



R | S | G INC.
RESOURCE SYSTEMS GROUP, INC.

Regional Travel Demand Modeling with TransCAD

The Benefits of Standardization &
Daily Modeling Practices

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Presented to MTMUG
April 7, 2011

Introduction to RSG Transportation Modeling

RSG's Clients

RSG works extensively with state DOT's, MPO's and others to ensure that their planning process is backed by accurate, detailed demand analysis

Current Modeling Clients

- FHWA
- National Park Service
- Transportation Research Board
- Florida, Utah DOTs
- Seattle, San Fran, Sacramento MPOs
- Rochester, Syracuse, Poughkeepsie MPOs
- Burlington, Portsmouth MPOs
- Salt Lake, Provo, Logan, St. George MPOs
- New York City Transit
- Utah Transit Authority



Founded in 1986

Staff of 80 professionals with extensive experience in planning, modeling, and engineering

Primary Offices



Personal Introduction

Role at RSG

- 24 years of modeling experience
- Lead 30 transportation modelers
- “Bringing Research into Practice”

Professional Experience / Areas of Research

- Dynamic Traffic Assignment - FHWA Guidebook for Convergence
- Activity Based Models - SHRP 2 C10
- Data & Parameter Transferability - FHWA Research
- NEPA Land use and Transportation FHWA Guidance
- State and MPO GHG Forecasting- FHWA Research
- Transit Sensitivity to Build Environment - TRCP
- Smart Growth Planning - SHRP 2 C16
- Health Impacts of Walkable Communities - NIH

Modeling Philosophy

Purpose of Modeling

- Modeling is just a tool to assist in our thinking
- Physical Models
- Mental Models

Personal Philosophy

- Make the model no more complicated than necessary
- Must be explainable
- Must be understandable
- Must be easy to use
- Must support a discussion on the issues of interest

Discussion Outline

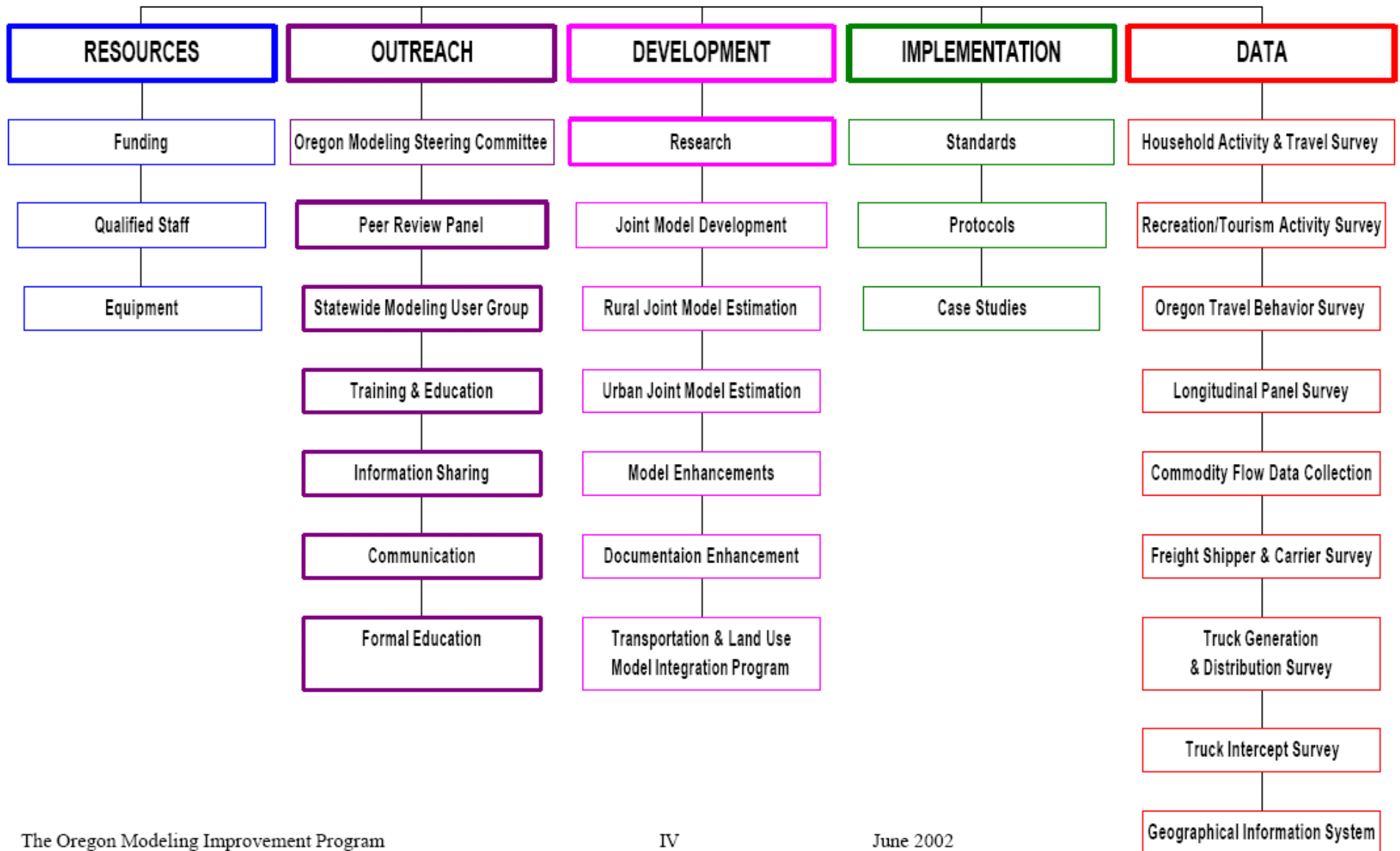
1. What a consistent model framework means
 - Common practices
 - Advantages
2. Generalized Model using TransCAD
 - Intersection Modeling
 - Special Generators
3. Time of day modeling
 - Options
 - Most common method

