SEMCOG

The Southeast Michigan Council of Governments

SEMCOG Travel Models

Current Status and Future Development

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Transportation Modeling Group

A Presentation for
Transportation Technical Committee Meeting
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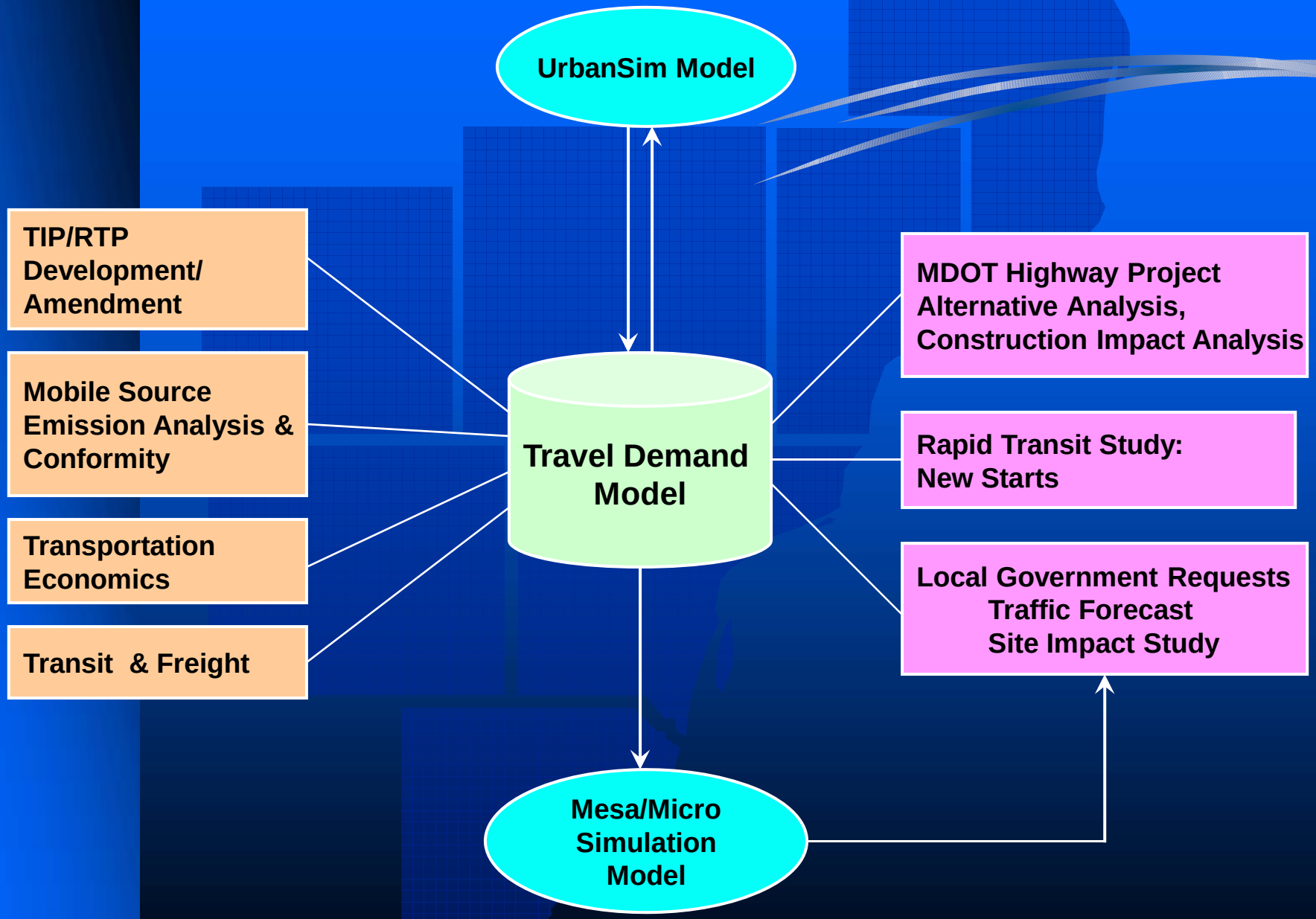
Predicting the impacts that various policies and programs will have on travel in the urban area.

