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A Tour of ELToD4 Model

TPB Travel Forecasting Subcommittee

Lihe Wang, P.E.

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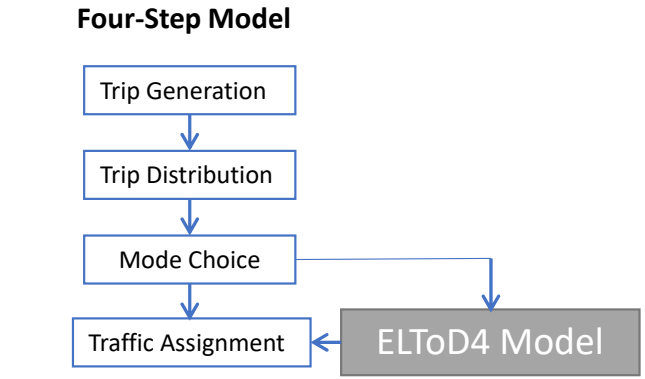
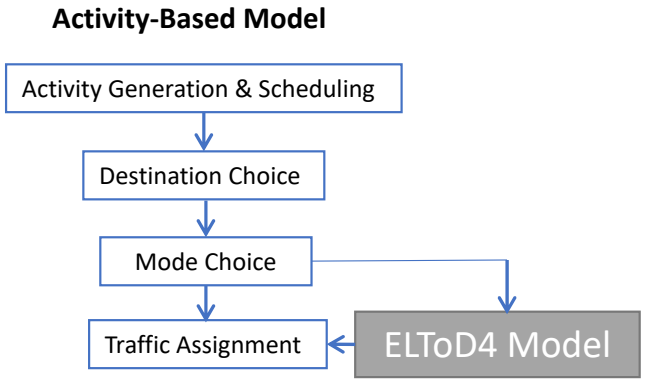
What is ELToD4?

- 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
- It can be a standalone tool for express lanes studies
- It can provide dynamic toll rate inputs to regional model
- It is open source programmed in C++





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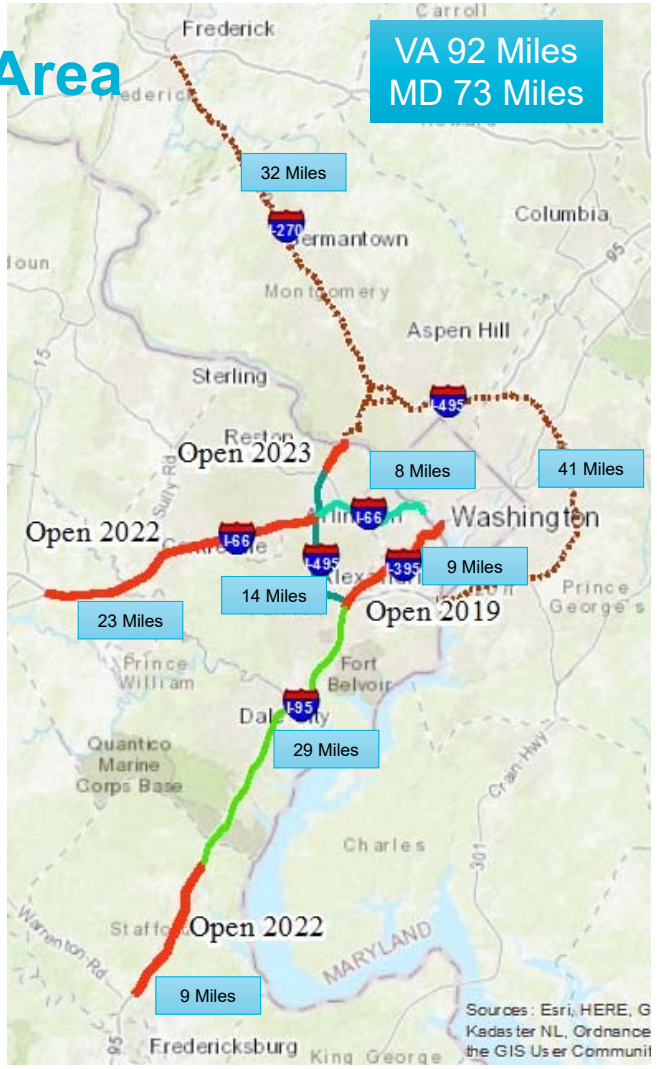
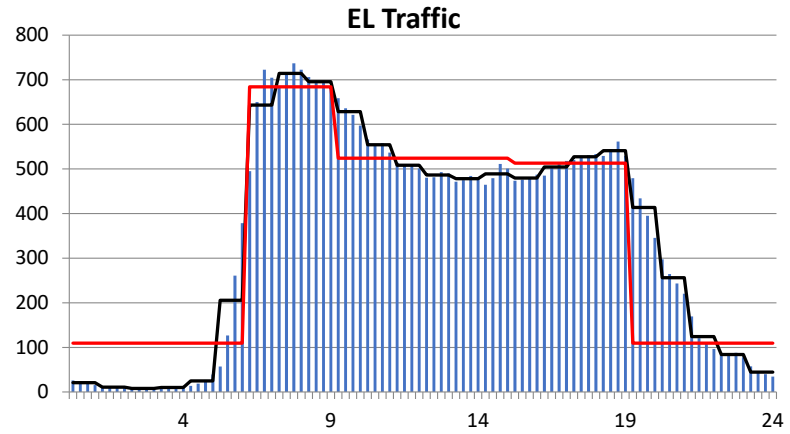
Express Lanes Network in Greater Washington Area