Locations with some level of coordination

- Florida
 - FSUTMS model structure
 - Comprehensive Research & Outreach
- Oregon
 - Comprehensive Research & Outreach
- Ohio
 - Large & active “model forecasting unit” at ODOT
 - Certified traffic forecasting process & “small MPO” model
- Utah
 - Each MPO has same model structure
- California (SB 375)
 - Integrated land use-activity based model in 4 largest MPOs
- NY State
 - Syracuse, Rochester, Poughkeepsie

Oregon Modeling Improvement Program

OREGON MODELING IMPROVEMENT PROGRAM STRATEGIC ELEMENTS



Meaning of Common Framework

	Common among models	Unique to each model
Trip Generation	<p>Logic (eg. cross class model)</p> <p>land use types (SF, MF, res, ret, nrt, shop, etc.)</p> <p>Trip types (HBW, HBShop, HBO, NHB, etc.)</p> <p>Data structures and file names</p> <p>How special generators & externals are handled</p>	<p>Socioeconomic data</p> <p>Special generators</p>
Trip Distribution	<p>Logic (eg. Gravity model)</p> <p>Data structures and file names</p> <p>Validation logic & reporting</p>	<p>Estimated trip lengths & friction factors</p> <p>travel times & costs</p>
Mode Choice	<p>Logic (eg. Logit choice model)</p> <p>Mode Choices (auto, bus, walk/bike, etc.)</p> <p>Use of environmental indicators (location to bus stops)</p> <p>Pedestrian environmental factors</p>	<p>Unique network choices by mode</p> <p>travel times & costs</p>
Assignment	<p>Logic (eg. Time of day, dynamic user equilibrium)</p> <p>Capacity assumptions</p> <p>Delay curves</p>	<p>Different networks</p>
Other Thoughts	<p>Time of Day (agreed upon methods)</p> <p>Calibration Standards (common metrics & reports)</p> <p>Documentation (standardized format)</p>	

Generalized Modeling Frameworks

Advantages

- Shared development costs (data and models)
- Shared experience & expertise (easier to help each other out)
- Easier for consulting community to correctly apply models (less variation/nuance among urban areas)
- Easier for DOT to play central role
- Less expensive to build model, maintain models, write documentation
- Allows modelers to focus on unique aspects of region

