How is an Activity-Based Model Set Developed?

Chicago Metropolitan Agency for Planning

Symposium on Developing and Implementing an Activity-Based Travel Demand Model

August 27, 2008

John L Bowman, Ph.D.

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JBowman.net

Outline

- Activity-Based (AB) Model System
- Development Tasks
- Basic Build Approaches
- Development Roles
- Management Keys to Success

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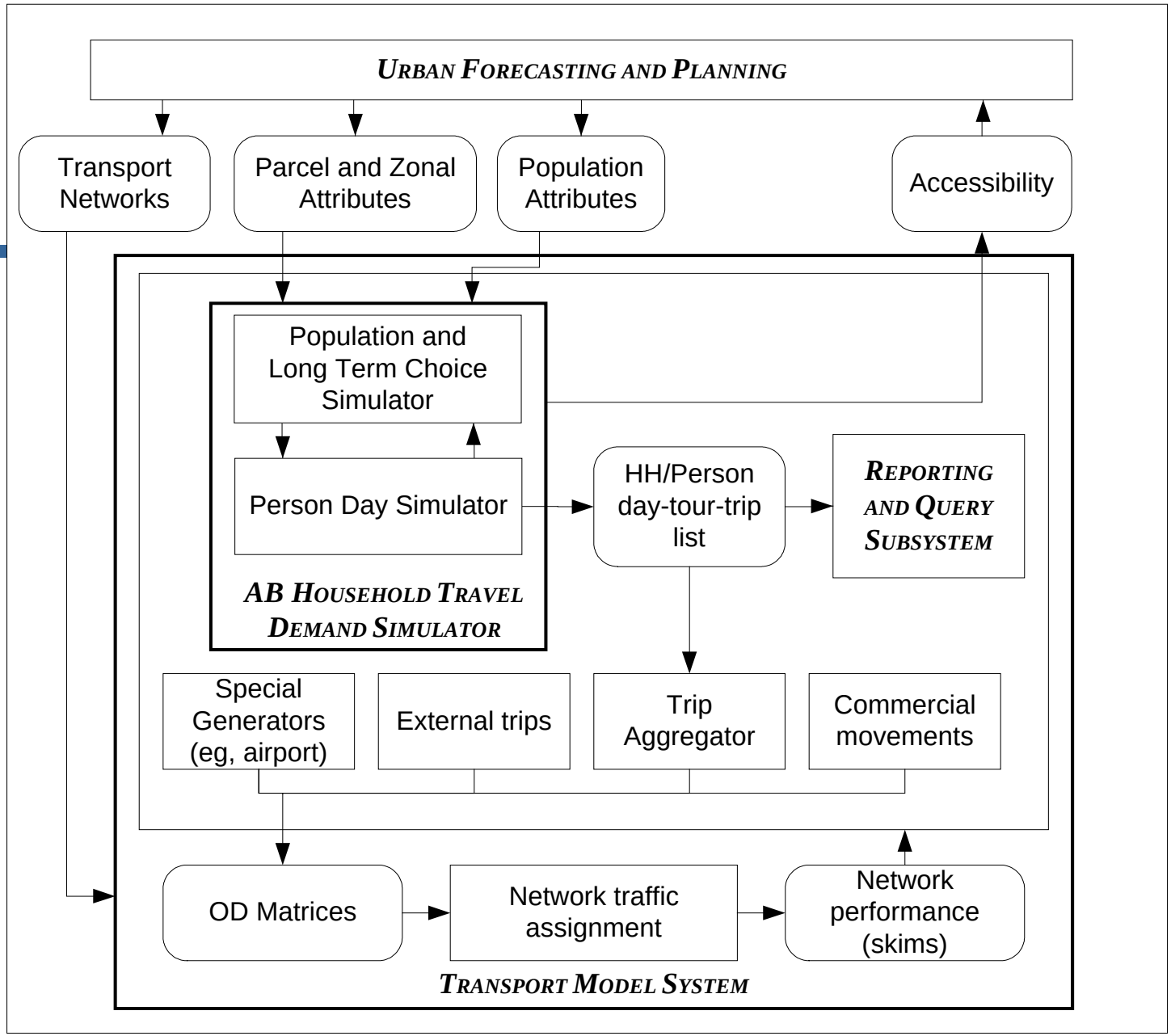

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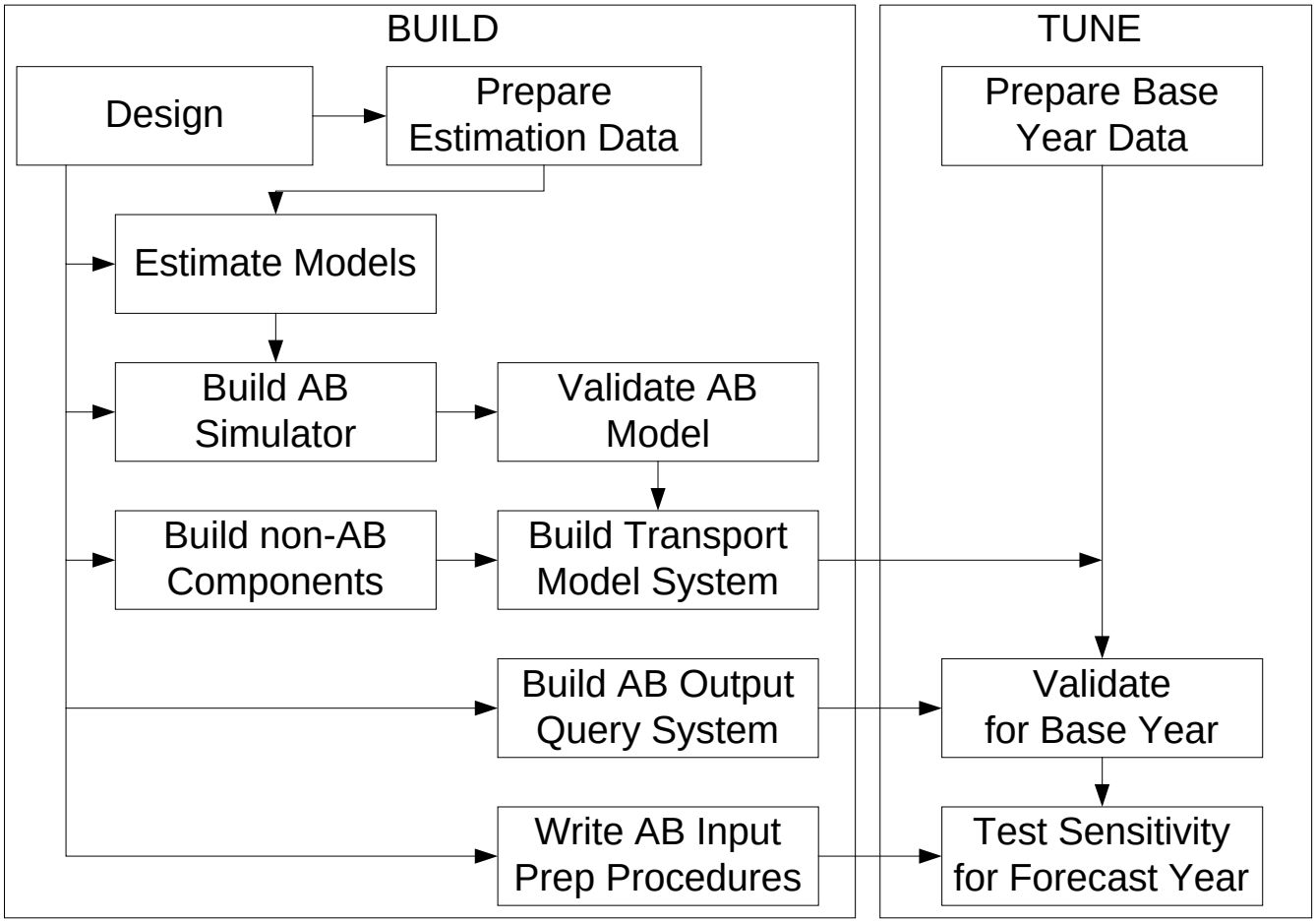
The Tasks



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Basic Build Approaches

- Invent
- Adapt
- Adopt

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Development Roles

- AB Developer
- Trip-Based Model Expert
- GIS/DB/GUI Expert(s)
- Application Expert

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Management Keys to Success

- A sound design
- Capable innovative developers
- Sustained sponsorship

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- Postscript—A Few Suggestions

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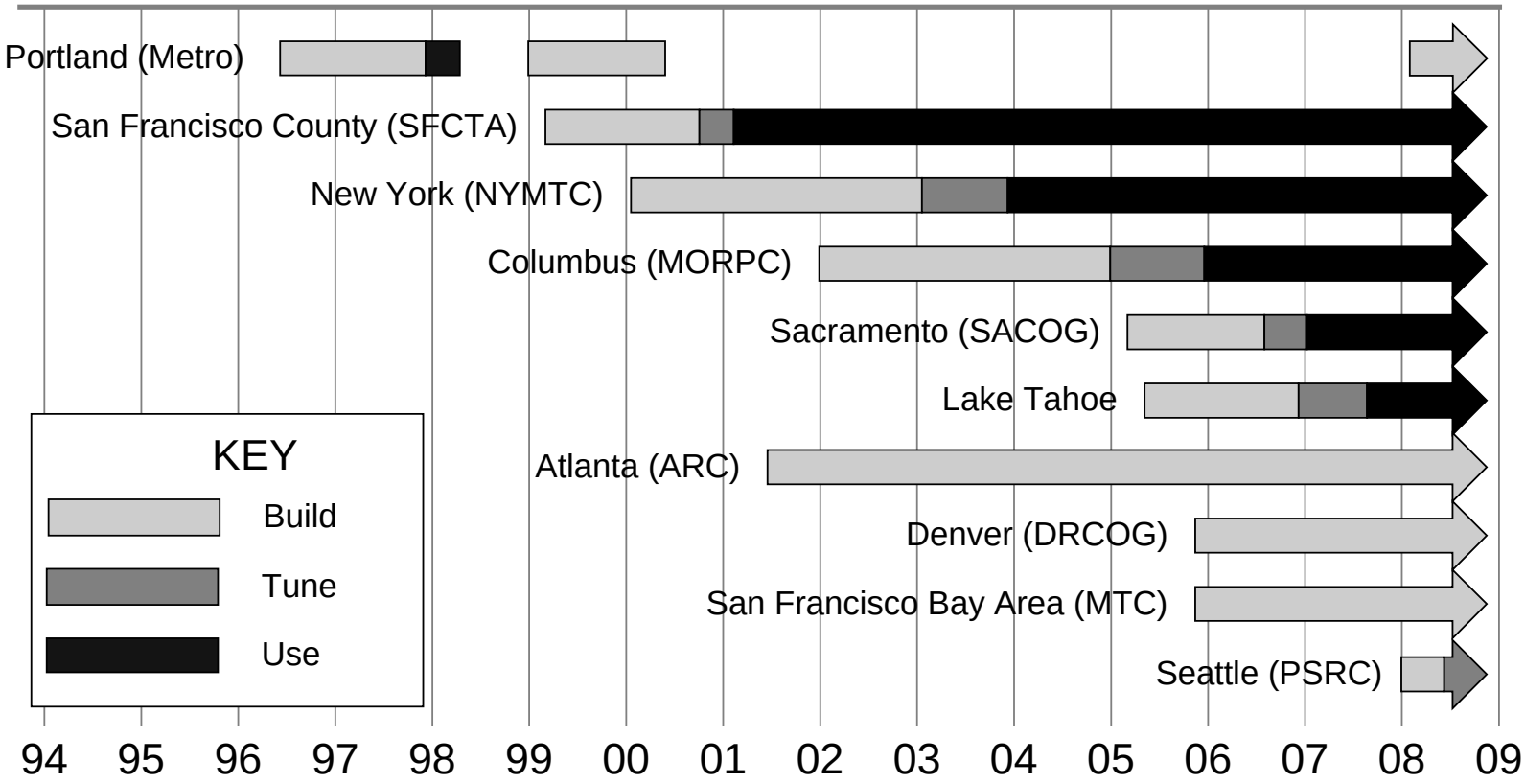
U.S. Projects