- FHWA UMTA 1977

Modeling Objectives

- Consistent with “state-of-the-practice” modeling
- Tools that support all decision-making requirements, e.g. FTA new starts, RTP and TIP development, local project development
- Information required to estimate vehicle emissions for conformity determination


UrbanSim Model
TIP/RTP Development/ Amendment
Mobile Source Emission Analysis & Conformity
Transportation Economics
Transit & Freight
Travel Demand Model
MDOT Highway Project Alternative Analysis, Construction Impact Analysis
Rapid Transit Study: New Starts
Local Government Requests Traffic Forecast Site Impact Study
Mesa/Micro Simulation Model

Travel Model Versions

- E1: Translated from original TRANPLAN model (2001)
- E2 – E4: Different MGF and TransCAD versions, with various model improvements.
- E5: Updated version using 2005 HH survey data, with TransCAD 5.0

Data Used in Model Development

- Survey data
  - 2005 household travel survey
  - 1996 SEMCOG's Commercial Vehicle Survey for internal trips
  - 2001 On-board Transit Survey
  - 1995 external station survey
- 2035 Socioeconomic data
- SEMCOG Traffic Count Database System

2005 Household Travel Survey Background

- Combination of two household surveys
  - Michigan Travel Counts
  - SEMCOG Travel Counts
- Survey similarities
  - Consultants (MORPACE, PB, Brogan)
  - Activity-based survey design
  - Survey methodology
  - Relational database structure

	Michigan Travel Counts	SEMCOG Travel Counts
Area surveyed	State of Michigan	Southeast Michigan
Total households surveyed	15,000	3,800
SE MI households surveyed	2,200	3,800 (for total of 6,000)
Survey period	Feb ’04–Mar ’05	Oct ’04–May ’05
Days surveyed	Two days	One day
Prior residence?	No	Yes
“Stop along the way” question?	No	Yes
Transit focus?	No	Yes (600 samples)

SEMCOG's Post-Processing Data Checks

Database Integrity Checks

Individual Field Checks

Intra-Record Checks

Inter-Record Checks

Distribution Plots

Survey Sample Expansion

- Relational database structure: Household, Person, and Trip
- Stratified by Household size, auto ownership, number of workers, and County
- Used 2005 regional demographic statistics as population base

Survey Sample Expansion (cont.)

- Excluded second day trip diary from MDOT samples
- Aggregated cells with insufficient samples
- Used a four-dimensional balancing algorithm by Parsons to reach sector control totals

