An introduction to the COG/TPB Travel Model

Presented at the March 11, 2014 meeting/webinar of the Cooperative Forecasting and Data Subcommittee, held at the Metropolitan Washington Council of Governments

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Metropolitan Washington Council of Governments (COG)
National Capital Region Transportation Planning Board (TPB)

Overview

1. Differences between COG and TPB
2. Model development process at COG
3. Modeled area: the area covered by the model
4. Overview of four-step models
5. Zone system
6. Inputs to the model
7. Demographic models
8. Conclusions

The last time I presented this topic to the subcommittee was 2002

Metropolitan Washington Council of Governments (MWCOG or COG)

- Voluntary organization of local governments in the Washington, D.C. metropolitan area
  - Washington, D.C.
  - Suburban MD & Northern VA
- Founded in 1957, independent, non-profit association
- Mission: To enhance the quality of life in the Washington metropolitan region, particularly as it relates to regional issues, such as air quality, transportation, affordable housing, and public safety
- Staff: 120 employees

National Capital Region Transportation Planning Board (NCRTPB or TPB)

- One of several policy boards that operate at COG
- Federally designated Metropolitan Planning Organization (MPO) for the Washington, D.C. metropolitan area
- Created in 1965 by the region's local and state governments; Associated with COG in 1966
- Prepares a financially constrained, long-range transportation plan (25+ years) that the federal govt. must approve in order for federal-aid transportation funds to flow to the region
- Staffed by COG's Dept. of Transportation Planning (DTP) – ca. 60 people
- About 380 MPOs in U.S. (11% pop. > 1 M)

Model development process at COG

- COG/TPB staff develops and maintains, with consultant assistance, a series of regional travel demand models
- These regional models are developed under the guidance of the Travel Forecasting Subcommittee (TFS), a subcommittee of TPB's Technical Committee
- At any given time, COG/TPB staff typically maintains two regional travel demand models
  - An adopted, production-use model
  - A developmental model
- The production-use model is the one that is used planning studies conducted by COG/TPB and is made available to outside parties for their use

Model development process at COG

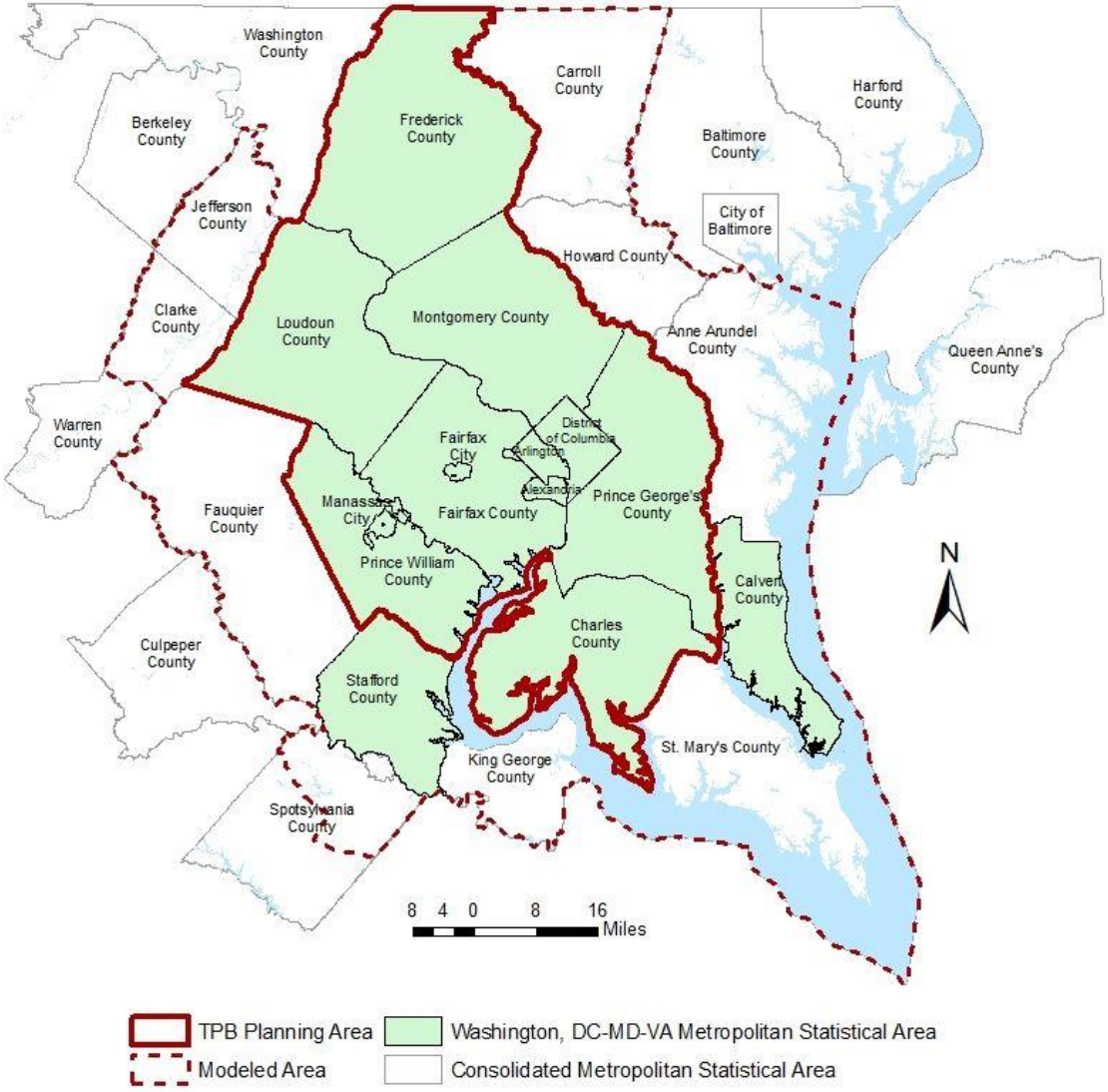
- Current production-use model is the Version 2.3 Travel Model, Build 52
  - Each major change or revision to the model is referred to as a "build" and is often indicated as the third index in the model version number, e.g., Version 2.3.52
- Version 2.3.52 Travel Model became the adopted, production-use model on July 17, 2013, when the TPB took two actions
  - Approved the air quality conformity (AQC) analysis of the 2013 Constrained, Long-Range Transportation Plan (CLRP) and the FY 2013-2018 Transportation Improvement Plan (TIP)
  - Approved the 2013 CLRP