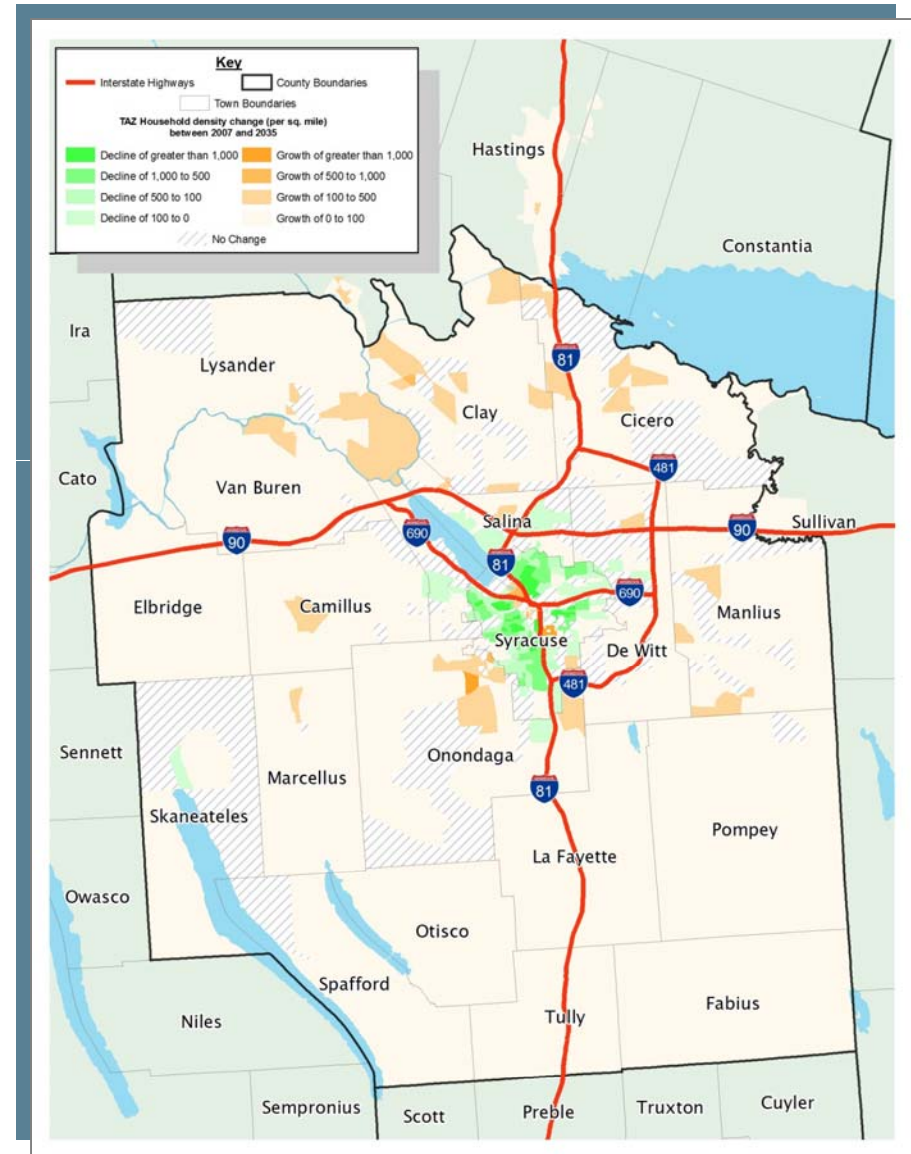
Considerations

- Need to come to agreement on a basic structure
- Need to allow for incremental improvement
- Must not let “structure” inhibit unique needs of an area

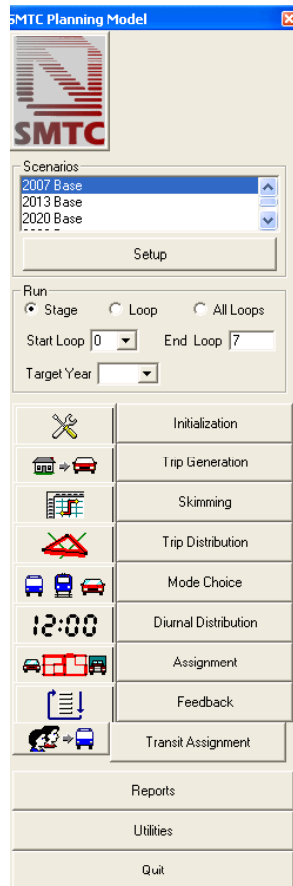
Generalized Model in TransCAD

Example Model Structure – Syracuse MPO

- Interesting elements:
 - Intersection Modeling
 - Special generators
 - Time-of-Day Modeling
- SMTC is the MPO for Syracuse, NY (Onondaga County)
 - 470,000 people
 - 195,000 households
 - 250,000 jobs