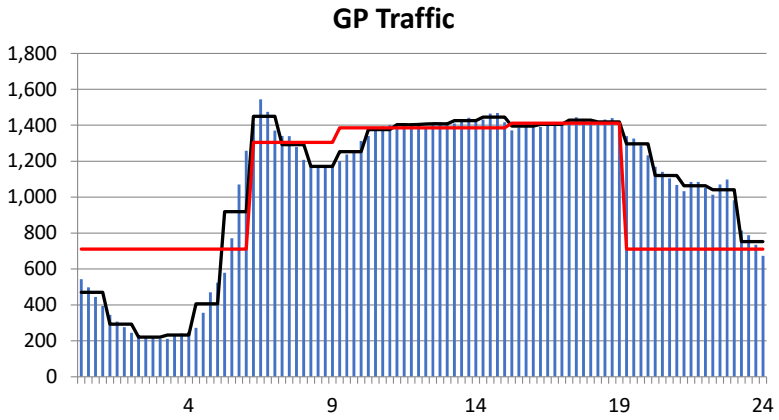
VDOT	66 ExpressLanes INSIDE THE BELTWAY	5:30AM – 9:30AM Eastbound 3:00PM – 7:00PM Westbound Freeway other time	HOV2 Free	No Trucks
Transurban	95 ExpressLanes 495 ExpressLanes	2:30AM – 11:00AM Northbound 1:00PM – 12:00AM Southbound Closed other time 24 hours	HOV3 Free	No Trucks
Cintra	66 OUTSIDE the Beltway	24 hours	HOV3 Free	Allow Trucks

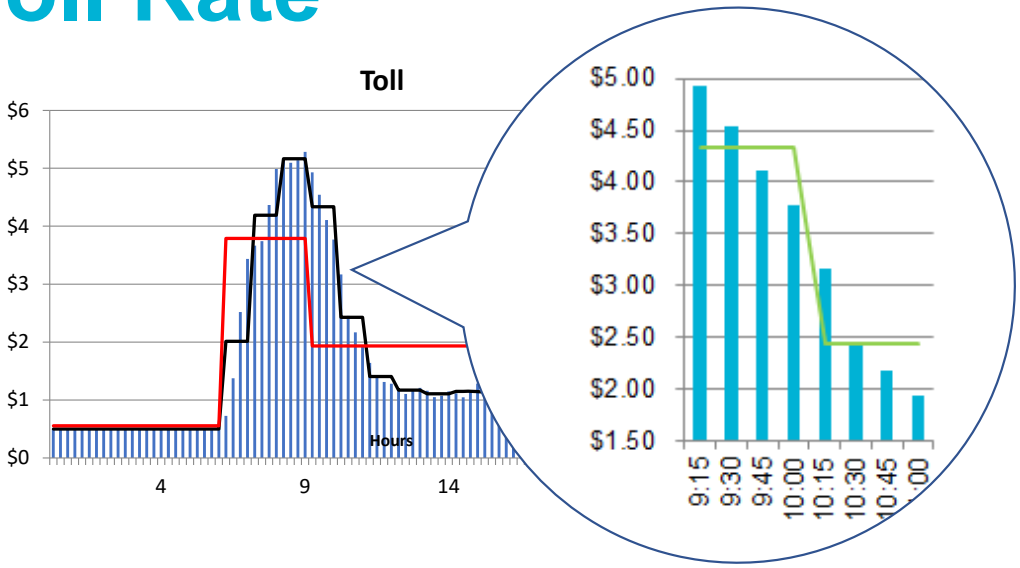
*MDOT I495 I270 may not have HOV free policy