Model development process at COG

- Version 2.3 model was calibrated to year-2007 conditions in 2012, and this work was documented in a calibration report
  - *Calibration Report for the TPB Travel Forecasting Model, Version 2.3, on the 3,722-Zone Area System*. January 20, 2012.
- In 2013, the model was validated to year-2010 conditions, and this work was documented in a recent memo and is also in an appendix to the latest AQC report:
  - Milone, Ronald. "2010 Validation of the Version 2.3 Travel Demand Model." Memorandum, June 30, 2013.

Modeled area

- Larger than either the TPB planning area or MSA
- Ensures better modeled results in TPB planning area
- Influenced by air quality conformity requirements
- 5 million people and 3 million jobs
- 6,800 sq. mi. (4,000 sq. mi. in MSA)
- 22 “jurisdictions”
- DC, MD, VA, & 1 county in WVA

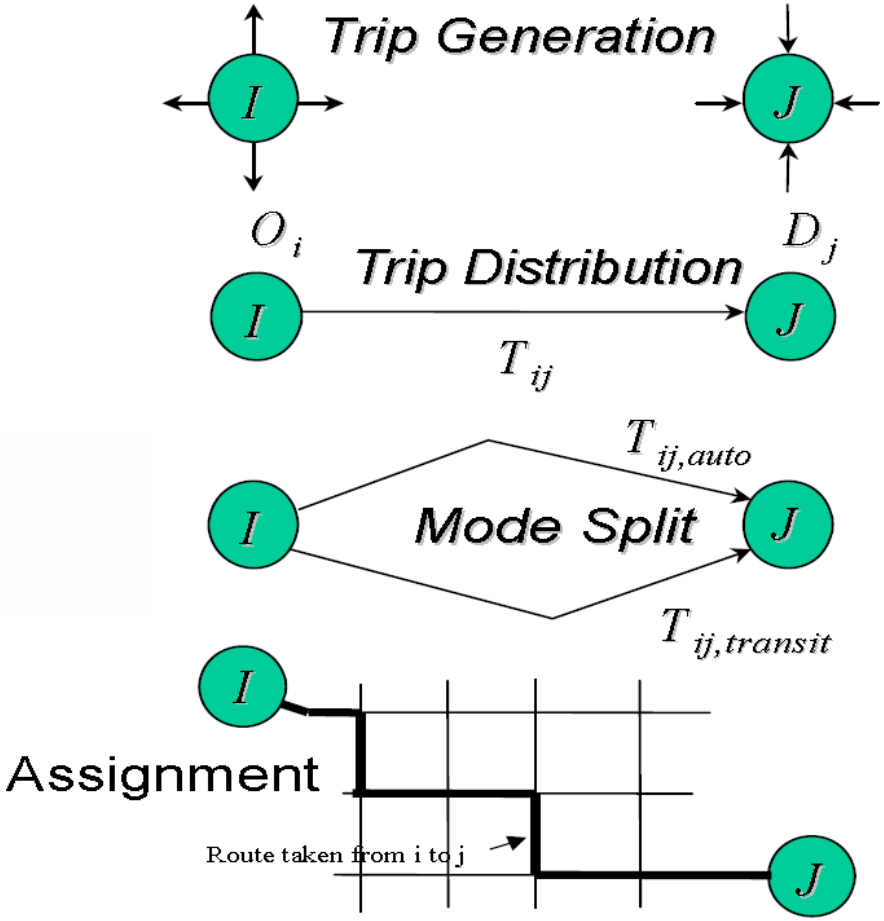


Structure of the travel model

- TPB Version 2.3 Travel Model is a classic, trip-based, “four-step,” regional travel demand model
  - Trip generation
  - Trip distribution
  - Mode choice
  - Traffic assignment
- The model actually has six major steps and includes both traffic assignment and transit assignment (discussed later)

