Advanced Toll Modeling

Presented By

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For

Model Task Force Meeting
Orlando, Florida

November 9-10, 2009

Advanced Toll Modeling

- MTF Priorities Survey

1. Time-of-Day Modeling
2. Land Use Interfaces
3. Advanced Toll Modeling
   - Florida Turnpike Features since the Toll Facilities Model

Advanced Toll Modeling

- History and Development
- Application at Florida's Turnpike
  - Technology Advances
  - Alternate Tolling Strategies
- Cube-FSUTMS Application

Development History of Toll Modeling

- CTOLL
- UTPS -- UROAD
- Toll Facilities Model
- Other Miscellaneous

  Toll Modeling Developments
- Ramp-to-Ramp Toll Modeling

CTOLL

- Conversion of cost to time based upon average income in study area
- Equilibrium highway load parameter: ranges from 0.02 (income = $100k) to 0.10 (income = $20k)

CTOLL
Turnpike Modeling

$$CTOLL = \frac{(1248 * IVTT) / (EIP * INCOME)}{TIMEC}$$

1248 – factor to convert income in dollars/year to cents/minute
(assumes 2080 work hours/year)

IVTT – Coefficient for In-Vehicle Travel Time (i.e. : Florida – 0.02)

EIP – Expendable Income Percentage (Range : 10 – 35 %)

INCOME – Average regional household income

TIMEC – Coefficient of Time, Statistical Estimation of Mode & Route Choice based on Survey Data Collected
(i.e. : Orlando – 0.0469, Tampa - 0.0492, Jacksonville – 0.0489)

Example CTOLL – Jacksonville Region =0.0736, Clay Co =0.0798, St Johns Co =0.0511

CTOLL
General Modeling

CTOLL = 1.0 / (Rate * A)

Where:

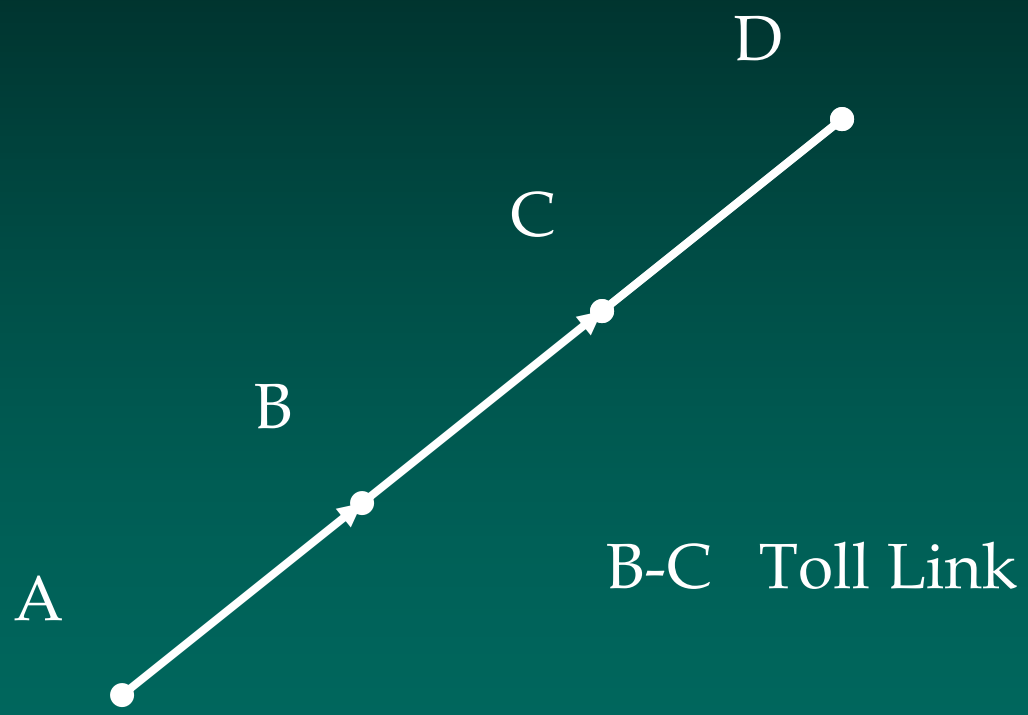
Rate = Average Wage Rate for Study Area

A = Value of Time Factor (30 – 40 percent)

