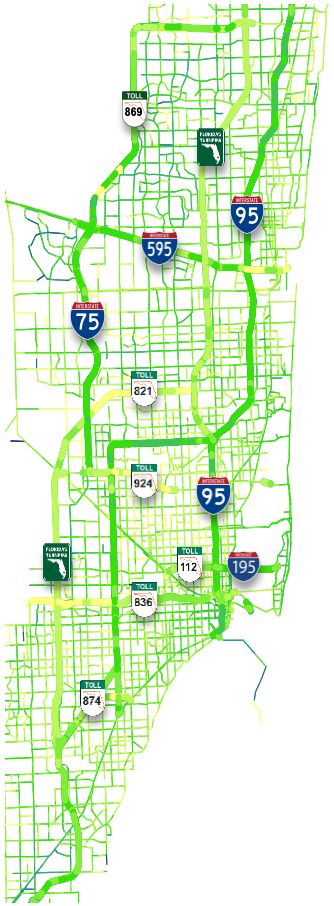
Penetration Rate

< 10%

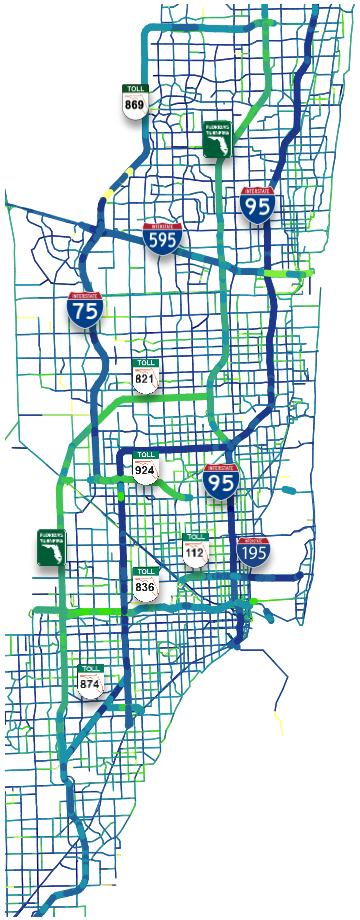
50%

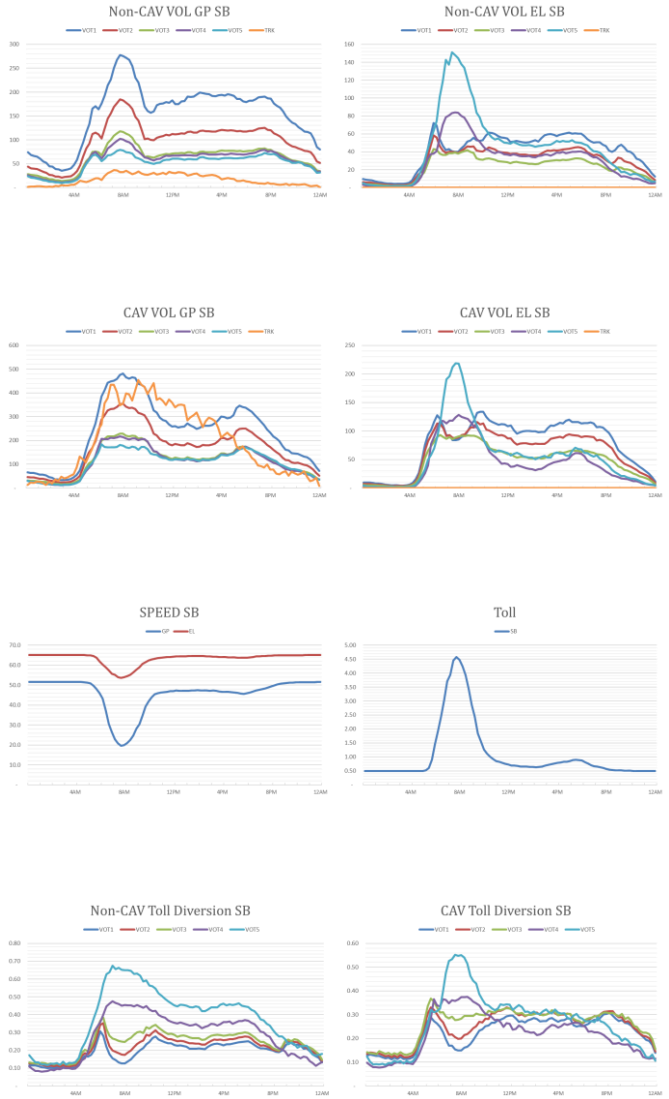
> 90%

Regional Penetration Rate 20%



Regional Penetration Rate 60%





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