Four-step travel model: Overview

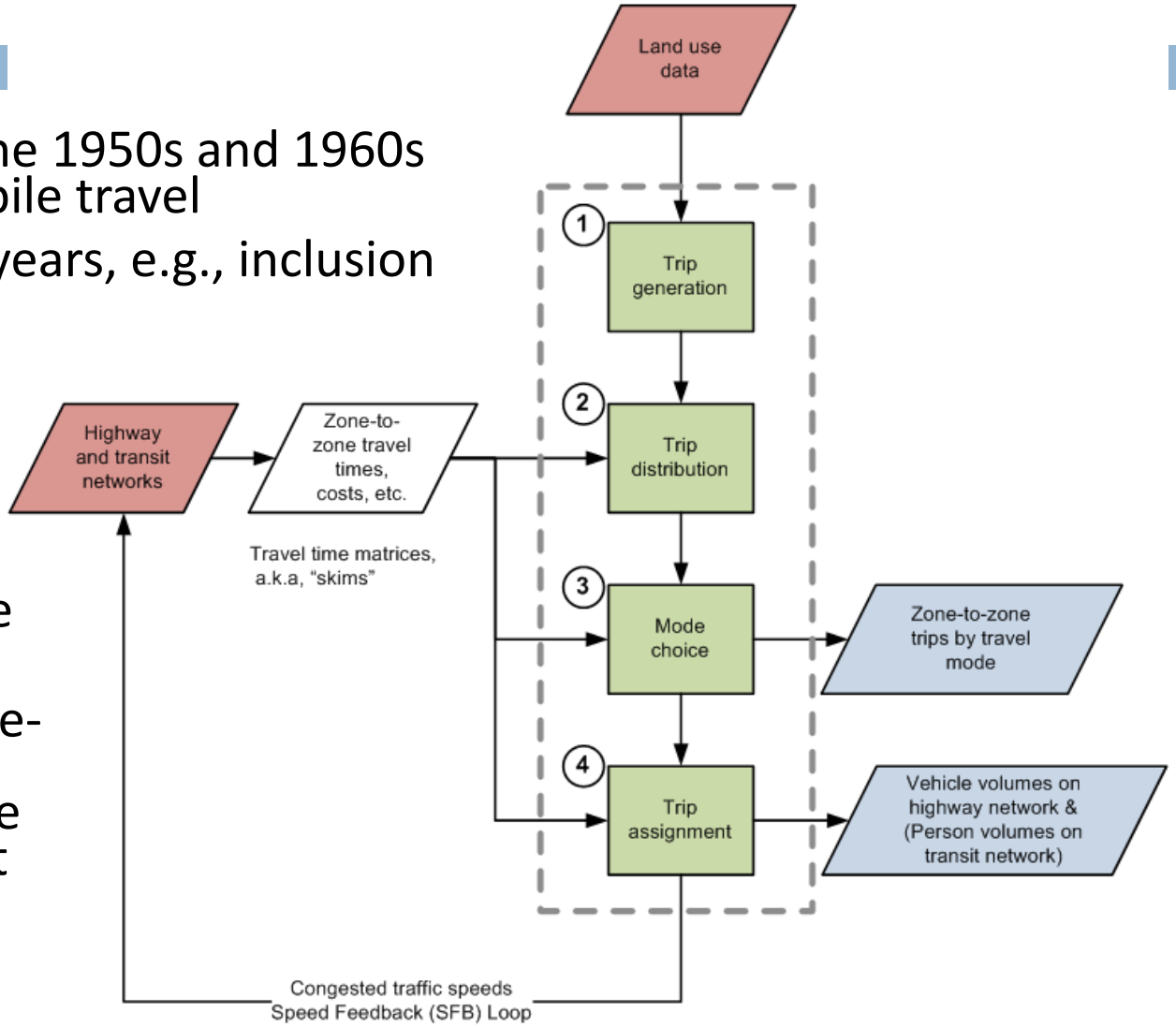
- Trip generation
  - Predict the no. of trip ends generated in each zone
- Trip distribution
  - Predict where trips are going, i.e., connecting trip ends into trips
- Mode choice
  - Predict the share of trips made by each travel mode
- Trip assignment
  - Assign trips to the network. Equilibration of supply and demand