Observed Traffic and Toll Rate







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

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

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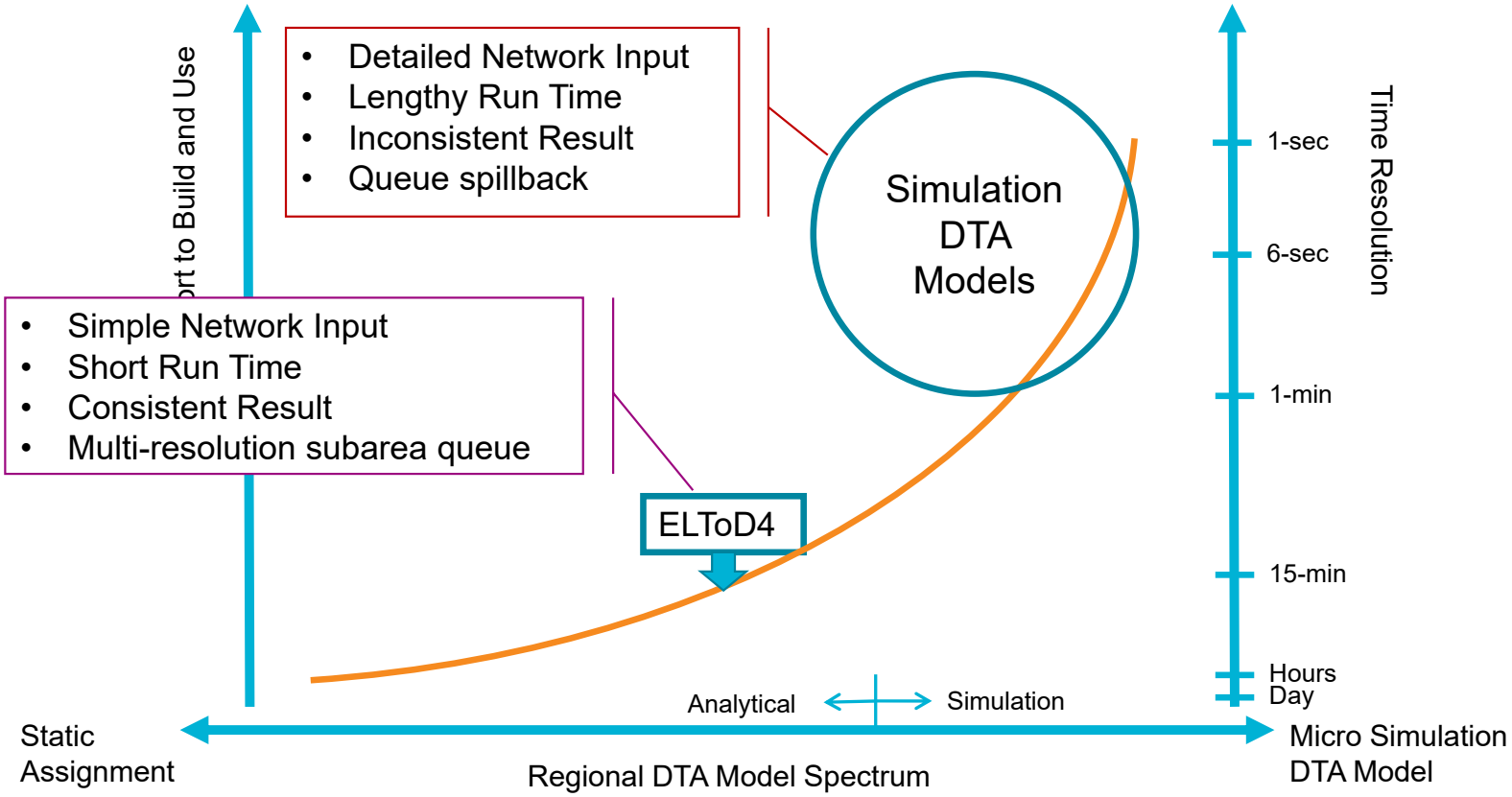
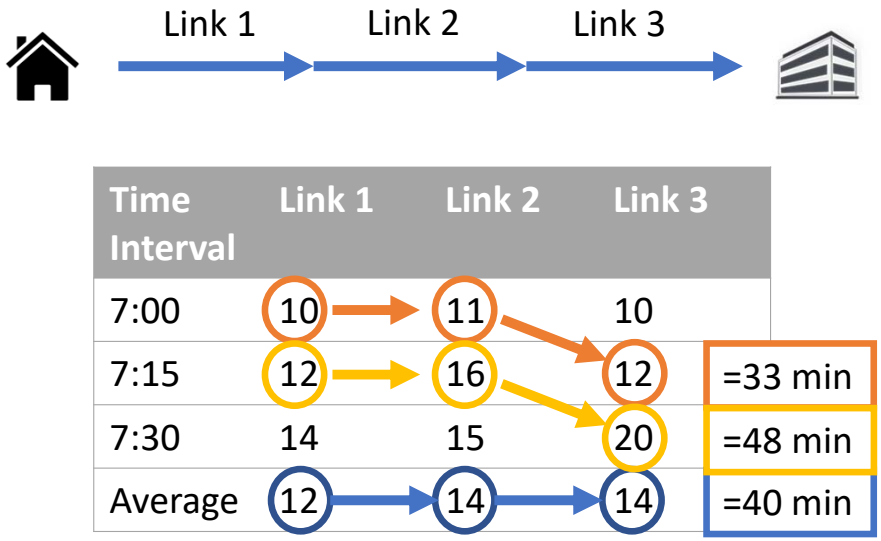
Time and Effort Requirement



