Activity-Based Models
1994-2009

ITS Lab Presentation
March 10, 2009

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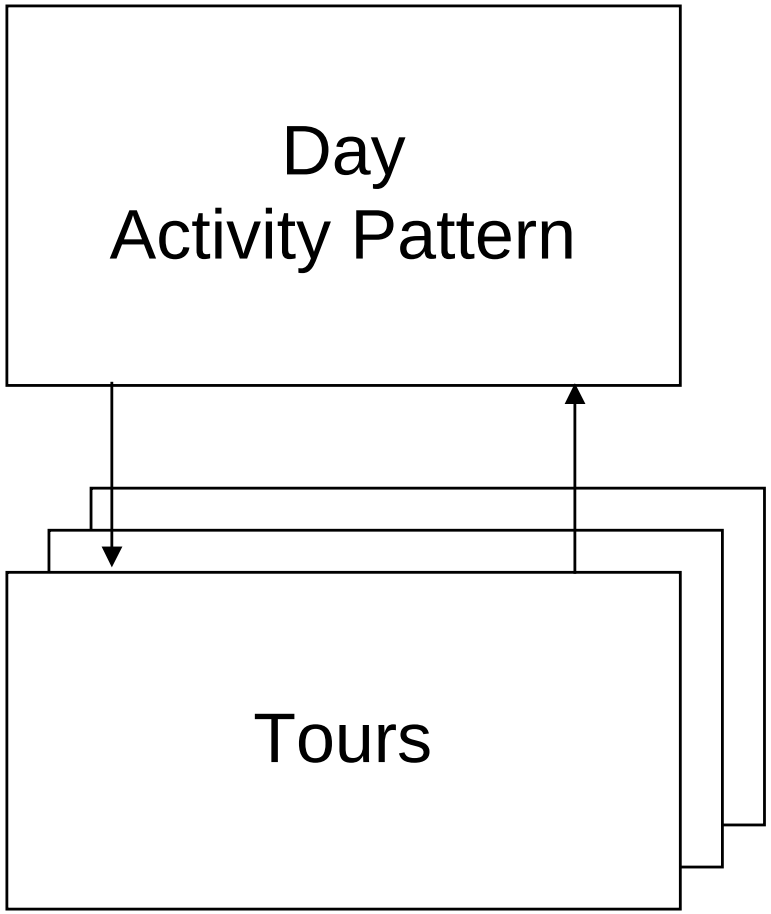
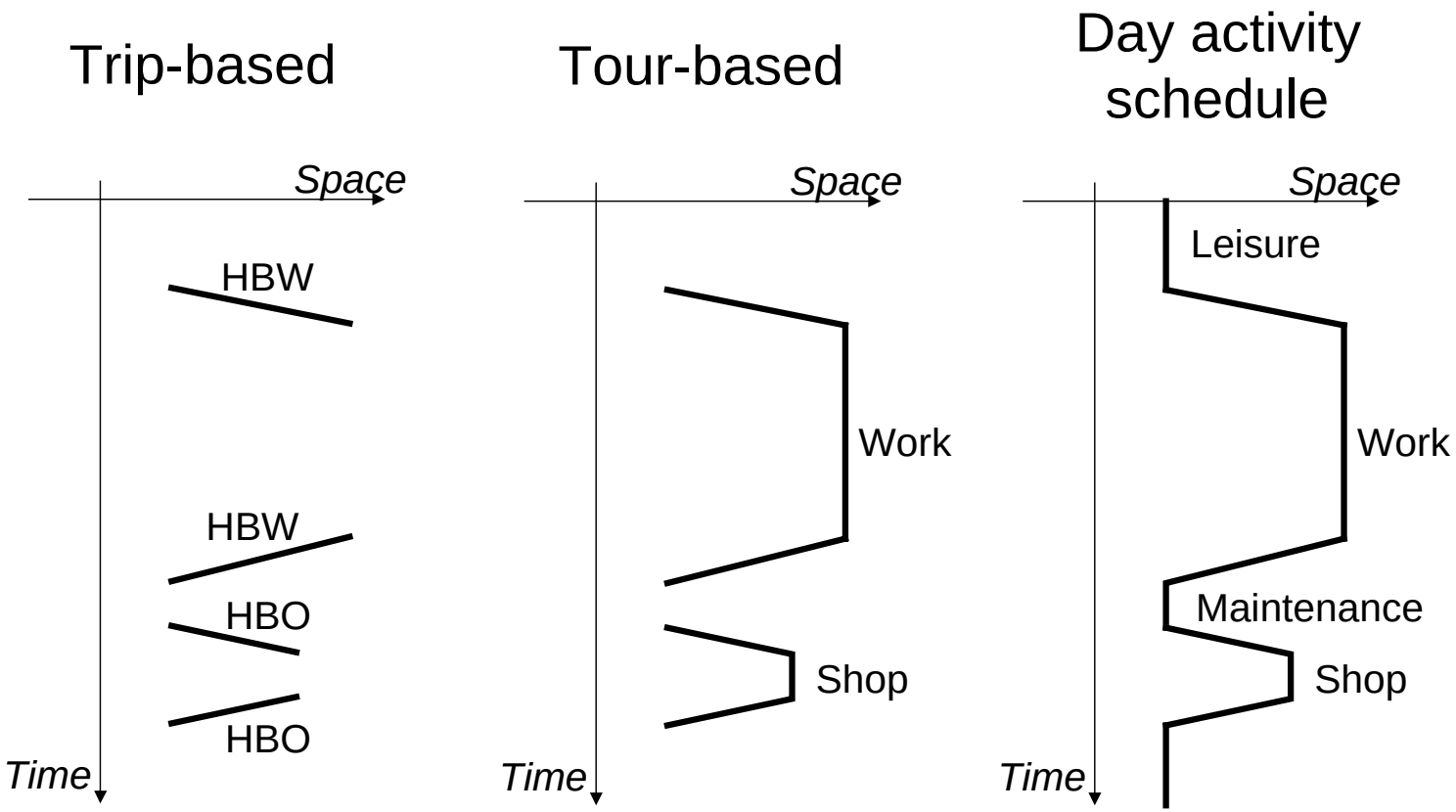
Activity-Based Models
1994-2009

- Day Activity Schedule Approach
- What's happening in the US
- Basics of the "Activity-Based" model systems
- Technical evolution
- What lies ahead?

The Day Activity Schedule
(TRB January 1994)



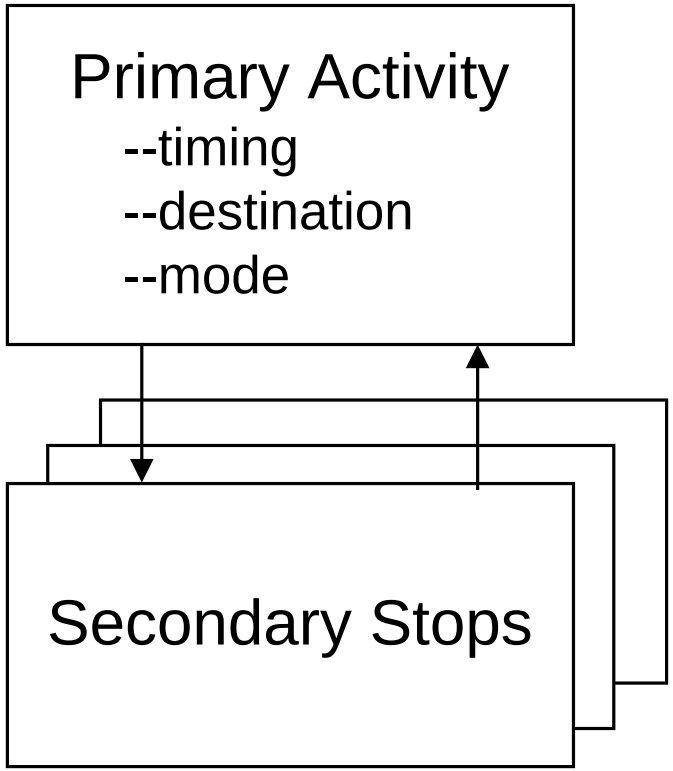
Discrete Choice Approaches



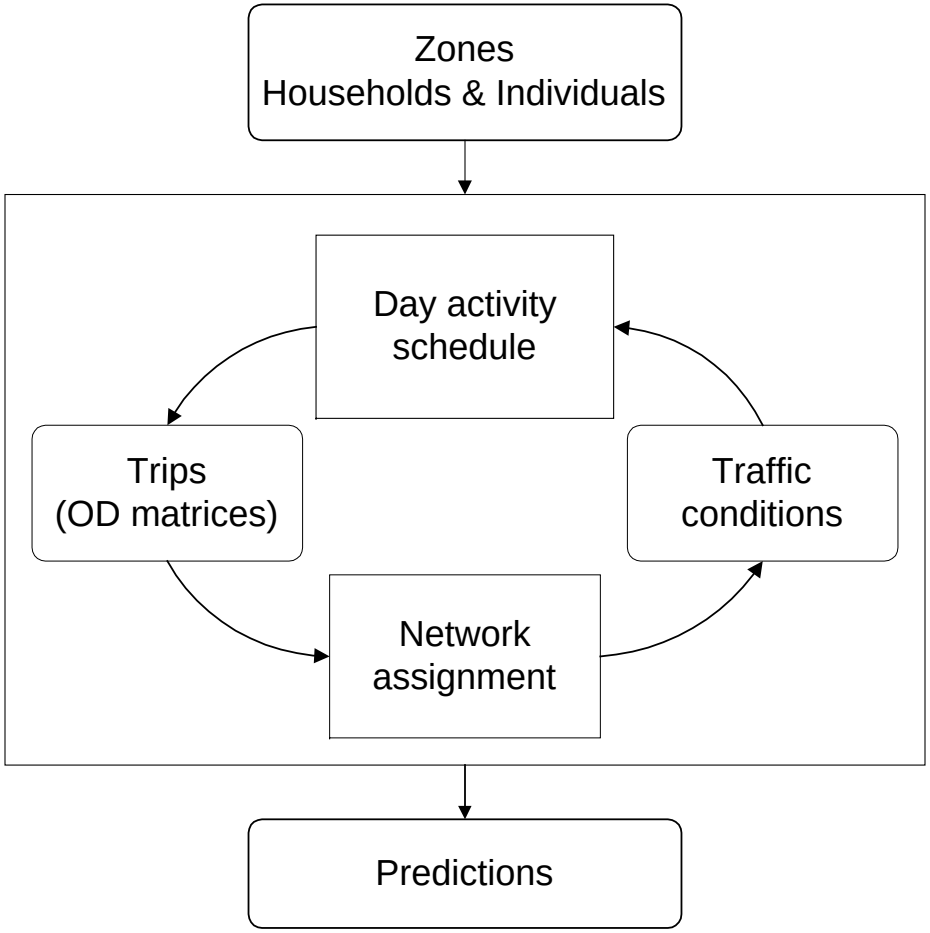
Day Activity Pattern

Day Activity Pattern
-- primary activity -- primary tour type -- number and purpose of secondary tours -- number and purpose of activity stops in secondary tours

Tours


Primary Activity
--timing
--destination
--mode
Secondary Stops

Model Application



Jan 1995: MIT Prototype

- 😐 operational for forecasting and policy analysis
- ☺ available data and discrete choice methods
- ☺ integrated system of daily activity and travel choices
  - ☺ tours in a daily activity pattern
  - 😐 activity time of day

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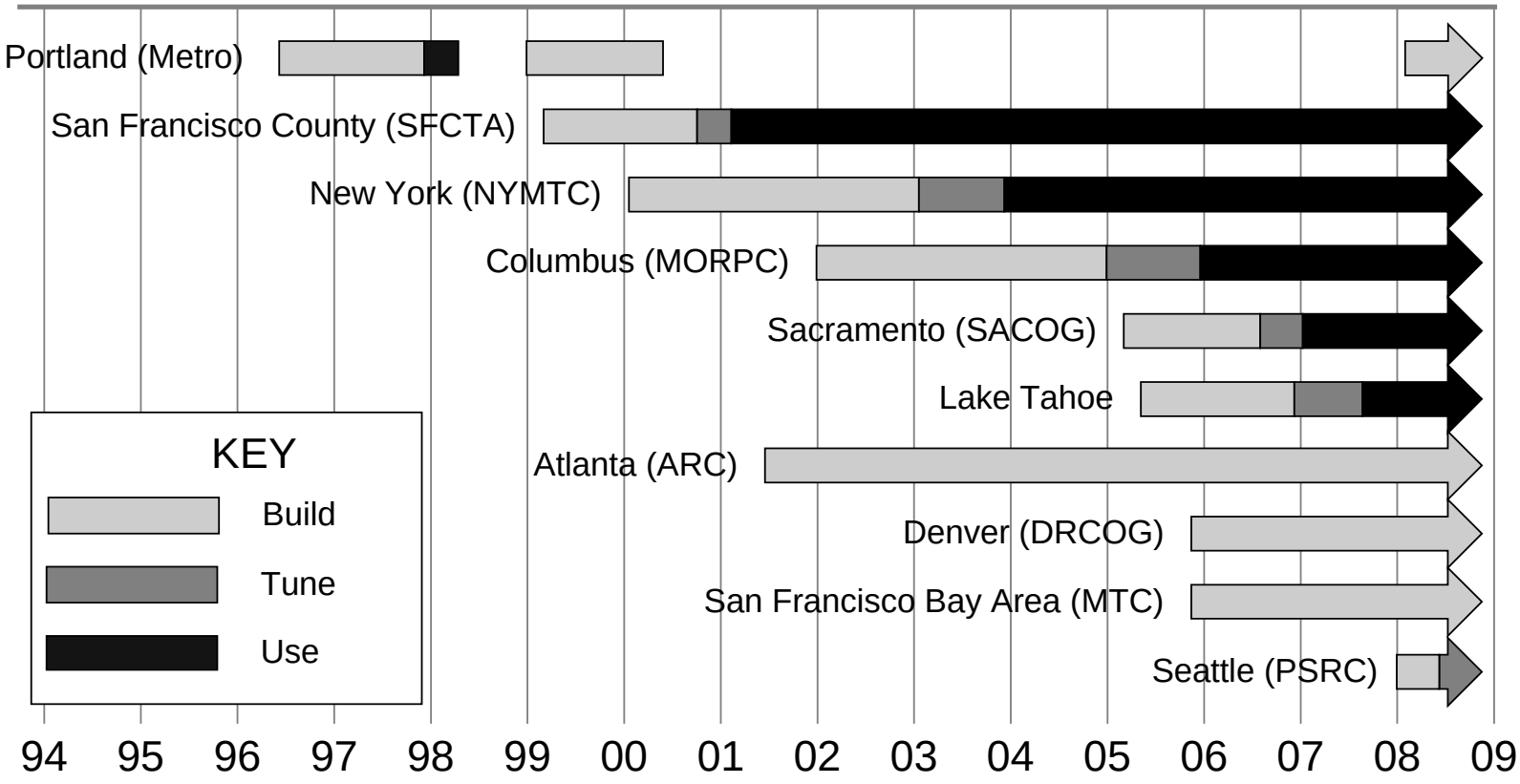
U.S. Projects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New York (NYMTC)
Columbus (MORPC)
Sacramento (SACOG)
Lake Tahoe
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Denver (DRCOG)
San Francisco Bay Area (MTC)
Seattle (PSRC)
KEY
Build
Tune
Use
94
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Pending in US

- San Diego
- Phoenix
- Los Angeles
- Tampa
- Boston
- Washington DC
- Others?

Why?

- Political priorities
  - land use
  - road pricing
  - energy
  - environment

TRB Special Report 288 (2007)

- committee formed by FHWA, FTA, Secretary of Transportation, and TRB
- to **evaluate** the state of practice in metropolitan travel forecasting, and **recommend** improvements
- report:
  "METROPOLITAN TRAVEL FORECASTING: Current Practice and Future Direction"

TRB Special Report 288
Evaluation

- "The basic modeling approach at most MPOs remains a sequential four step process... "
- "The demands on forecasting models have grown significantly in recent years... Existing models are inadequate to address many of these new concerns."
- "...the processes...in the four-step model are not behavioral in nature; ... and are not well suited to representing travelers' responses to the complex range of policies typically of interest to today's planners and politicians."

TRB Special Report 288
Recommendation

"The committee recommends that the USDOT, the FHWA, and FTA take the (seven) steps outlined below to assist in the needed improvements in practice.

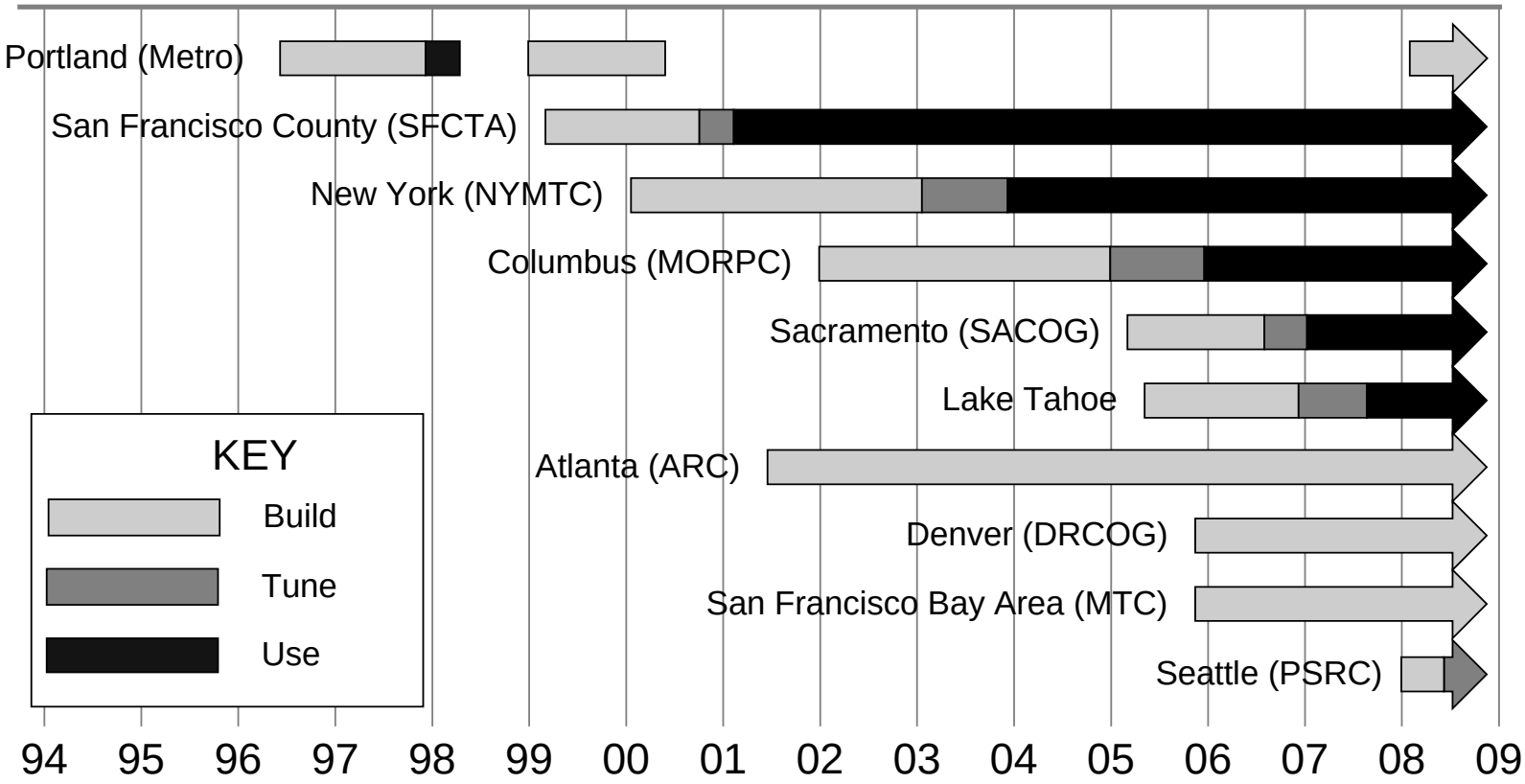
2. Support and provide funding for the continued development, demonstration, and implementation of advanced modeling approaches, including **activity-based models**.