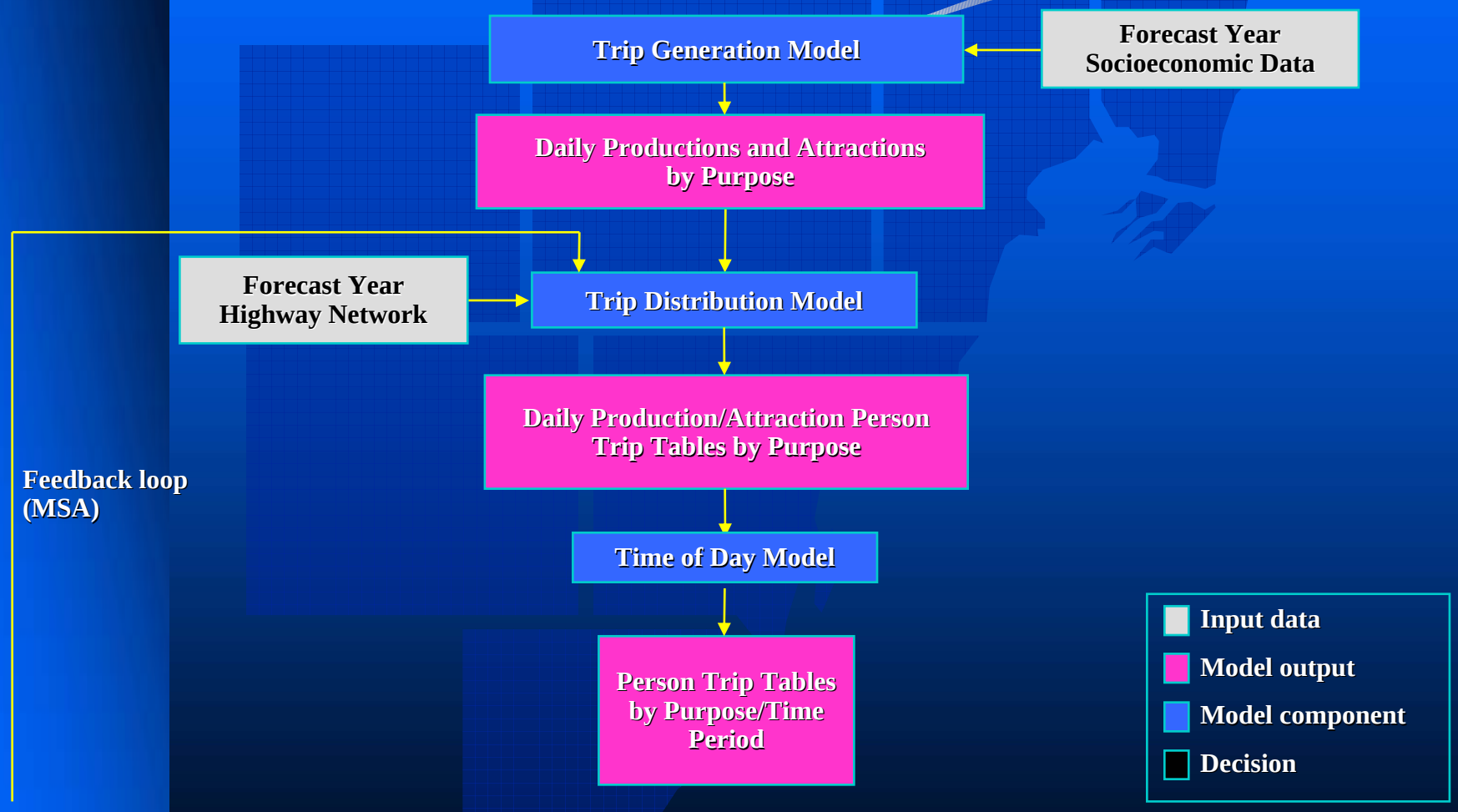
Using Final Expansion Factors

Category	2005 Households	Expanded Data	Percent Diff.
HH Size = 1	519,891	519,891	0.0%
HH Size = 2	598,931	598,931	0.0%
HH Size = 3	317,948	317,948	0.0%
HH Size = 4+	489,328	489,328	0.0%
Workers = 0	489,996	489,996	0.0%
Workers = 1	745,816	745,816	0.0%
Workers = 2	557,358	557,358	0.0%
Workers = 3+	132,929	132,929	0.0%
Overall	1,926,098	1,926,098	0.00%