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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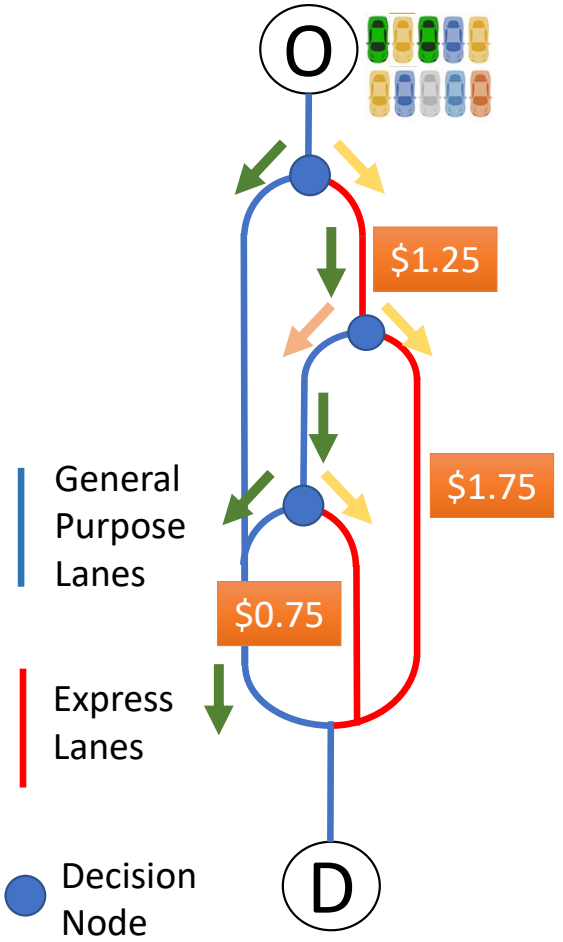
En-route Toll Choice Making

To simulate driver's behavior:

- Generalized cost 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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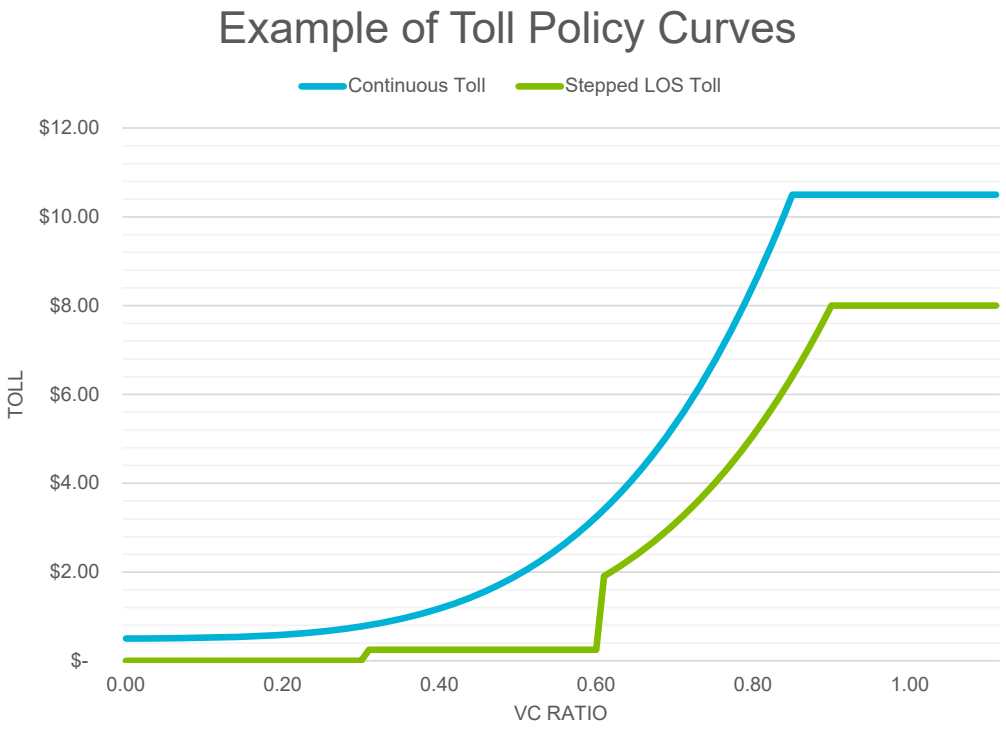
Toll Policy Curves

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



- 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

Mixed Multinomial Logit Toll Choice Model

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

where

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

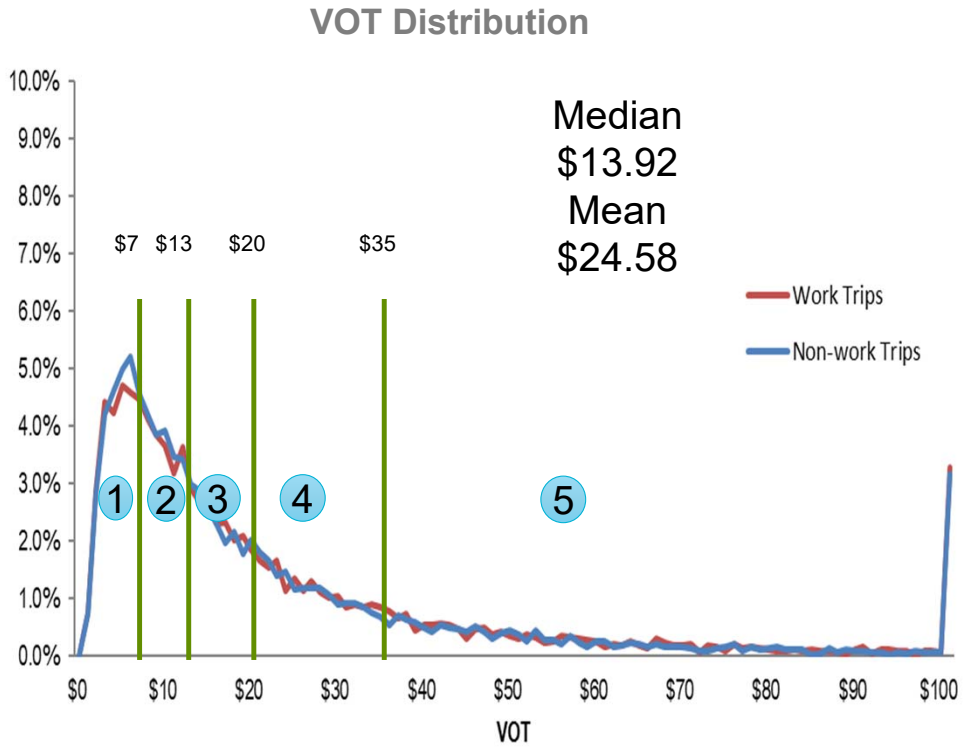
$$Reliability = \gamma_r \times \left(Time_{Congested} - Time_{FreeFlow}\right) \times (Distance)^{-\eta_r}$$