4. Continue support for the implementation of **activity-based modeling** and other advanced practices; considerably expand this support through deployment efforts in multiple urban areas."

California

- Senate Bill 375 (Sep 2008)
  requires the California Transportation Commission to maintain guidelines for travel demand models
- CTC Guidelines (May 2008)
  The largest four MPOs and other COGs and RTPAs with rapid growth and established transit systems "should develop tour-based travel models in the short term and **activity-based travel models** within a few years."

U.S. Projects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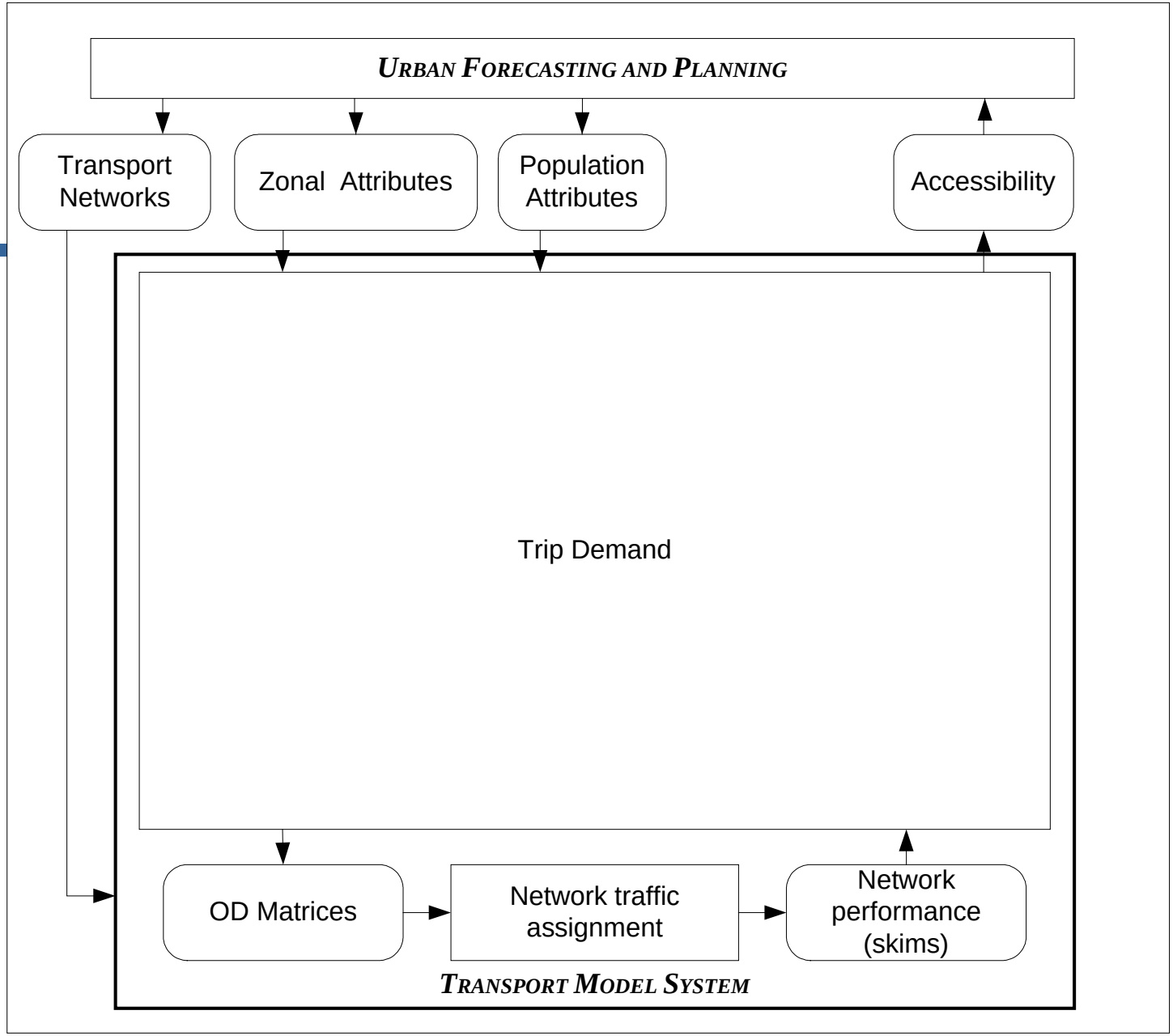
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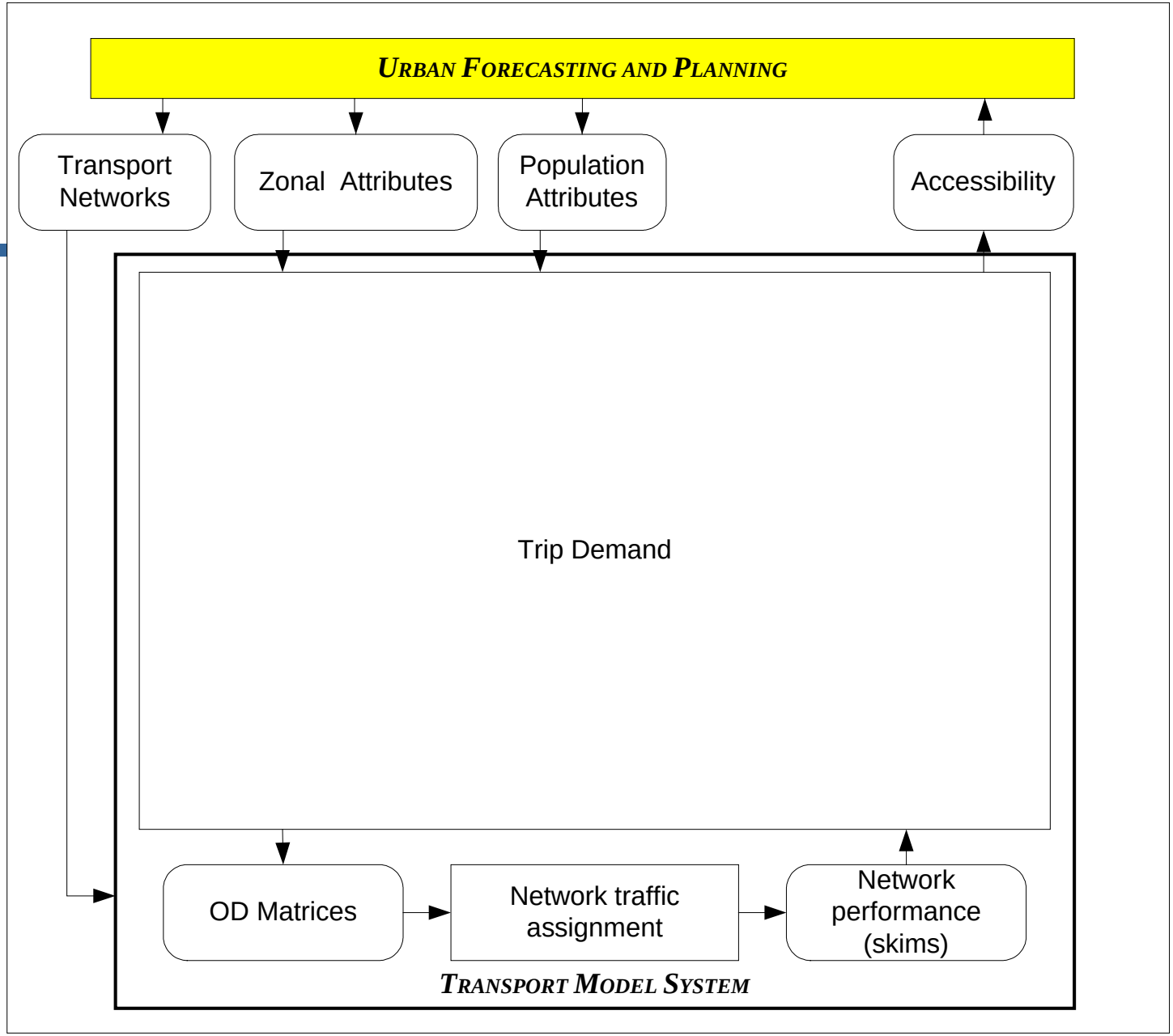
TRANSPORT MODEL SYSTEM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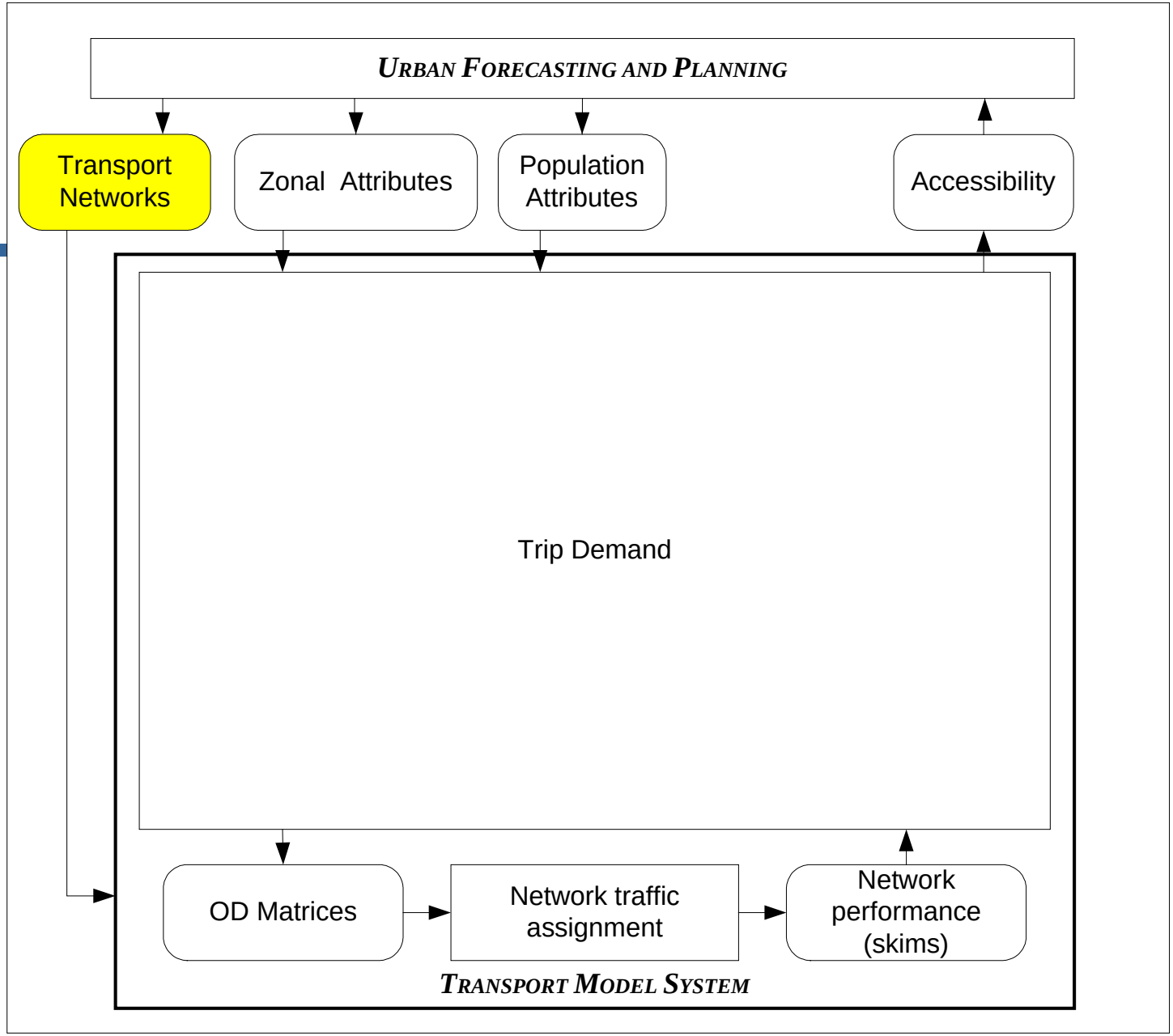
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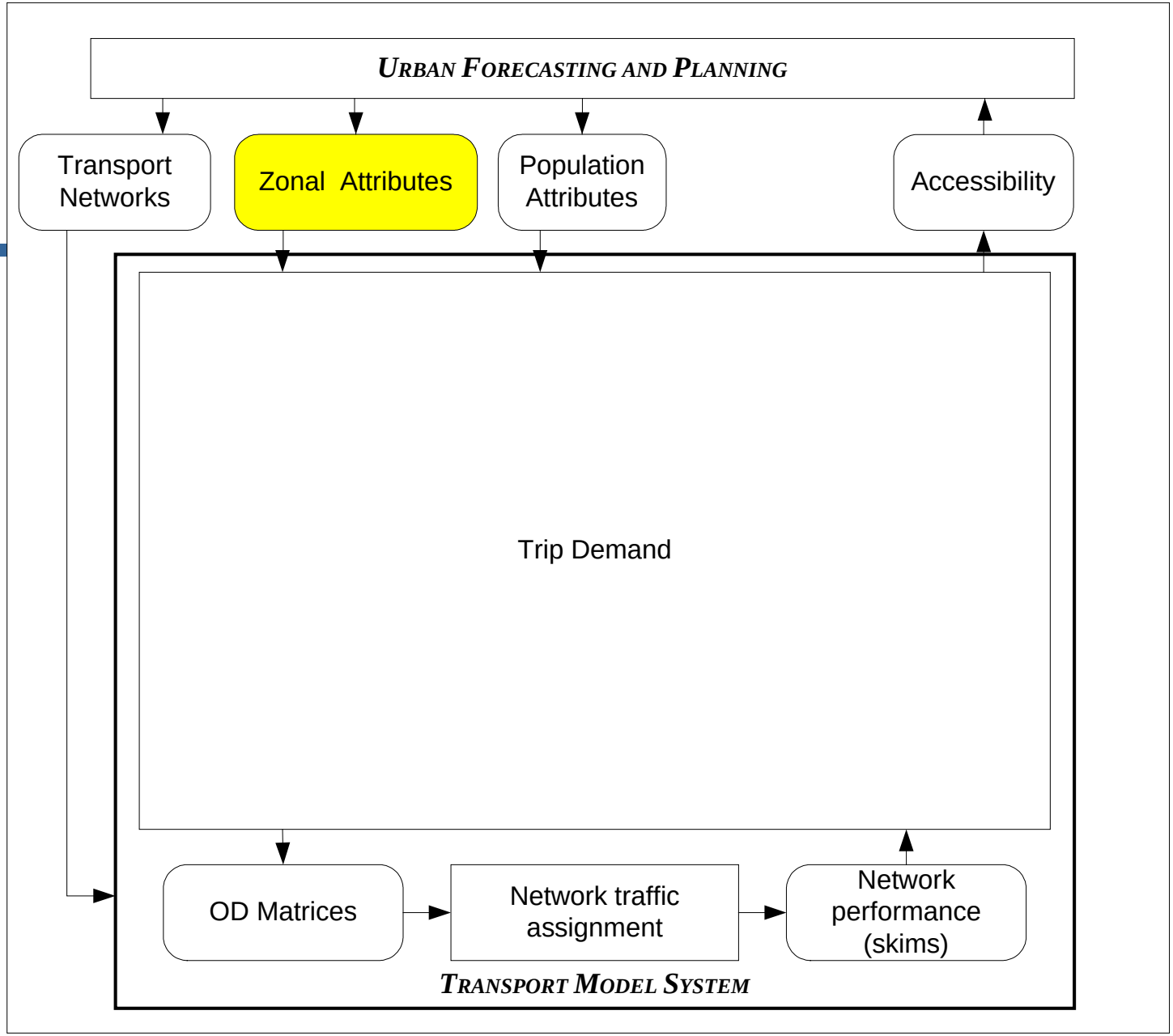
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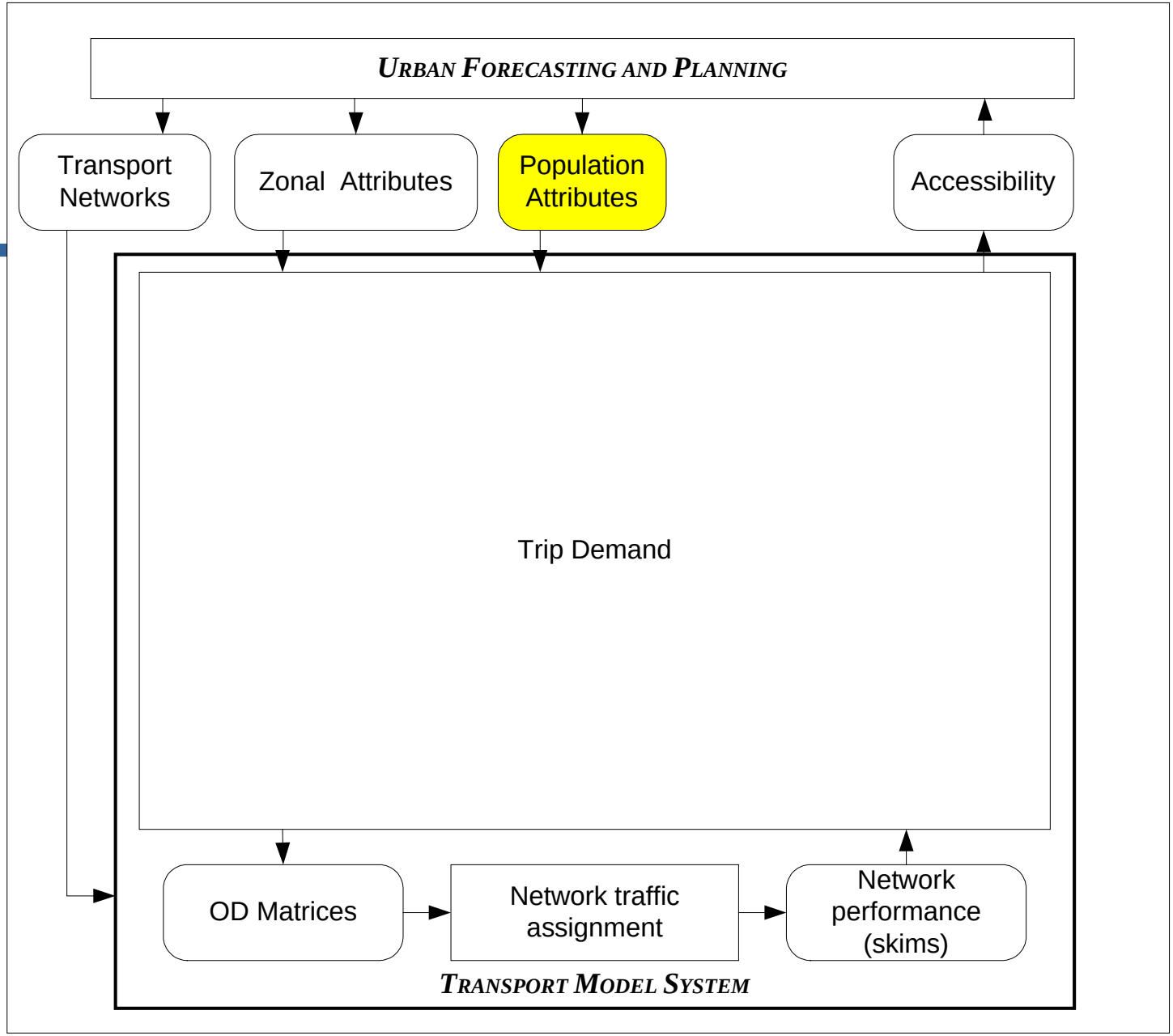
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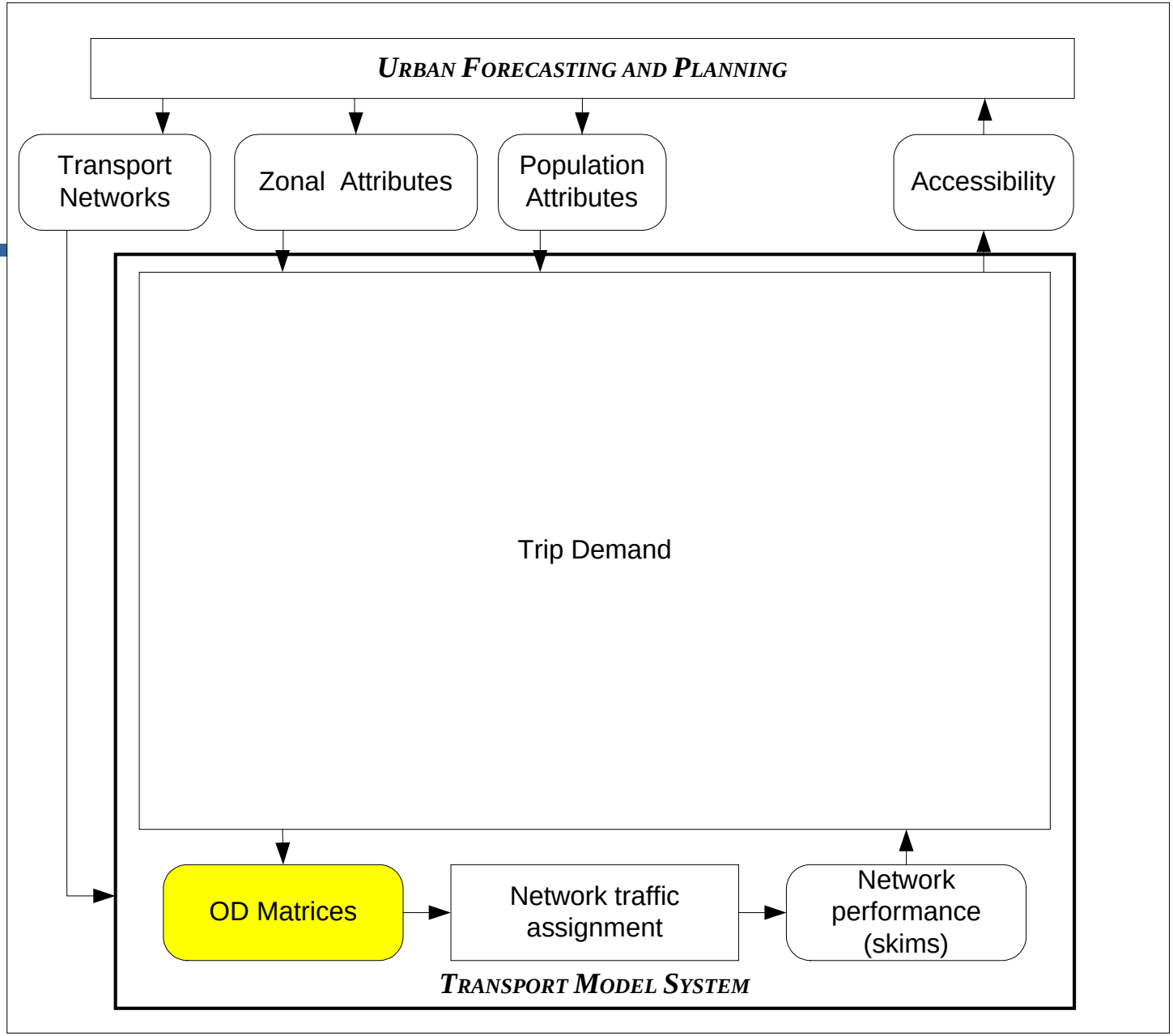
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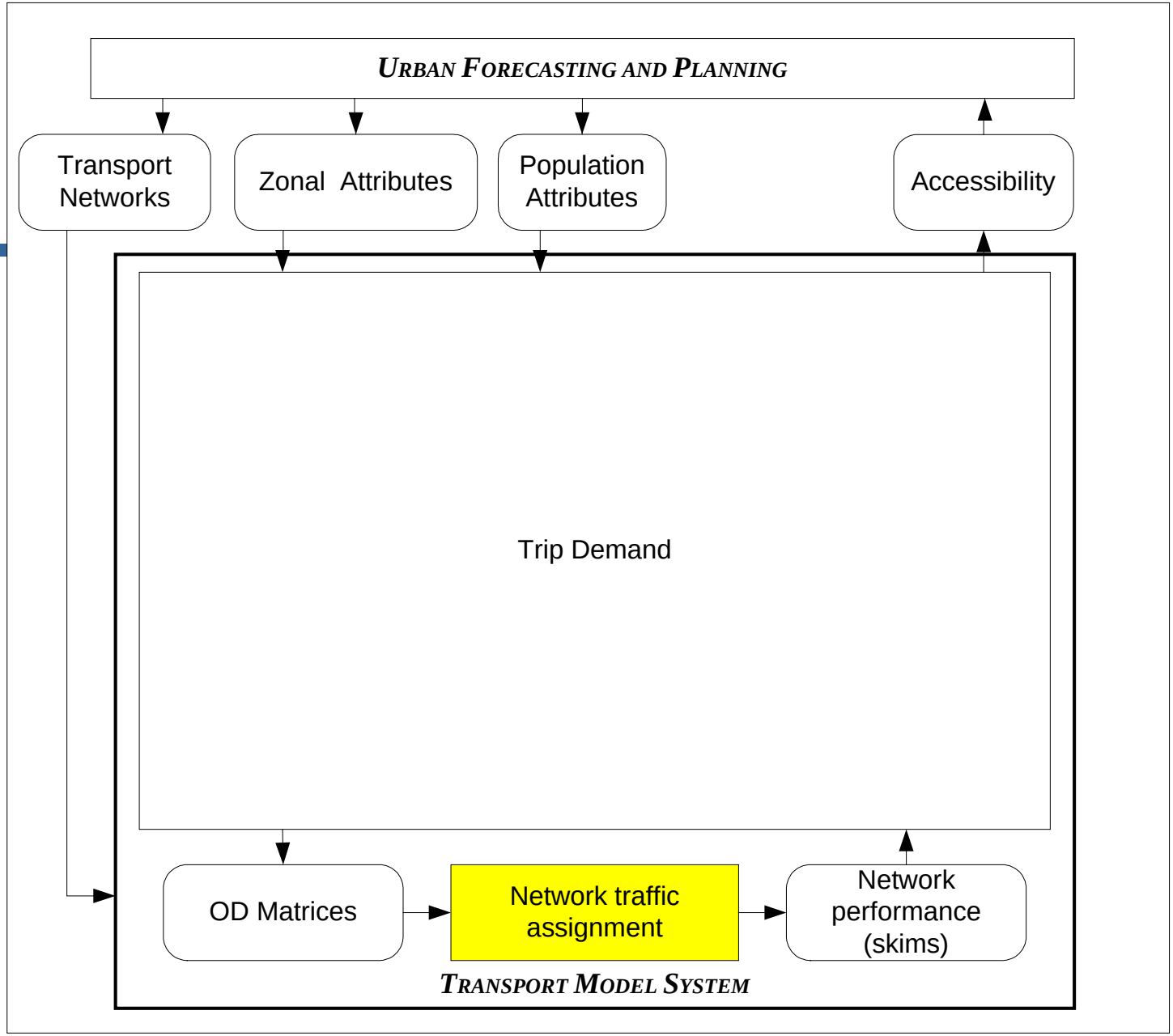