Travel Model Steps

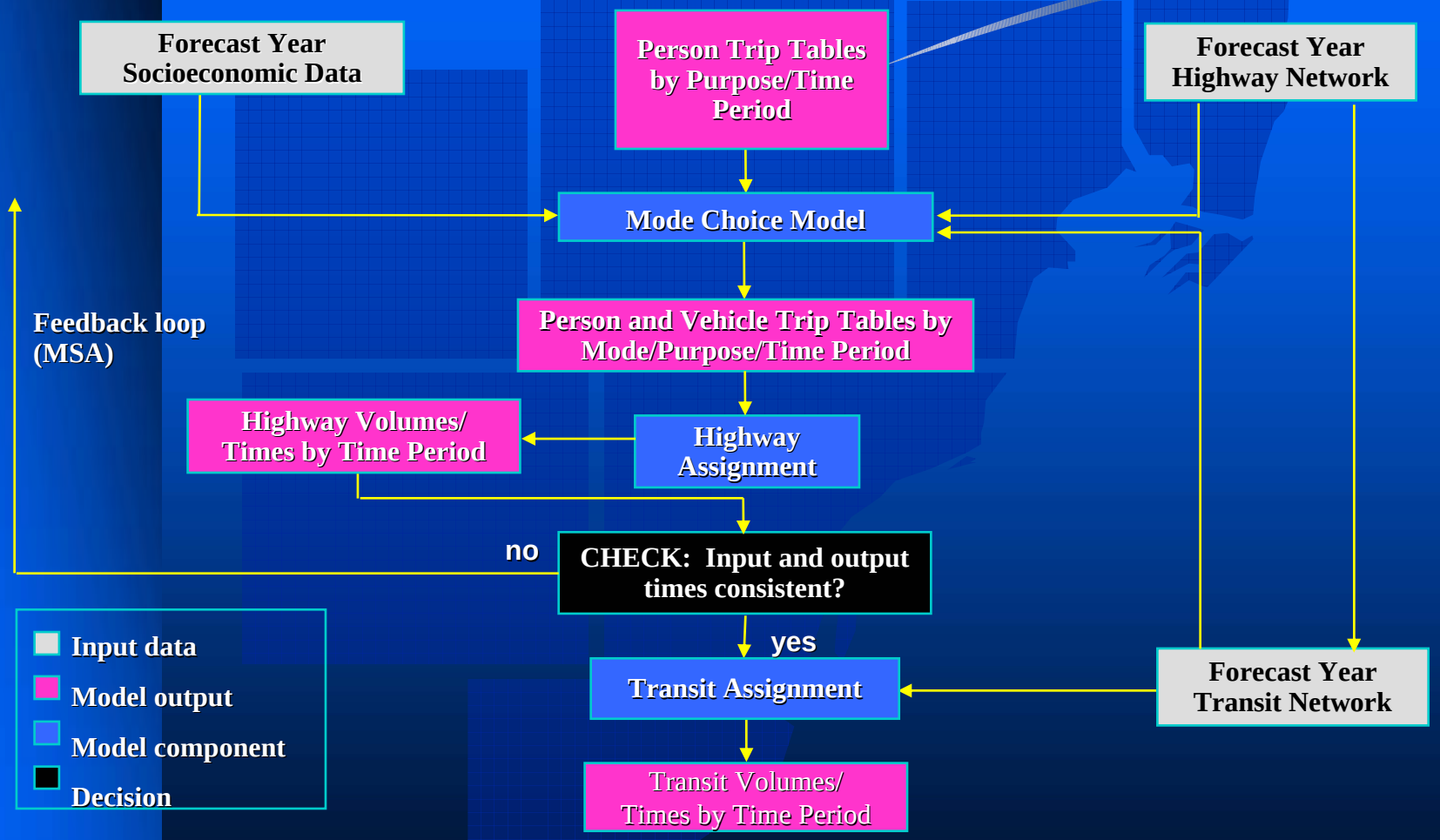
- Network and Zone Development
- Trip Generation
- Trip Distribution
- Time of Day
- Mode Choice
- Highway and Transit Assignment

SEMCOG Model Flow Chart



A SEMCOG presentation

SEMCOG Model Flow Chart (continued)



Highway Network

- Freeways, arterials, collectors, some local streets, ramps, & non-highway links & centroid connectors
- Attributes: Capacity, free-flow speed, distance, # of lanes, functional class, area type, etc.
- E5: derived from MGFv5 w/ approx. 34,400 links

Network & Zones

Model Version	E2	E4	E5
RTP	2025	2030	2035
# of TAZs	1,505	1,505	2,899
Total Links	19,533	23,090	34,425
Centroid Connectors	2,769	4,209	9,528
Avg CC/Zone	1.84	2.80	3.29

Transit Network

- Transit routes, walk and auto access links, park & ride lots
- Mode, fare, dwelling time, headway, operation period, speed, etc.
- E5: completely re-coded based on published 2007 schedule
- Transit modes: bus, express bus, BRT, light rail, commuter rail

Mode Table

MODE_NAME	MODE_ID	Type	Mode_Used	Fare_Type	XferFare	Max_IWait	Max_XWait
Transit Only	0	W	1				
Drive Only	1	H	1				
Drive and Walk	2	W	1				
Walk Only	3	W	1				
AATA Local	11	T	1	1	0		
AATA Express	12	T	0	1	0		
DDOT Local	15	T	1	1	0.25	30	25
DDOT Express	16	T	1	1	0.25	30	25
SMART Local	19	T	1	1	0.25	30	25
SMART Express	20	T	1	1	0.25	30	25
WALLY Commuter Rail	21	T	1	1	0.1		
AADD Commuter Rail	22	T	1	2			
RTCC LRT	24	T	1	1	1		
Detroit People Mover	25	T	1	1	0.5		
RTCC BRT	26	T	0	1			
WALLY Feeder Bus OutBound	27	T	1	1	0		
WALLY Feeder Bus InBound	28	T	1	1	0		
AADD Feeder Bus OutBound	29	T	1	1	0		
AADD Feeder Bus InBound	30	T	1	1	0		

Trip Generation

- Cross-classification for production
- Regression for attraction
- Six internal trip purposes: HBW, HBSH, HBSC, HBO, NHBW, NHBO
- Three commercial vehicle classes
- Internal-external (IE) / External-external (EE) trips