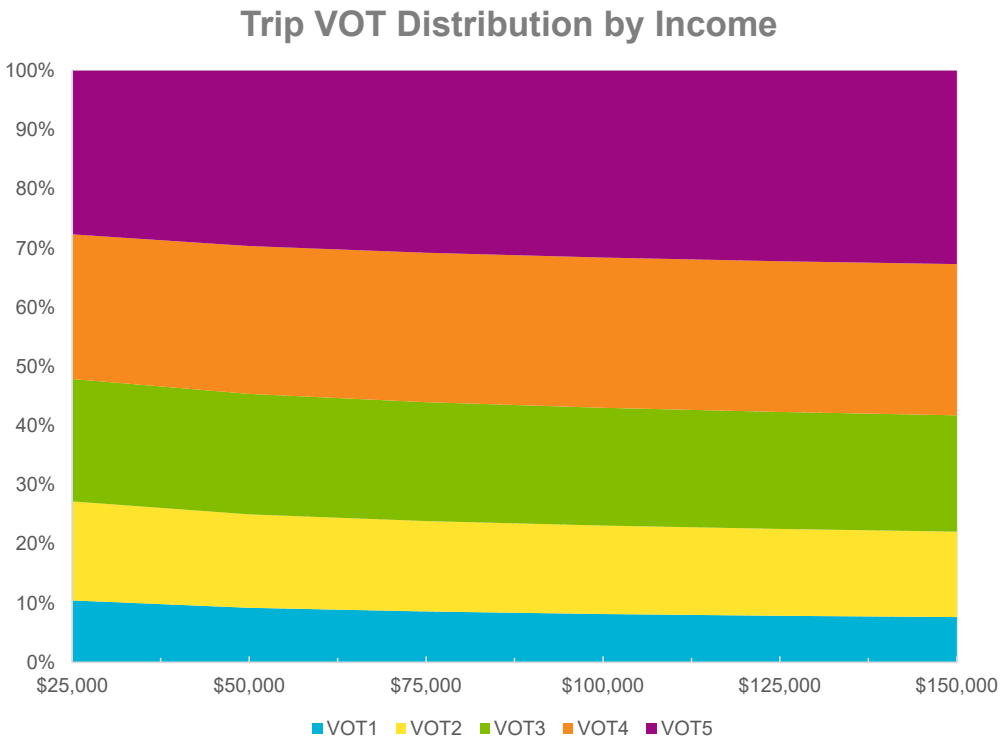
$$VOT = \frac{60 * \beta\_Time}{\beta\_Toll}$$

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

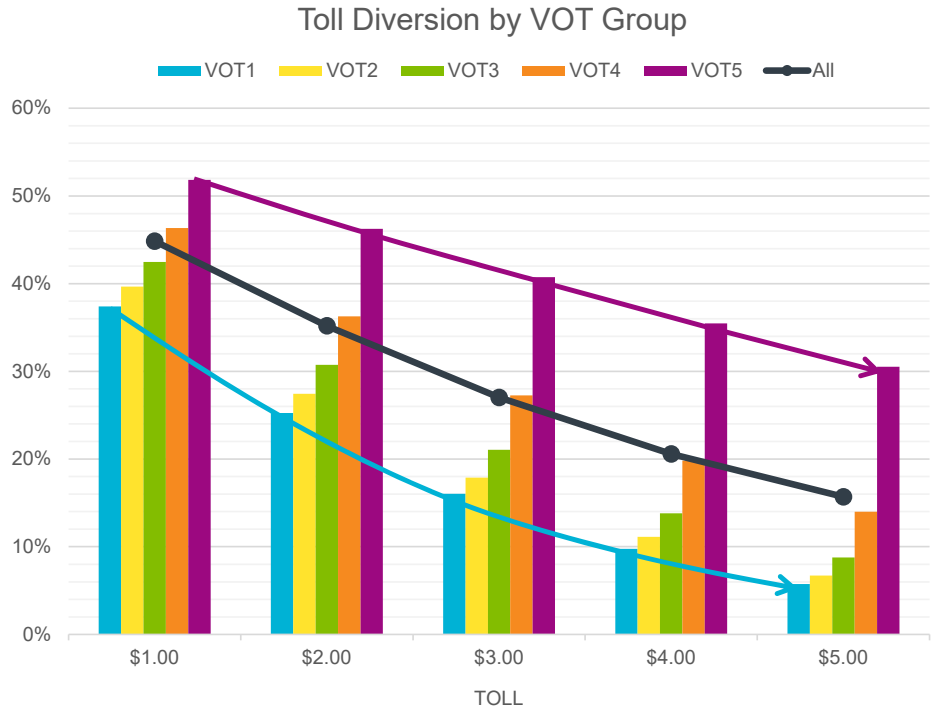
*Reliability formula is base on TRB SHRP2 Report S2-L04-RR-1, Incorporating Reliability Measures into Operation and Planning Model Tools, 2014, page 37