UTPS – UROAD Toll Representation

- Up to 20 toll categories
- Coded in the TRANPLAN cost field
- TOLLS – toll in dollars for each category (converted to time via CTOLL)
- SERVT – service time in minutes
- Toll links should be coded with zero distance on links to turn off capacity restraint calculation

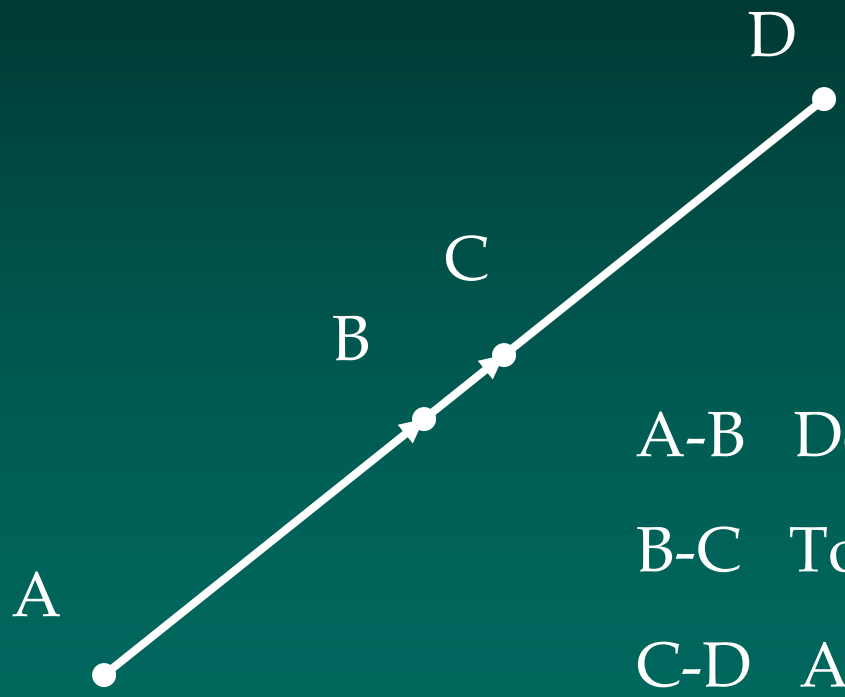
UTPS – UROAD
Link Representation



Toll Facilities Model

- Current FSUTMS Toll Model
- TOLDATA file
  - CTOLL (overrides any parameter)
  - A-NODE and B-NODE
  - Toll in dollars
  - Service time in minutes : seconds
  - Toll facility identification
  - Number of lanes
  - Toll type ramp (no accel/decel) or barrier