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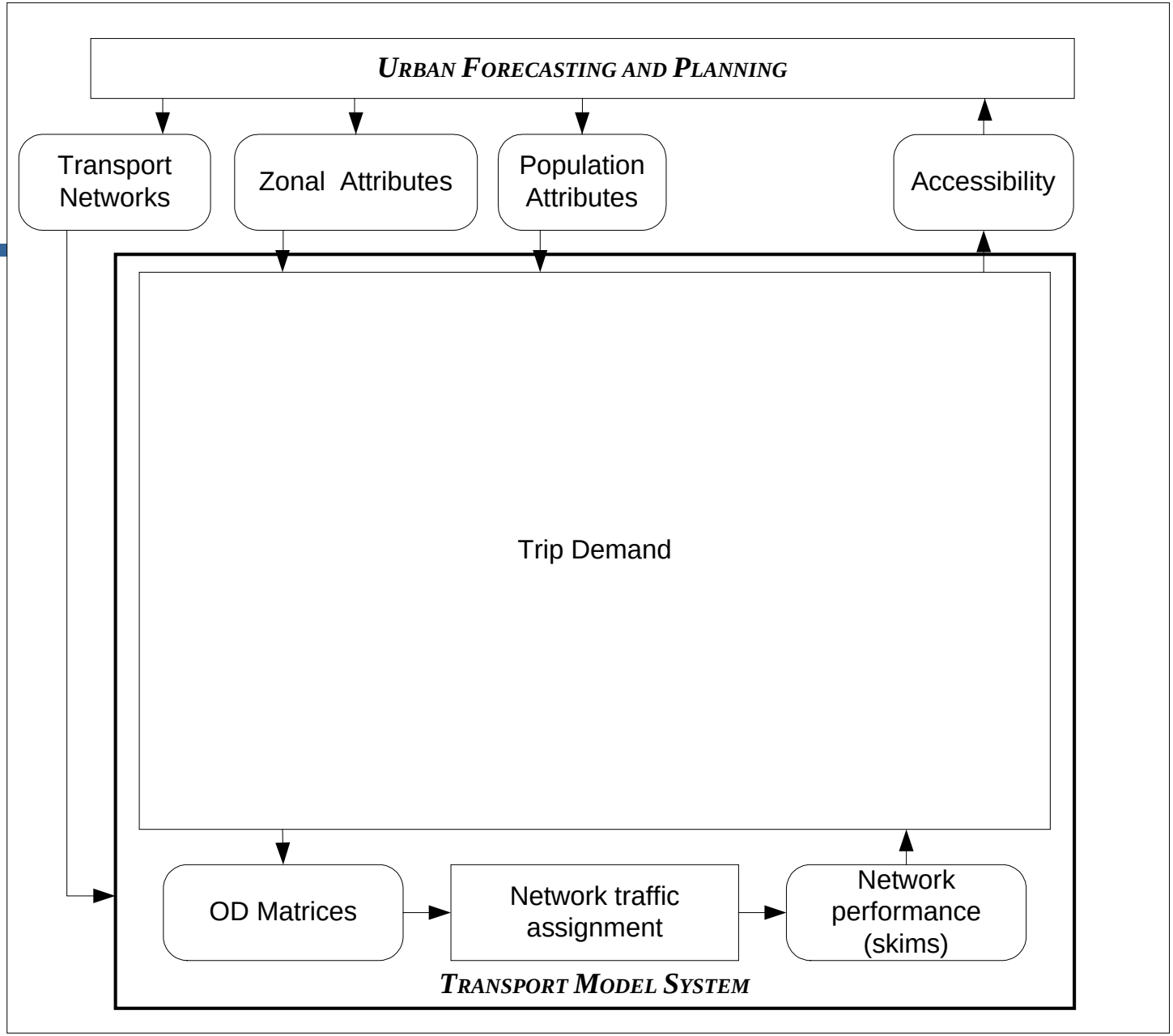

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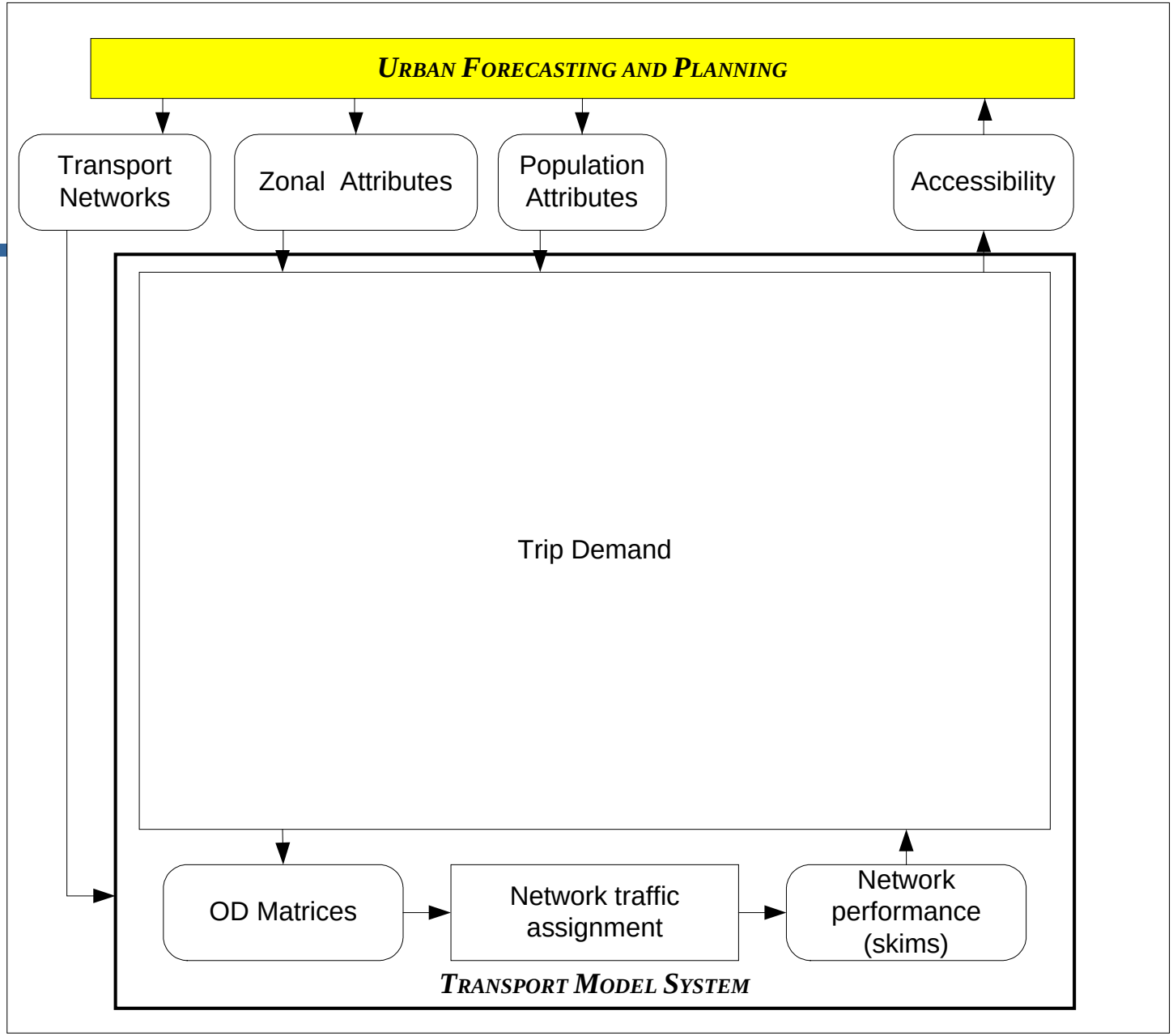

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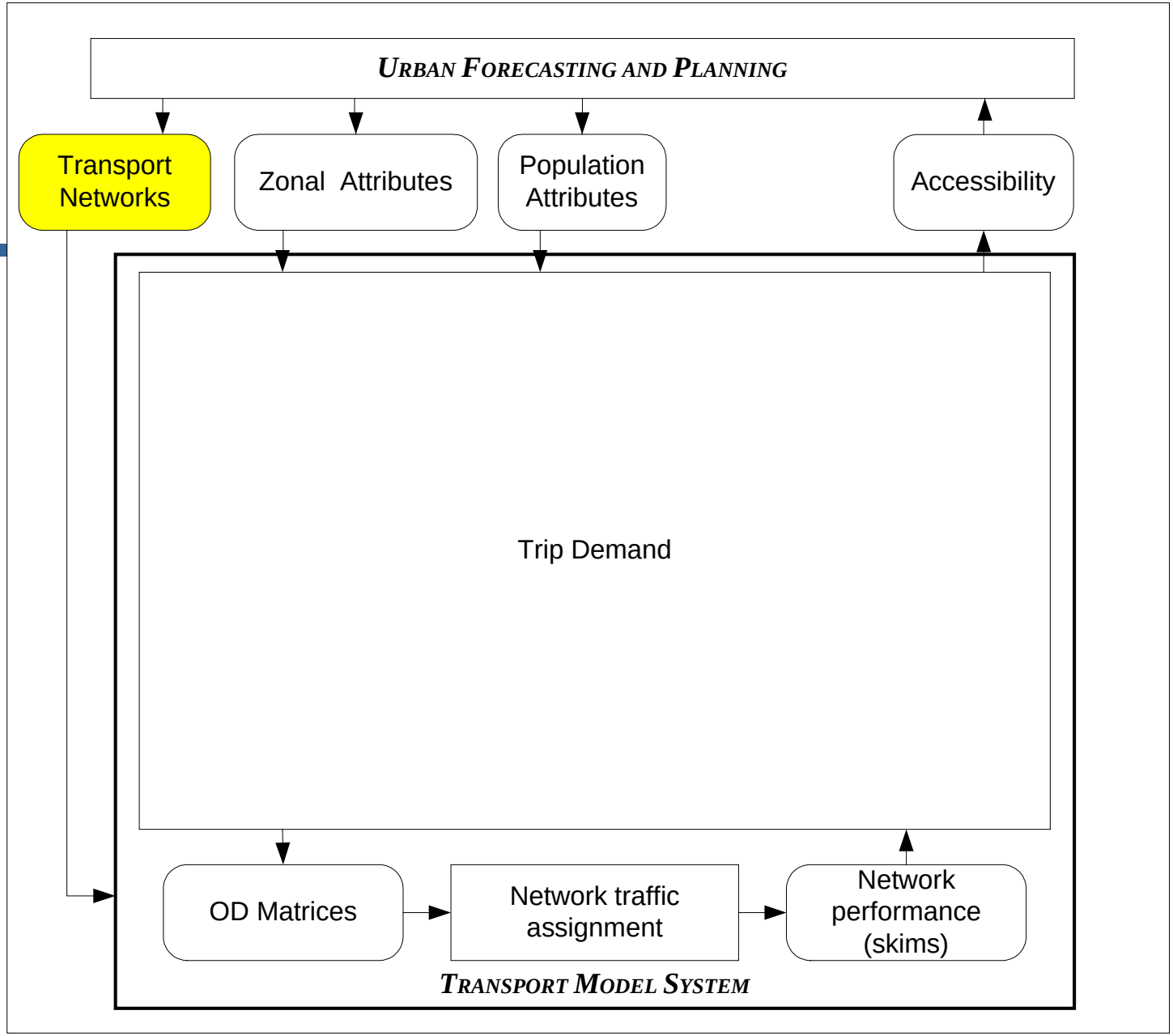