Trip Generation Input

- Population, households, school enrollment
- HH size based distribution: Auto ownership, # of workers and children
- Employment type: basic, non-basic, retail, other
- Acreage: employment, residential

HBW Production Rates

Workers/ Household	Autos/household			
	0	1	2	3+
1	1.34	1.13	1.38	1.46
2	2.27	2.06	2.31	2.39
3+	3.51	3.30	3.55	3.63

1994 HH Survey

Workers/ Household	Autos/household			
	0	1	2	3+
1	1.14	1.14	1.34	1.46
2	2.06	2.06	2.26	2.38
3+	3.89	3.89	4.09	4.21

2005 Travel Survey

Trip Rate Comparison

	1994 HH Survey		2005 HH Survey	
Trip Purpose	% of Trips	Trips/ Household	% of Trips	Trips/ Household
Home Based Work	16%	1.4	15%	1.4
Home Based Non-Work	53%	4.6	55%	5.4
Non-Home Based	32%	2.8	30%	3.0
Total	100%	8.7	100%	9.8

Attraction Models

		Total Emp	Households	Retail	Other	Emp Acres
E4/1994 HH Survey	HBW	1.390				
	HBO		2.211	3.394	0.570	
E5/2005 HH Survey	HBW	1.210				
	HBO		1.610	2.501	0.711	2.462

Trip Distribution Models

- Gravity model for trip distribution
- E4 time skim was attached as initial trip length
- Three formulations were tested
  1. Friction Factors
  2. Gamma function
  3. UTPS