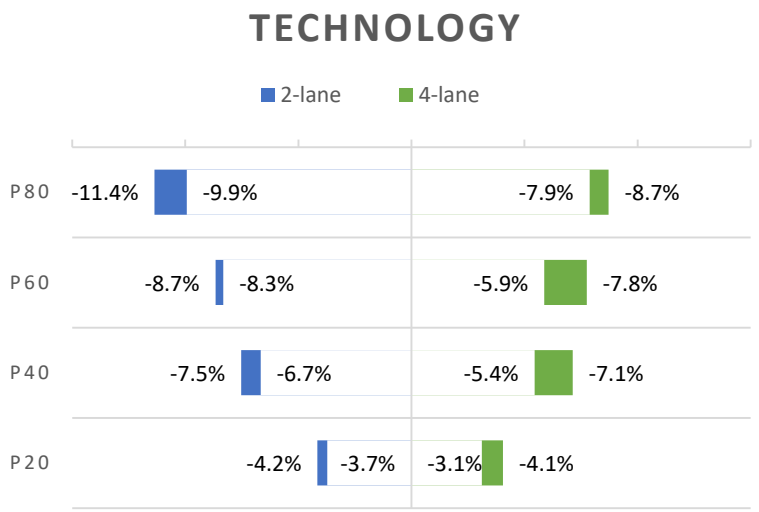
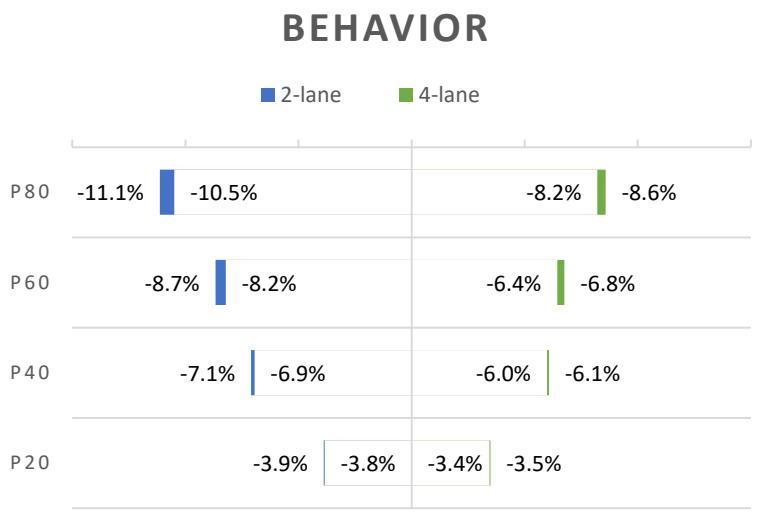
Example: CAV Impact Analysis

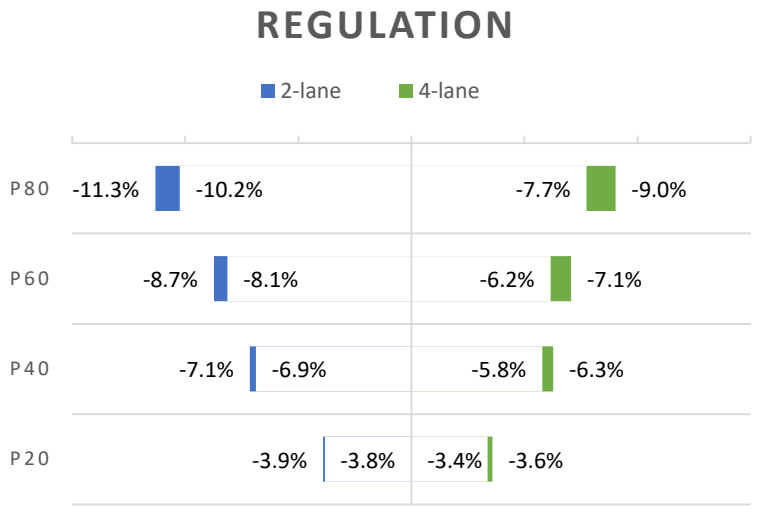
Question: What is the CAV impact to transactions comparing 2-lane and 4-lane express lanes network in 2045?