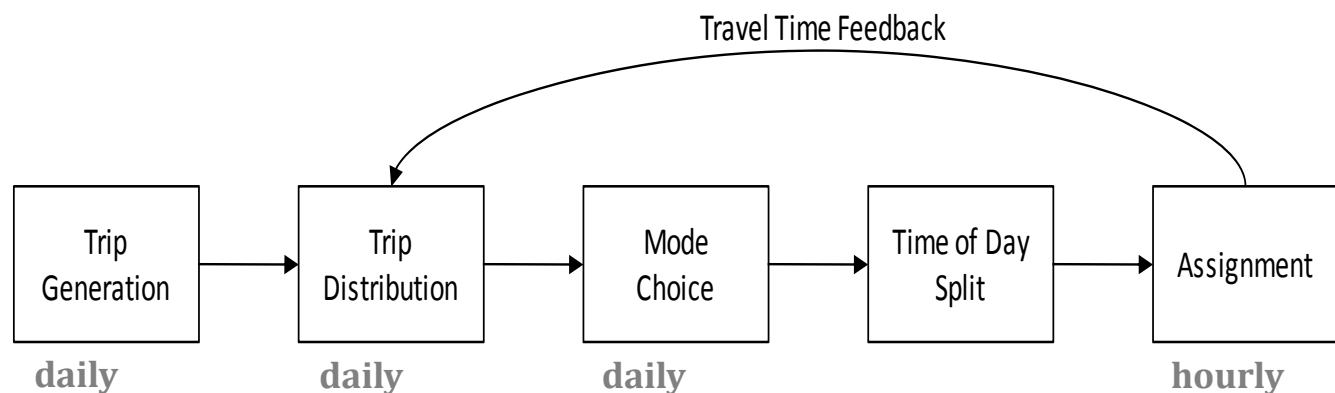
Overall Model Structure



Traditional 4-Step Regional Travel Demand Model

- 1) HBW, HBOther, HBShop, NHB trip purposes
- 2) Trip Generation (cross classification: autos x household size)
- 3) Trip Distribution (gravity model)
- 4) Mode Choice (logit choice model) - autos, bus, walk/bike
- 5) Trip Assignment (user equilibrium)
- 6) Custom reports summarizing model output

The SMTC Model includes a Time of Day step where trips are split into time periods, and a feedback loop to ensure distribution and mode choices reflect congested travel times



Where:

Vehicle Assignment – Intersection Modeling

- Vehicle trips by hour are assigned onto the regional highway network using a built-in TransCAD volume-delay function that includes delay from both Links and Intersections
- Hourly capacities are coded in the network to represent Level of Service (LOS) F
- Resulting AM peak hour and PM peak hour travel model link flows can be used to support engineering and operations analyses
- Freeway VDF is link-based and approximates a steep BPR curve
- (IITPR – Logit Delay Function)

$$d = D_l + I_l$$

$$D_l = t_0 \cdot \sigma_1 \left[\frac{1}{1 - \frac{\sigma_2}{1 + \exp\left(\sigma_3 - \sigma_4 \cdot \frac{x}{C}\right)}} \right]$$

$$I_l = d_0 \cdot p_1 \left[1 + \frac{p_2}{1 + \exp\left(p_3 - p_4 \cdot \frac{x}{X}\right)} \right]$$