Graphic from Meyer & Miller (2001), p. 272

Four-step travel model: Overview

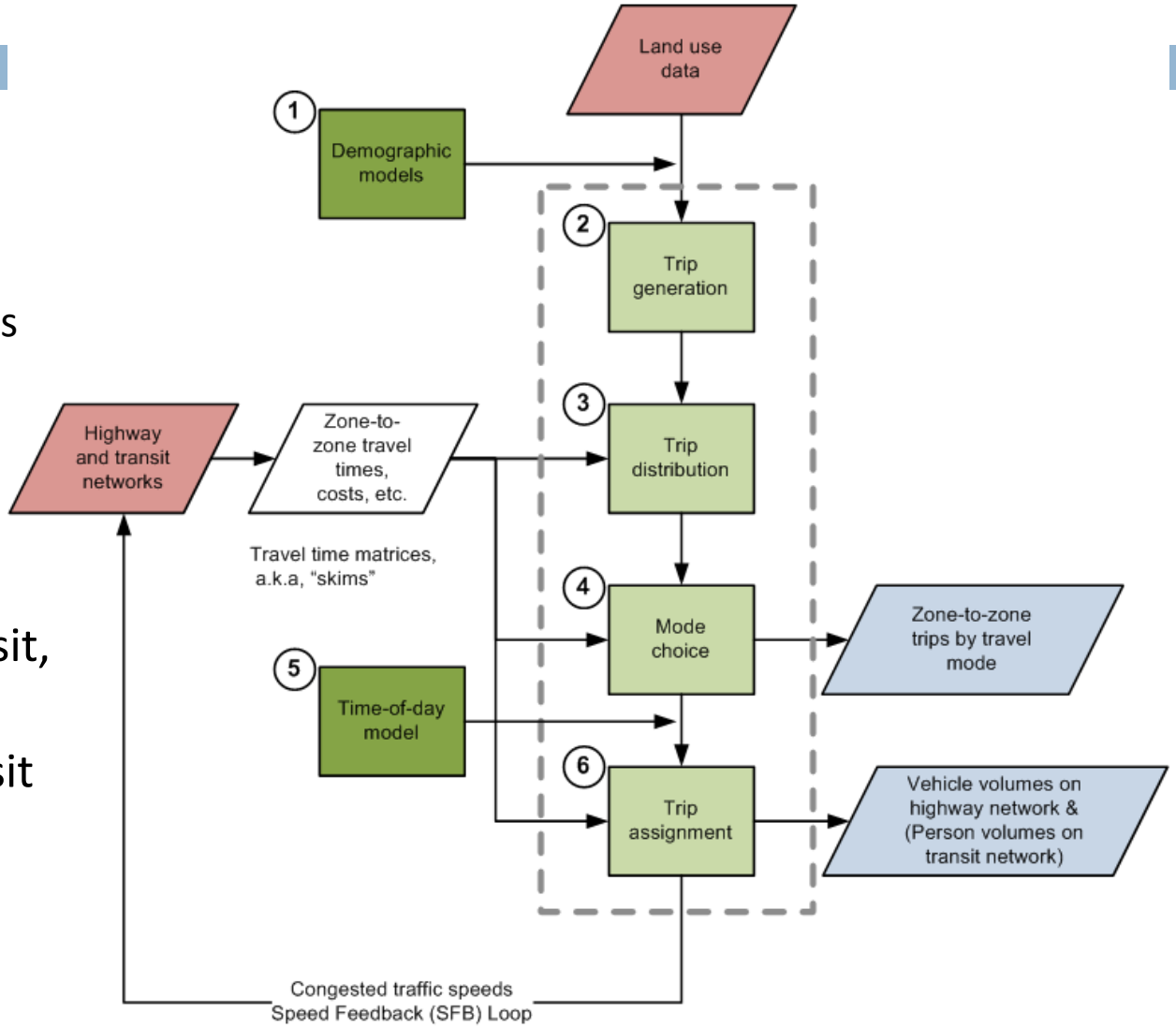
- First developed in the 1950s and 1960s to forecast automobile travel
- Enhanced over the years, e.g., inclusion of transit



- Urban area must be divided into zones
- Model predicts zone-to-zone person and vehicle flows via the highway and transit networks

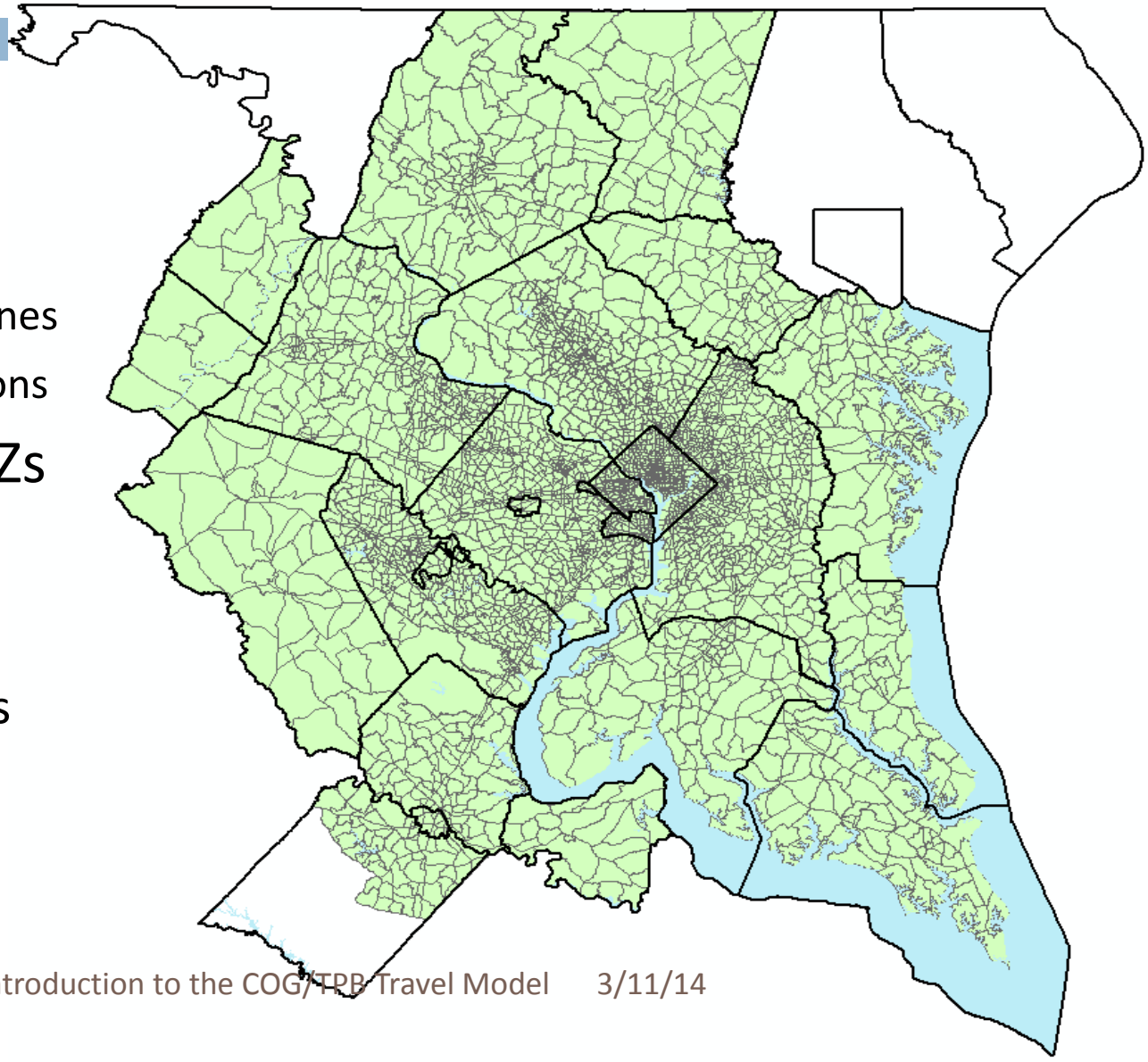
Six-step travel model?