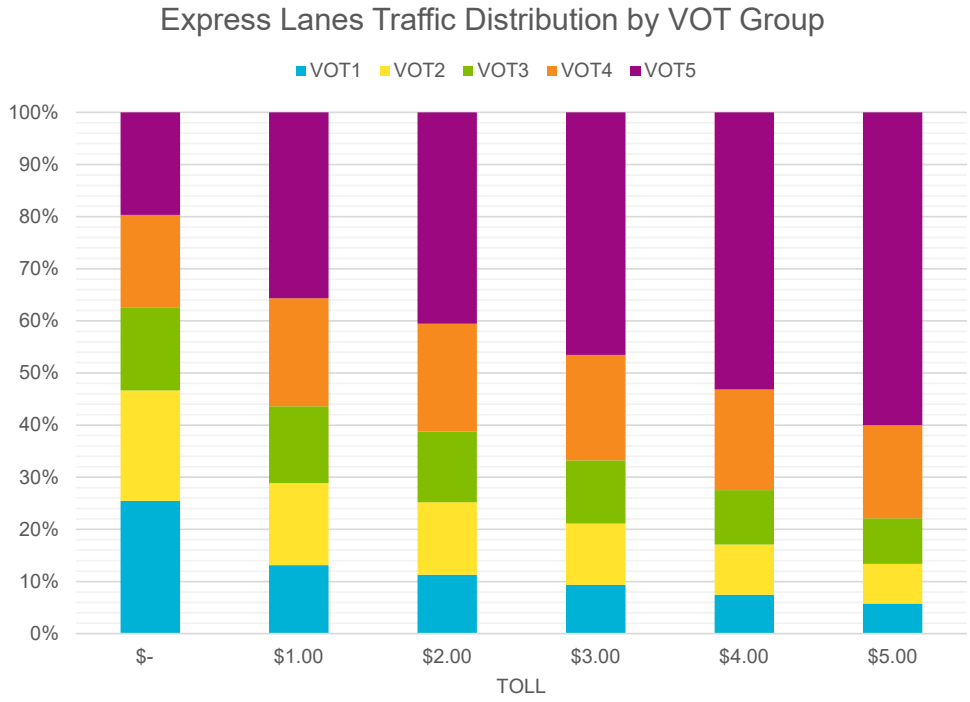
Distributed Value of Time (VOT)