D_l = link delay

I_l = node delay

t_0 = freeflow travel time

d_0 = freeflow travel time

x = traffic flow

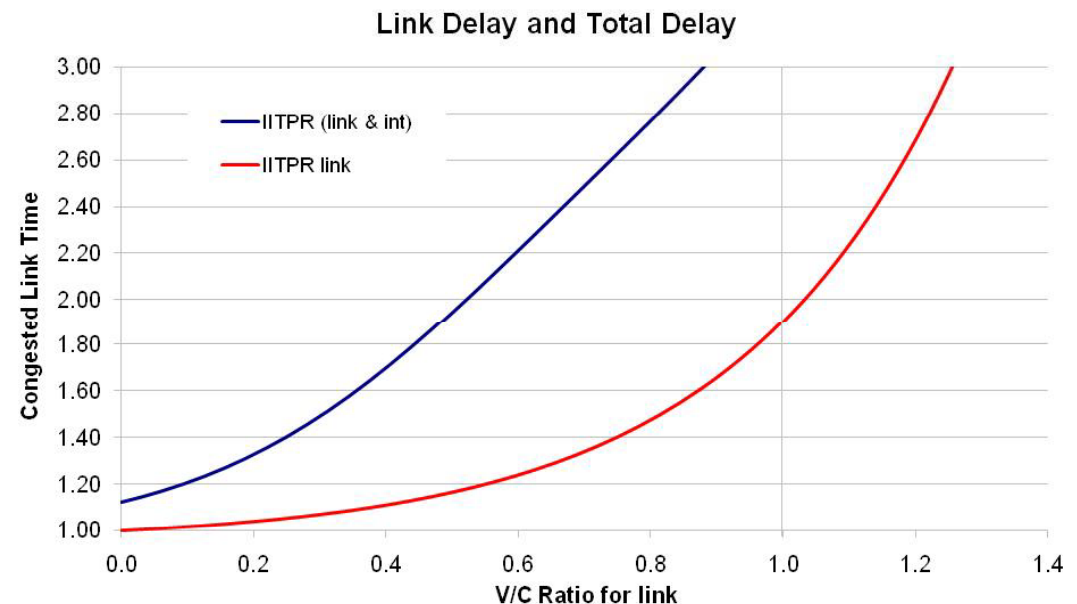
x = traffic flow

C = link capacity

X = node capacity

$\sigma_1, \sigma_2, \sigma_3, \sigma_4$ = link parameters
























































p_1, p_2, p_3, p_4 = node parameters



Vehicle Assignment – Intersection Capacities

Intersection capacities developed using Synchro for hypothetical intersections

Signalized Intersection 24-Hour Capacity Values*

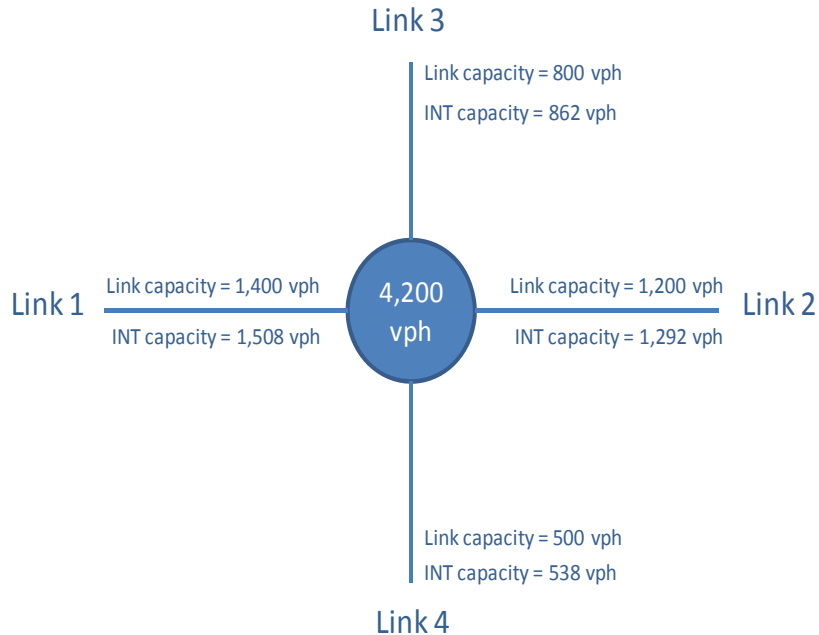
	Minor Lane Groups									
Major Lane Group		Single	Left Turn Bays	Left & Right Turn Bays	Left & 2 Through	Left, Right & 2 Through	2 Throughs	3 Throughs	Left & 3 Through	Left, Right and Three Through
	Single	23,000								
	Left Turn Bays	28,000	33,000							
	Left & Right Turn Bays	31,000	36,000	38,000						
	Left & 2 Through	40,000	44,000	49,000	53,000					
	Left, Right & 2 Throughs	46,000	50,000	54,000	58,000	62,000				
	2 Throughs	29,000	33,000	37,000	39,000	43,000	35,000			
	3 Throughs	32,000	36,000	40,000	46,000	46,000	38,000	40,000		
	Left & 3 Through	48,000	52,000	56,000	60,000	64,000	50,000	54,000	66,000	
	Left, Right and Three Through	50,000	54,000	58,000	62,000	66,000	52,000	56,000	68,000	72,000