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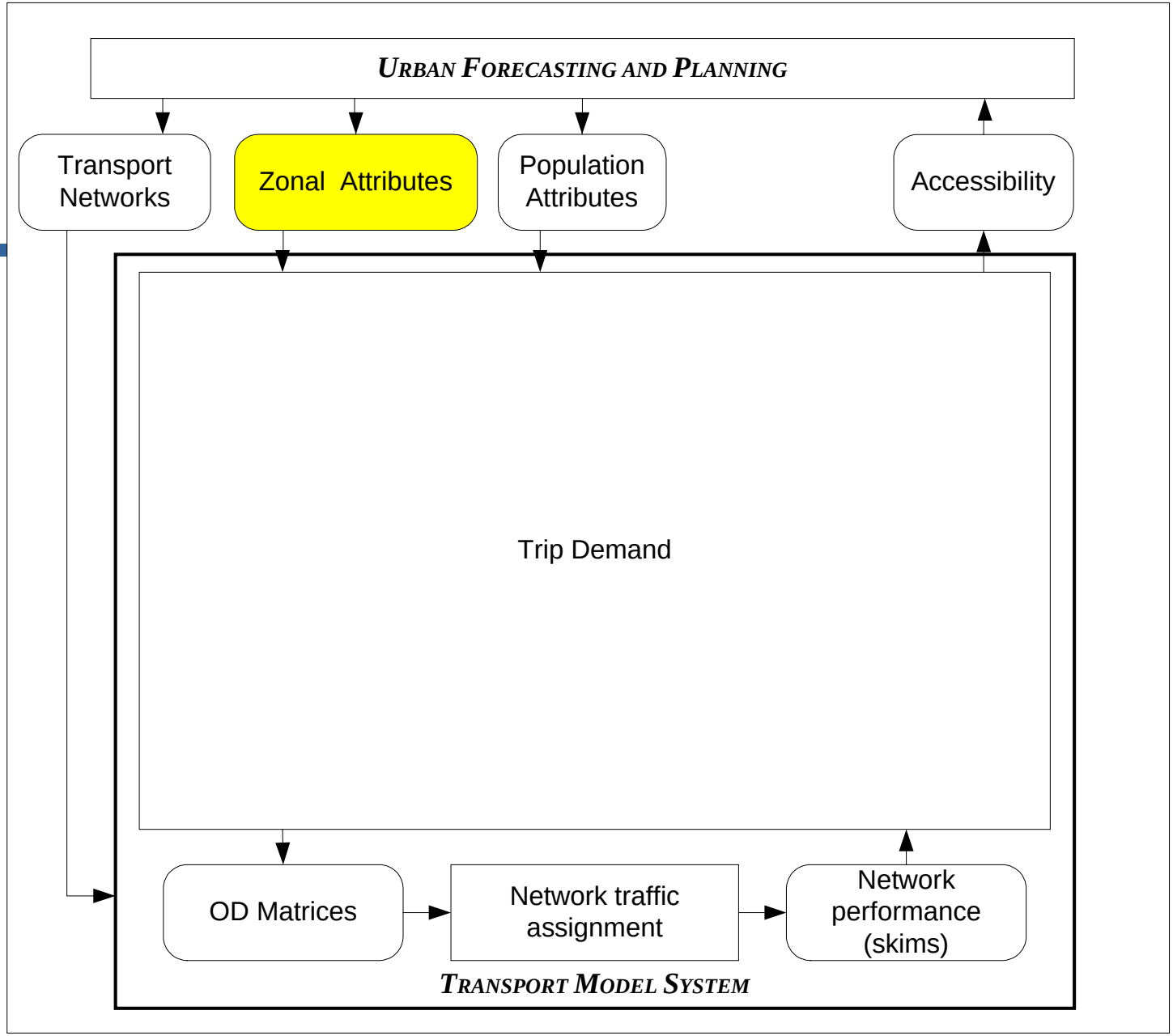

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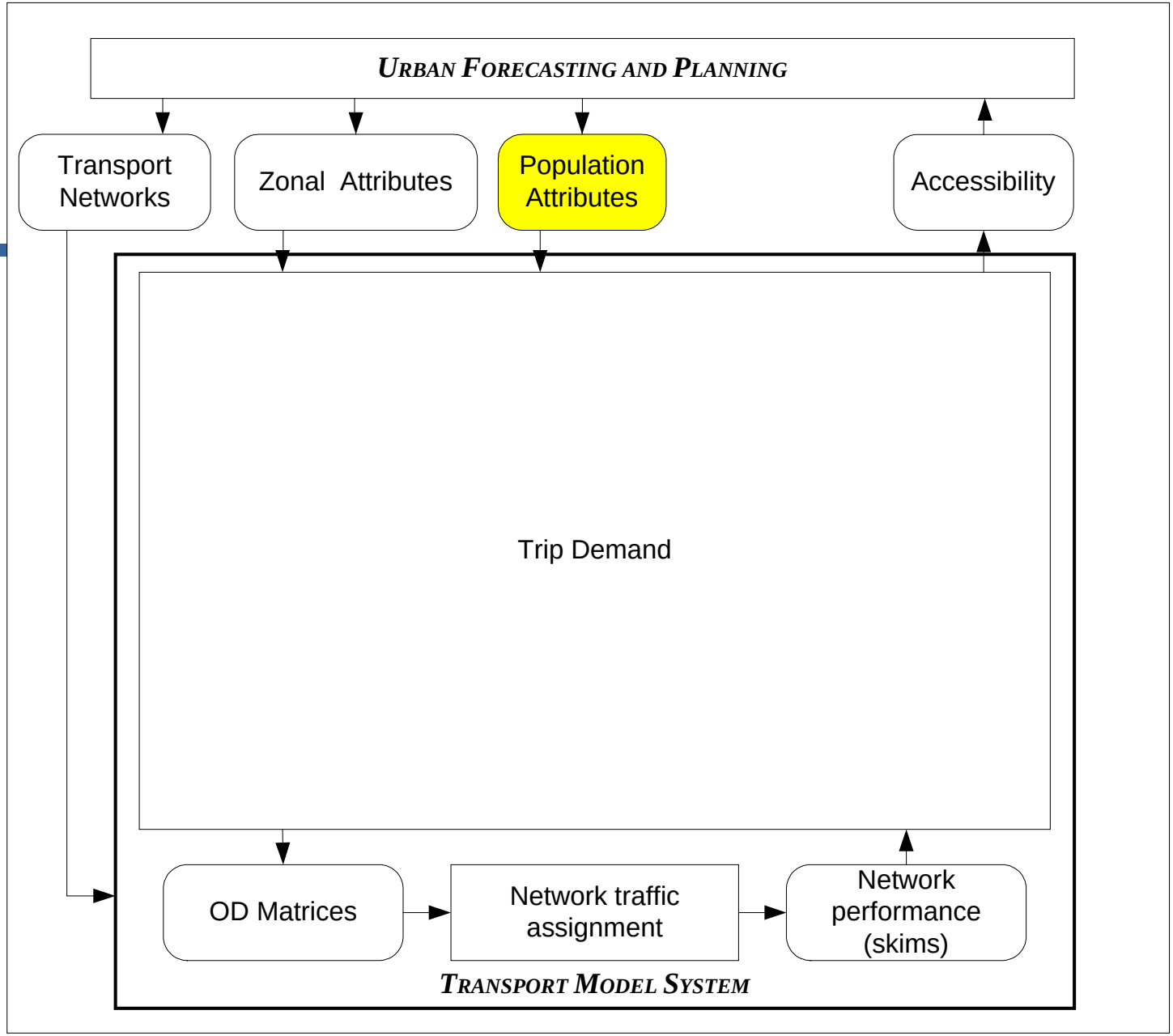

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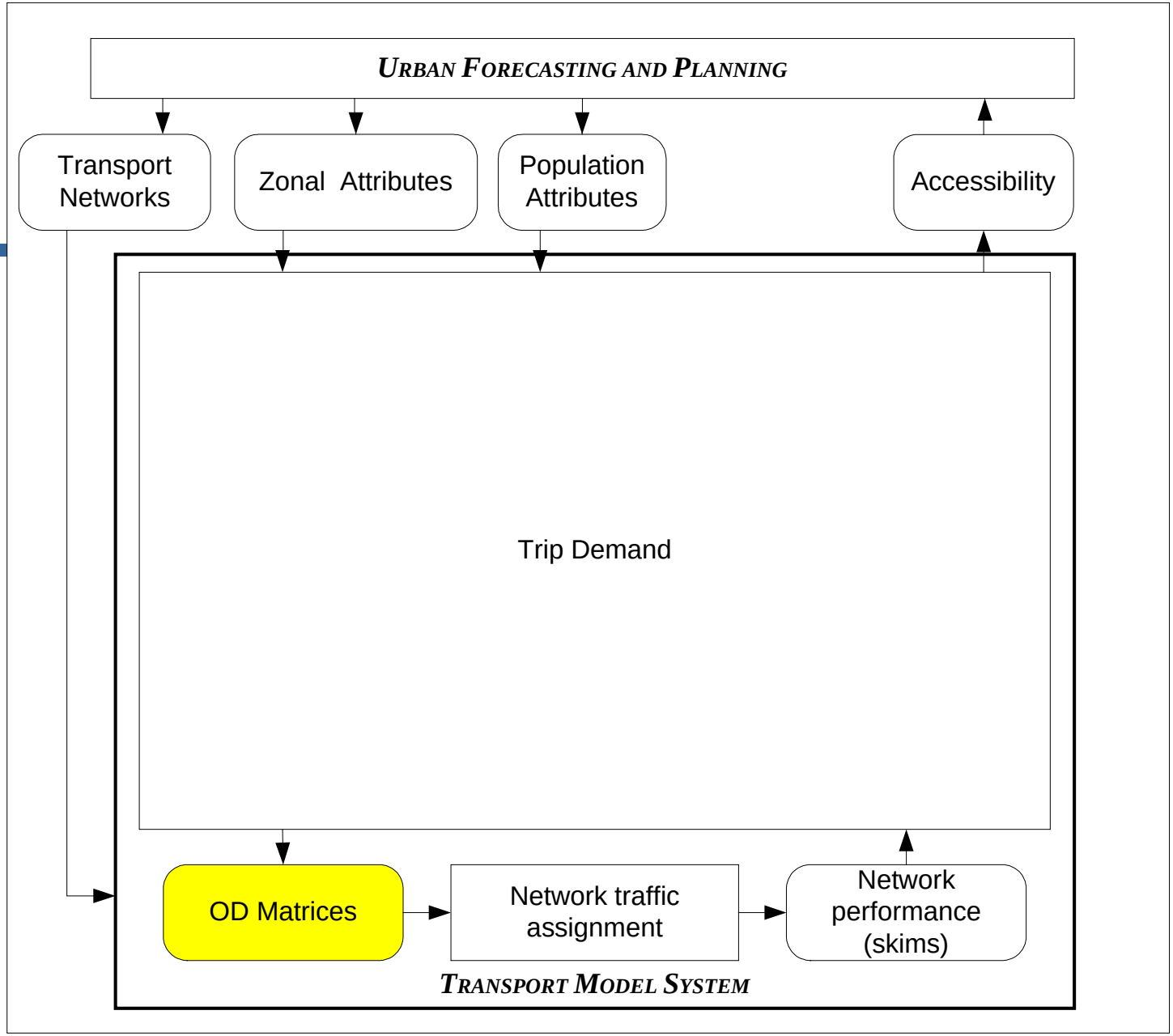