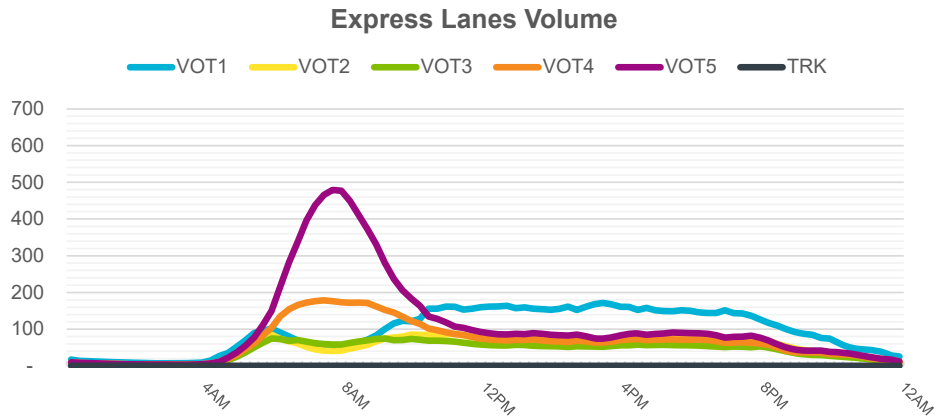
Choice Model Toll Sensitivity

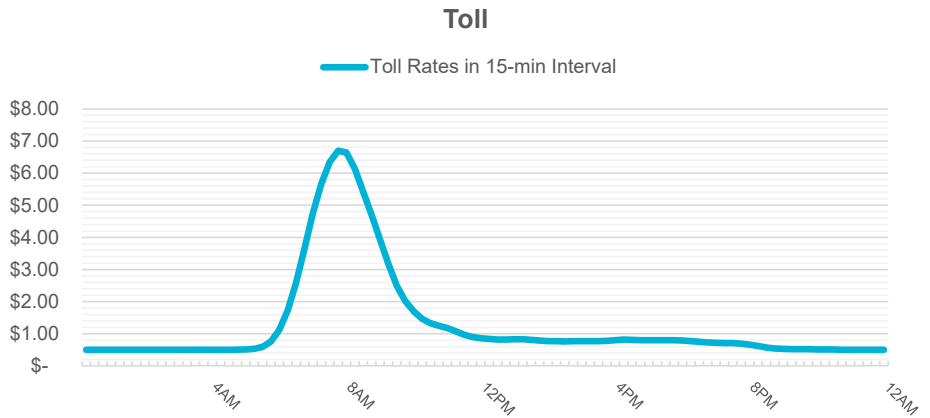


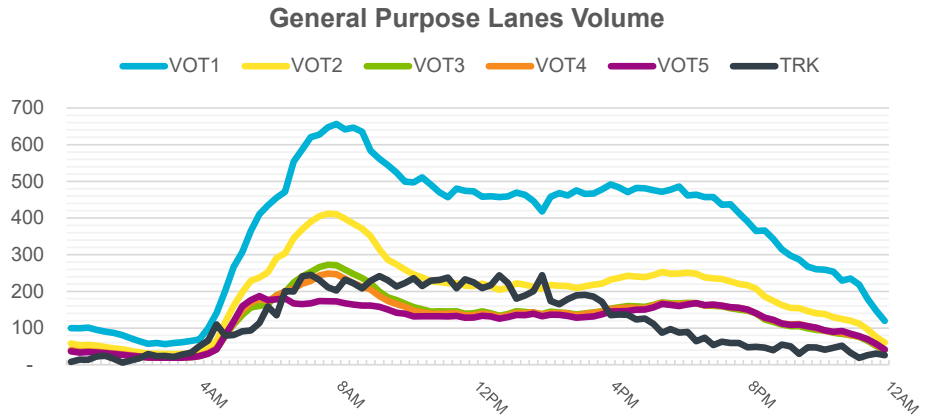


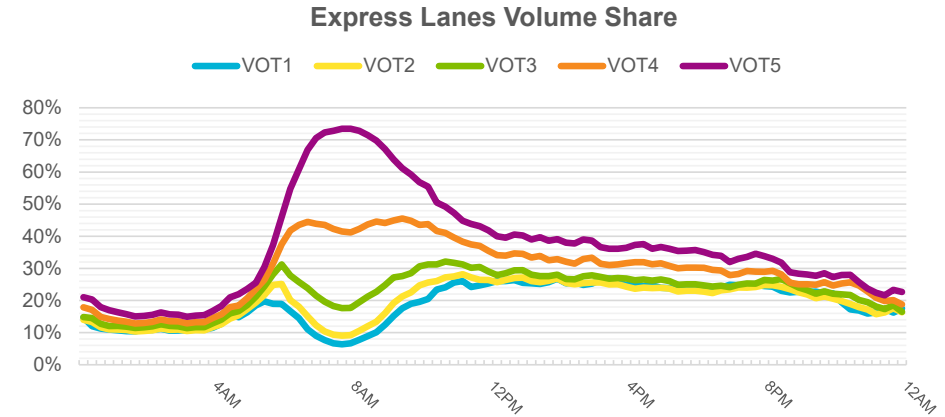
Time savings = 1 minute; Distance = 4 miles; Income = $85,000

Model Result Example









Florida I-95 express lanes segment 1 Southbound

Summary

- Free software continuously supported by the Florida's Turnpike Enterprise
- Practical model that has been successfully used for multiple express lane projects in Florida
- Necessary utilities included: select link; subarea extraction; ODME
- CAV impacts module for autonomous vehicles analysis
- Future improvements:
  - Application on regular static toll roads
  - Integrated subarea simulation (hybrid model)

Any questions?

Contact us

Lihe Wang, P.E.
Consulting Manager
D 703-340-3030
lihe.wang@aecom.com

David B. Roden, P.E.
Senior Consulting Manager
D 703-340-3069
david.roden@aecom.com