*Divide by 10 for hourly capacity

Vehicle Assignment – Intersection Modeling

Signalized Intersections

Allocation of Intersection capacity to links

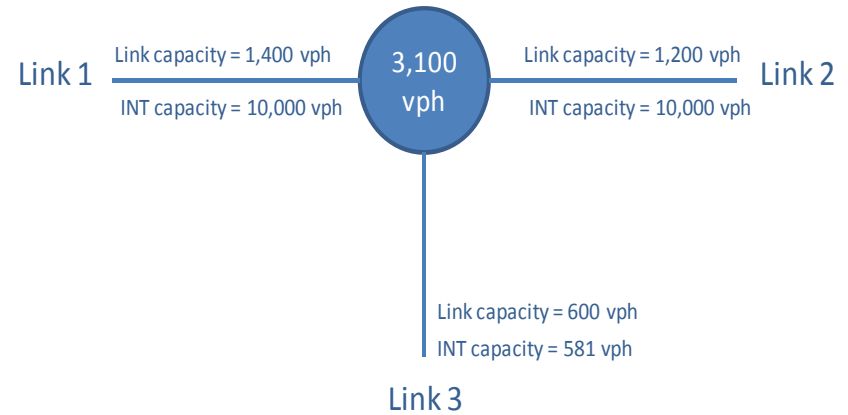


Link Segment	Link Capacity (vph)	Share	Node Capacity (vph)	INT Capacity (vph)
1	1,400	36%	x 4200 =	1,508
2	1,200	31%		1,292
3	800	21%		862
4	500	13%		538
Total	3,900	100%		4,200

Proportional allocation of intersection capacity to major & minor approach links

Un-Signalized Intersections

Allocation of Intersection capacity to links



Link Segment	Link Capacity (vph)	Share	Node Capacity (vph)	INT Capacity (vph)
1	1,400	44%	x 3100 =	1,356 → 10,000
2	1,200	38%		1,163 → 10,000
3	600	19%		581
Total	3,200	100%		3,100

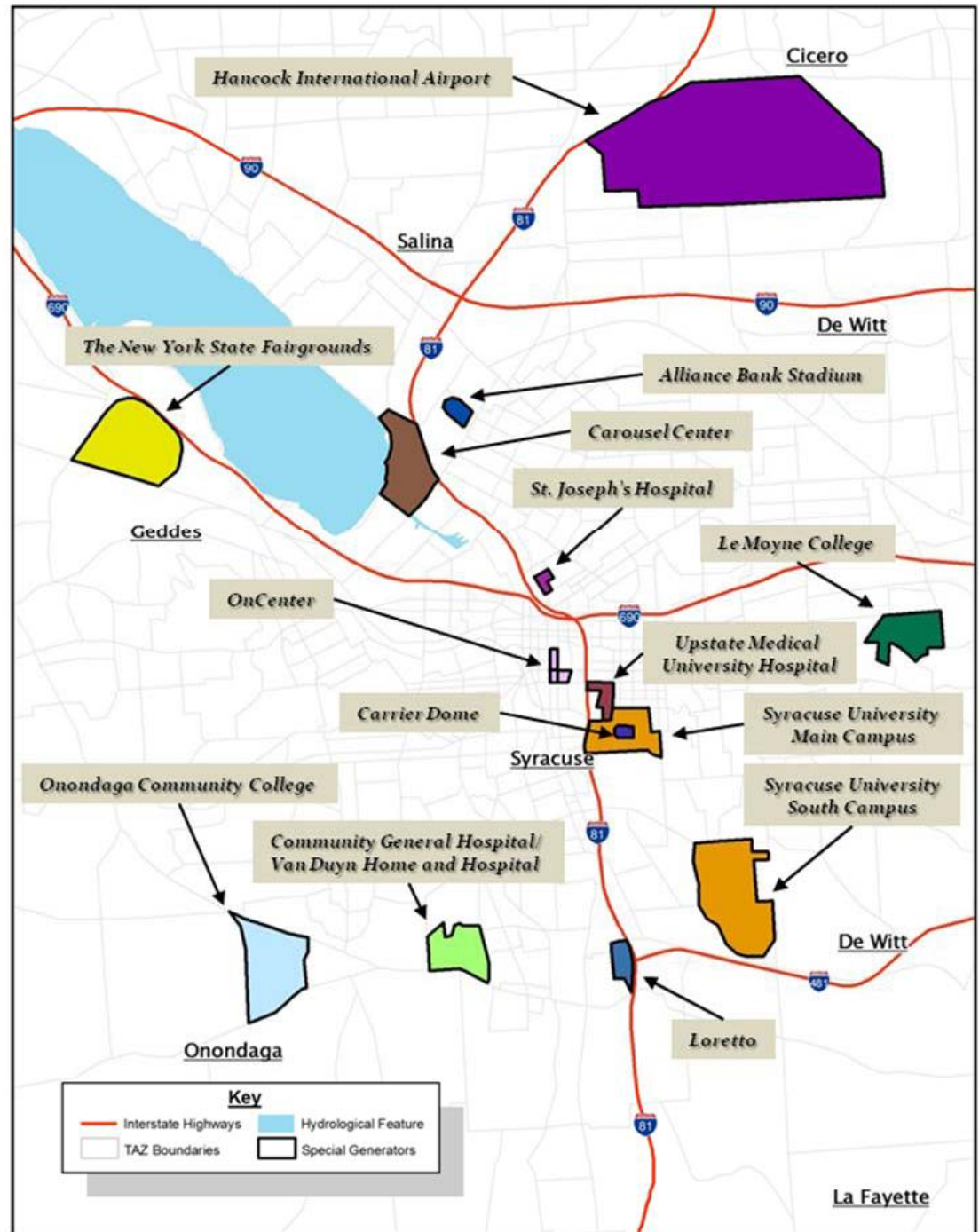
Calculated intersection delay is applied to only the minor approach of the intersection (in this case the stop-controlled leg - Link 3)