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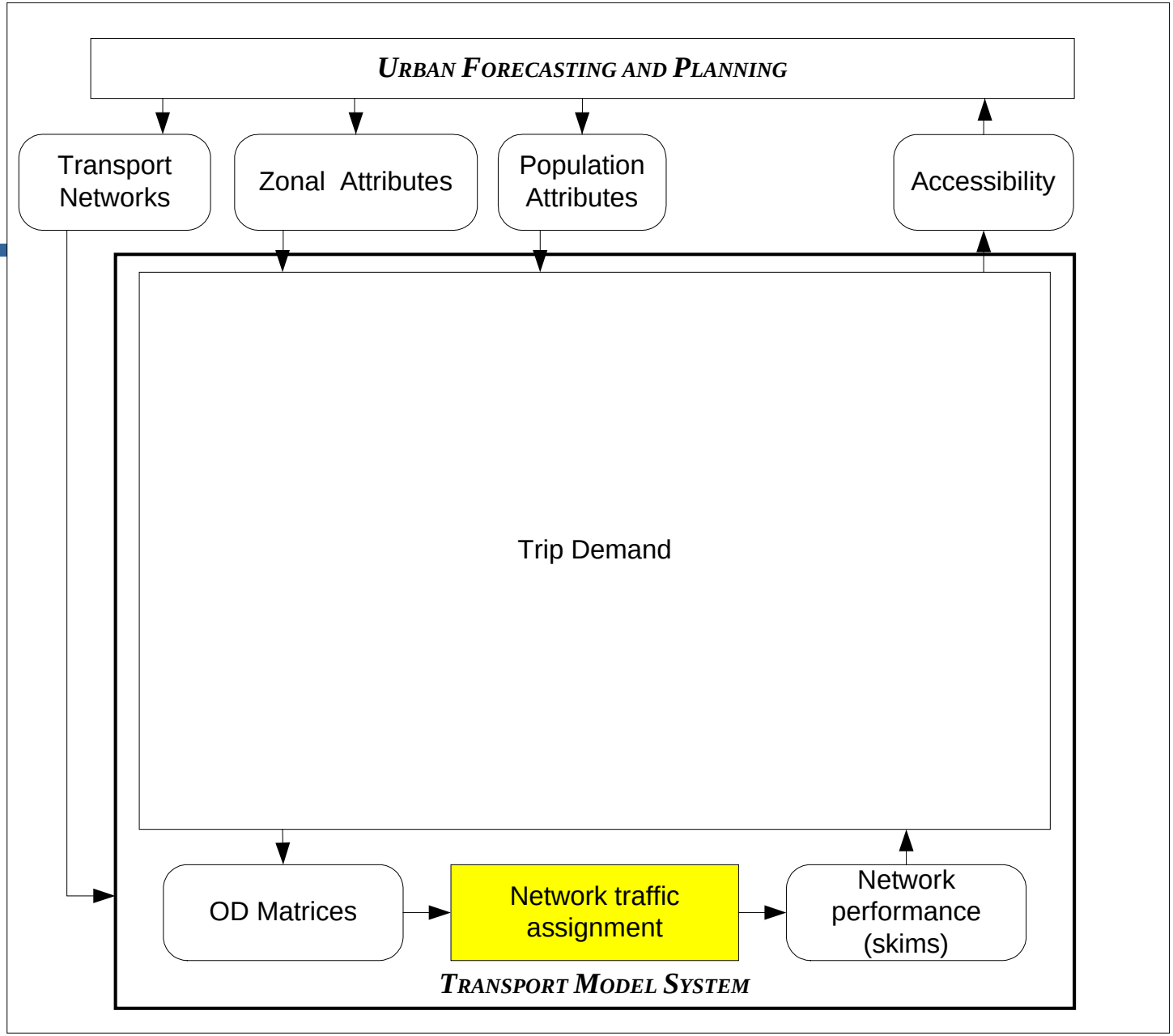

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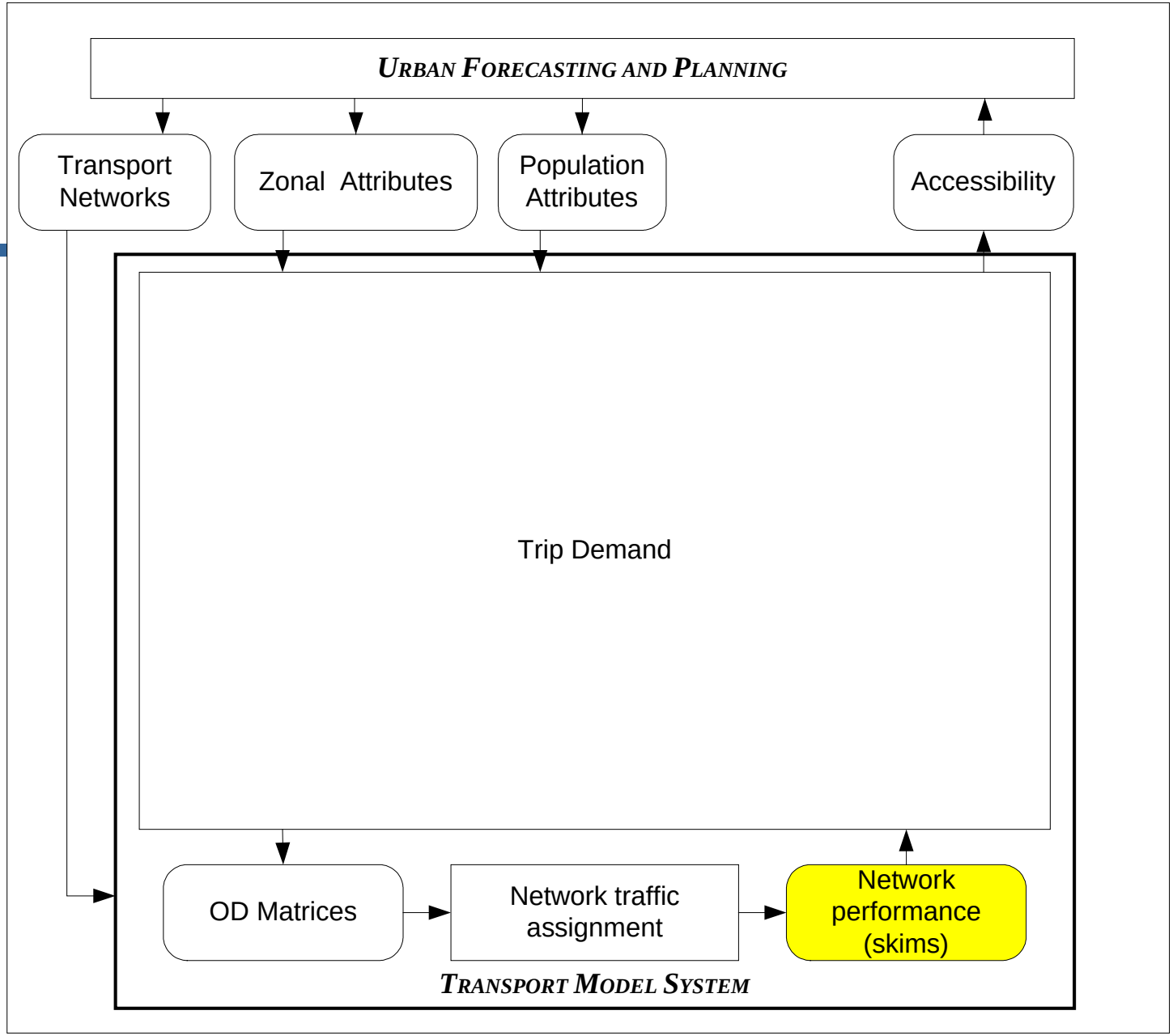

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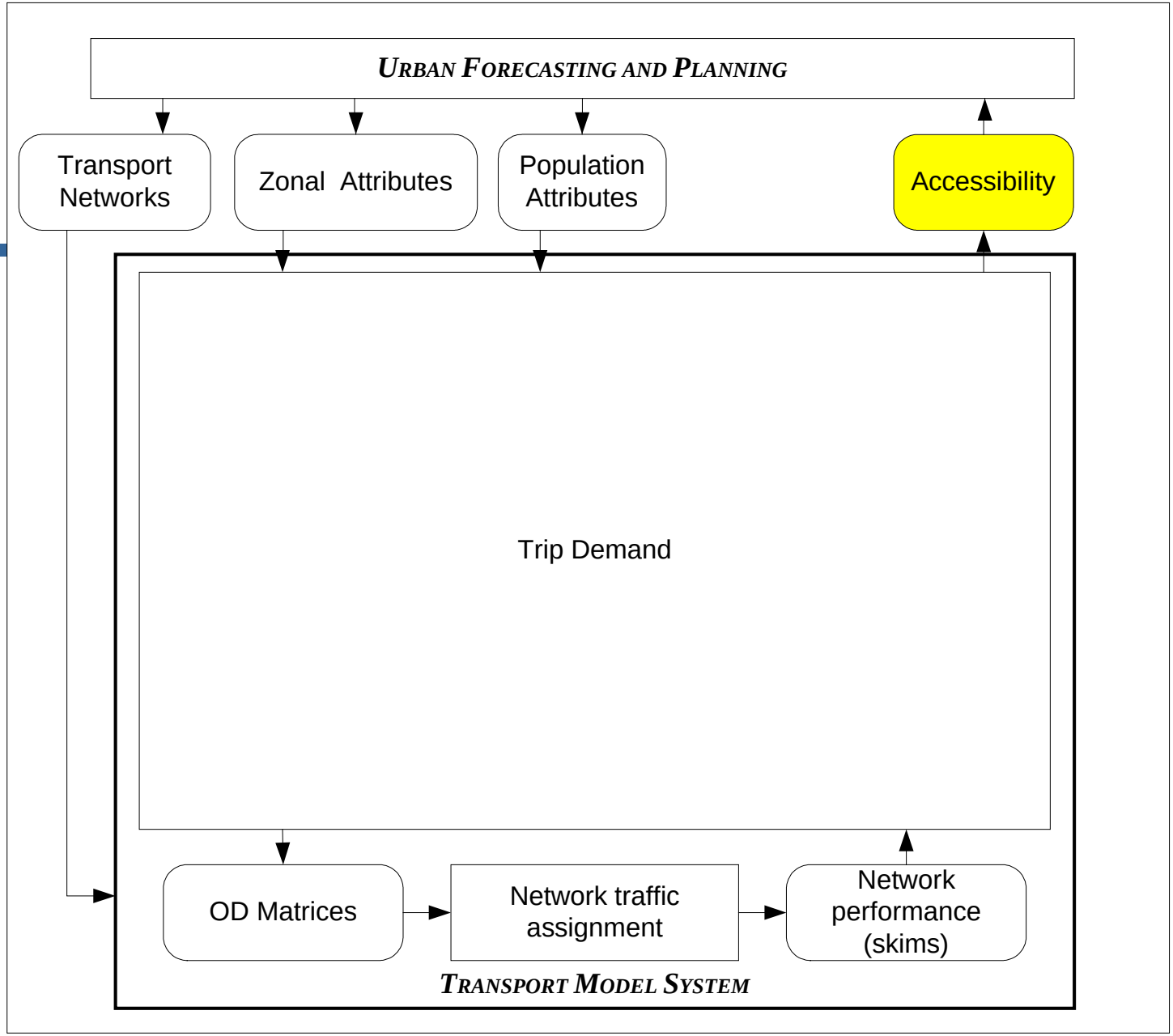