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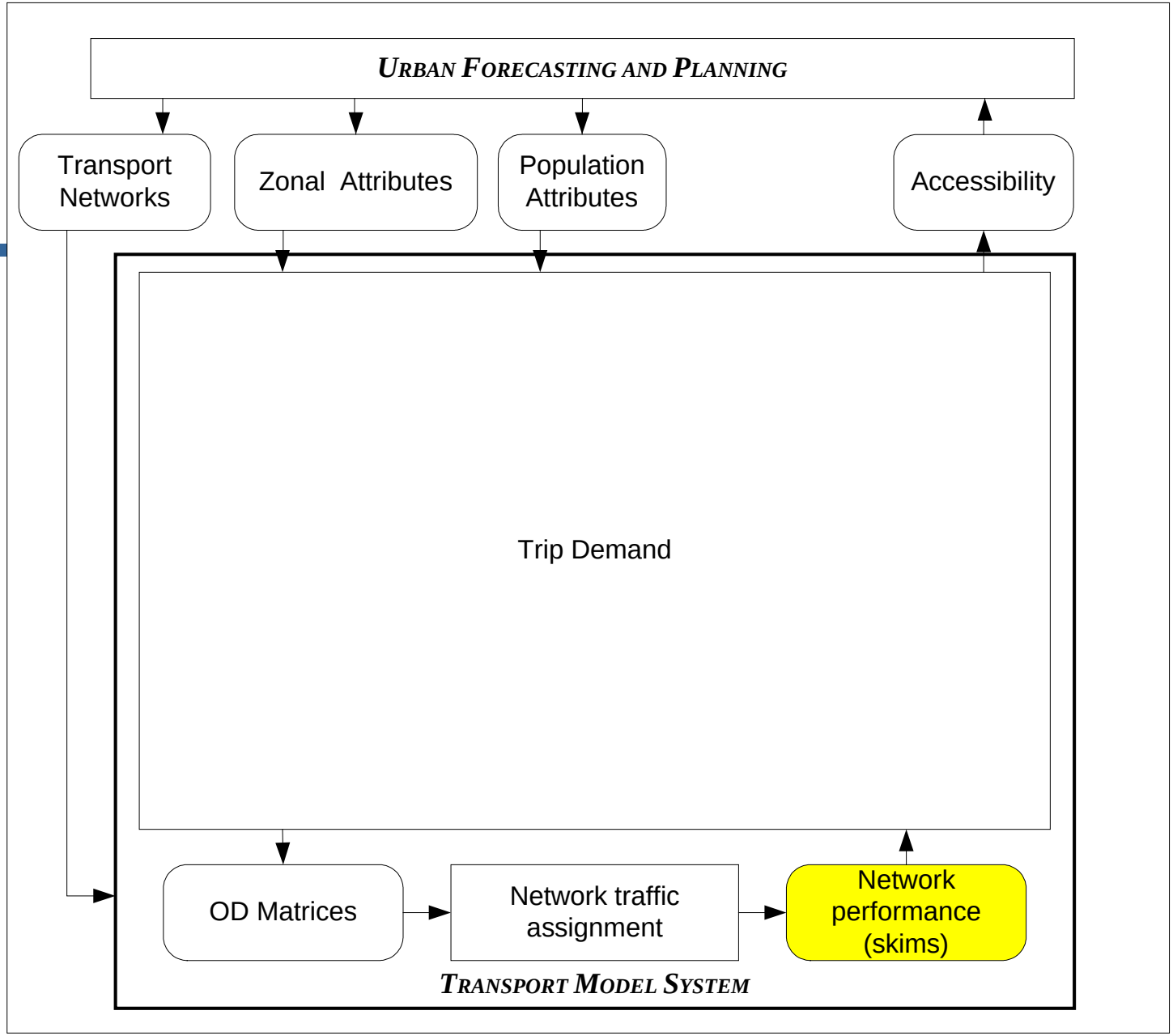
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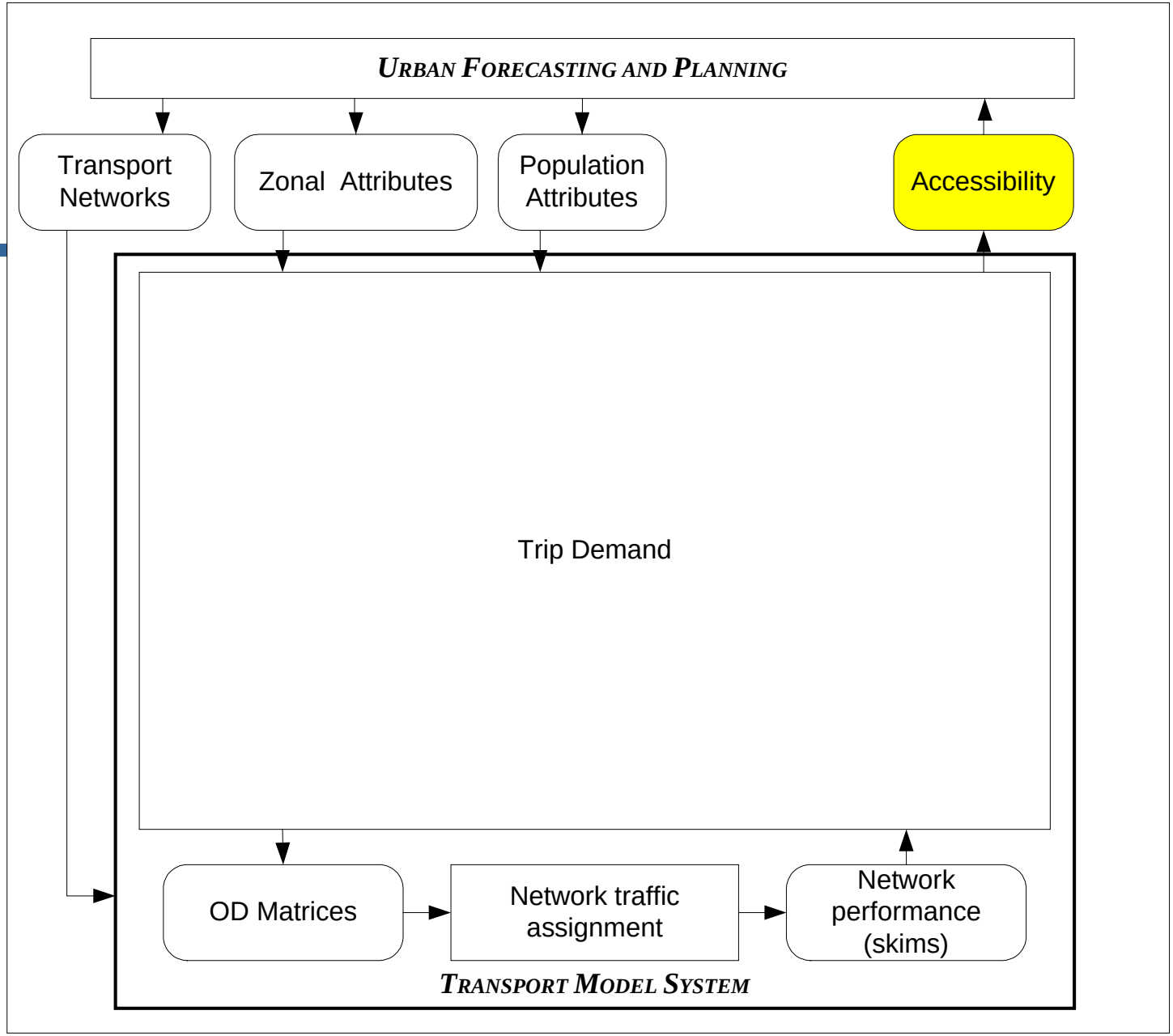
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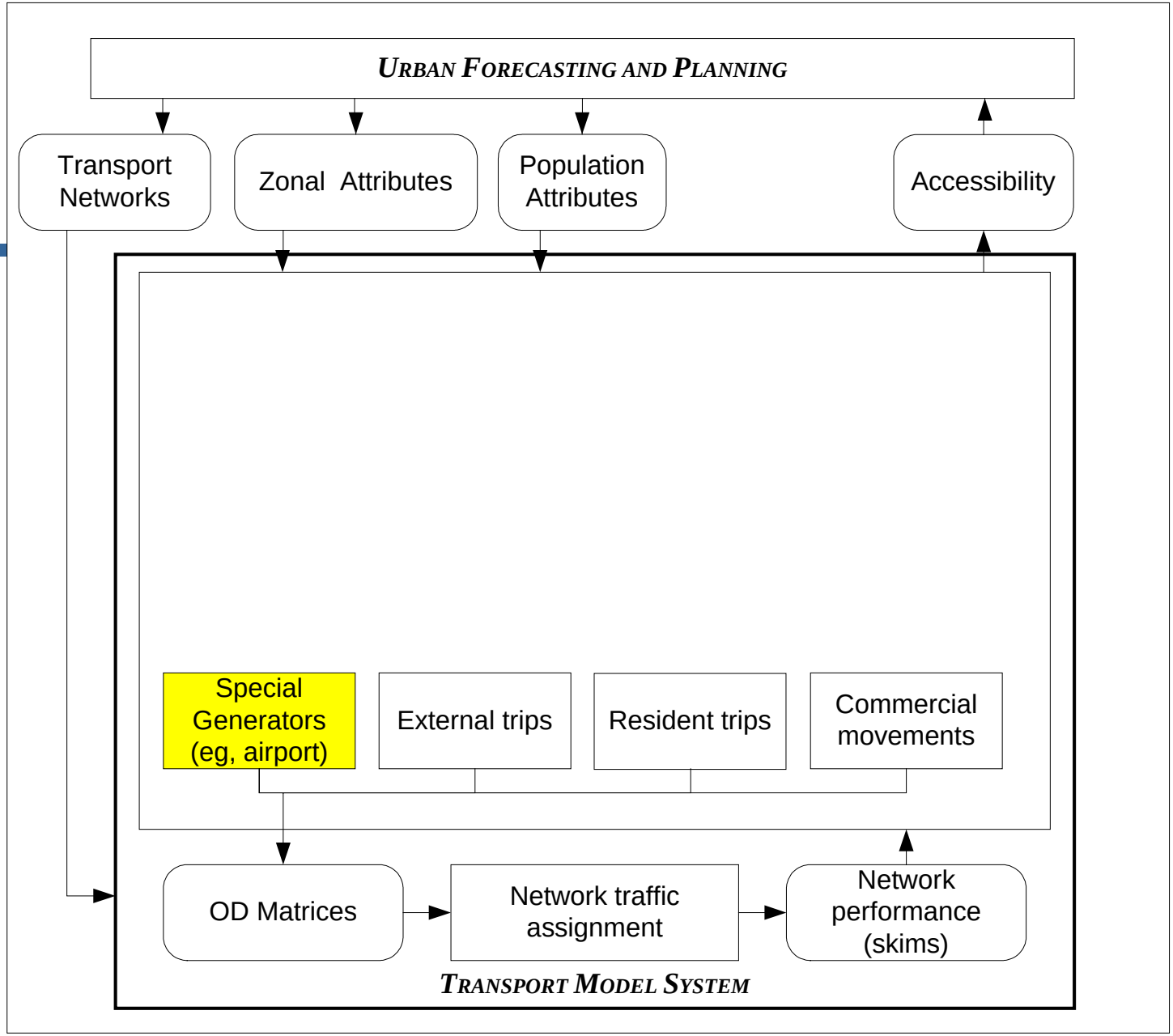
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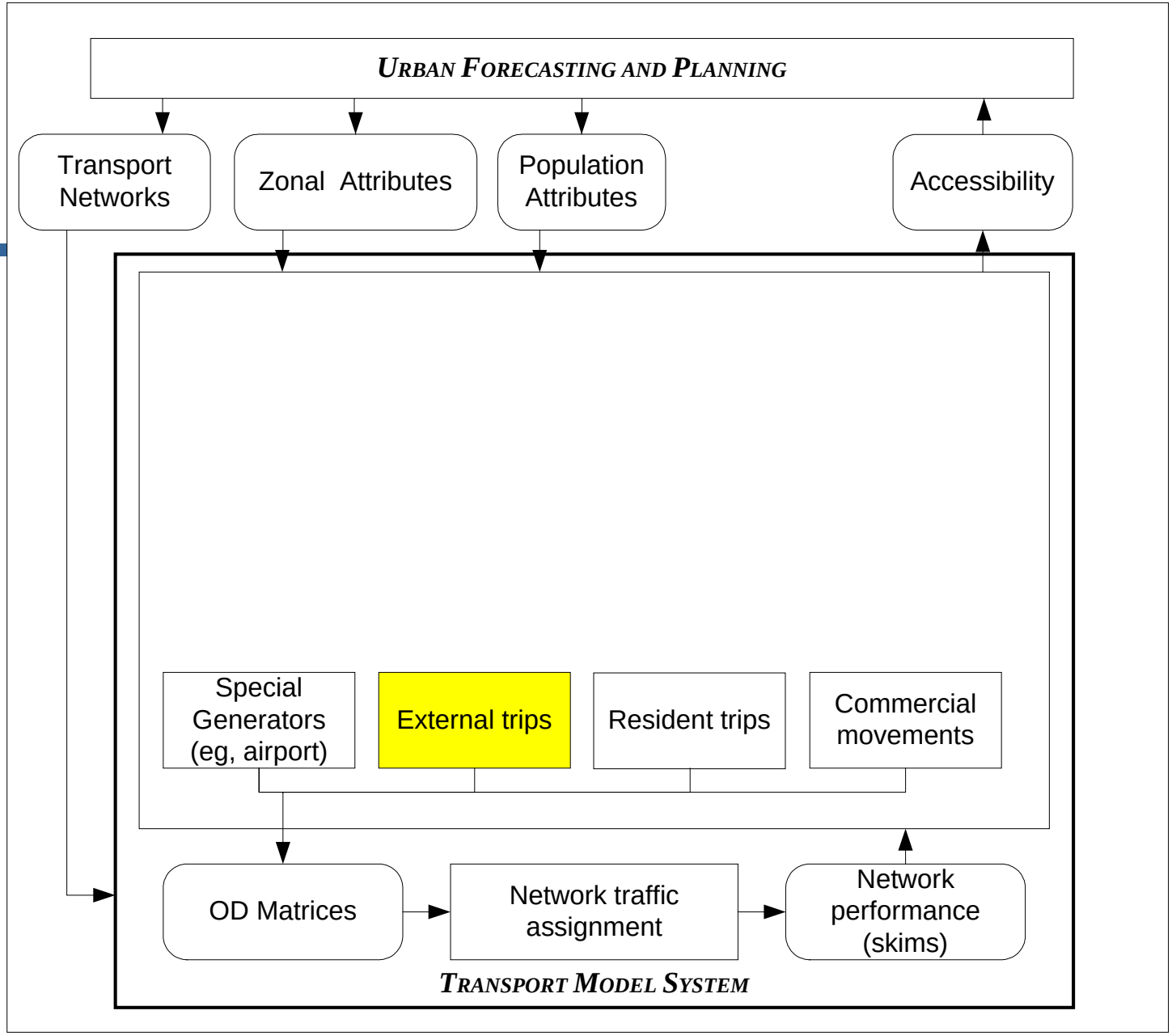
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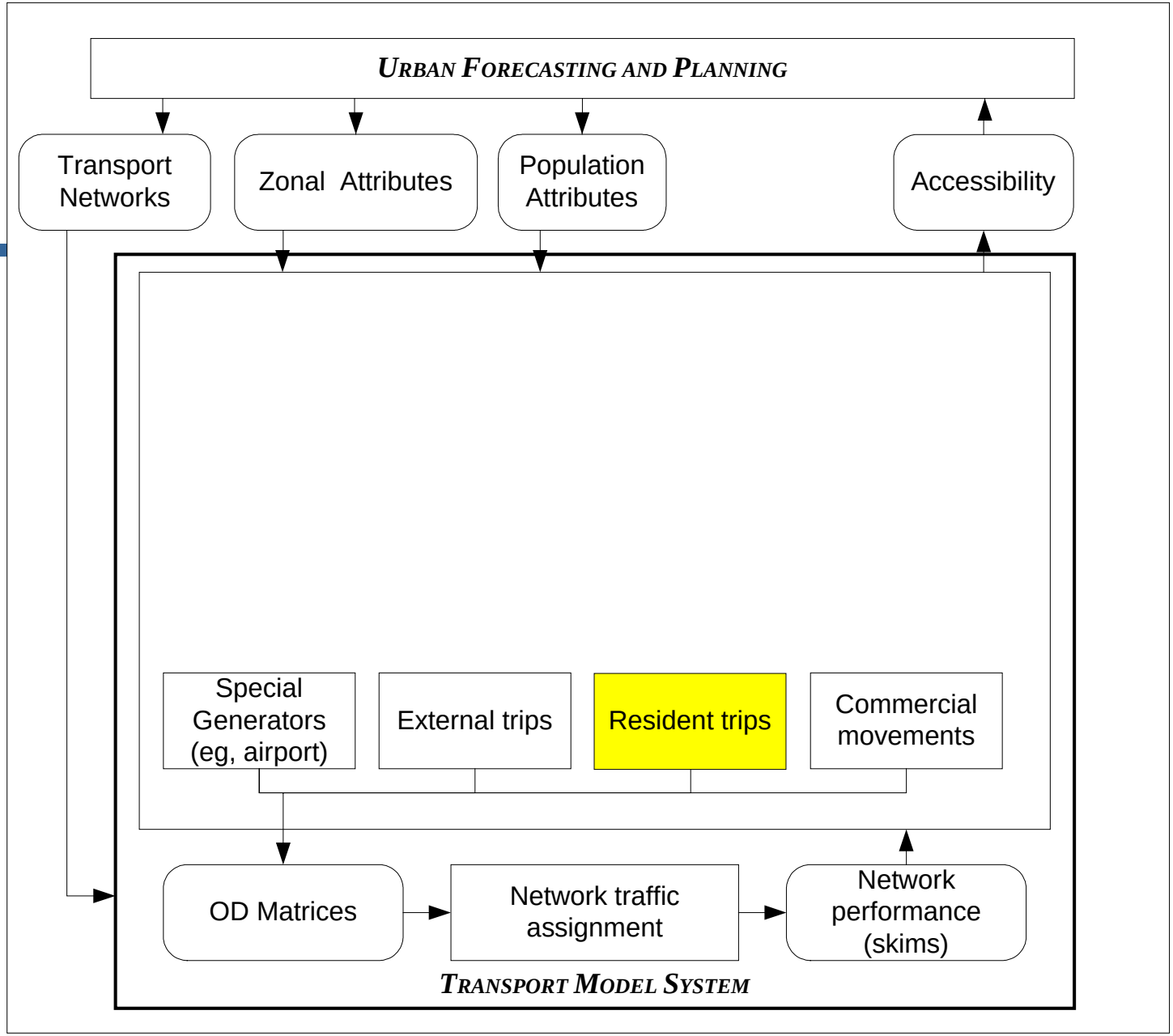
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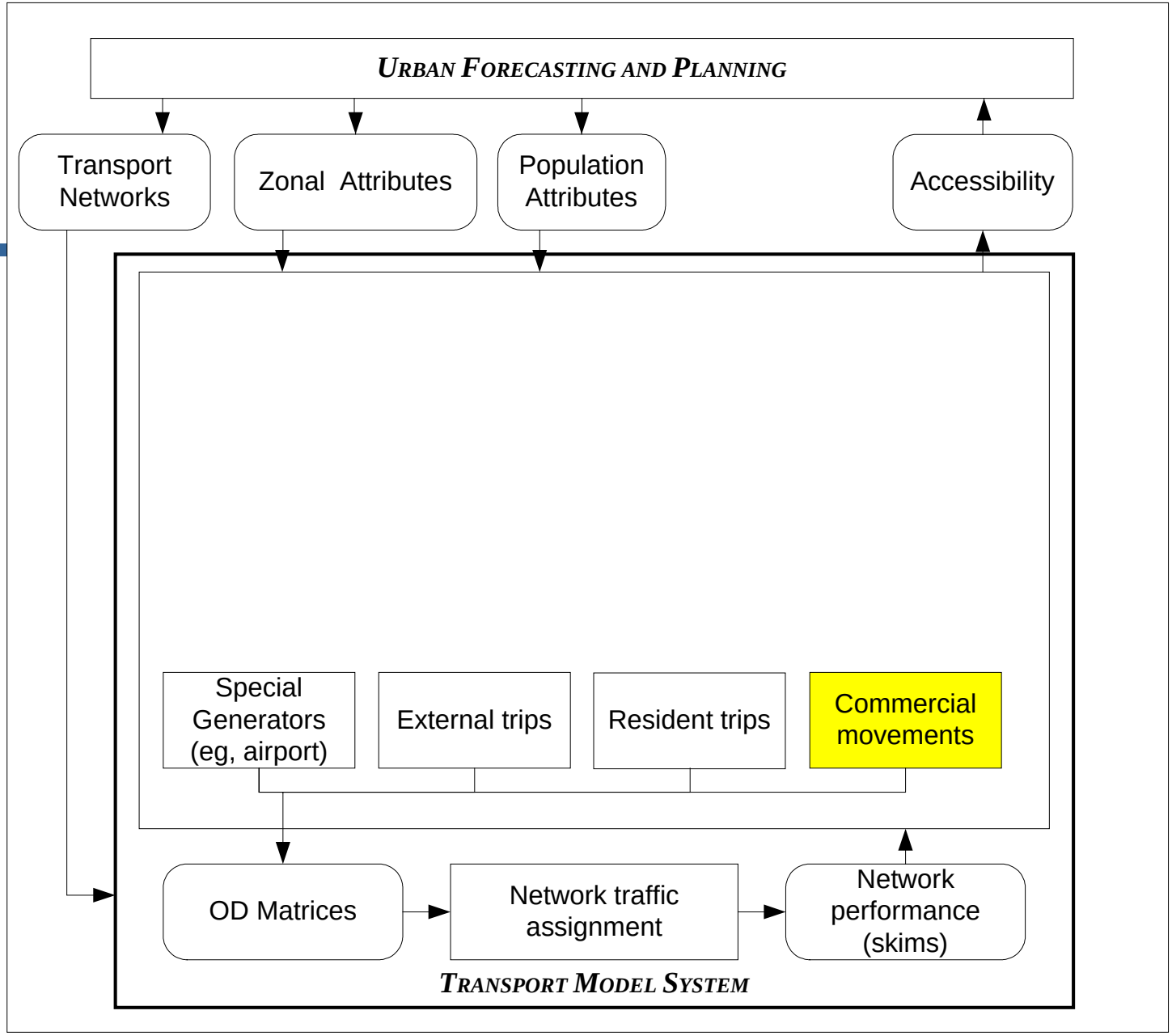