Intersection delay for the major approaches is effectively zero (by setting INT capacity = 10,000)

Special Generators

Unique attractions are modeled using actual data on worker/student/visitor zip codes (if available) and ITE trip generation (if no data). Zip code data were available for the Universities, Airport and Hospitals.

If Zip Code data were available, the modeled trip distribution is overwritten by an exogenous trip distribution derived from the visitation data. This is done for each trip purpose (work, non-work) if applicable given the data.



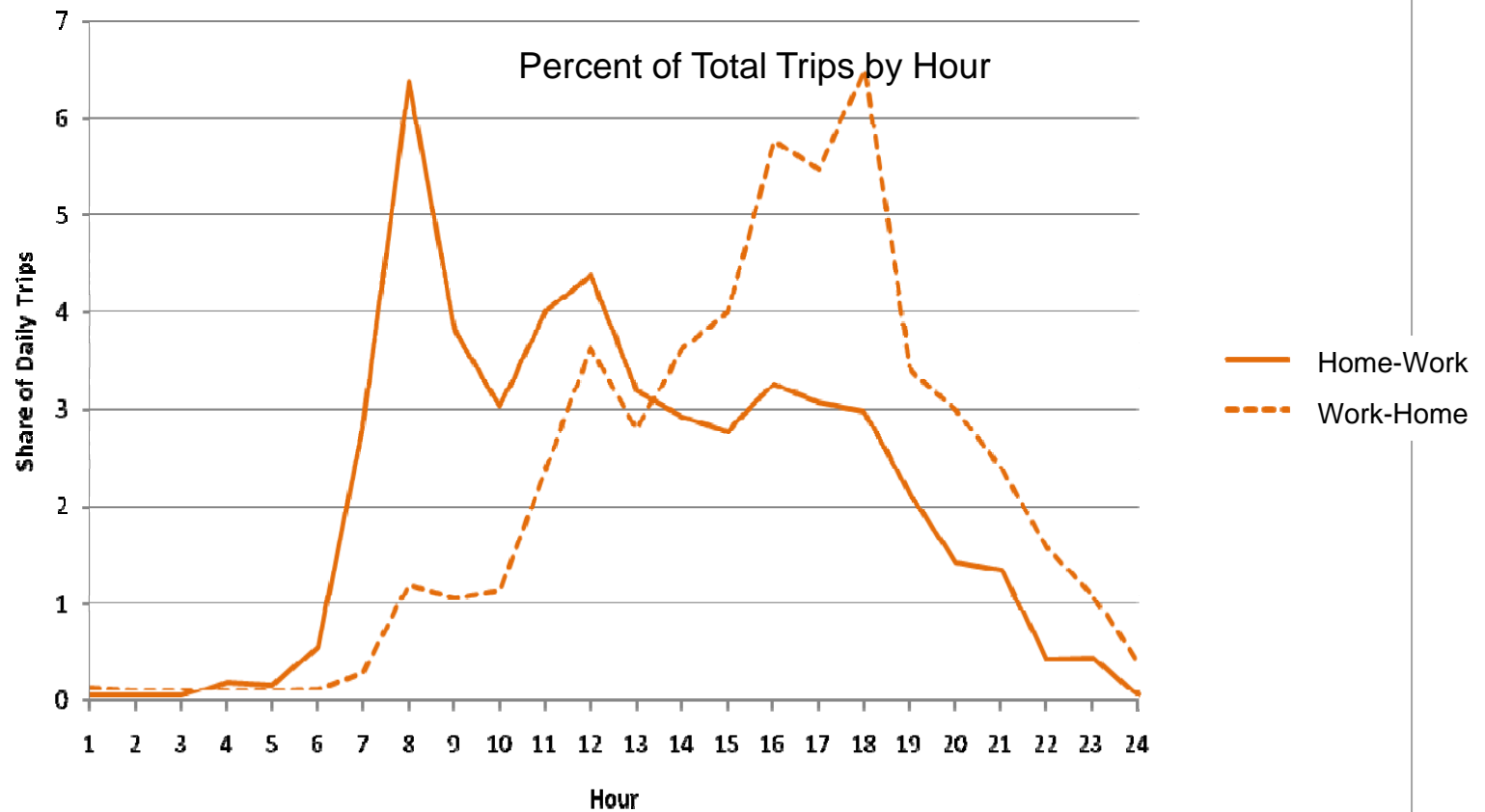
Time of Day Modeling

Adding Time of Day & Behavioral Sensitivity Options

Advanced Trip-Based (4-Step) Model	Hybrid Trip/ Activity-Based Model	Activity-Based Model
<p>Trip generation sensitive to congestion</p> <p>Intersection modeling</p> <p>Time of day represented with fixed diurnal distributions by trip type</p>	<p>Suppressed/Induced Demand</p> <p>Trip Chaining</p> <p>Destination choices based on cost, availability, overall trip chain</p> <p>Mode choice based on trip chain and environmental variables</p> <p>Time of day choice model uses delays and costs. Represents peak shifting</p>	<p>First handles long term choices such as work location and auto ownership</p> <p>Next handles short-term choices like making a recreation