- Four-step model is often a six-step model
  - Pre trip generation demographic models
    - Household size
    - Household income group
    - Vehicle ownership
  - Time-of-day model
- Also, in larger urban areas with good transit, the last step often includes both traffic assignment and transit assignment.



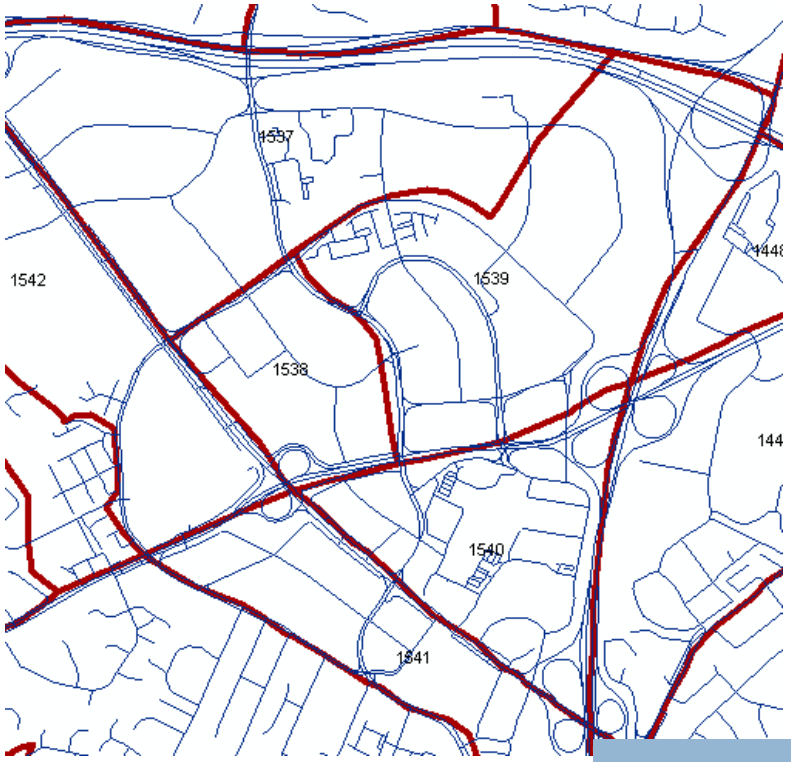
Zone system, Ver. 2.3 Travel Model

- Transportation Analysis Zones (TAZs)
  - 3,675 internal zones
  - 47 external stations
  - 3,722 total TAZs
- 6,800 sq. mi.
- 22 jurisdictions
- DC & three states (MD, VA, WVA)