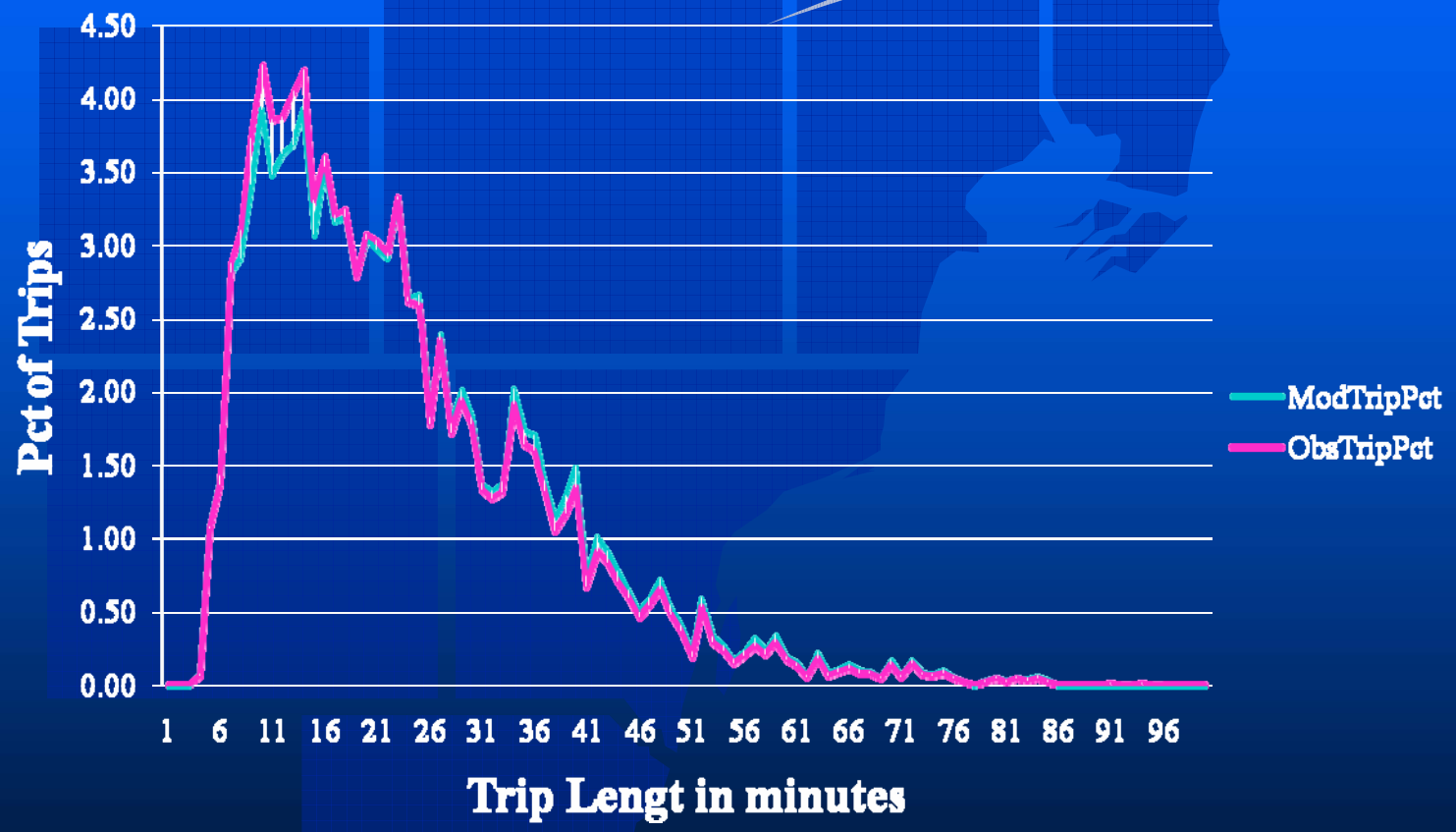
Average Trip Length

Trip Purpose	Friction Factor				Gamma Function			
	Observed	Model	Diff%	CR	Observed	Model	Diff%	CR
HBW	24.03	25.03	4.2%	90.0%	24.23	25.21	4.1%	86.0%
HBSH	13.25	13.96	5.4%	90.3%	13.16	13.76	4.6%	75.8%
HBSC	11.54	11.79	2.2%	87.8%	11.51	11.81	2.6%	71.6%
HBO	14.39	14.83	3.1%	94.1%	14.29	14.82	3.7%	82.9%
NHBW	19.75	20.78	5.2%	88.5%	19.39	21.38	10.3%	78.1%
NHBO	13.88	14.54	4.8%	91.7%	13.82	14.50	4.9%	83.3%

Trip Length Comparison

Trip Purpose	Average Trip Length (Minutes)		
	E4 Modeled 1994 Survey	E5 Modeled 2005 Survey	Diff%
HBW	24.2	25.0	3.4%
HBSH	16.7	14.0	-16.4%
HBSC	17.2	11.8	-31.5%
HBO	17.7	14.8	-16.2%
NHBW	19.4	20.8	7.1%
NHBO	16.1	14.5	-9.7%