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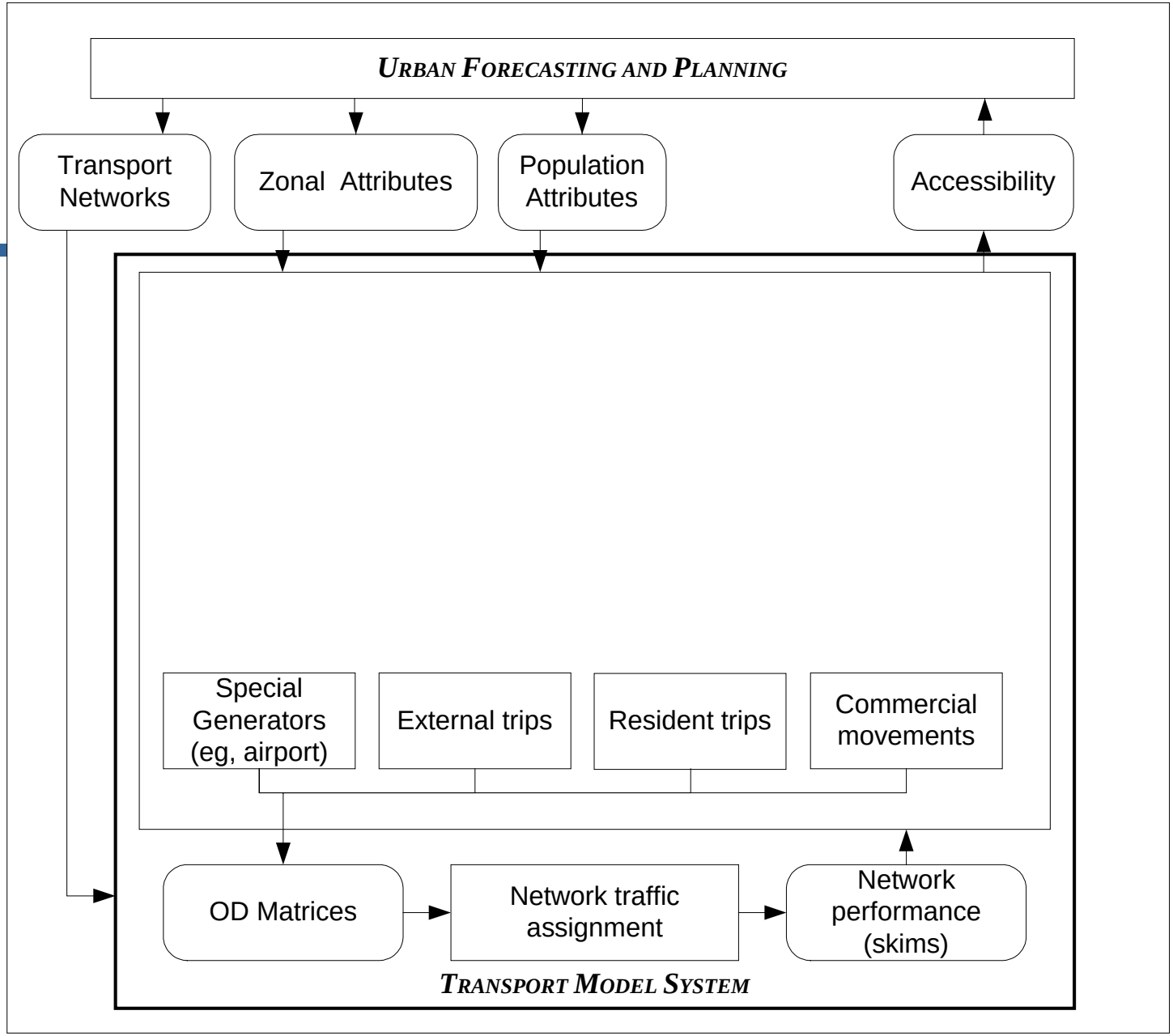
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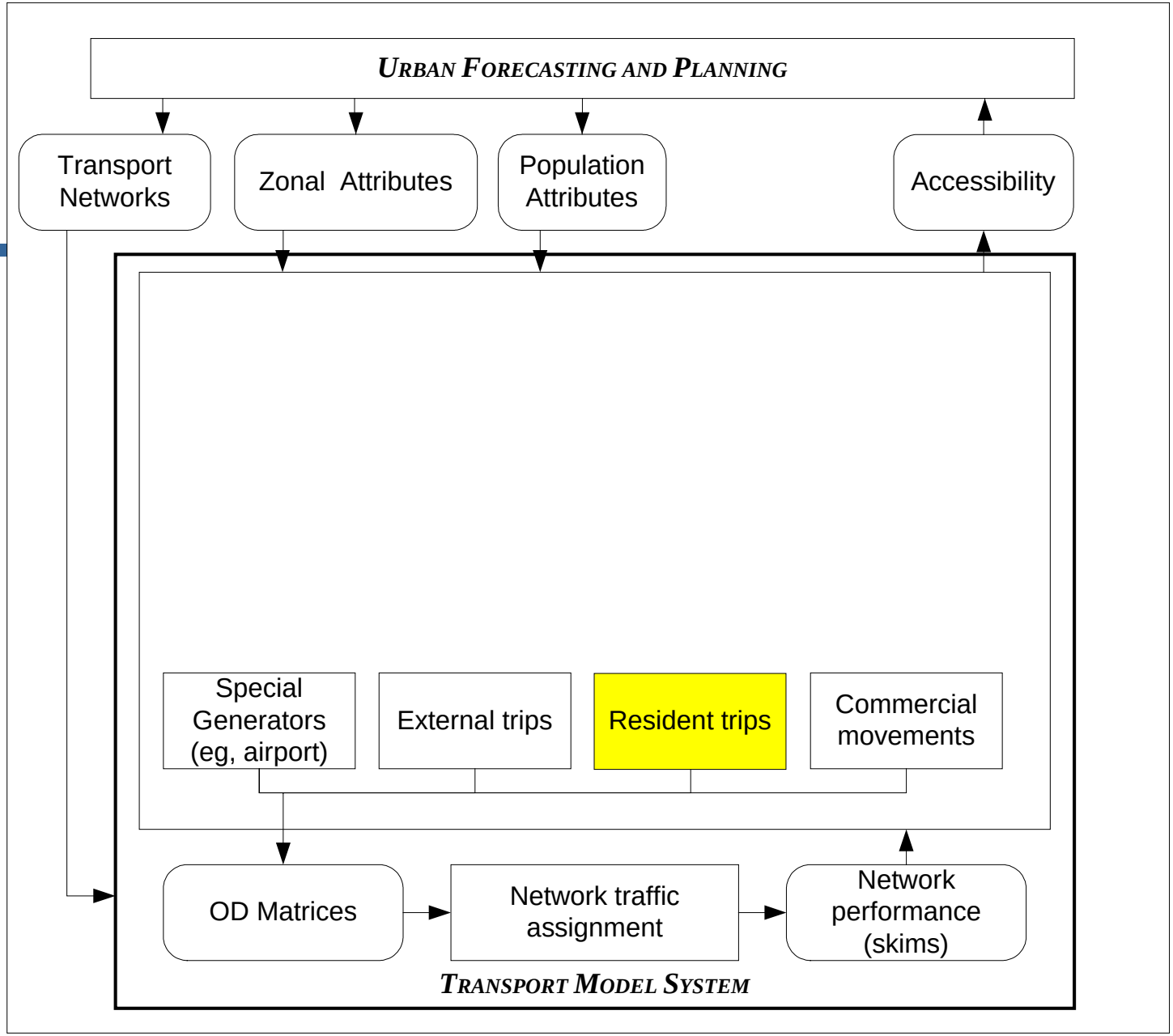
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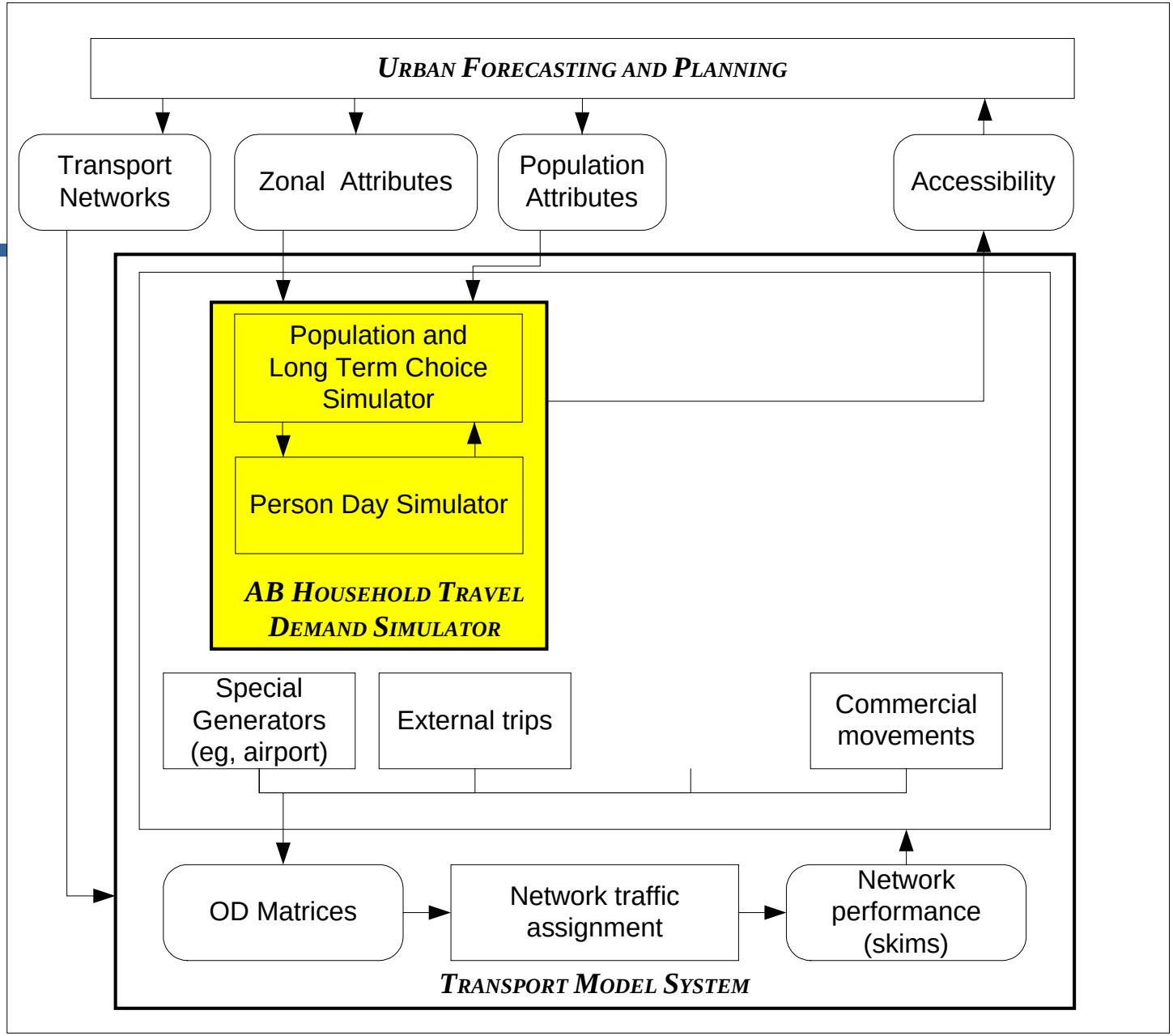
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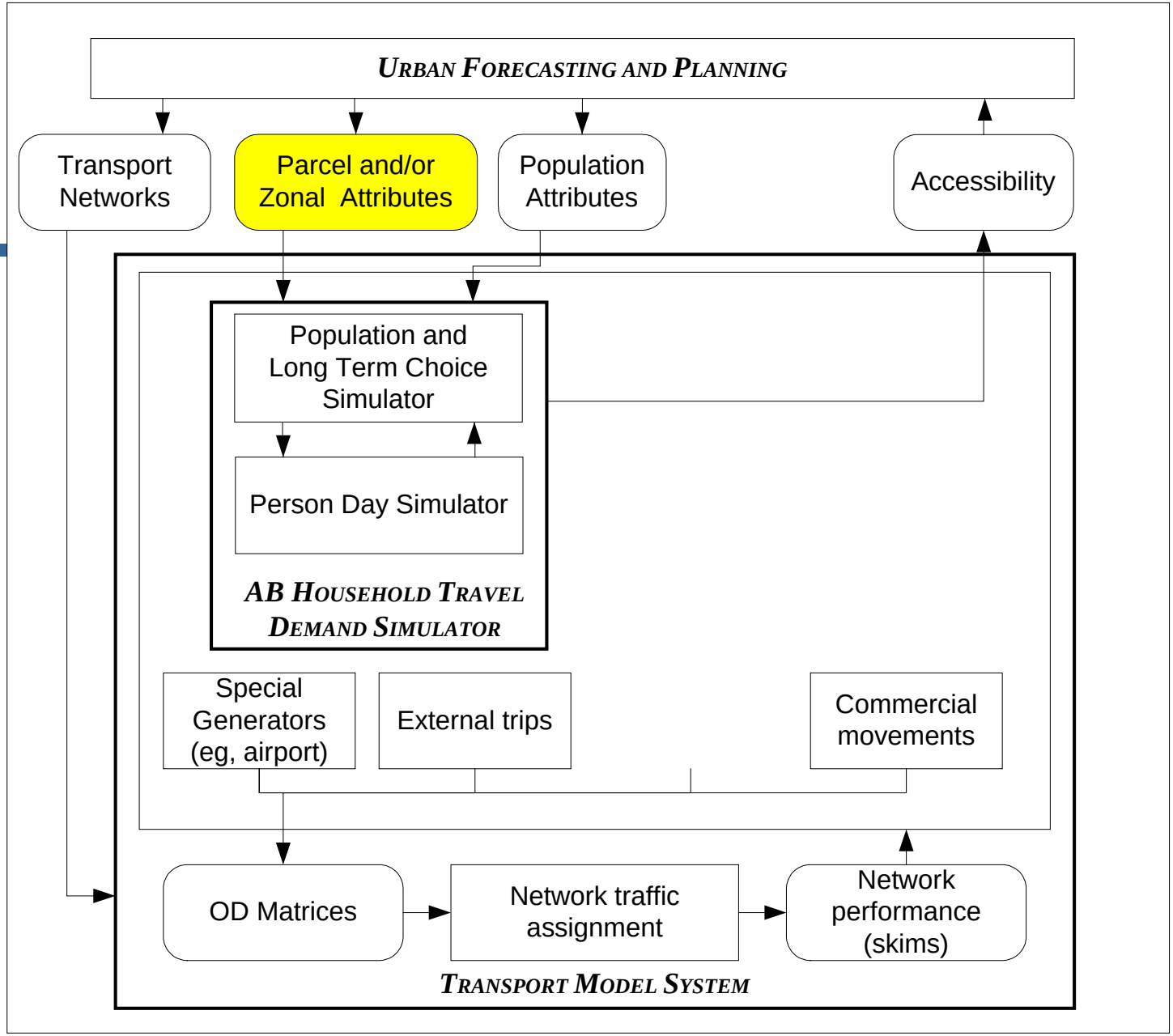
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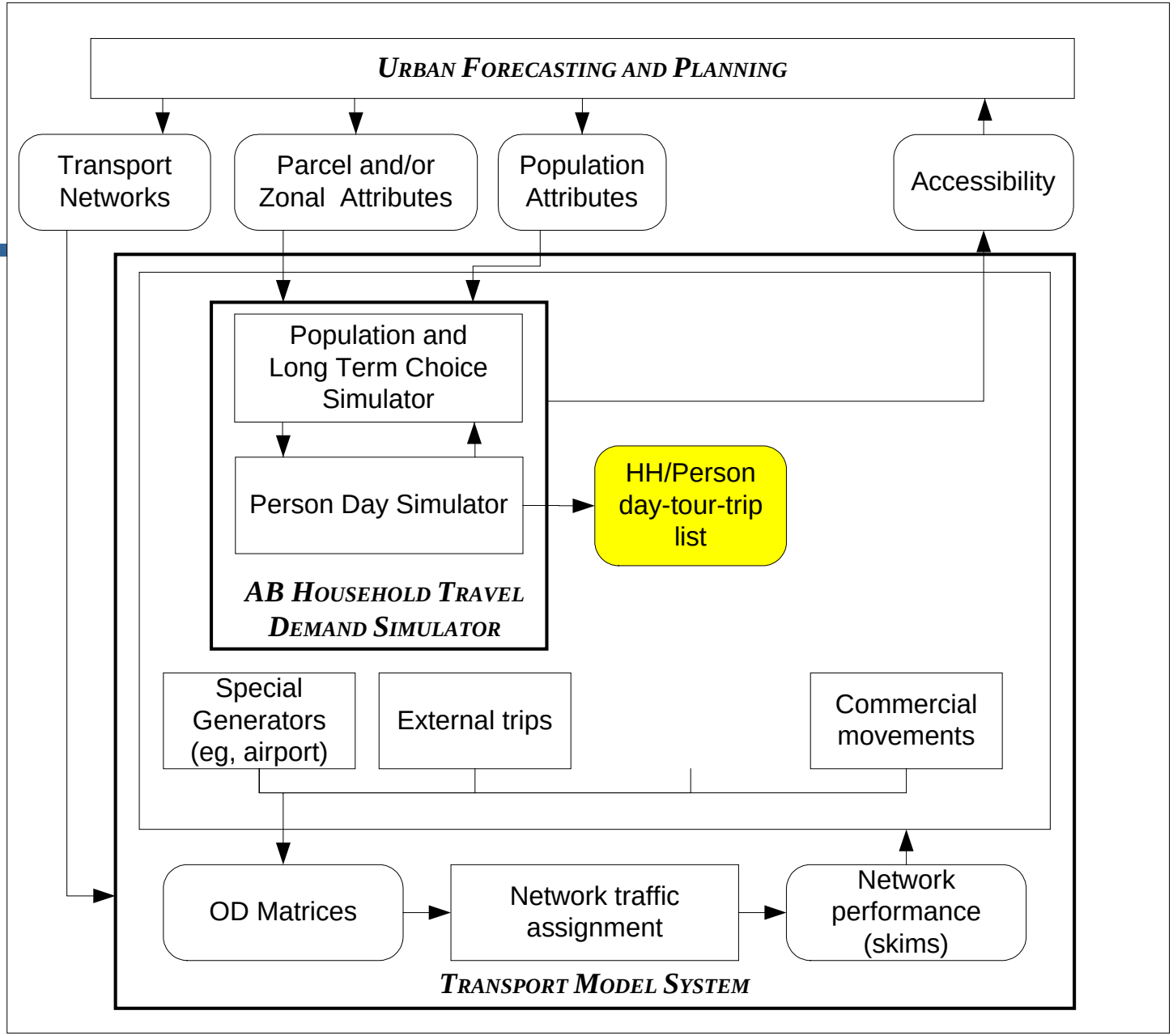
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HH/Person day-tour-trip list
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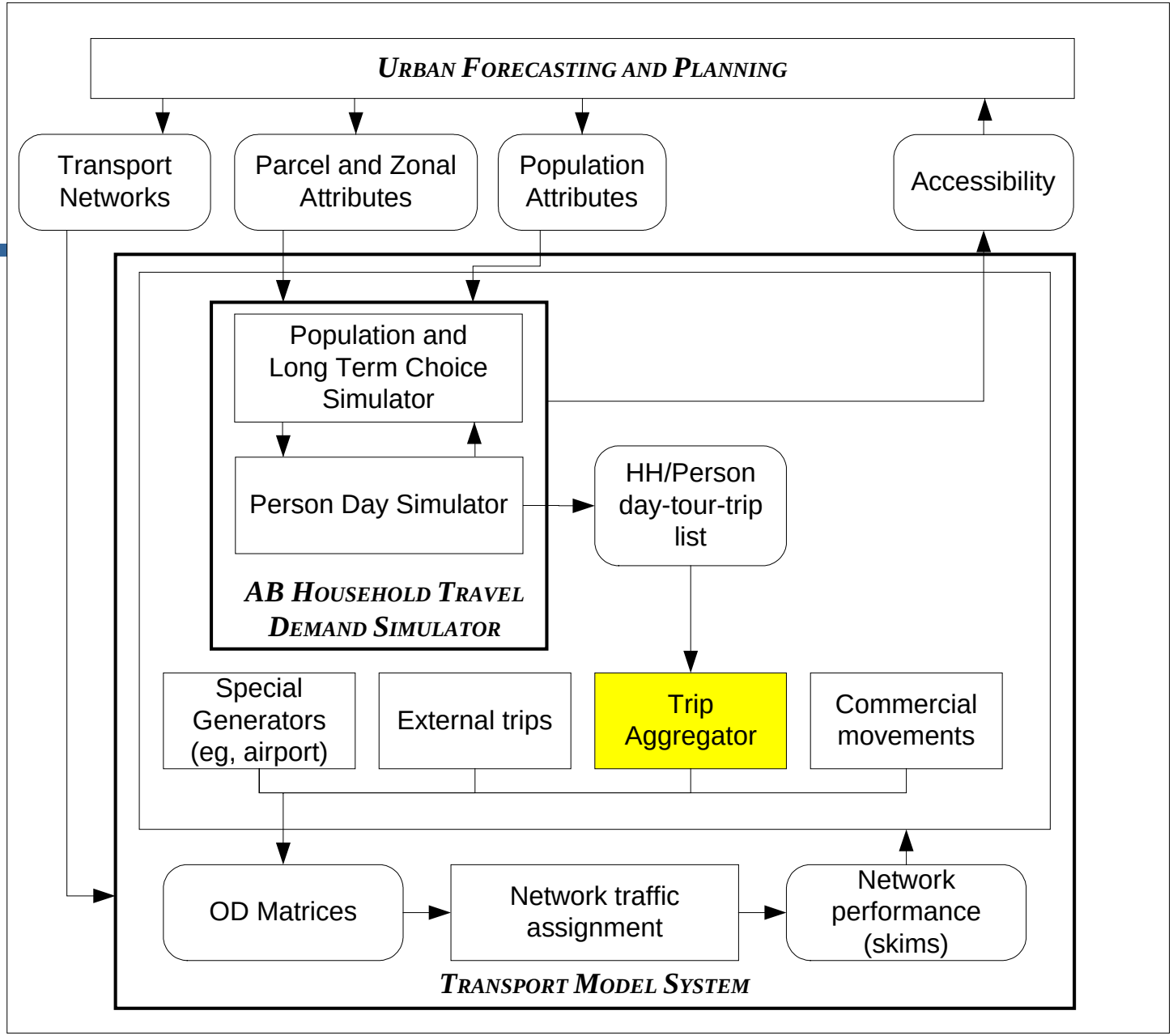
TRANSPORT MODEL SYSTEM