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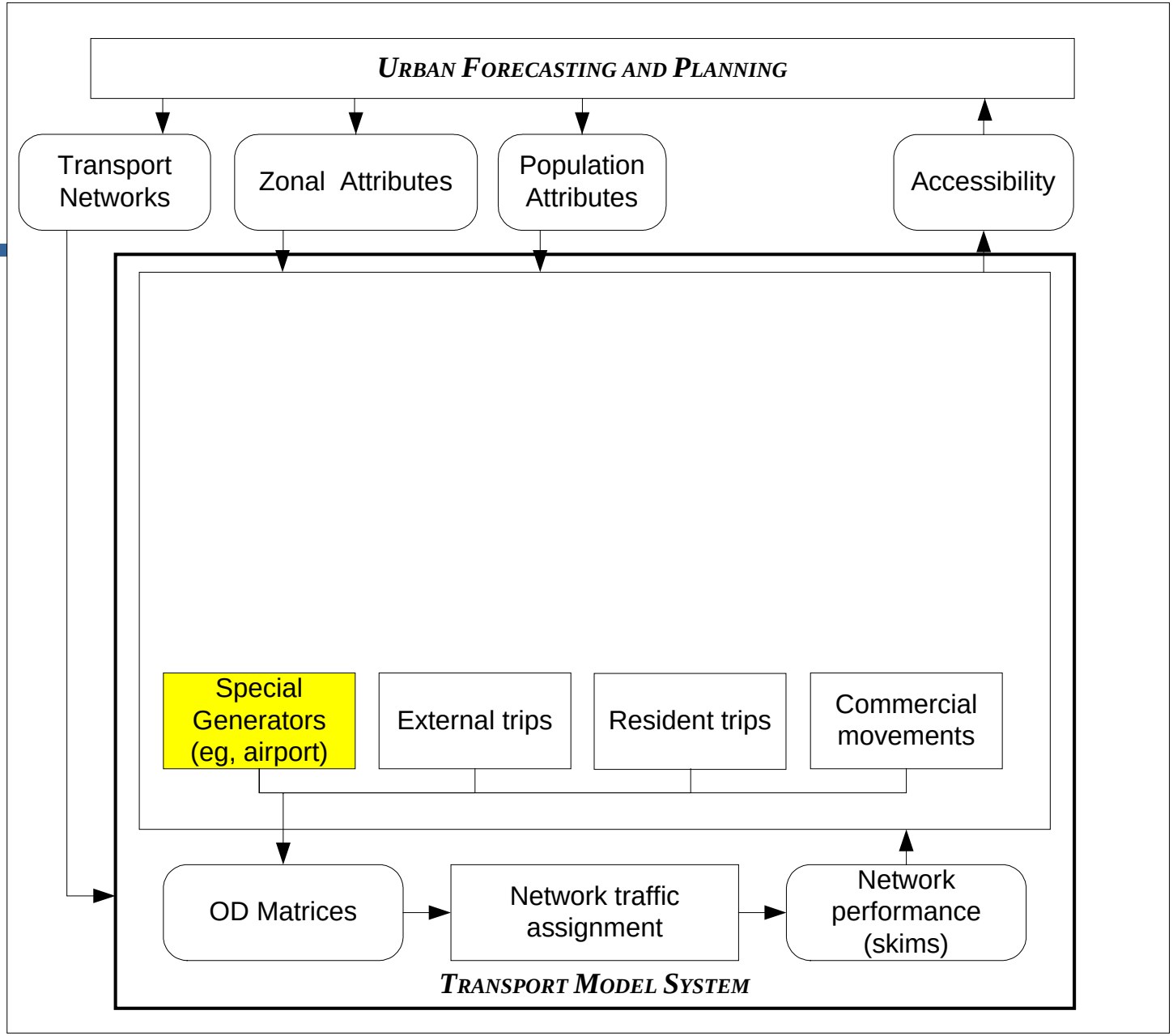

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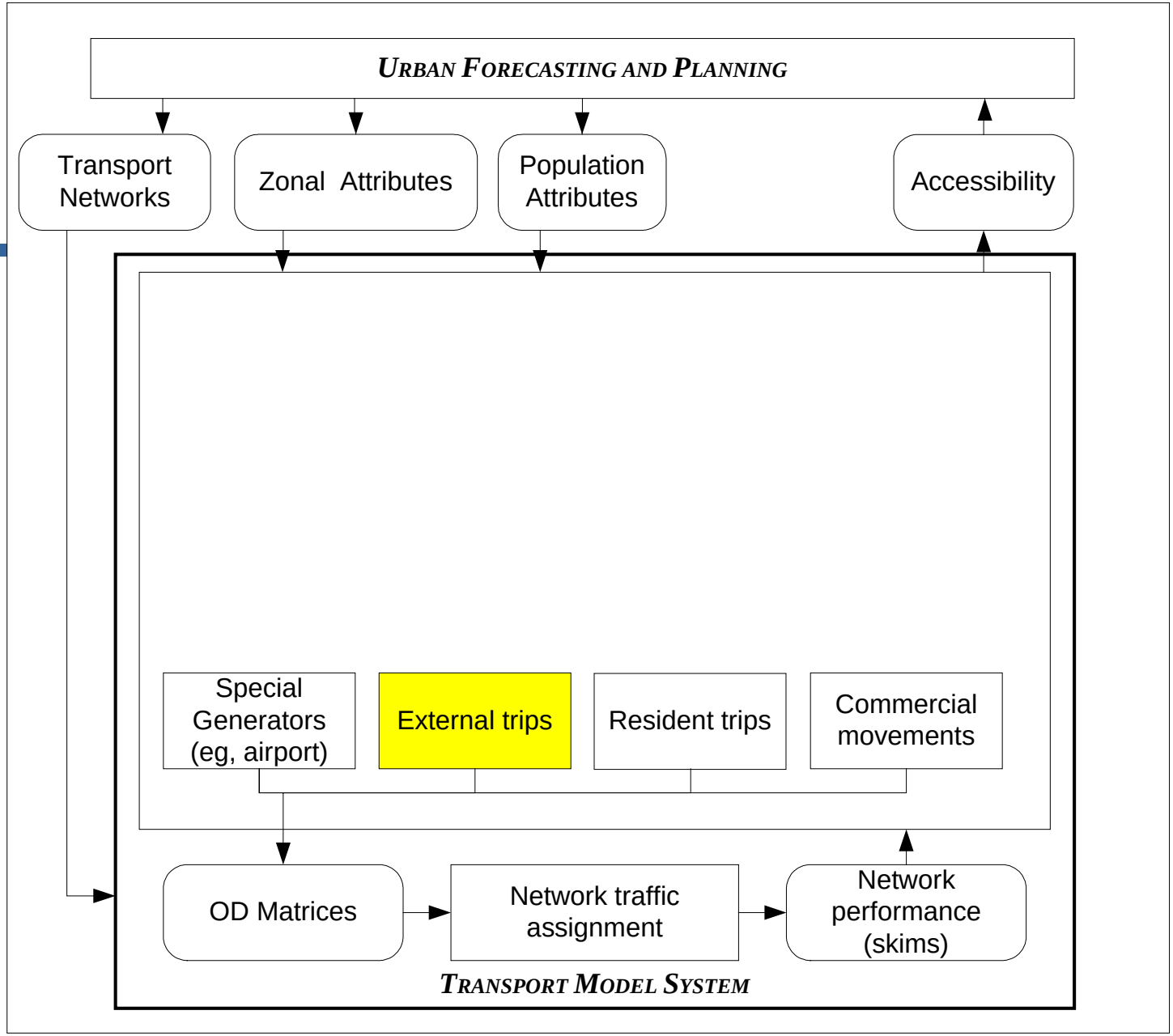

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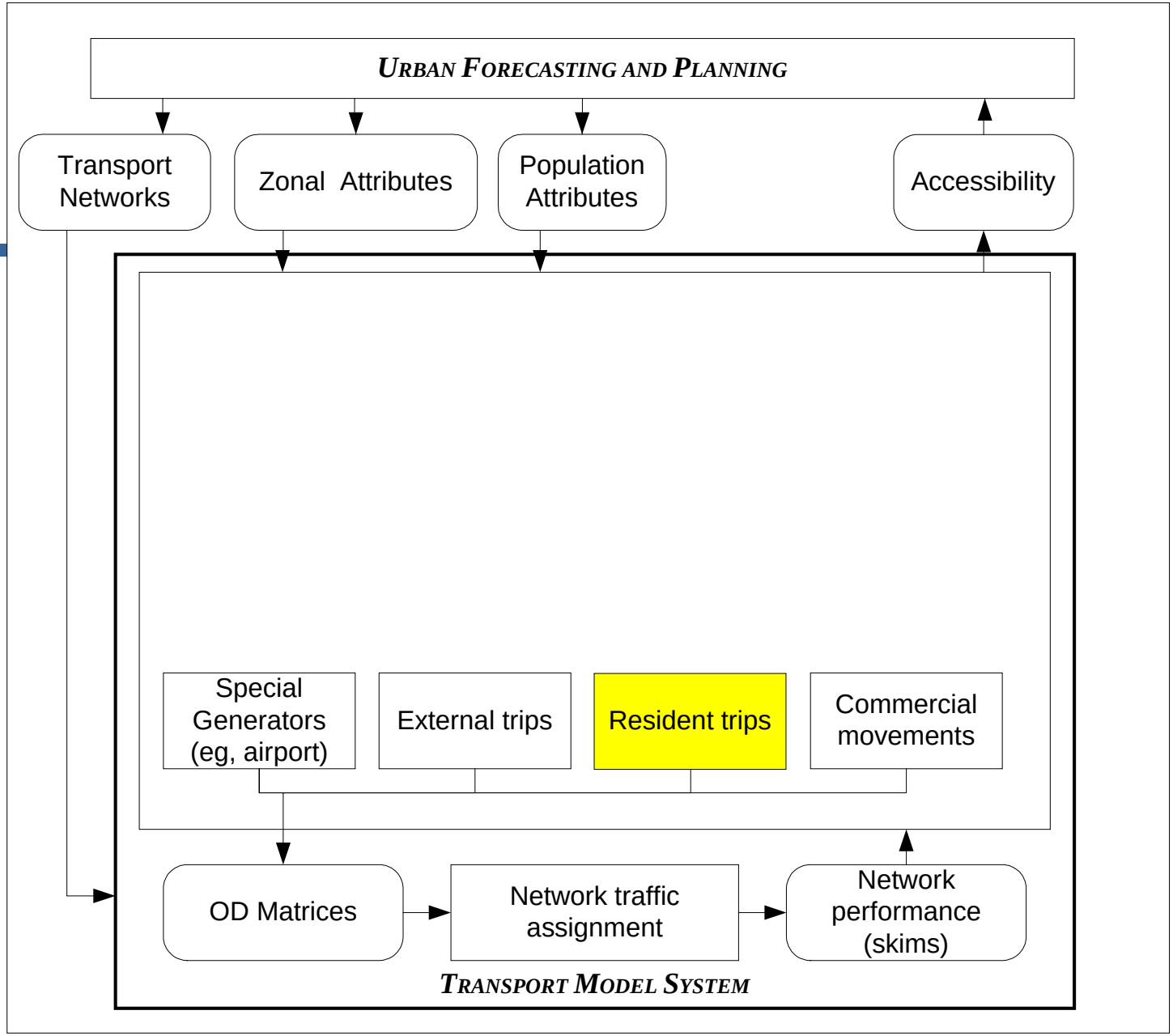

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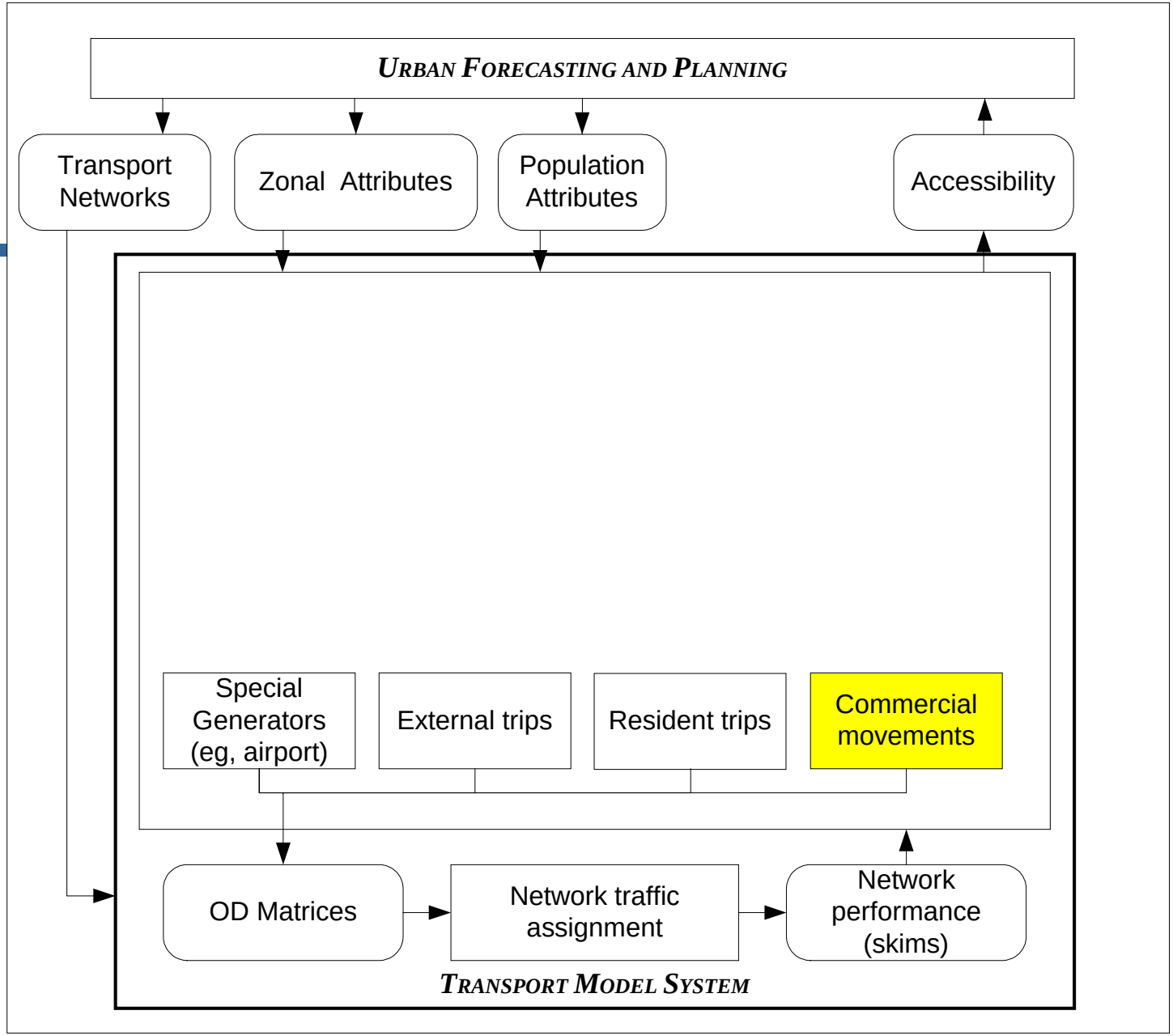