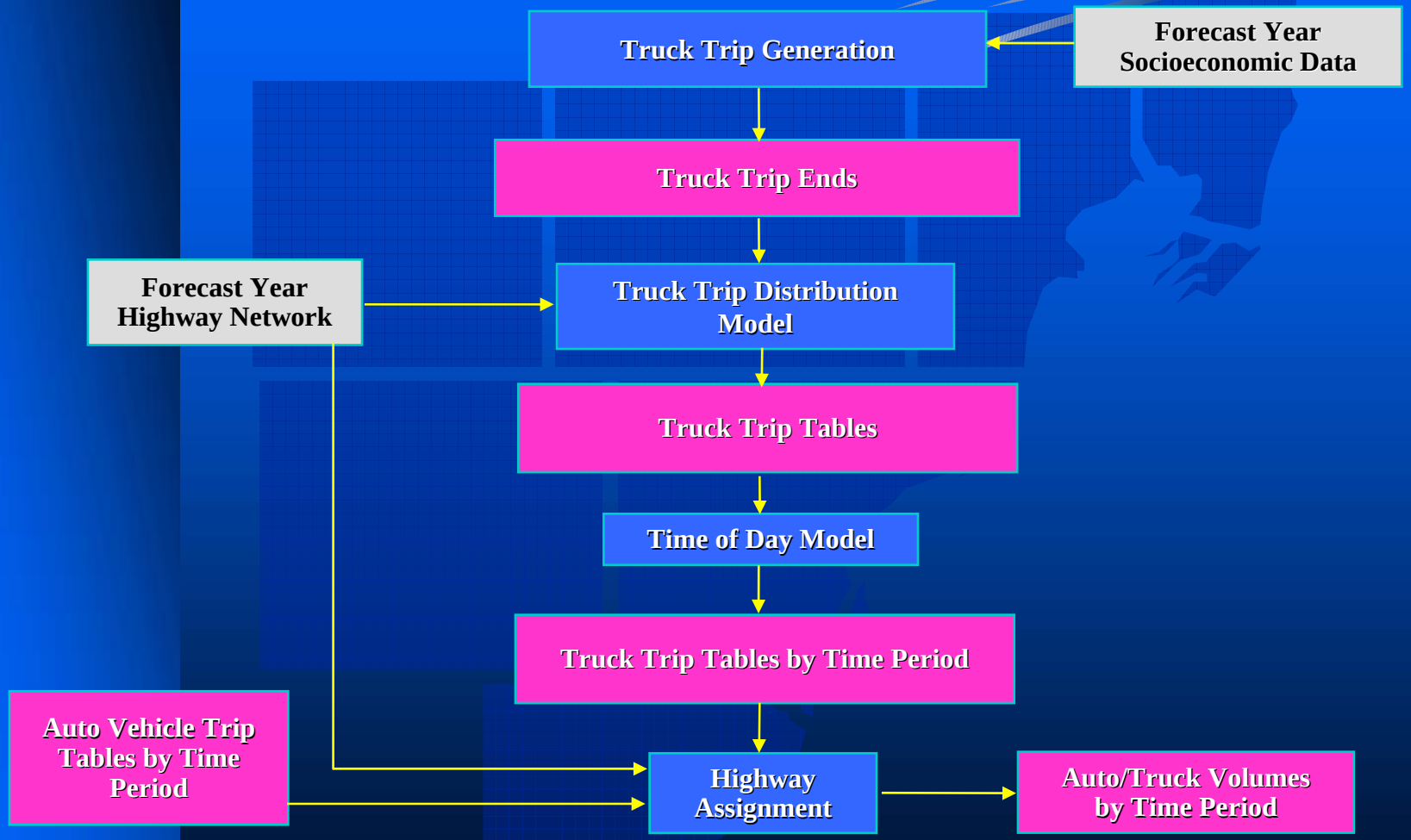
HBW Trip Length Distribution



External Travel Models

- External stations classified by roadway type
- Trip generation based on zone size and distance from regional boundary
- Gravity model for trip distribution
- Models based on external survey data

Truck Modeling Process



Commercial Vehicle Model

- Internal trip generation: rates based on CVS data
- Internal trip distribution: gravity models
- External trips: allocation of statewide trip tables
- Assignment: part of the multi-class assignment with auto trips

Time of Day

- Four periods defined from household survey data
  - Morning peak (07:00 – 09:00)
  - Mid-day (09:00 – 15:00)
  - Afternoon peak (15:00 – 18:00)
  - Off peak (18:00 – 07:00)
- Time of day (TOD) factors applied after trip distribution
- TOD factors are by purpose and based on 1994 household survey

Mode Choice

- Developed based on 1994 household & 2001 On-board Transit Survey
- Multinomial models: drive, walk to transit, drive to transit
- Auto availability considered
- Performed reasonableness check and adjusted based on other metro area practice

Mode Choice Parameters

- In-vehicle time, waiting time, transfer time, dwelling time, walk and drive access time, egress time, etc.
- Parking cost, drive cost, fare and transfer fare, value of time

Coefficient Adjustment

Coefficients	E4 Model		E5 Model	
	Work	Non Work	Work	Non Work
Auto IVTT/ Drive Access IVTT	-0.0522	-0.019	-0.02784	-0.019
Auto Mileage Cost	-0.00413	-0.00657	-0.00413	-0.00657
Auto OVTT/Terminal		-0.0408		-0.0408
Parking Cost	-0.00413	-0.00657	-0.00413	-0.00657
Transit Fare	-0.00413	-0.00224	-0.00413	-0.00657
Transit IVTT	-0.00928	-0.00224	-0.02784	-0.019
Transit OVTT	-0.0186	-0.00673	-0.0558	-0.0504
Access/Egress Time	-0.0186	-0.00673	-0.0558	-0.0504
PEVa (Dest/Attrac)	0.05	0.07	0.05	0.07
PEVb (Origin /Produc)		0.07		0.07
Pop_Density		0.056		0.056
MSadj1		-1.01		-1.25
MSadj2		-1.01		-1.25

Highway Assignment

- Multi--class user equilibrium assignment:
  - Single occupant auto, 2 person carpool, and 3+ person carpool
  - Light, medium, and heavy trucks
- Modified BPR volume-delay flow curve
- Generalized cost functions, with value of time (15c/minute) and auto driving cost (35c/mile)