HH/Person/Day/Tour/Trip List

For each…	List includes…
Household	Location, size, vehicles, etc
Person	Age, gender, usual work & school locations, etc
Day	Number of tours and stops
Tour	Purpose, destination, timing, main mode, number of stops
Trip	Origin, destination, origin purpose, destination purpose, mode, departure time, travel time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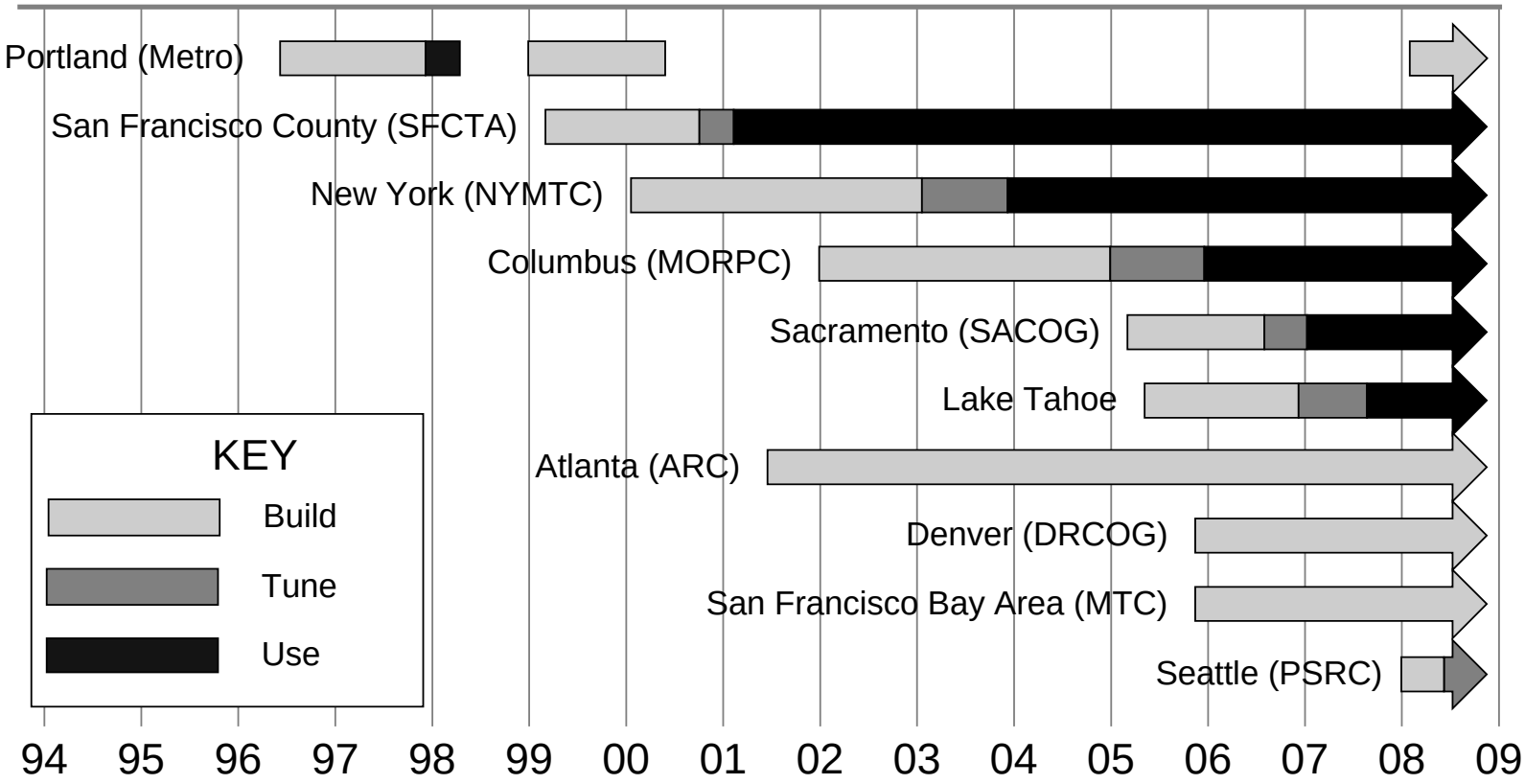
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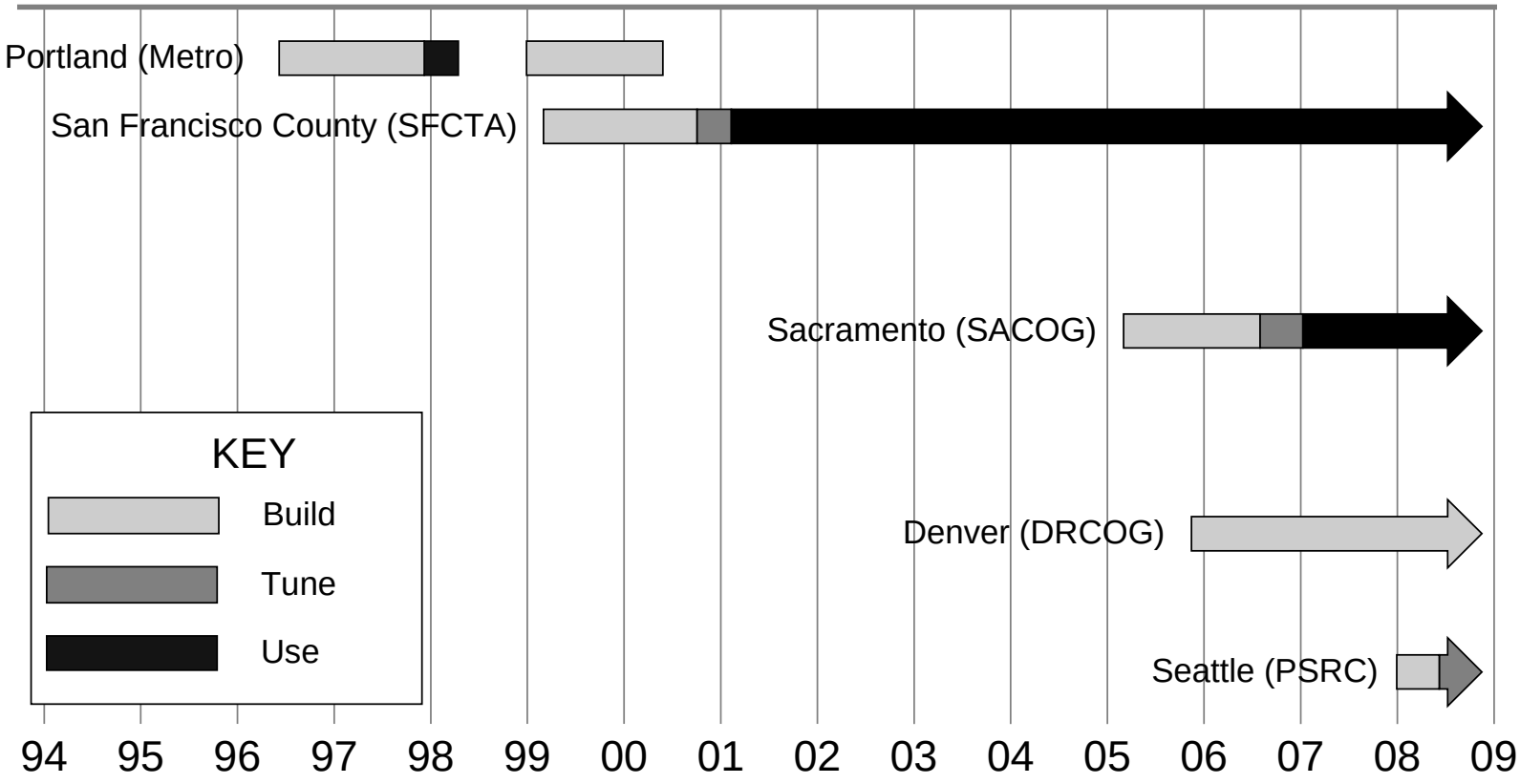
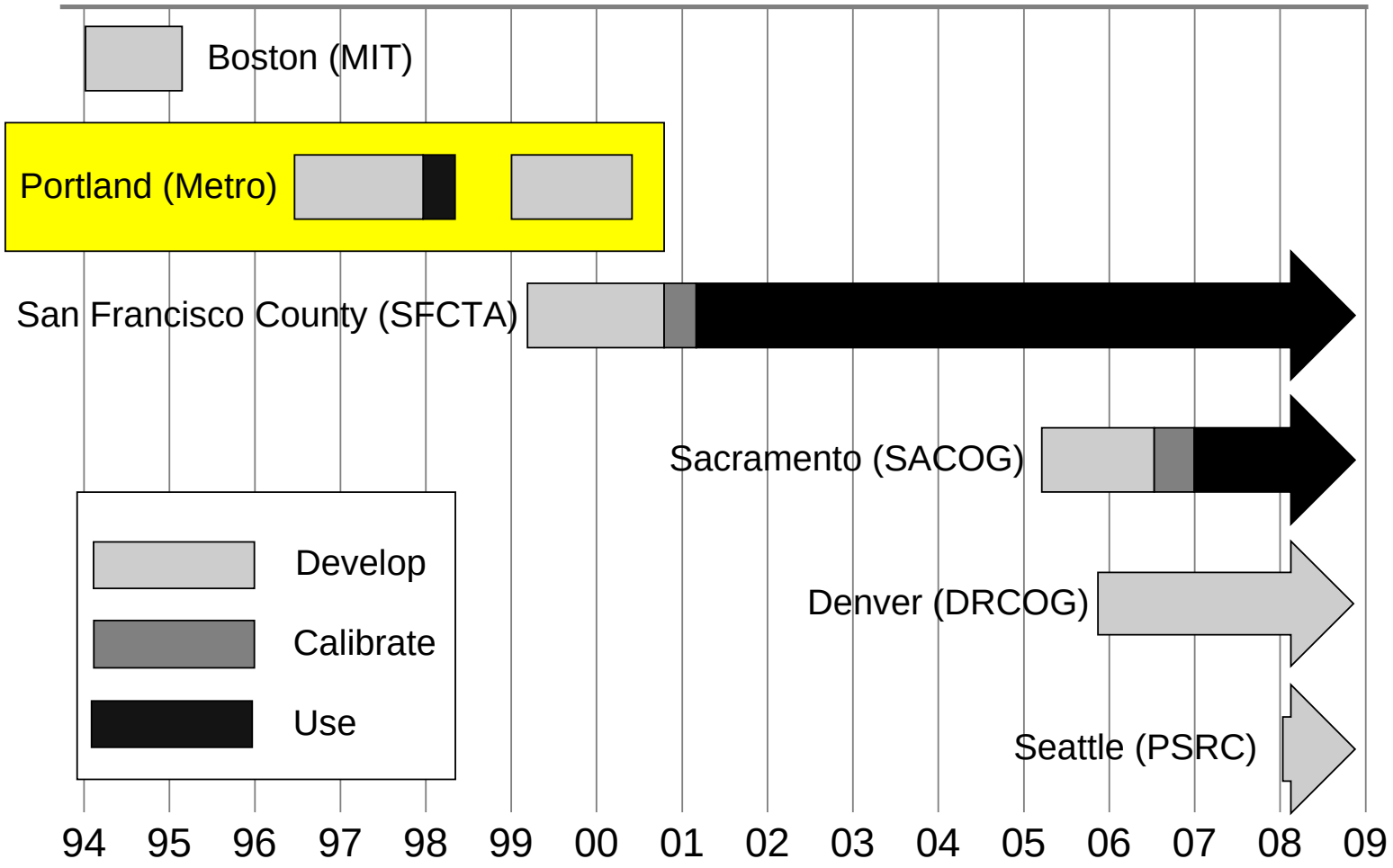
Descendents of the MIT Prototype



Portland Metro



1996-1998: Portland Metro

- Features not in MIT prototype
  - Usual work and school location
  - Intermediate stops on tours
  - Detailed activity purposes (8)
  - Detailed spatial resolution (block face)
  - Work-based subtours
  - At-home activities
  - Integration with assignment models
- Used model for policy analysis

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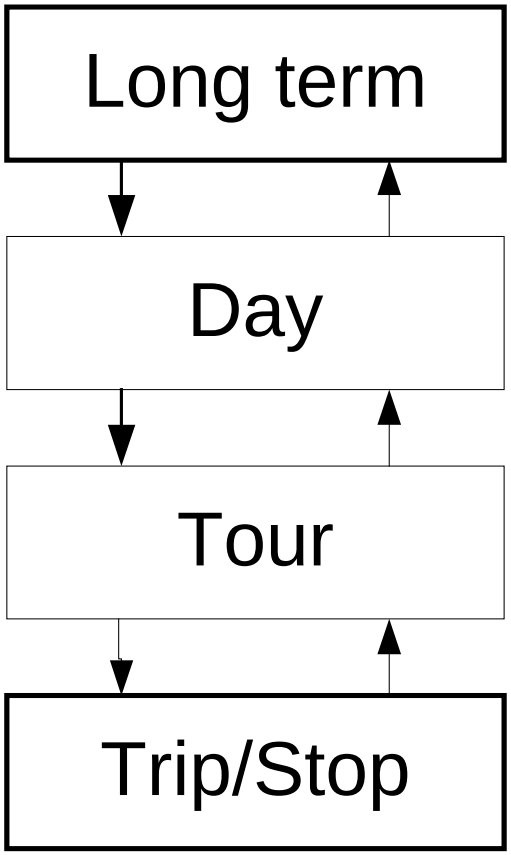

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Early Application Results (Portland 1998)

Effect of Change in Auto Variable Costs (AVC)			Double AVC all times of day		Double AVC in peak periods	
Purp	**Mode**	**Time of day**	**% chg Tours**	**% chg Miles**	**% chg Tours**	**% chg Miles**
Work						
	All	All	-0.8	-9.4	-0.6	-5.5
	SOV	All	-5.8	-14.6		
		AM peak			-5.9	-13.1
		Off-peak			+1.0	0.0
Maint	SOV	All	-8.7	-21.5	-1.2	-3.6
Discr			-10.7	-23.1	-1.3	-3.2

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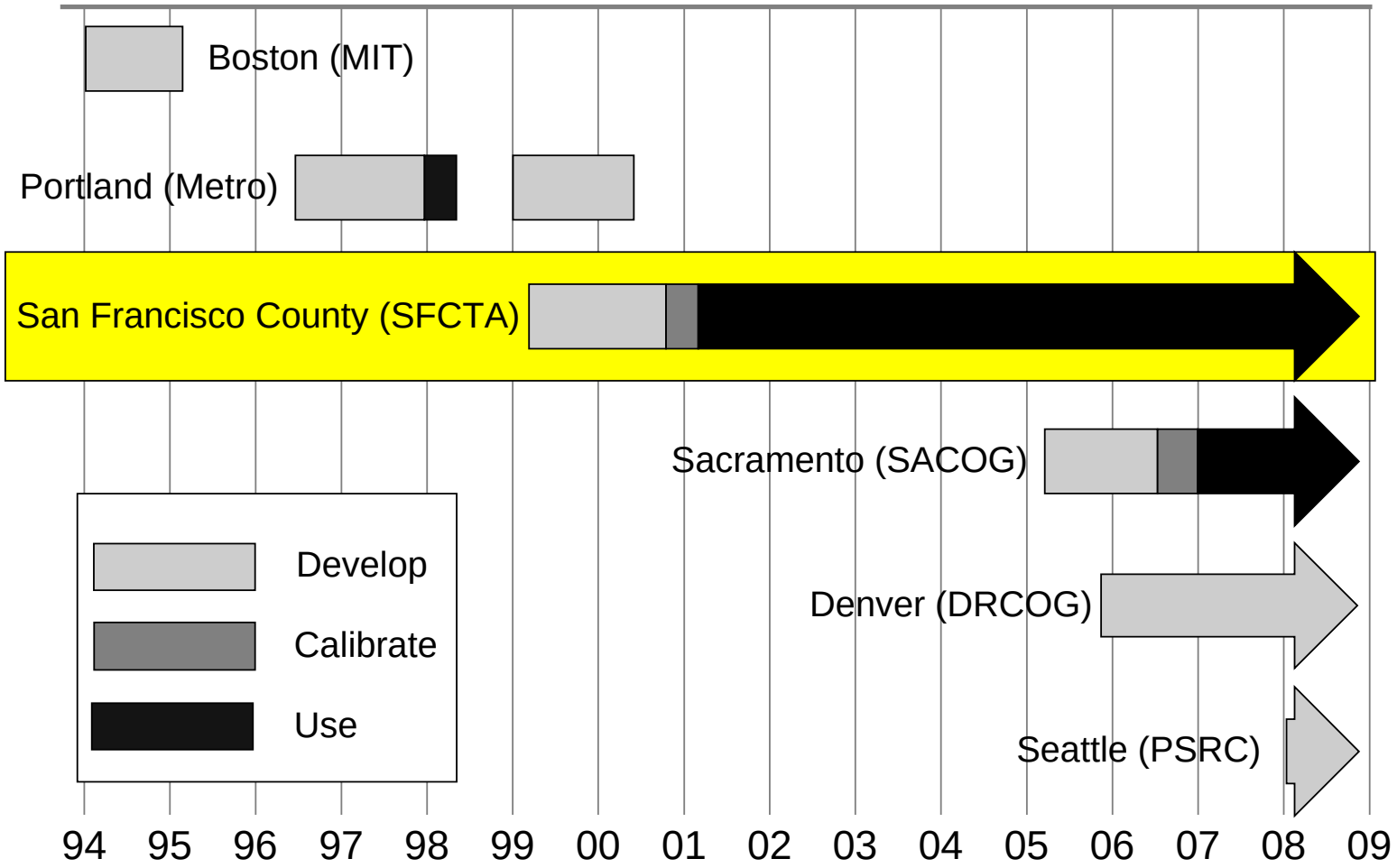
	All	All	-0.8	-9.4	-0.6	-5.5
	SOV	All	-5.8	-14.6		
		AM peak			-5.9	-13.1
		Off-peak			+1.0	0.0
Maint Discr	SOV	All	-8.7 -10.7	-21.5 -23.1	-1.2 -1.3	-3.6 -3.2

San Francisco County (SFCTA)



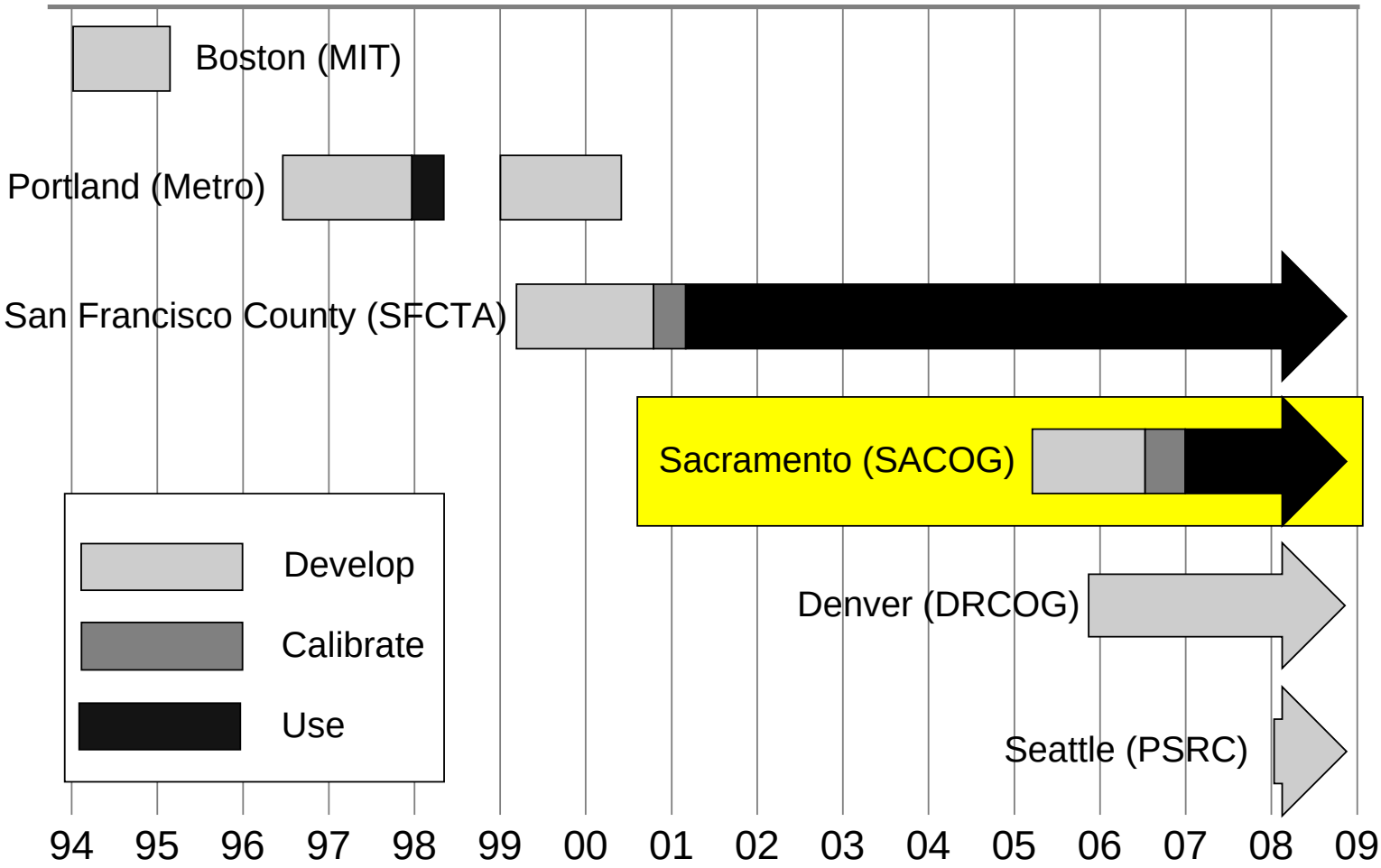
1999-2001: SFCTA

- Ongoing use for policy analysis
  - Development Impact Analysis
  - Countywide Transportation Plan
  - Central Subway New Starts
  - Equity analysis
  - Many more
- User benefits calculation for New Starts (SUMMIT) analysis

2007: SFCTA

- Mode choice using tolled versus free paths
- Distributed values of time

Sacramento (SACOG)



2005-2006: SACOG

- **Respecified day activity pattern**
- High resolution
  - purpose (7)
  - time (1/2 hr)
  - space (parcel)
- Improved integration
- Equilibration techniques

Reformulated Day Activity Pattern

- Seven specific tour and stop purposes
- No placement of stops at specific points on tours

2005-2006: SACOG

- Reformulated day activity pattern
- **High resolution**
  - purpose (7)
  - time (1/2 hr)
  - space (parcel)
- Improved integration
- Equilibration techniques