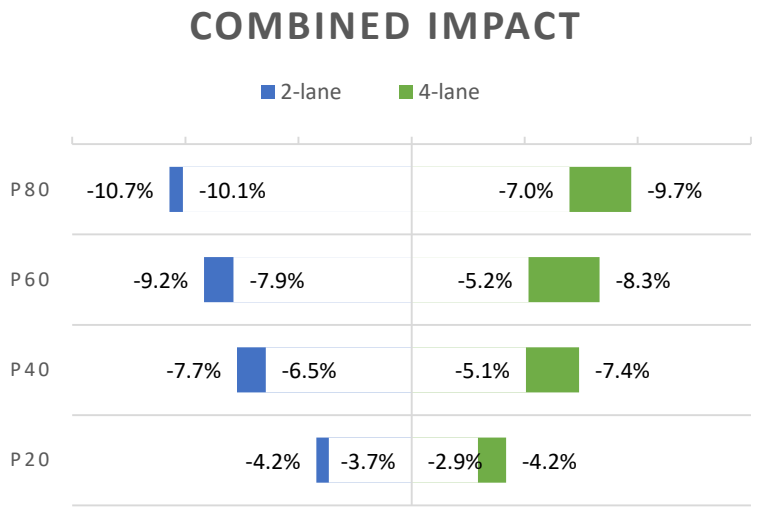
Variables Tested:

- Technology
  CAV headway reduction
- Regulation
  CAV preference on limited access road
- Driver behavior
  CAV has lower value of time









P##: Assumed CAV regional penetration rate

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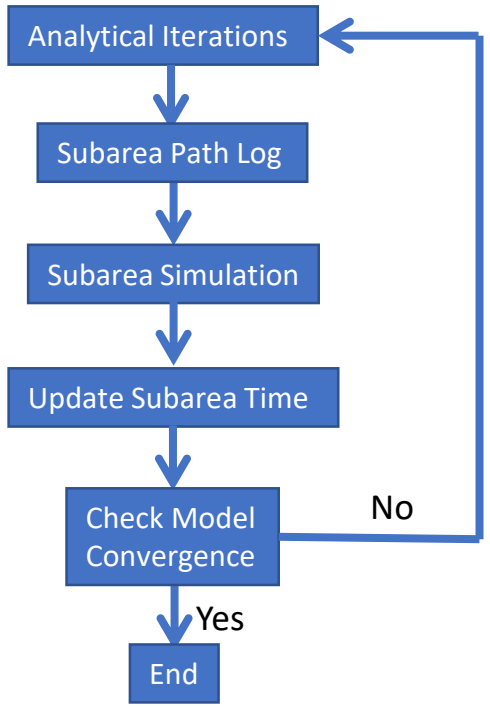
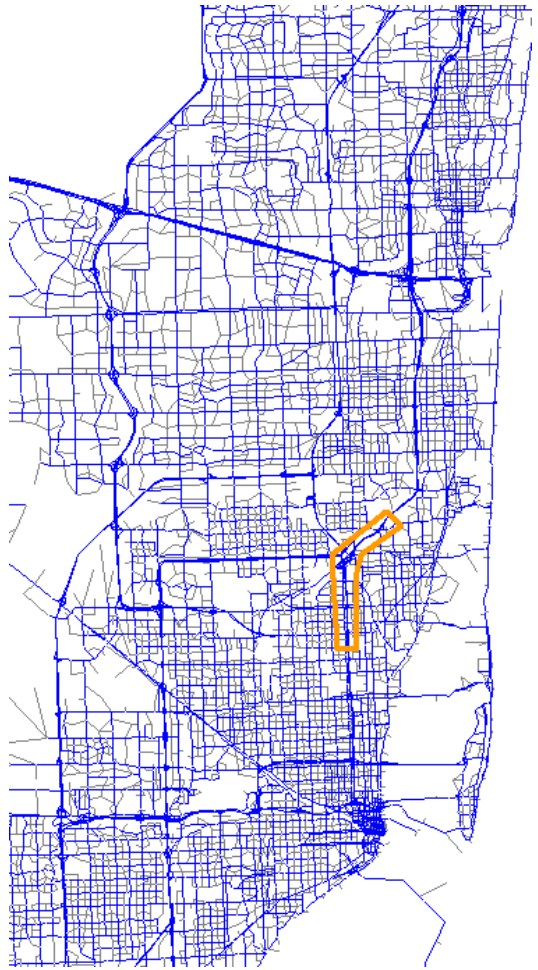
Hybrid Simulation Module - Ongoing

– Integrate mesoscopic simulation into the regional model





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Any questions?

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