TOLL FACILITIES MODEL
Link Representation



A-B Decel Link

B-C Toll Link

C-D Accel Link

Miscellaneous Toll Modeling Developments

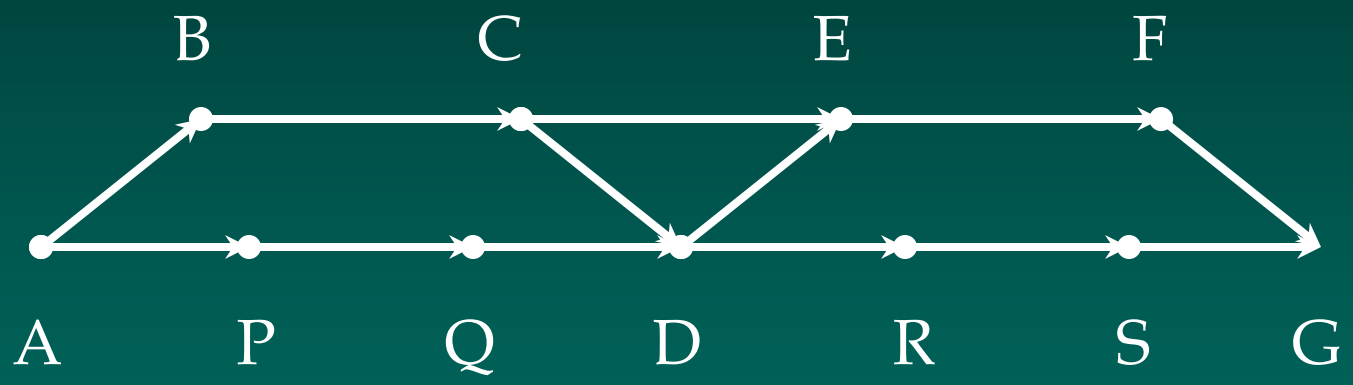
- Open Road Tolling (TOLDATA file additional fields)
- Hot-Lane (Value Pricing) Tolls
- Distance-Based Tolls
- Discrete Tolls – Toll based upon the number of toll facilities crossed
- Congestion-Pricing Tolls

Ramp-to-Ramp Toll Modeling

- Latest Toll Collection Methods
  - Ramp-to-Ramp (Card System)
  - Barrier
  - Electronic Tolling (SunPass)
  - Discount Pricing (Discrete Tolling)
  - Open Road Tolling
  - Variable Pricing (HOT-Lanes)
  - Congestion Pricing
- Flexible for all cases
- Software Modifications

Ramp-to-Ramp Toll Modeling

Software Problem:



Toll Pathing : A B C D + 50
D E F G + 75
A B C E F G + 125

Ramp-to-Ramp Toll Modeling

Software Solutions:

- **Network Restructure**
- **Pseudo Links**
  - **Turn Prohibitors / Penalties**
  - **Selected Links**
- **Pseudo to Real Links**
- **Assignment by Iteration**
- **Output File – Real Links**

Ramp-to-Ramp Toll Modeling

Software Output :

- Ramp-to-Ramp Detail Report
  - Volumes
  - Estimated Revenue
  - Ramp ID's
- Company Summary
- DBF Output for Other Software Interfaces