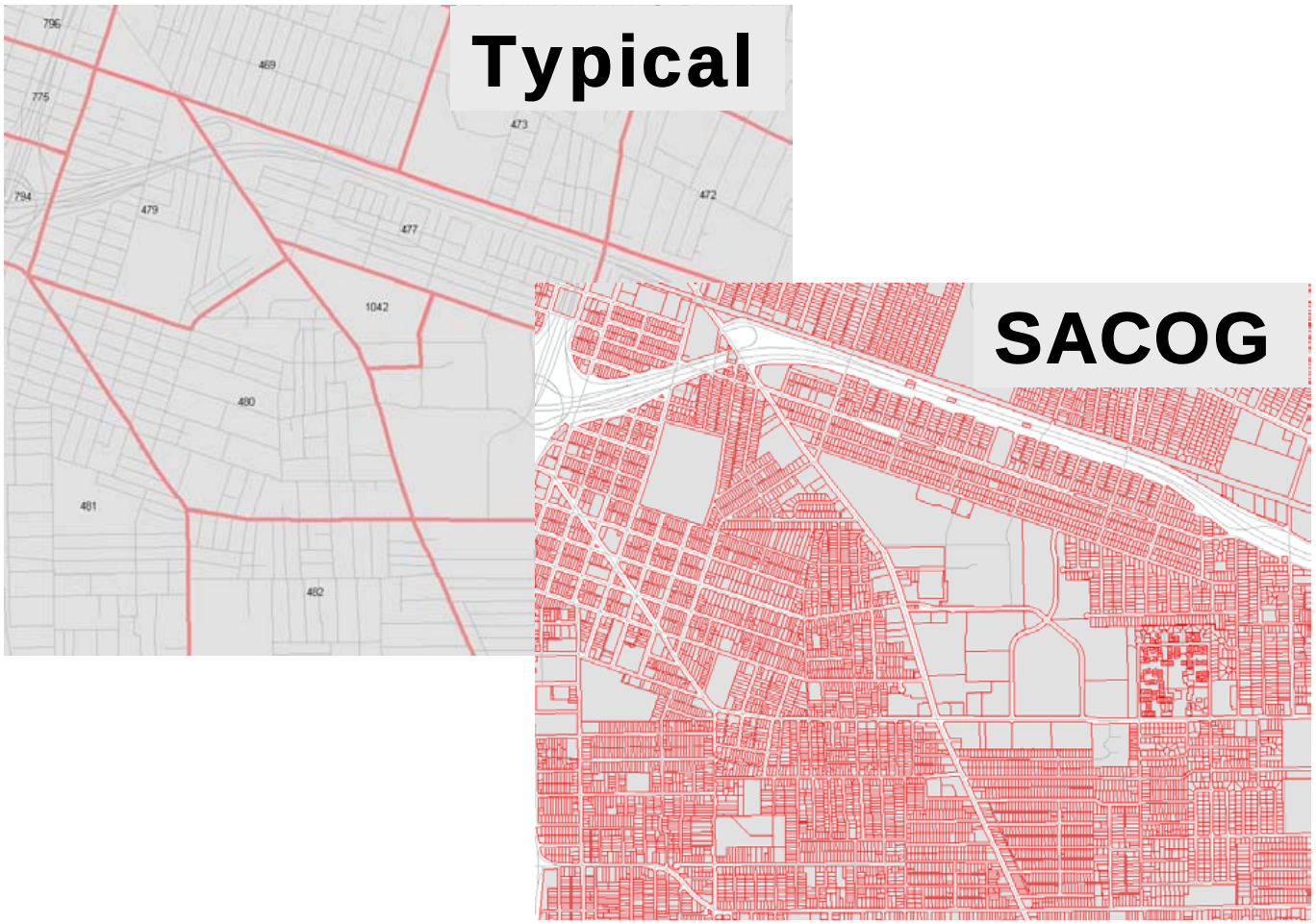
Disaggregating Purpose

Typical	**SACOG**
Work	Work
School	School
Maintenance	Escort
	Personal Business
	Shopping
Discretionary	Meal
	Social/recreation

Disaggregating Time

Typical	SACOG
AM peak Midday PM peak evening night & early AM	48 half-hour periods

Disaggregating Location—750,000 parcels



Model Disaggregation

Long Term Choices	**750,000 parcels**
Day Activity Pattern	**7 purposes**
Tour Destination	**750,000 parcels**
Mode	**8 modes**
Time Period	**48 half-hour periods**
No. & Purpose of Stops	**7 purposes**
Stop Location	**750,000 parcels**
Trip Mode	**8 modes**
Departure Time	**48 half-hour periods**

2005-2006: SACOG

- Reformulated day activity pattern
- High resolution
  - purpose (7)
  - time (1/2 hr)
  - space (parcel)
- **Improved integration**
- Equilibration techniques

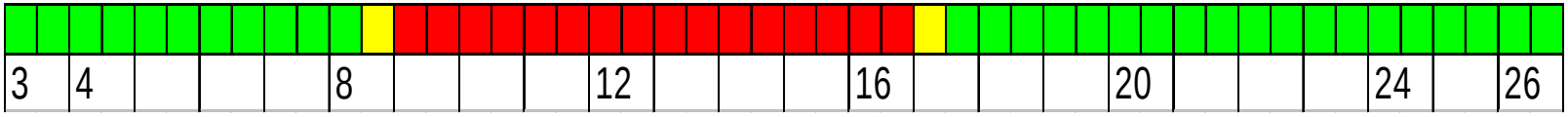
Model System Integration

- Downward integration
  - Conditional lower models
  - Enforce time-space constraints
- Upward integration--Upper levels affected by lower level opportunities
  - mode choice logsums with simulated time of day
  - aggregate logsums

Downward Integration
Time-Space Constraints

- Model
  - arrival and departure periods (approximate duration)
  - 1716 arrival-departure choice alternatives

Work tour scheduled:



Model System Integration

- Downward integration
  - Conditional lower models
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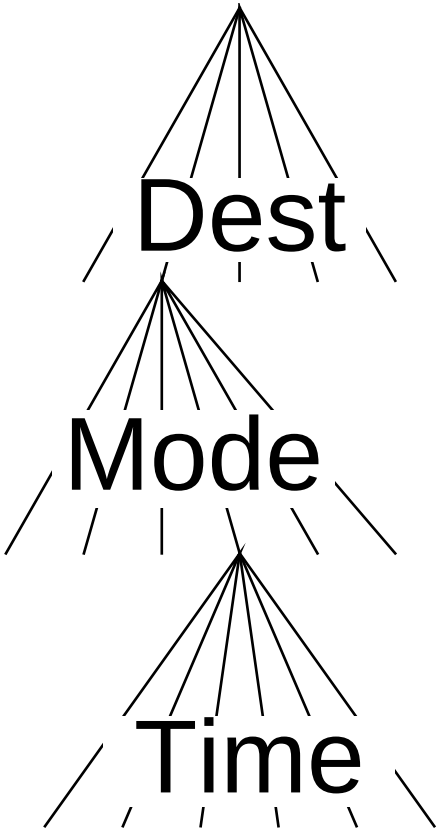
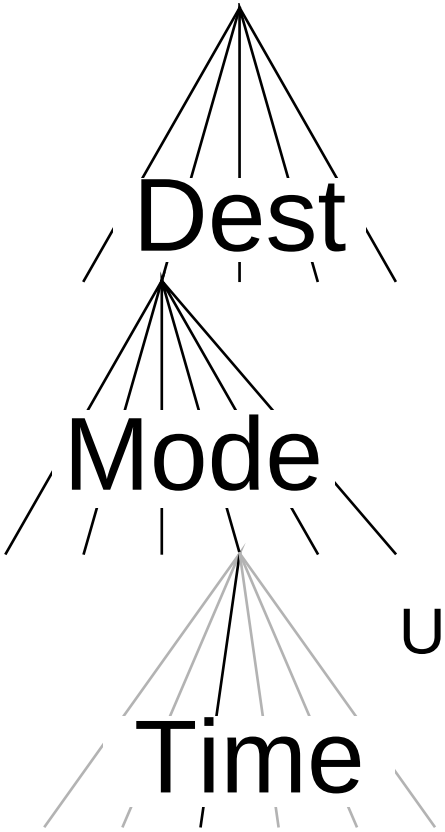
- Upward integration--Upper levels affected by lower level opportunities
  - mode choice logsums with simulated time of day
  - aggregate logsums

Upward Integration
Logsums with assumed TOD

Instead of this



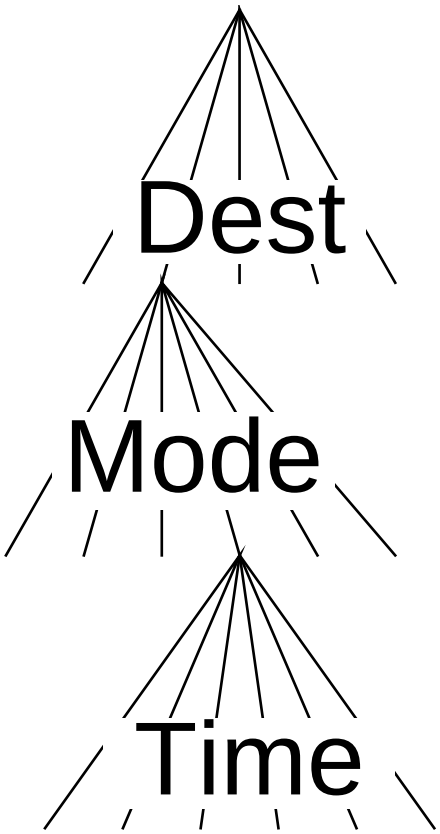
Typical simplification



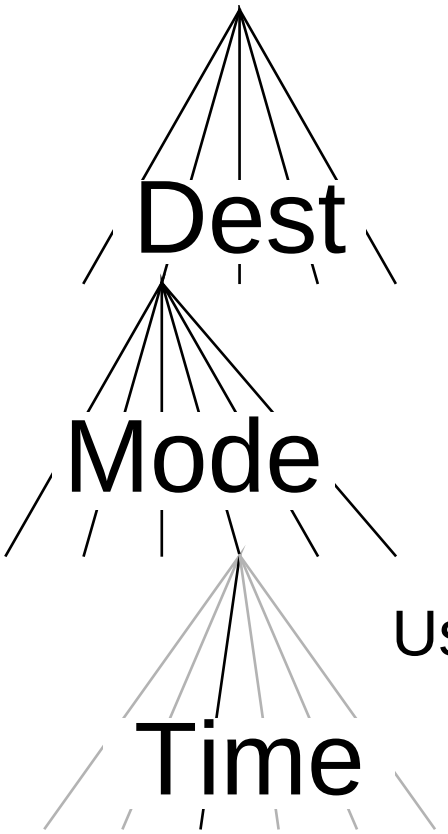
Use assumed time

Upward Integration
Logsums with simulated TOD

Instead of this



Do this



Use simulated time

Upward Integration
Aggregate mode-dest logsums

- 84 pre-calculated per TAZ
  - 7 purposes
  - 4 car availability levels
  - 3 categories of origin proximity to transit

Upward Integration
Intermediate stop logsums

- 4 pre-calculated per TAZ OD pair
  - 2 tour modes (auto & transit)
  - 2 times of day (peak & offpeak)

Upward Integration
Use of logsums in models

Model	Mode logsums	Mode-dest logsums	Intermediate stop logsums
Usual loc.	To usual loc.	At usual loc.	
Auto ownership	To usual locs. of workers & students	At home	
Day Pattern	To usu. locs. for work & school tours	At home for other purps	Between home and usual work loc.
Tour Dest	To tour dest.	At tour dest.	
No. & purp of interm. stops			for auto-based tours

2005-2006: SACOG

- Reformulated day activity pattern
- High resolution
  - purpose (7)
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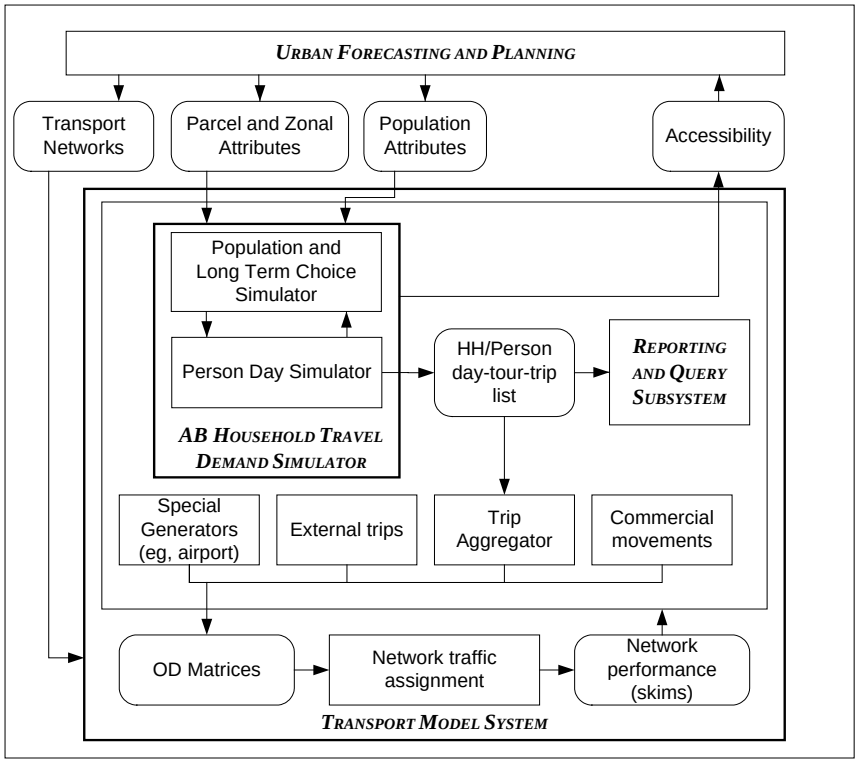
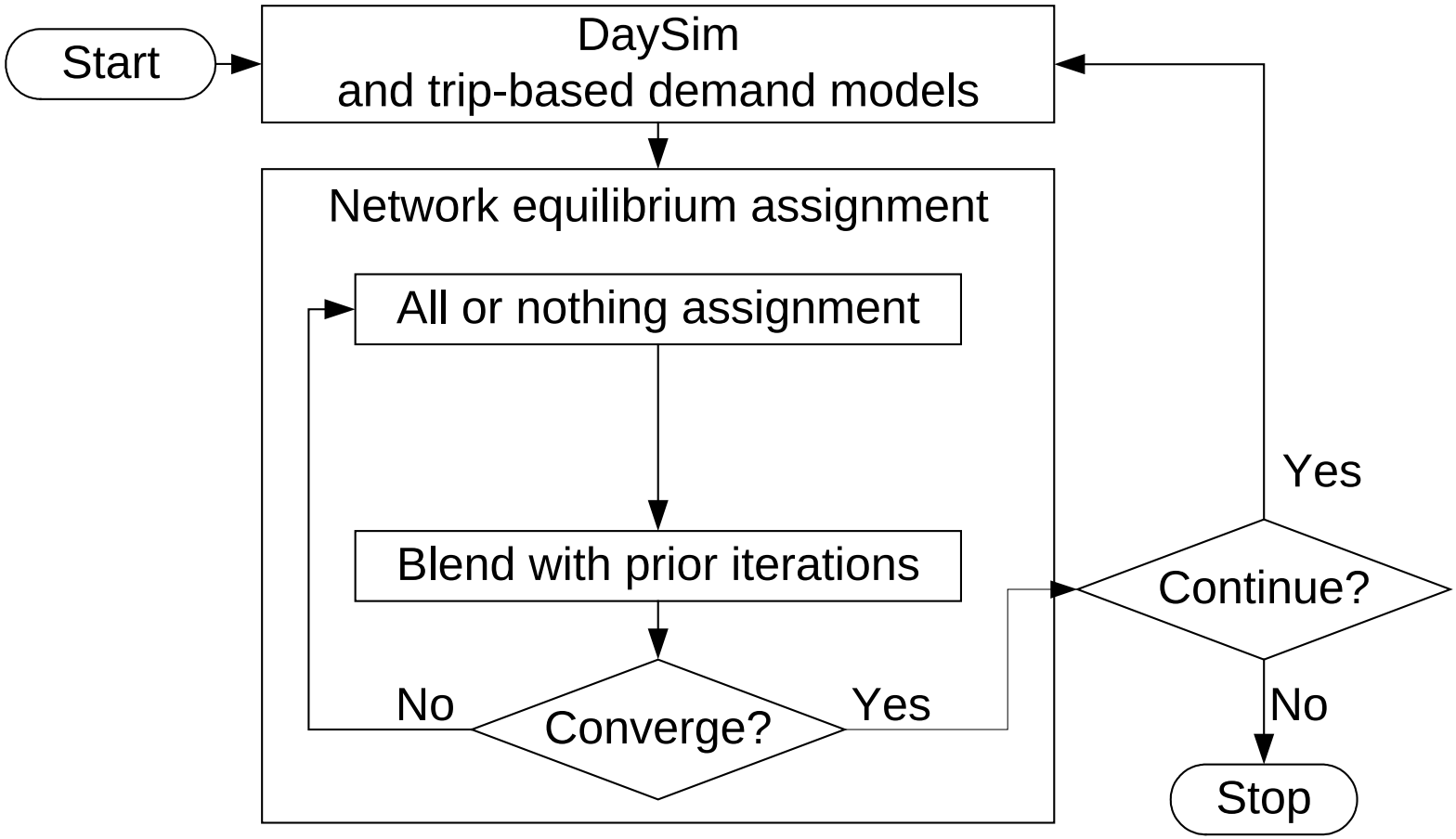
  - space (parcel)
- Improved integration
- **Equilibration techniques**