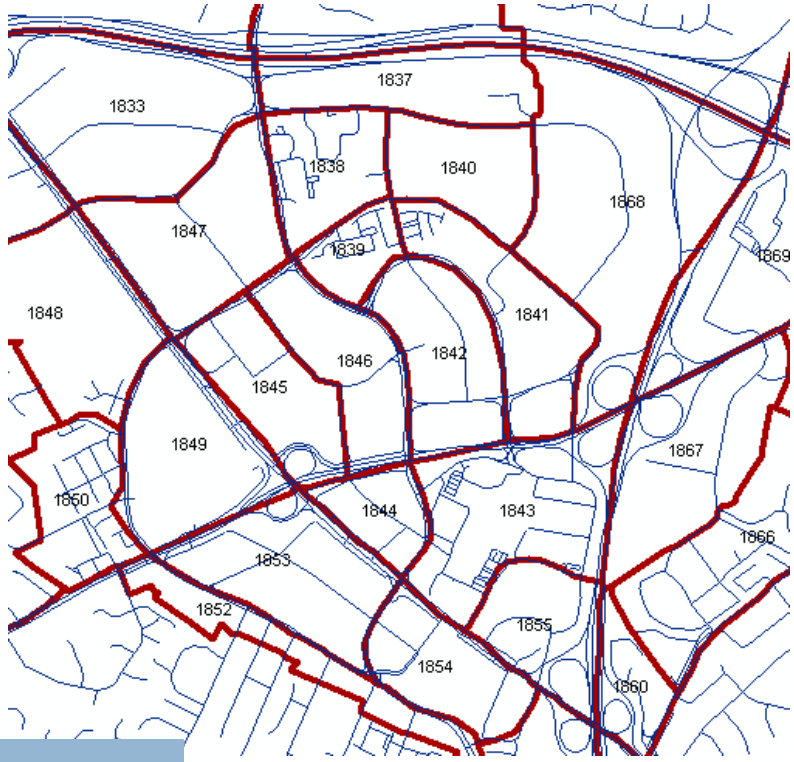


Increased number of TAZs in 2009: Example: Tysons Corner, Virginia

2,191-TAZ system



3,722-TAZ system



4 TAZs is now 14 TAZs

COG TAZ vs. TPB TAZ

- 3,722-TAZ area system was developed in 2008-2009
- Reviews of the initial 3,722-TAZ system used in the COG Cooperative Forecasting process uncovered instances where TAZ boundary refinements were needed
- Final result: There are now two sets of zones for the 3,722-TAZ area system
  - COG TAZs: For land activity forecasts
  - TPB TAZs: For transportation modeling
- Specific differences are discussed in a recent draft report:
  - Highway and Transit Networks for the Version 2.3.52 Travel Model, Based on the 2013 CLRP and FY 2013-2018 TIP. Draft. February 14, 2014 (p. 2-5)

Model inputs: Land use forecasts

- Households
- Household population
- Group quarters population
  - e.g., correctional institutions, nursing homes, juvenile institutions, college dormitories, military quarters, and group homes
- Total population
- Total employment
  - Industrial employment
  - Retail employment
  - Office employment
  - Other employment

Model inputs: Land use forecasts

- Zone-level land activity forecasts are developed by COG's Cooperative Forecasting Program, via its Cooperative Forecasting and Data Subcommittee
- COG does not use a formal land use model
  - In the early 1970s, COG tried using a land use model (EMPIRIC), but staff was not satisfied with its performance, and abandoned its use.
- Instead, like many MPOs, COG uses a process, often known as a "modified Delphi process," which involves reconciling top-down and bottom-up land activity forecasts

Model inputs: Land use forecasts

- Top-down forecasts are regional econometric projections of employment, population, and households
- Bottom-up forecasts are for the same 3 variables, but are made at the zone level, based on information from the local governments. Forecasts are derived from
  - Building permits (providing short-term information)
  - Comprehensive land use plans (providing long-term information)
- Each update of the zone-level, land activity forecasts in the Cooperative Forecasting program is called a "round" and the latest update is Round 8.2.

CTPP-based employment adjustment

- Before the zone-level land activity data can be used as an input to the travel model, it must undergo an adjustment process, known as the CTPP-based employment adjustment
- This ensures that a consistent employment definition is used by all counties and jurisdictions in the modeled area
- Rationale: Different jurisdictions in the modeled area use different definitions of employment. For example,
  - Baltimore region jurisdictions develop their base-year employment estimates using data from Bureau of Economic Analysis (BEA).
  - By contrast, Washington region jurisdictions develop their base-year employment estimates using data from the Quarterly Census of Employment and Wages (QCEW) collected by the Bureau of Labor Statistics (BLS).