Ramp-to-Ramp Toll Modeling

Ramp-to-Ramp Identification Input

```
COMPANY NAME = 'Veterans Exwy'
COMPANY NUMBER = 11
RAMP LINK =  15478-  15501, RAMP ID = 'Veterans Exwy NB On at SR 60       '
RAMP LINK =  15505-  15501, RAMP ID = 'Veterans Exwy NB On at Memorial    '
RAMP LINK =  15531-  15562, RAMP ID = 'Veterans Exwy NB On at Hillsborough'
RAMP LINK =  15609-  15605, RAMP ID = 'Veterans Exwy NB On at Waters       '
RAMP LINK =  15089-  15090, RAMP ID = 'Veterans Exwy NB On at Wilsky       '
RAMP LINK =  15084-  15115, RAMP ID = 'Veterans Exwy NB On at Gunn         '
RAMP LINK =  15198-  15224, RAMP ID = 'Veterans Exwy NB On at Ehrlich      '
RAMP LINK =  15720-  15735, RAMP ID = 'Veterans Exwy NB On at Hutchison    '
RAMP LINK =  15510-  15528, RAMP ID = 'Veterans Exwy NB Off at Hillsboroug'
RAMP LINK =  15598-  15610, RAMP ID = 'Veterans Exwy NB Off at Waters      '
RAMP LINK =  15604-  15689, RAMP ID = 'Veterans Exwy NB Off at Anderson    '
RAMP LINK =  15230-  15205, RAMP ID = 'Veterans Exwy NB Off at Linebaugh   '
RAMP LINK =  15020-  15073, RAMP ID = 'Veterans Exwy NB Off at Gunn        '
RAMP LINK =  15171-  15195, RAMP ID = 'Veterans Exwy NB Off at Ehrlich     '
RAMP LINK =  15615-  15674, RAMP ID = 'Veterans Exwy NB Off at Hutchison   '
RAMP LINK =  15596-  15589, RAMP ID = 'Veterans Exwy NB Off at Suncoast    '
RAMP LINK =  16622-  16773, RAMP ID = 'Veterans Exwy NB Off at Dale Mabry  '
RAMP LINK =  15479-  15496, RAMP ID = 'Veterans Exwy SB On at Hillsborough'
RAMP LINK =  15584-  15583, RAMP ID = 'Veterans Exwy SB On at Waters       '
RAMP LINK =  15649-  15594, RAMP ID = 'Veterans Exwy SB On at Anderson     '
RAMP LINK =  15176-  15246, RAMP ID = 'Veterans Exwy SB On at Linebaugh    '
RAMP LINK =  15046-  15001, RAMP ID = 'Veterans Exwy SB On at Gunn         '
RAMP LINK =  15181-  15165, RAMP ID = 'Veterans Exwy SB On at Ehrlich      '
RAMP LINK =  15659-  15612, RAMP ID = 'Veterans Exwy SB On at Hutchison    '
RAMP LINK =  15586-  15576, RAMP ID = 'Veterans Exwy SB On at Suncoast     '
RAMP LINK =  16767-  16575, RAMP ID = 'Veterans Exwy SB On at Dale Mabry   '
RAMP LINK =  15489-  15447, RAMP ID = 'Veterans Exwy SB Off at SR 60       '
RAMP LINK =  15489-  15458, RAMP ID = 'Veterans Exwy SB Off at Memorial    '
RAMP LINK =  15540-  15490, RAMP ID = 'Veterans Exwy SB Off at Hillsboroug'
RAMP LINK =  15595-  15588, RAMP ID = 'Veterans Exwy SB Off at Waters      '
RAMP LINK =  15116-  15089, RAMP ID = 'Veterans Exwy SB Off at Wilsky      '
RAMP LINK =  15105-  15074, RAMP ID = 'Veterans Exwy SB Off at Gunn        '
RAMP LINK =  15216-  15185, RAMP ID = 'Veterans Exwy SB Off at Ehrlich     '
RAMP LINK =  15719-  15672, RAMP ID = 'Veterans Exwy SB Off at Hutchison   '
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Ramp-to-Ramp Toll Modeling

Ramp-to-Ramp Toll Specifications