The equilibration challenge

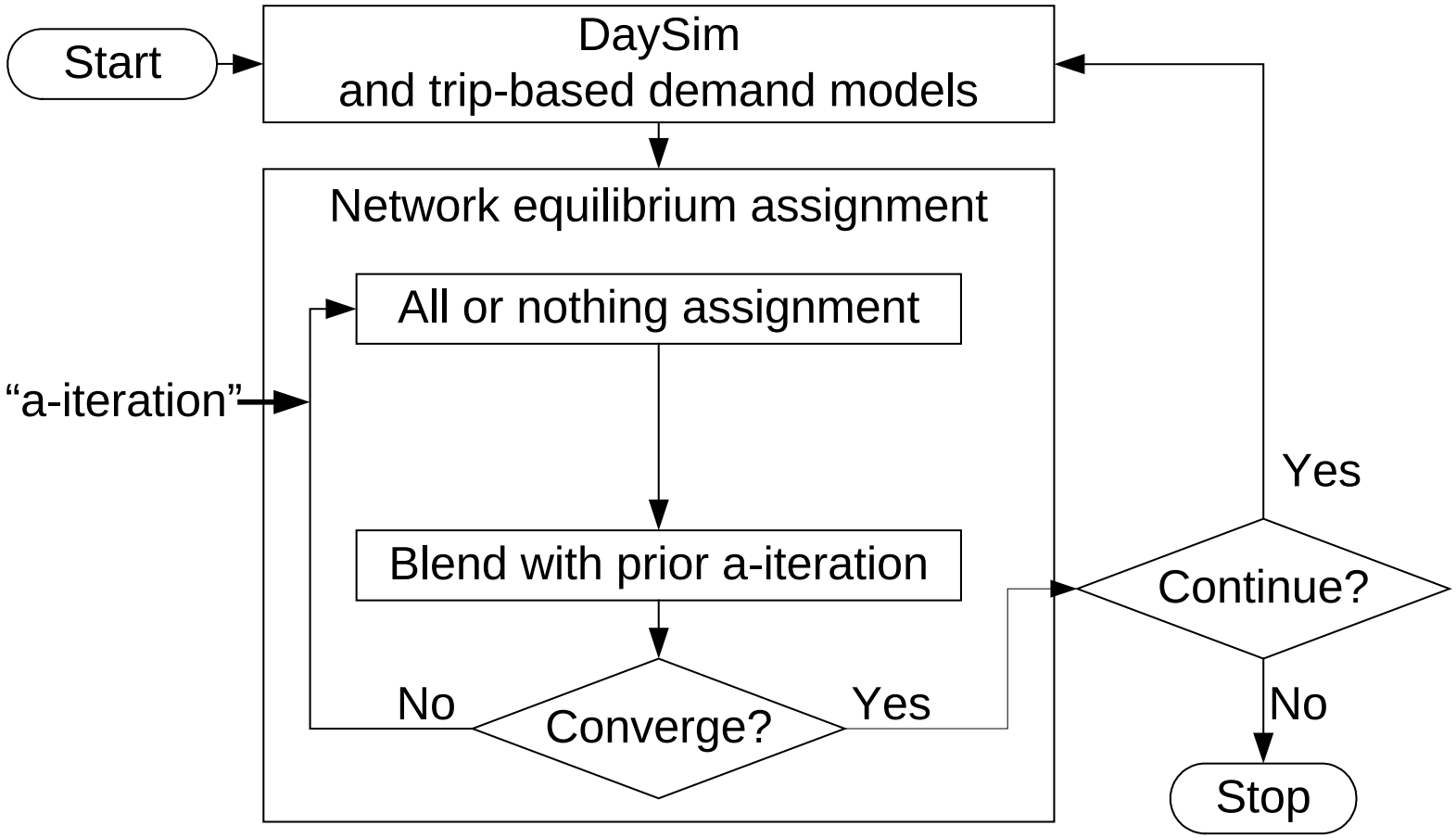
- Equilibration
- Performance



Equilibration
Iteration algorithm



Stabilizing iterations



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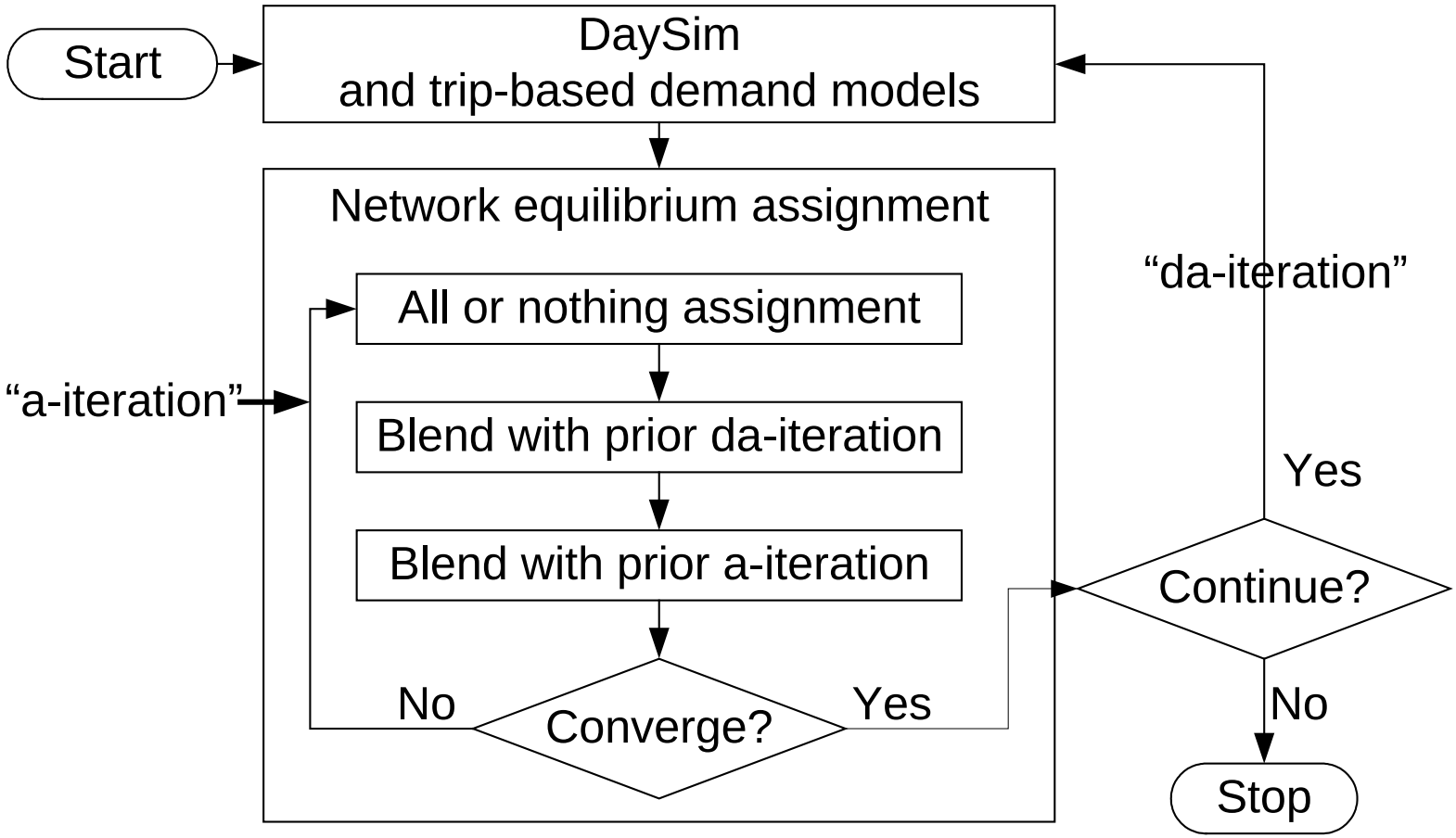


Speeding convergence

da-iteration	1	2	3	4	5	6	7	8	9
DaySim portion of population	2^{-7}	2^{-7}	2^{-6}	2^{-5}	2^{-4}	2^{-3}	2^{-2}	2^{-1}	1

2008: SACOG

- Distributed processing
- Multiple run modes
  - long-range
  - short-range
  - FTA New Starts

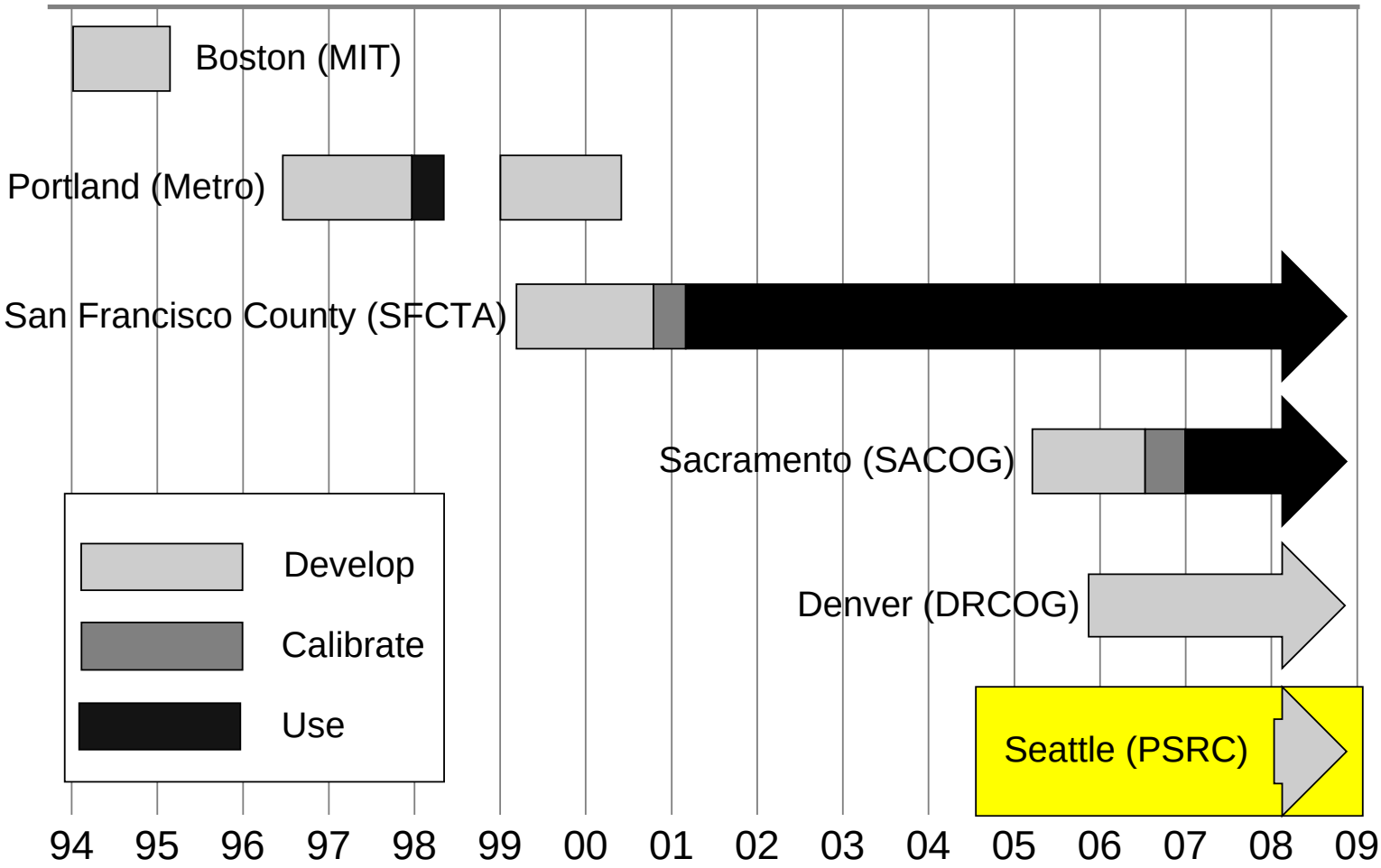
Multiple Run Modes

Short-term Effects	FTA New Starts
Long Term Choices	Long Term Choices
Day Activity Pattern	Day Activity Pattern
Tour Destination	Tour Destination
Mode	Mode
Time Period	Time Period
No. & Purp. of Stops	No. & Purp.of Stops
Stop Location	Stop Location
Trip Mode	Trip Mode
Departure Time	Departure Time

Activity-Based Models
1994-2009

- Day Activity Schedule Approach
- What's happening in the US
- Basics of the "Activity-Based" model systems
- Technical evolution
- What lies ahead?

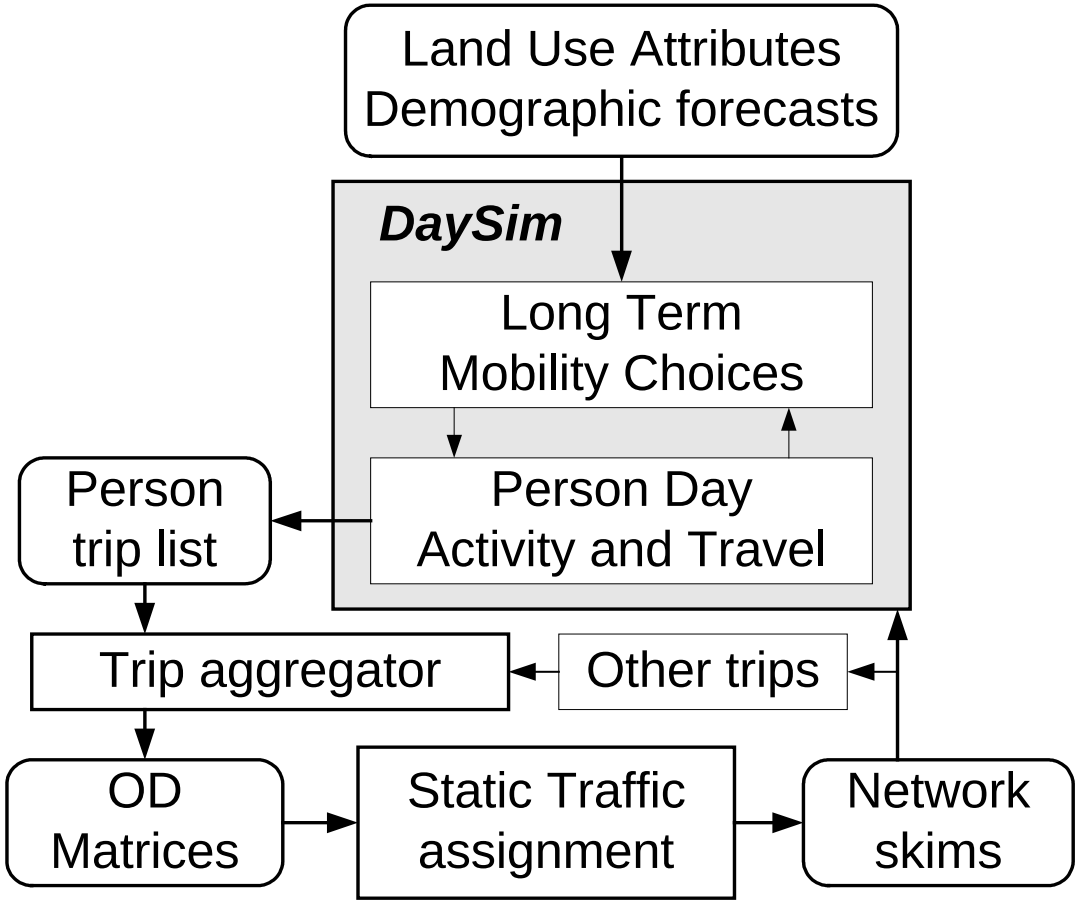
Seattle (PSRC)



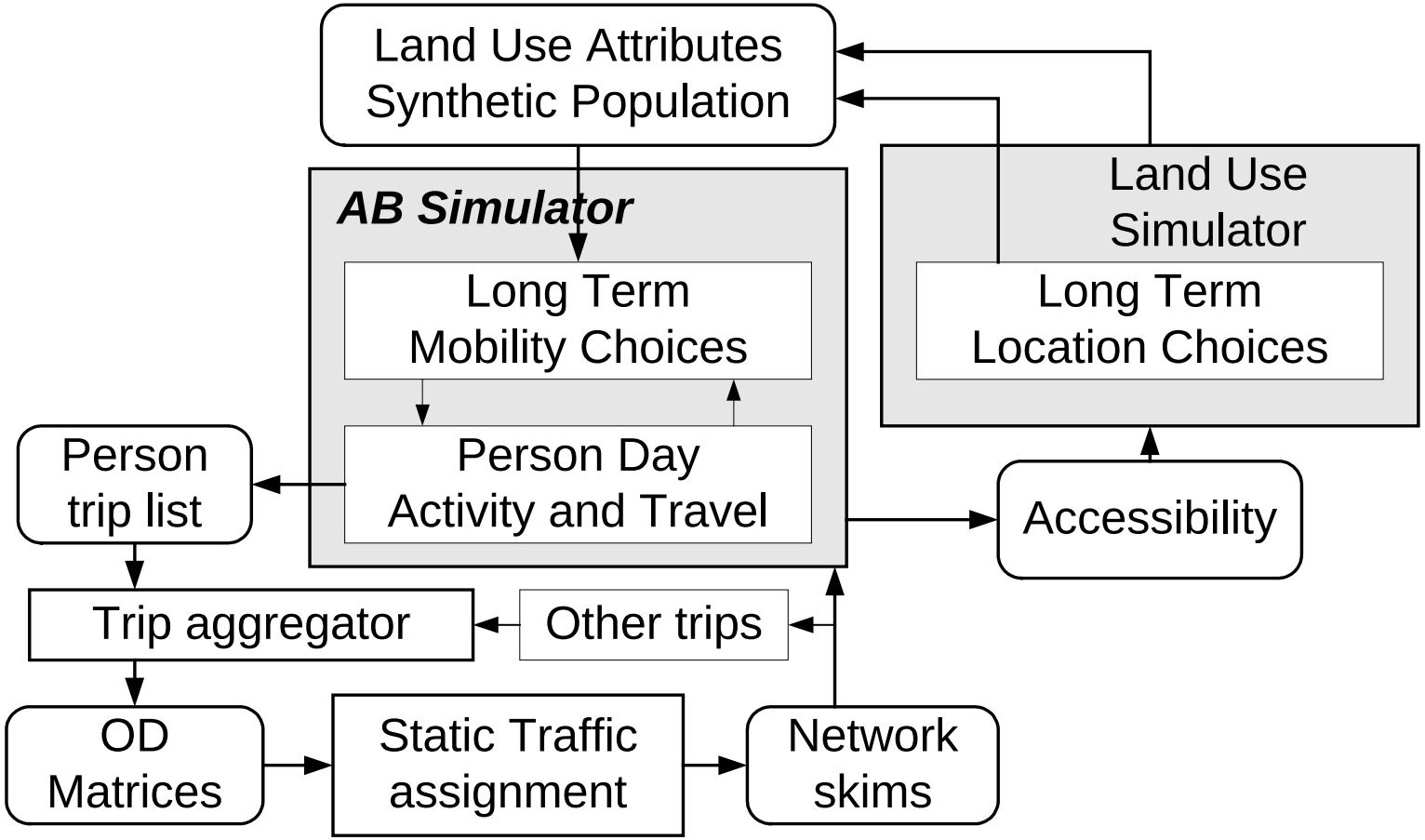
PSRC Design
New features

- Integrated land use simulator
- New long-term models
- Household day models

Existing Model



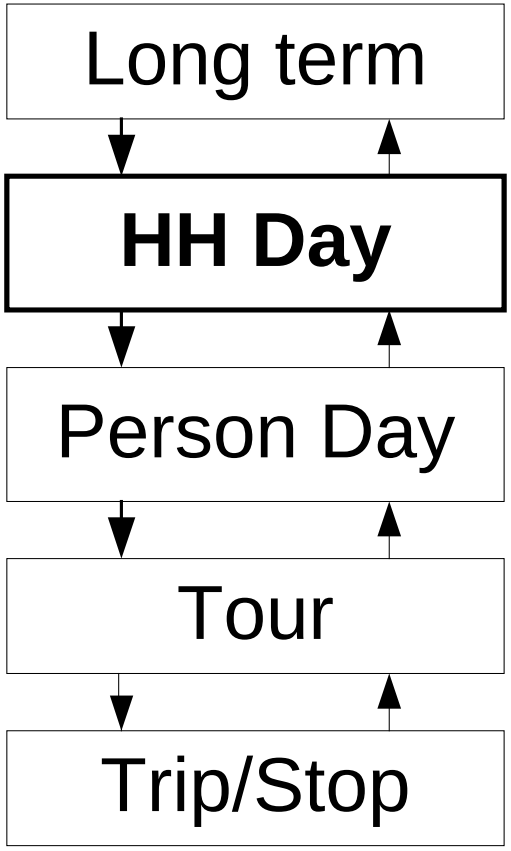
PSRC Design
Integrated Land Use Simulator



PSRC Design
New Long-term models

- Usual mode to work
- Transit pass

PSRC Design
Household day models



PSRC Design
Intra-household models

- Household day pattern
  - work, school, other or home for each member
- Chauffeur half-tours—take passenger to/from school or work
  - on way to/from work
  - as a ‘serve passenger’ tour
- Joint tours

PSRC Design
New features

- Integrated land use simulator
- New long-term models
- Household day models

More possibilities
In the queue and around the corner

- Integrated vehicle models
  - vehicle type choice
  - vehicle usage
- Park and walk
- Effects of reliability
- Tour-based commercial movements
- Integration with dynamic traffic assignment

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