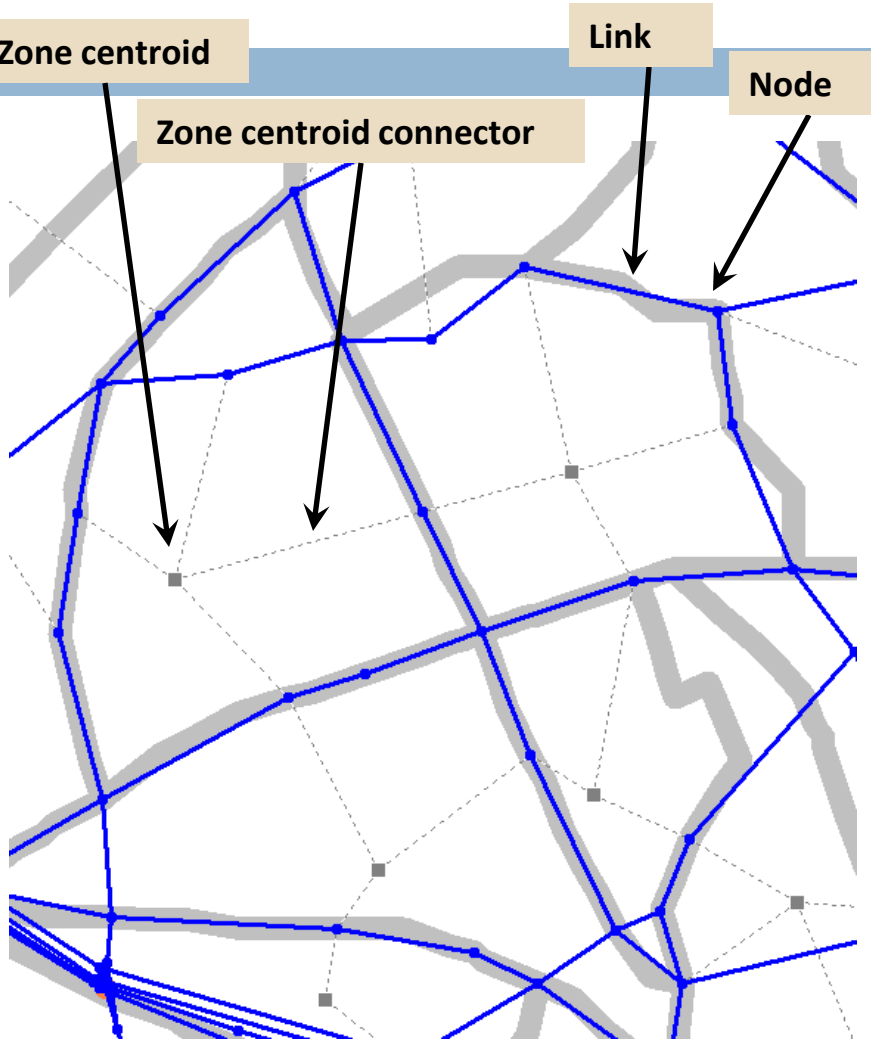
CTPP-based employment adjustment

- Current adjustment factors

Juris	CTPP-Based Employment Factor
dc	
mtg	
pg	
arl	
alx	1.000000
ffx	
ldn	
pw	
frd	
how	0.844375
aa	0.853219
chs	1.000788
car	0.802331
cal	0.998598
stm	0.939573
kg	
fbg	1.000000
sta	
spt	
fau	1.224679
clk	1.343964
jef	1.254410

Model inputs: Highway Network

- Primary building blocks: links and nodes
- Highway links can be 1-way or 2-way
- Highway links: 1) freeways, 2) arterials, 3) collectors, 4) local roads
- Region is divided into TAZs
  - Zone boundaries are not explicitly part of highway network
  - Though zones centroids are included
- Centroids are connected to road links by centroid connectors
  - Each zone centroid connector represents one or more local roads in a zone
- External stations



Highway network attributes: Area type

- A measure of the land use density and mixing
- A function of zonal population density and zonal employment density
  - 1 => Urban
  - 6 => Exurban
- Both link capacity and free-flow link speeds are a function of area type & facility type (road type)
- Other models that use area type
  - Vehicle availability
  - Trip attraction
  - Non-motorized (walk & bike) trip end

One-Mile "Floating" Population Density (Pop/Sq mi)	One- mile "Floating" Employment Density (Emp/Sq mi)						
	0-100	101-350	351-1,500	1,501-3,550	3,551-13,750	13,751-15,000	15,001+
0-750	6	6	5	3	3	3	2
751-1,500	6	5	5	3	3	3	2
1,501-3,500	6	5	5	3	3	2	2
3,501-6,000	6	4	4	3	2	2	1
6,001-10,000	4	4	4	2	2	2	1
10,001-15,000	4	4	4	2	2	2	1
15,001+	2	2	2	2	2	1	1

Model inputs: Transit network

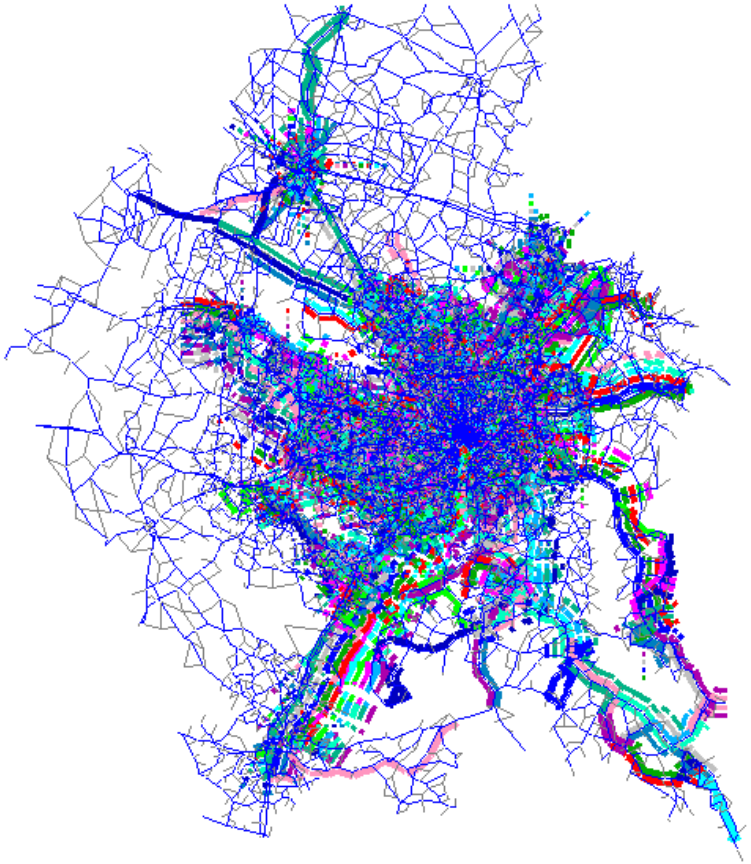
	Element	Description
Base	Highway network	
Add	Transit infrastructure	• Rail stations (nodes) • Rail links • Park-and-ride lots (nodes)

	Transit service	• Transit routes (path, headway, speed) by mode
		  • Local bus
		  • Express bus
		  • Metrorail
		  • Commuter rail
		  • Light rail transit (LRT)
		  • Bus rapid transit (BRT)