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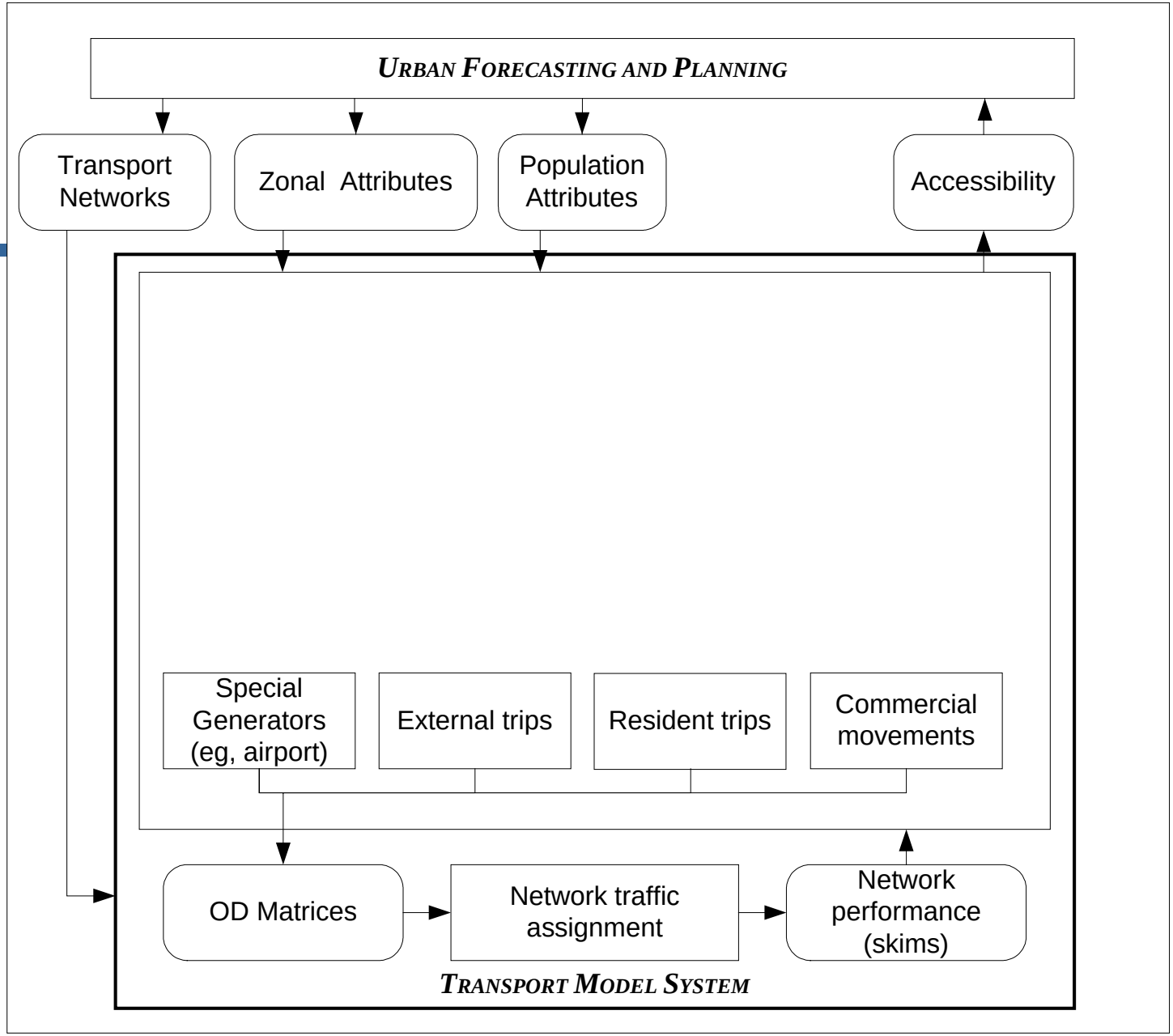

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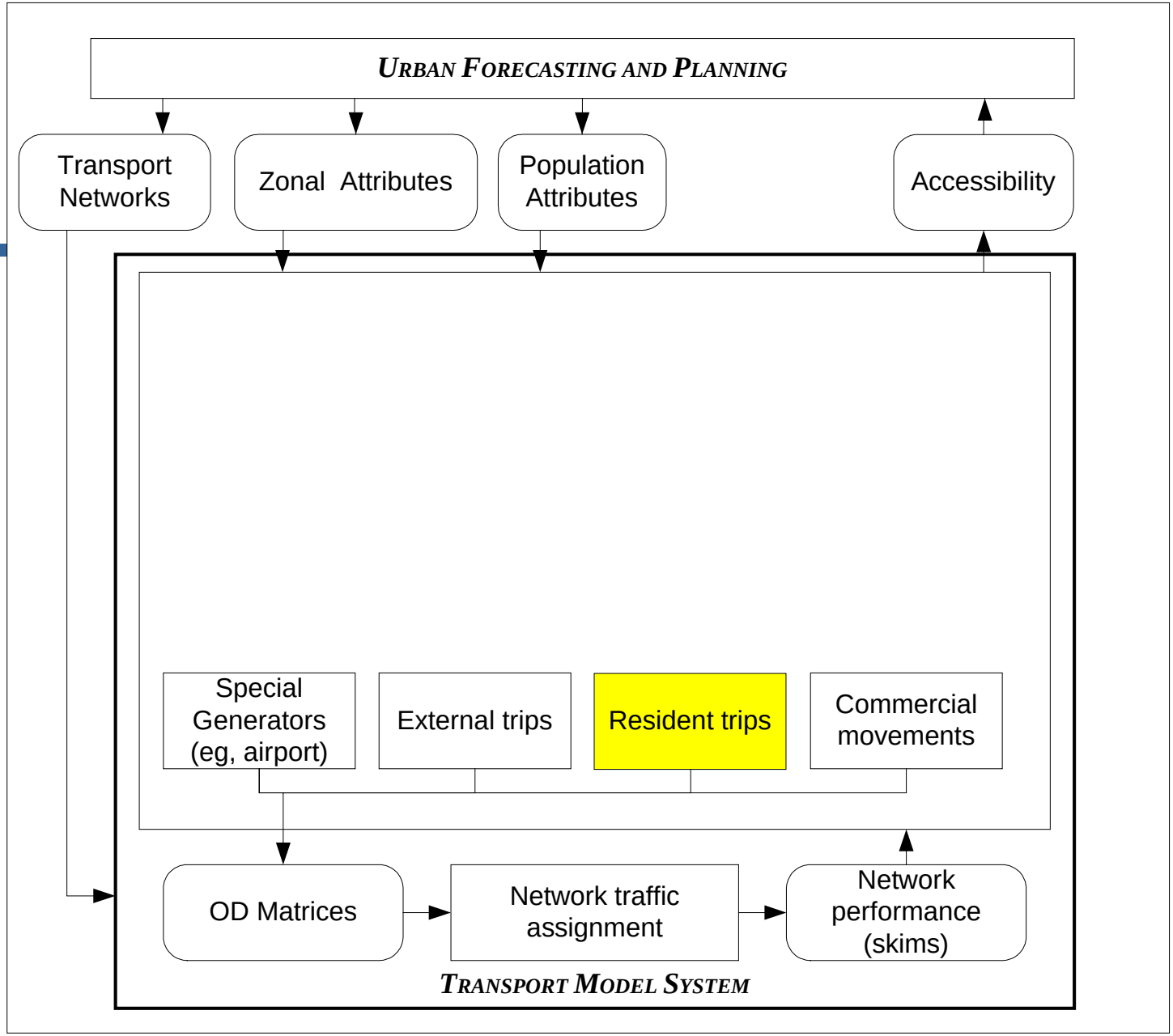

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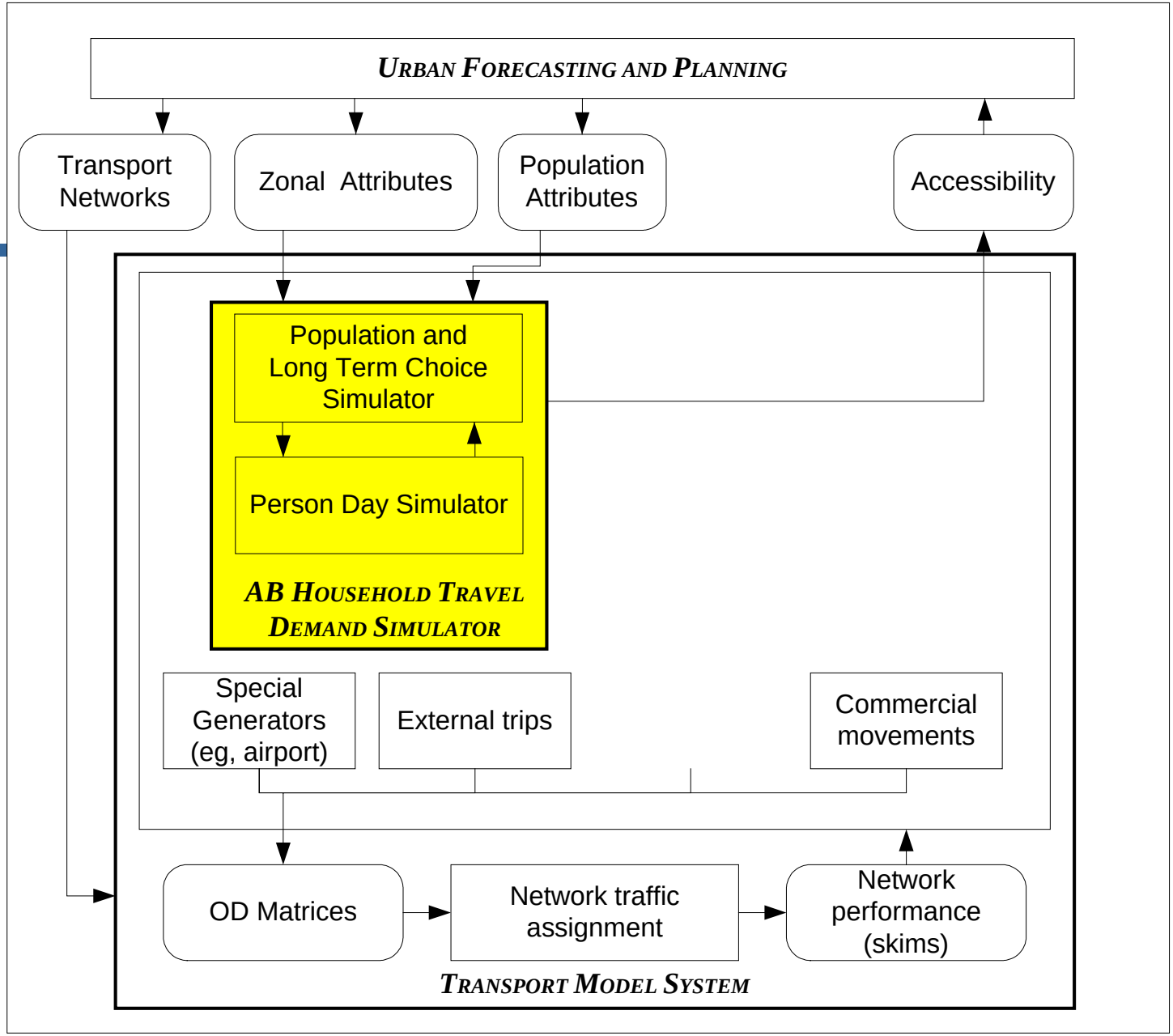