Assignment Calibration

Volume-Based Statistics: 2004-06 AWDT

Filters	Cnt Mean	Mod Mean	Obs	Per Error	PRMSE	R Squared
System	14,279	14,112	6,982	-1.2%	53.0%	0.689
FC=1&2 Freeway	42,390	41,076	320	-3.1%	36.9%	0.605
FC=4 Maj. Arterial	24,553	23,278	1,735	-5.2%	39.8%	0.357
FC=5 Min. Arterial	12,663	12,441	2,403	-1.8%	48.4%	0.382
FC=6 Collector	4,037	5,724	1,656	41.8%	117.3%	0.142
Obs:>= 50K	67,039	55,589	155	-17.1%	31.3%	0.257
Obs:25-50K	33,149	27,944	1,003	-15.7%	33.2%	0.160
Obs:10-25K	16,368	15,900	2,472	-2.9%	41.1%	0.213
Obs:5-10K	7,324	8,779	1,490	19.9%	74.7%	0.059
Obs:< 5K	2,514	5,102	1,862	103.0%	213.0%	0.030
COUNTY=1 DET	15,768	15,679	584	-0.6%	62.9%	0.712
COUNTY=2 WAY	16,699	15,252	971	-8.7%	49.1%	0.686
COUNTY=3 OAK	16,912	17,107	2,383	1.2%	48.6%	0.637
COUNTY=4 MAC	16,669	14,578	1,031	-12.5%	47.5%	0.674
COUNTY=5 WAS	10,112	10,933	871	8.1%	49.7%	0.761
COUNTY=6 MON	5,997	7,838	410	30.7%	90.8%	0.570
COUNTY=7 STC	10,686	8,756	143	-18.1%	41.1%	0.796
	6,773	8,111	589	19.7%	72.5%	0.700

Transit Assignment

- Transit trip tables assigned based on shortest path (TransCAD pathfinder)
- Walk access trips subject to maximum walk time of 18 minutes
- Auto access trips must go through park-and-ride lot

Transit Network Parameters

Variables	E4 Model	E5 Model
Max. # of Transfers	3.00	3.00
Value of Time	0.02	0.08
Fare	1.25	1.25
Transfer Fare	0.40	0.25
Drive Time Weight		3.00
Wait Time Weight	2.40	2.40
Dwell Time Weigh	-	-
Walk Time Weight	2.40	2.40
Max Drive Time	45.00	45.00
Transfer Penalty Time	3.00	6.00
Max Wait Time	20.00	20.00
Min Wait Time	2.00	2.00
Layover Time	5.00	5.00
Max Access Time	18.00	18.00
Max Egress Time	18.00	18.00
Max Transfer Time	18.00	18.00
Max Total Cost	6.50	20.00
Max Walk Access Paths	10.00	10.00
Combination Factor	-	0.50

Feedback Among Model Steps

- Uses method of successive averages (MSA) for feedback
- Convergence based on changes in link volumes and adjusted to balance needs and computation time
- Weighted averaging method of computing daily travel times

Summary of E5 Model Improvements

- 2900 zone system and MGF5 based highway network
- New-built transit network
- Network Management System
- Transit mode and transfer tables
- Enhanced area type model

Summary of E5 Model Improvements (cont.)

- Updated trip generation and distribution models using 2005 HH survey
- Restructured mode-choice model w/ updated parameters
- Re-calibration of highway assignment using 2004-06 traffic counts with new seasonal adjustment factors

Current Projects

- E6 Model Development
  - Highway functional class improvement
  - Trip generation with income stratification
  - Trip distribution model options
  - Nested logit mode choice model
  - External trip model improvement
  - Commercial vehicle model recalibration
  - Time-of-Day stratification

Current Projects (cont.)

- Novi-Farmington Hills subarea demonstration project
  - Micro-simulation using TransModeler
  - Dynamic Traffic Assignment (DTA)
- MOVES application development
- 2010 On-Board Transit Survey

Future Projects

- Synthetic population
- Destination choice model
- Advanced assignment method
- Multi-year model development plan
- Activity based model preparation
- Signal database

Challenges?

- Balance needs and resources
- Address policy related questions
- SE data consistency

Thank you very much ☺