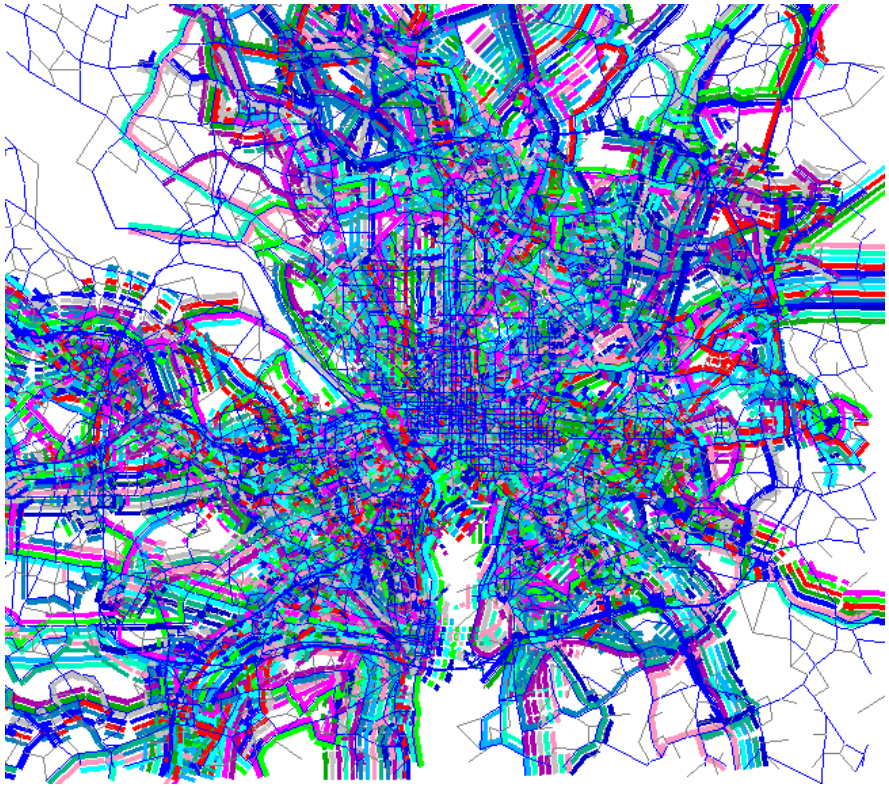
	Support links	• Access links (walk, KNR, PNR) • Transfer links (from one mode to another)

Model inputs: Transit network: AM, 2010

Entire region

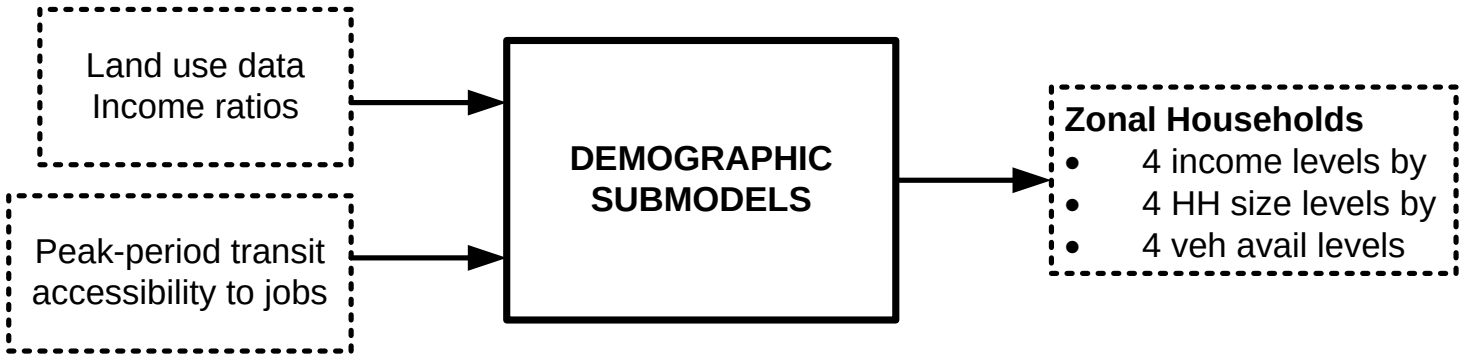


Inside the Beltway



Demographic models

- Apportion zonal households into 64 subclasses
  - Four HH size groups (1, 2, 3, 4+)
  - Four HH income groups (1st quarter, 2nd, 3rd, 4th)
  - Four HH vehicle availability groups (0, 1, 2, 3+)



Demographic models

- HH size and HH income models are "aggregate share" models calibrated from 2000 CTPP
  - HH income model was adjusted with 2007 ACS
- HH vehicle availability model is a discrete choice model estimated using the COG 2007/2008 Household Travel Survey
  - Vehicle availability = function of
    - HH size
    - HH income
    - transit accessibility to jobs
    - area type
    - DC indicator variable

Source: Martchouk, M. (2010, September 17). *Ver. 2.3 travel model, demographic sub-models: Household size, household income, and vehicle availability*. Presented at the September 17, 2010 meeting of the Travel Forecasting Subcommittee, held at the Metropolitan Washington Council of Governments, Washington, D.C.

Conclusions

- Your zone-level land activity forecasts are a vital input to the regional travel model
  - Thank you!
- We must apply an adjustment to employment data before it can be used by the model
- Our three demographic models are used to make forecasts that we do not currently get from the land use planners, such as no. of HHs by
  - HH size, HH income, and vehicle availability

Thank you!

- Questions?

- Mark Moran (mmoran@mwcog.org)