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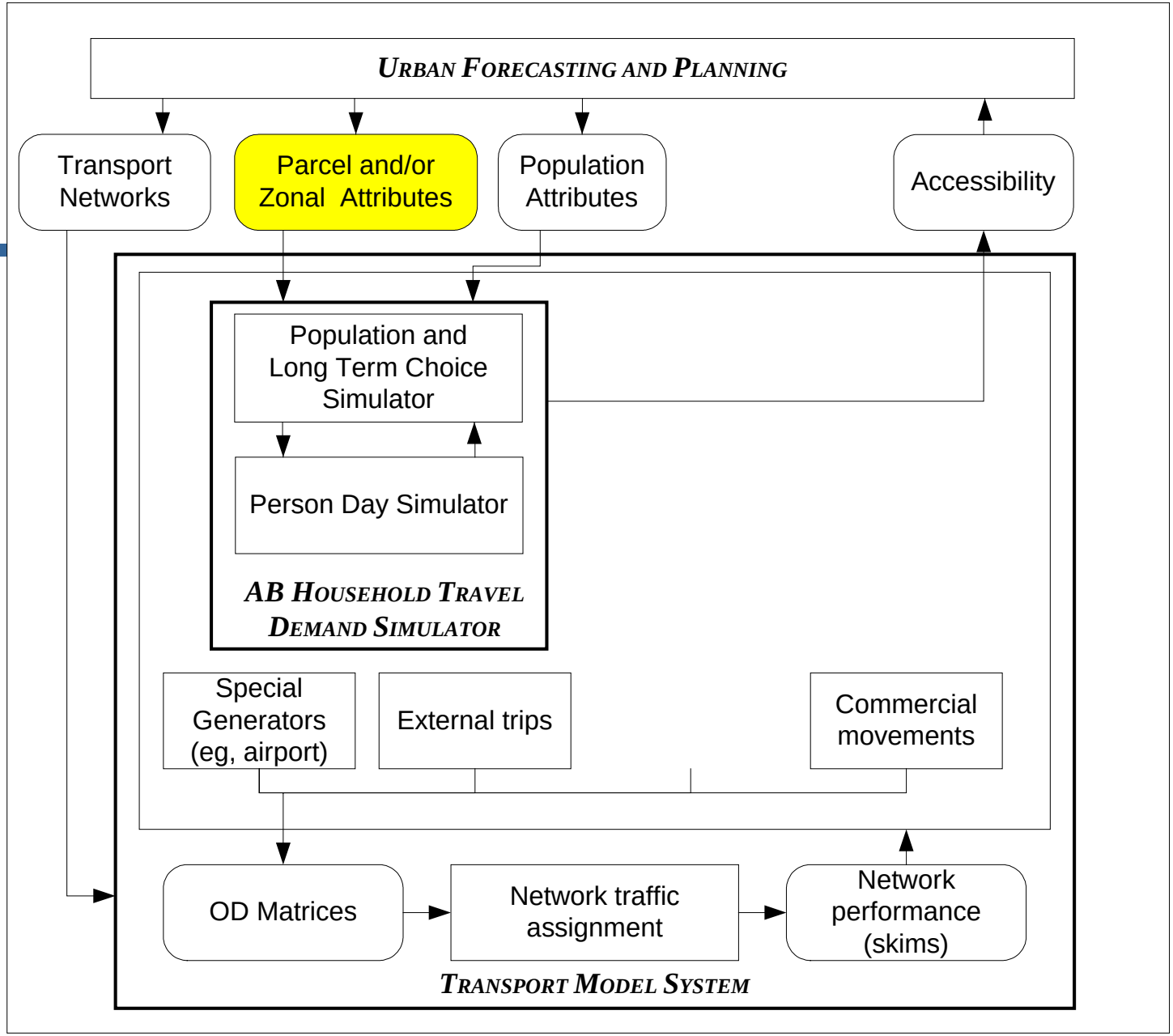

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Parcel Attributes

- Within parcel itself
  - Jobs and school enrollment by type
  - Households
  - Housing stock
  - Parking by type
  - Distance to transit by type
- Surrounding the parcel
  - Same as above
  - Intersections by type

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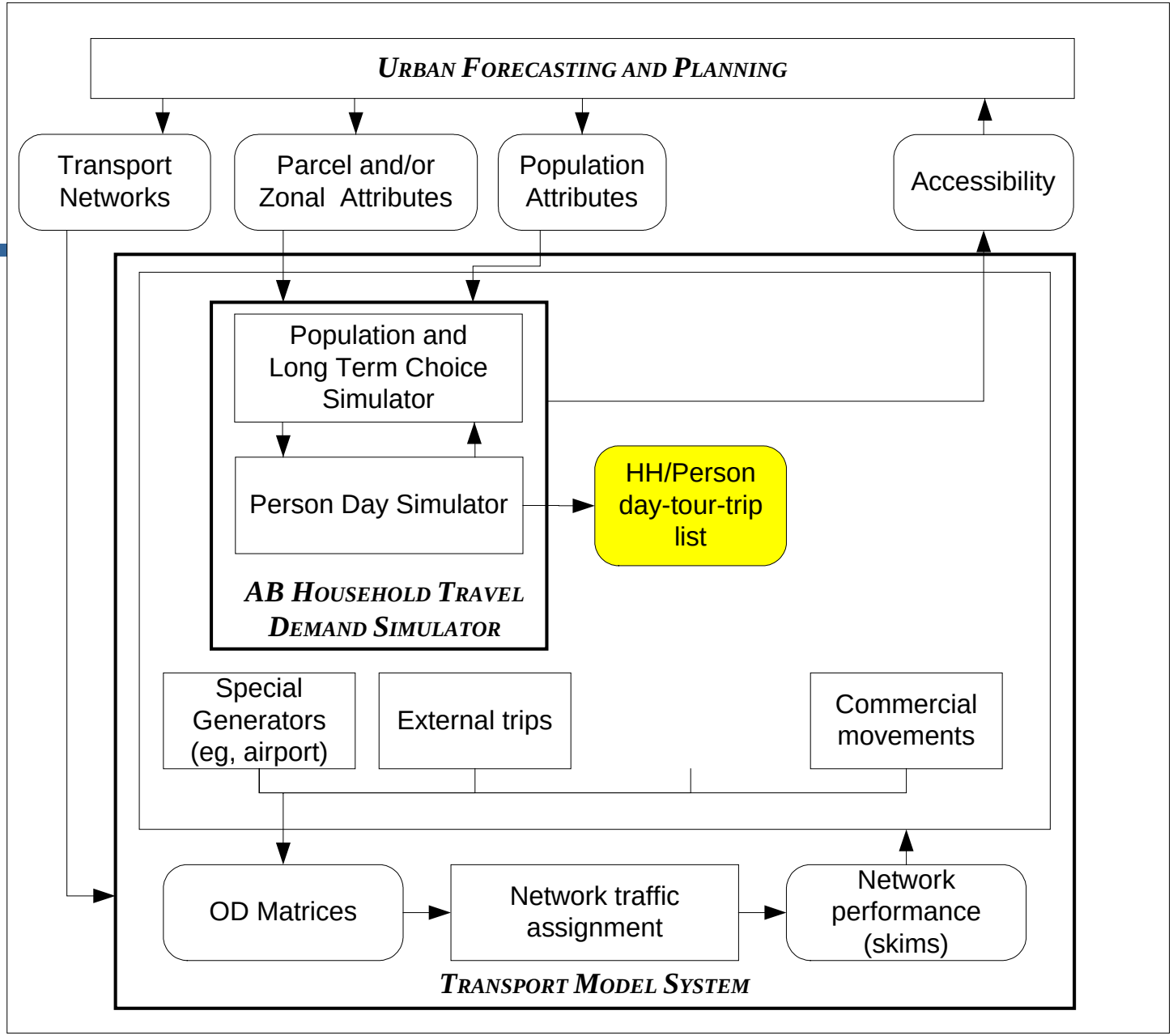

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HH/Person/Day/Tour/Trip List

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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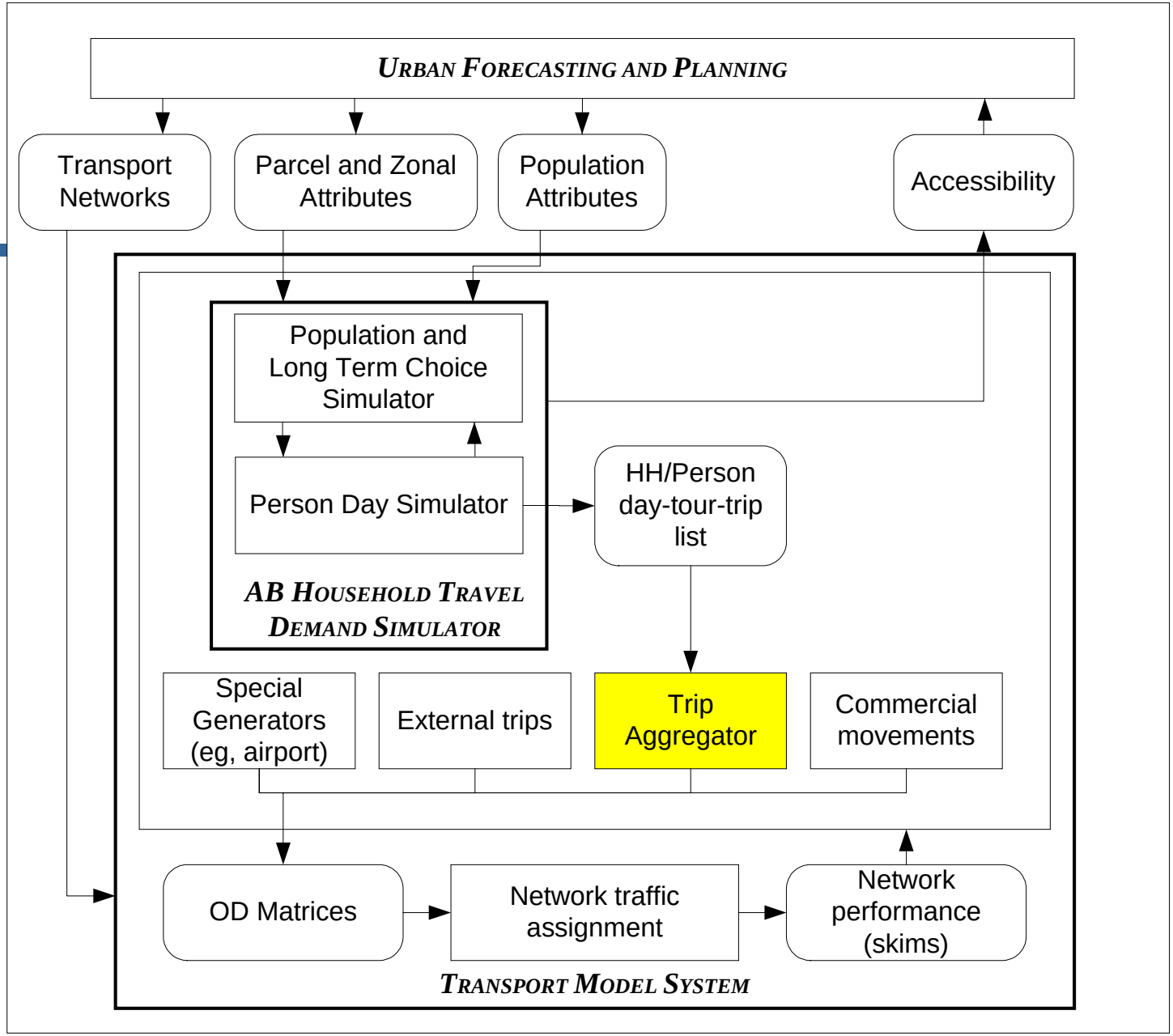