trip</p> <p>Fills in the day sensitive to other people in the household and constraints like auto availability</p> <p>Complex choice-based models but actually more intuitive behaviorally</p> <p>Time of day is at 30 minute level based on trip chaining.</p>

Time of Day Factoring

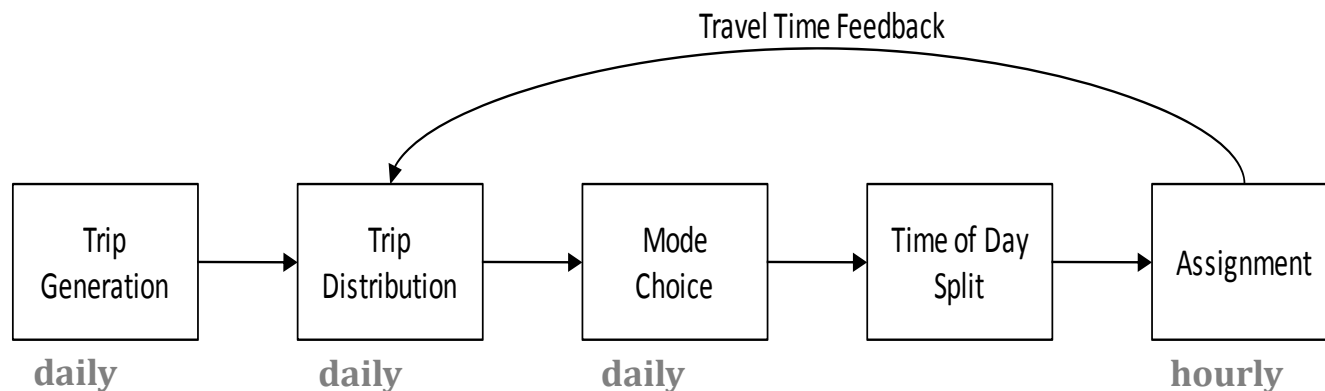
- Trips by purpose are allocated to each hourly time bin using factors derived from Household Survey and/or NHTS data
- Unique Time of Day factors for 'Departing' and 'Returning' trips (by purpose)



Where Time of Day falls in the model

Common practice

- Can model every hour of the day
- Can aggregate into 4 periods
- Feedback is usually AM for work trips, PM or OP for shopping and non-home based



Additional Considerations

Useful to have a group like the MTMUG that guides key decisions

- Data structures
- Model structures
- Joint contracts

Incremental Improvements & Versioning

- One size may not fit all (this was the case in every state previously listed)
- Need to allow incremental improvement
- Careful versioning and source control is important

Quality control around source code

- The model scripts can't have hard-coded data, variables or assumptions specific to one implementation
- Critical to use same version of TransCAD

Thank You

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April 7, 2011