```
RAMP TOLL =  0.2500, RAMP FROM =  15478-  15501, RAMP TO =  15510-  15528
RAMP TOLL =  0.5000, RAMP FROM =  15478-  15501, RAMP TO =  15598-  15610
RAMP TOLL =  1.0000, RAMP FROM =  15478-  15501, RAMP TO =  15604-  15689
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RAMP TOLL =  1.0000, RAMP FROM =  15084-  15115, RAMP TO =  16622-  16773
```

Ramp-to-Ramp Toll Modeling

Ramp-to-Ramp Detail Report

RAMP-RAMP TOLL DETAIL REPORT -- Mode = 1 -- Company Number: 11 -- Company Name: Veterans Exwy

Ramp-to-Ramp Identification			Toll ($)	Dist. (Miles)	Volume	Rev. ($)	From Ramp	To Ramp
Veterans Exwy SB On at Suncoast	-to-	Veterans Exwy SB Off at SR 60	1.75	11.5	11353	19868	15567-15557	15468-15425
	-to-	Veterans Exwy SB Off at Memorial	1.75	11.1	95	166		15468-15436
	-to-	Veterans Exwy SB Off at Hillsboroug	1.75	10.2	3762	6584		15521-15469
	-to-	Veterans Exwy SB Off at Waters	1.75	8.2	7827	13697		15576-15569
	-to-	Veterans Exwy SB Off at Wilsky	1.25	6.3	441	551		15093-15065
	-to-	Veterans Exwy SB Off at Gunn	1.00	4.5	997	997		15081-15050
	-to-	Veterans Exwy SB Off at Ehrlich	0.75	3.6	2374	1781		15193-15162
	-to-	Veterans Exwy SB Off at Hutchison	0.50	1.6	3777	1889		15700-15653
Veterans Exwy SB On at Dale Mabry	-to-	Veterans Exwy SB Off at SR 60	1.75	14.4	745	1304	16755-16563	15468-15425
	-to-	Veterans Exwy SB Off at Memorial	1.75	13.9	20	35		15468-15436
	-to-	Veterans Exwy SB Off at Hillsboroug	1.75	13.0	400	700		15521-15469
	-to-	Veterans Exwy SB Off at Waters	1.75	11.0	1601	2802		15576-15569
	-to-	Veterans Exwy SB Off at Wilsky	1.25	9.2	112	140		15093-15065
	-to-	Veterans Exwy SB Off at Gunn	1.00	7.4	634	634		15081-15050
	-to-	Veterans Exwy SB Off at Ehrlich	0.75	6.5	2419	1814		15193-15162
	-to-	Veterans Exwy SB Off at Hutchison	0.50	4.5	1243	622		15700-15653
Company Totals					169618*******			

Ramp-to-Ramp Toll Modeling

Company Summary Report

RAMP-RAMP TOLL SUMMARY REPORT:

Company Number	Company Name	Volume	Revenue ($)
7	Sunshine Skwy BR	73997	73997.
17	St. Johns Ferry	22963	74630.
12	Suncoast Pky	119374	97214.
42	Suncoast Pky 2	46591	43054.
29	Tpk NorthCoin Sys	318830	409126.
31	Tpk SouthCoin Sys	471758	561620.
28	Tpk SouthConn Ext	50633	28874.
30	Tpk Ticket Sys	214306	699633.
8	Treasure Is BR	8964	4482.
35	Venetian Causeway BR	13442	10082.
11	Veterans Exwy	168637	178632.
Total -- All Companies		6148844	5472082.

Congestion-Pricing Toll Modeling

- Internal to the Assignment Process
  - Iteration Toll Rate Calculations based upon Congestion
  - Intra-iteration (Lambda Calculations)
- Turnpike-Sponsored TRANPLAN Modifications
- Rates Variable by Toll Agency (Company)

Congestion-Pricing Toll Modeling

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  - Iteration Toll Rate Calculations based upon Congestion
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Congestion-Pricing Toll Modeling

1) Standard recalculation of link time based upon V/C value
2) Calculation of rate, by company, for the link based upon V/C value
3) Calculation of the toll based upon the link distance and the rate
4) Addition of the toll, converted to time via the CTOLL value

Congestion-Pricing Toll Modeling

Rate = MIN(mintoll+(maxtoll-mintoll)
***(xl_vc+vc_los_offset)**exponent)**

Where: Rate = calculated toll rate ($/mi)
mintoll = min. toll rate ($/mi)
maxtoll = max. toll rate ($/mi)
xl_vc = link V/C ratio (base upon LOS E saturation capacity)

Congestion-Pricing Toll Modeling

Rate = MIN(mintoll+(maxtoll-mintoll)

***(xl_vc+vc_los_offset)**exponent)**

Where: vc_los_offset = shifts the rate curve asymptote to protect given LOS

exponent = shape of the rate curve (2 = quadratic, 3 = cubic…)

CUBE Application

- **Identification of Pertinent Advanced Features**
- **Features Currently in CUBE**
- **Verification of CUBE and TRANPLAN Features**

CUBE Application Identification of Pertinent Advanced Features

- **Discussions with key modelers in Florida**
- **Determine which Advanced Toll Features to be in Future Versions of CUBE-FSUTMS**

CUBE Application
Features Currently in CUBE

- Review Current CUBE Documentation
- Undocumented Features About to be Released
- Discussions with Citilabs

CUBE Application
CUBE and TRANPLAN
Verification

- Recognize the Inherent Differences in the Equilibrium Assignments
- Rigorous Testing of the Selected Toll Features utilizing TRANPLAN as a Benchmark
- Ensure Adequate Reporting Capabilities

CUBE Application CUBE and TRANPLAN Verification

- **Project Time Frame: 18-24 months**

Advance Toll Modeling

- Questions?

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