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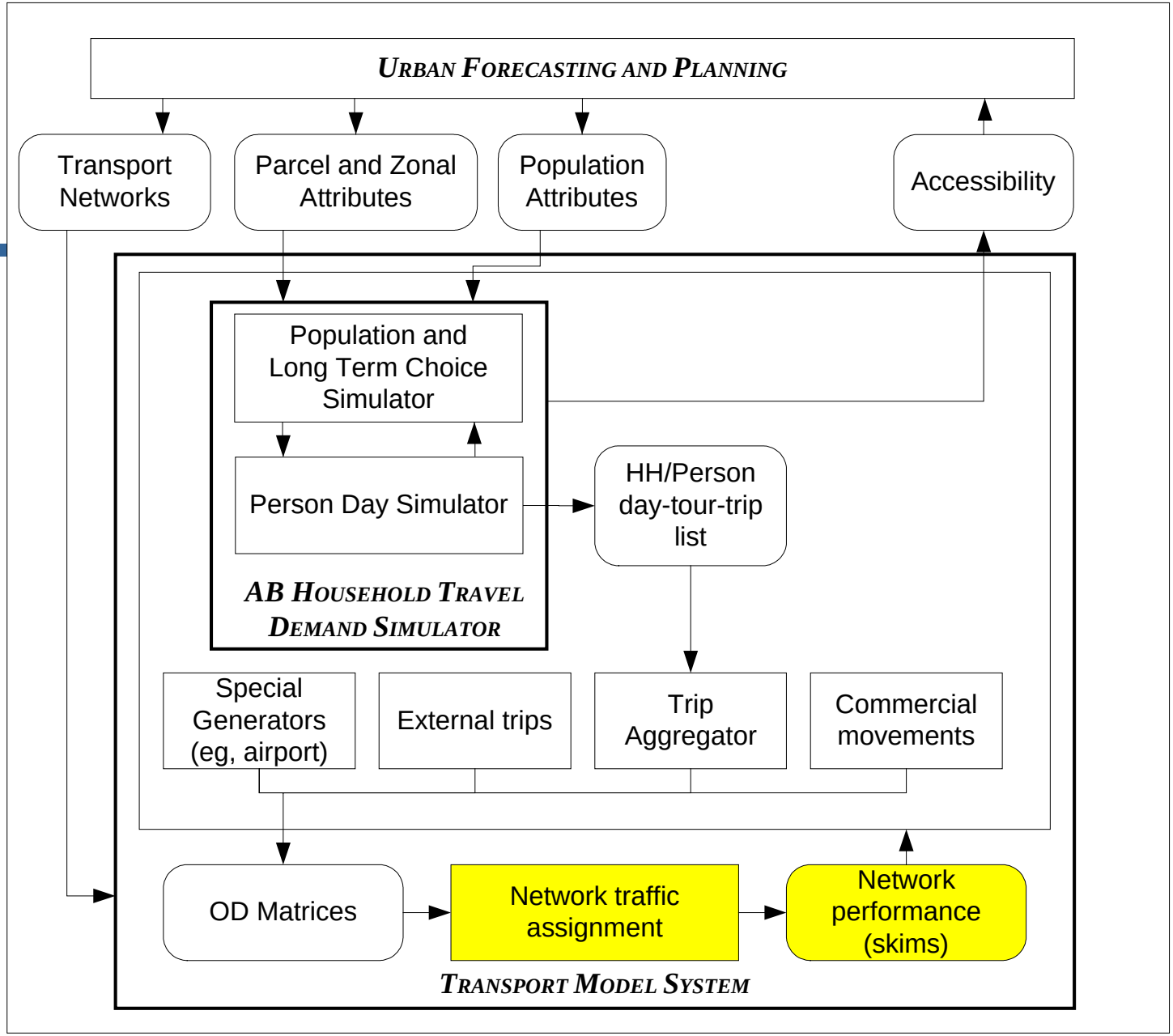

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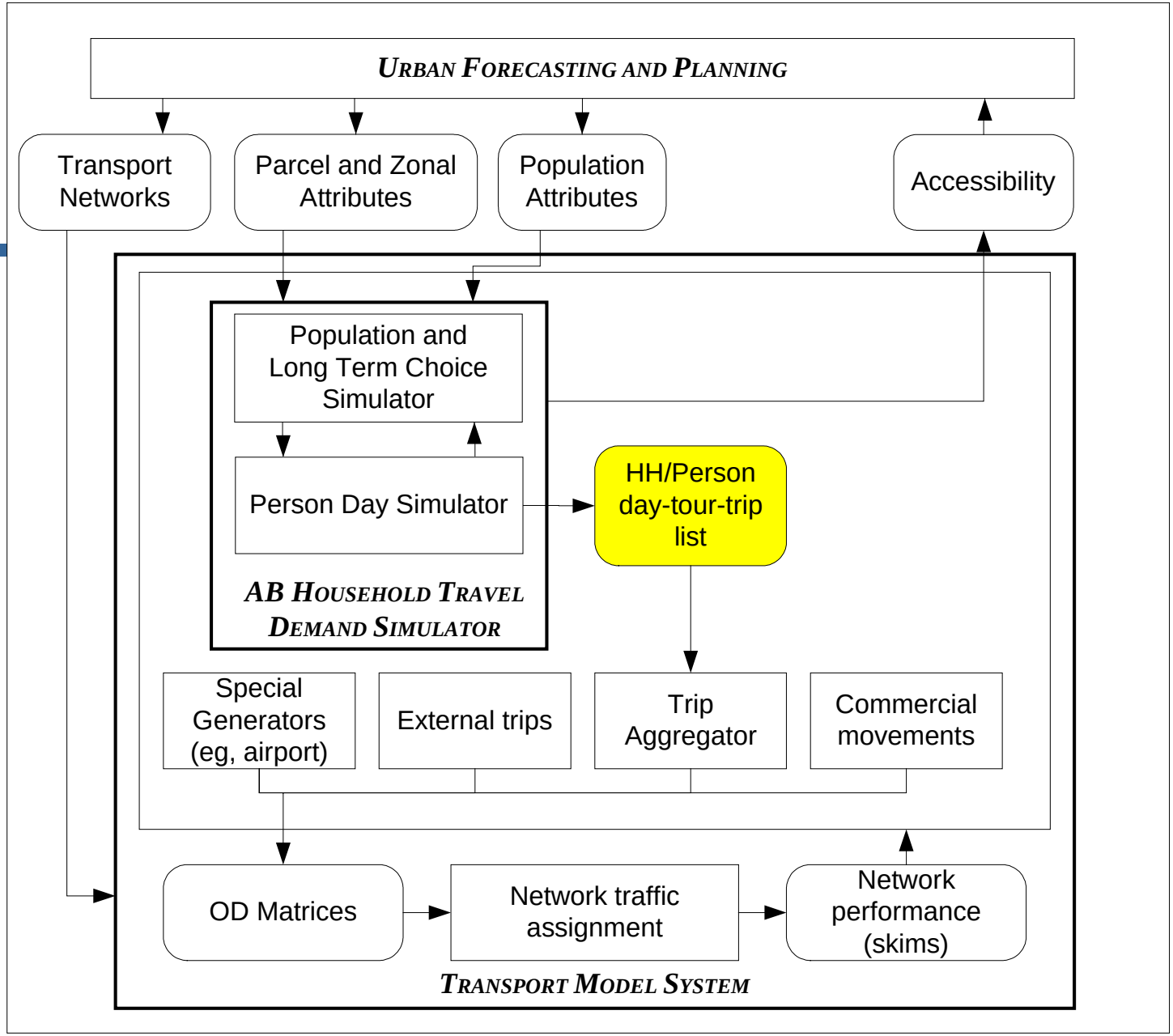

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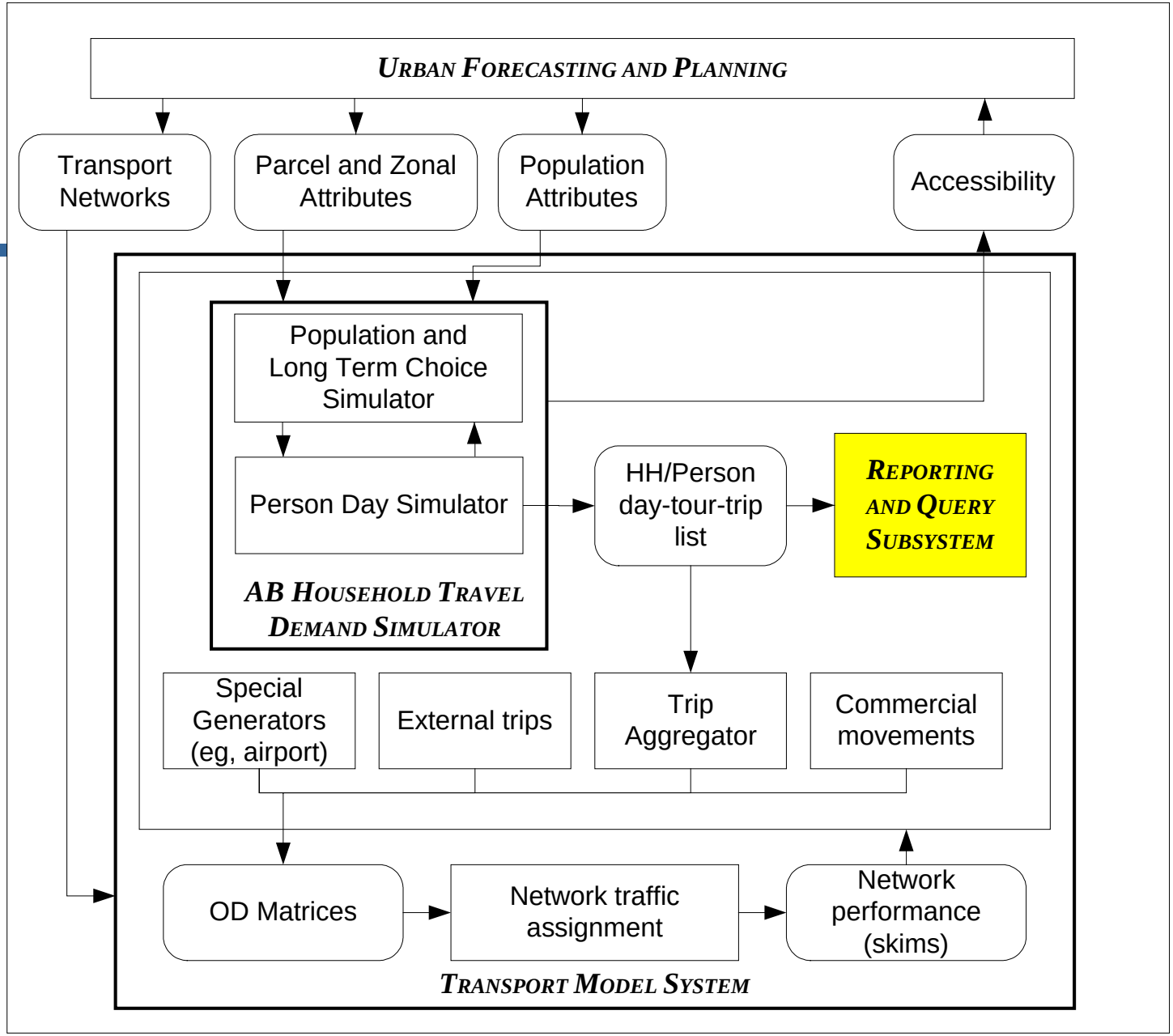

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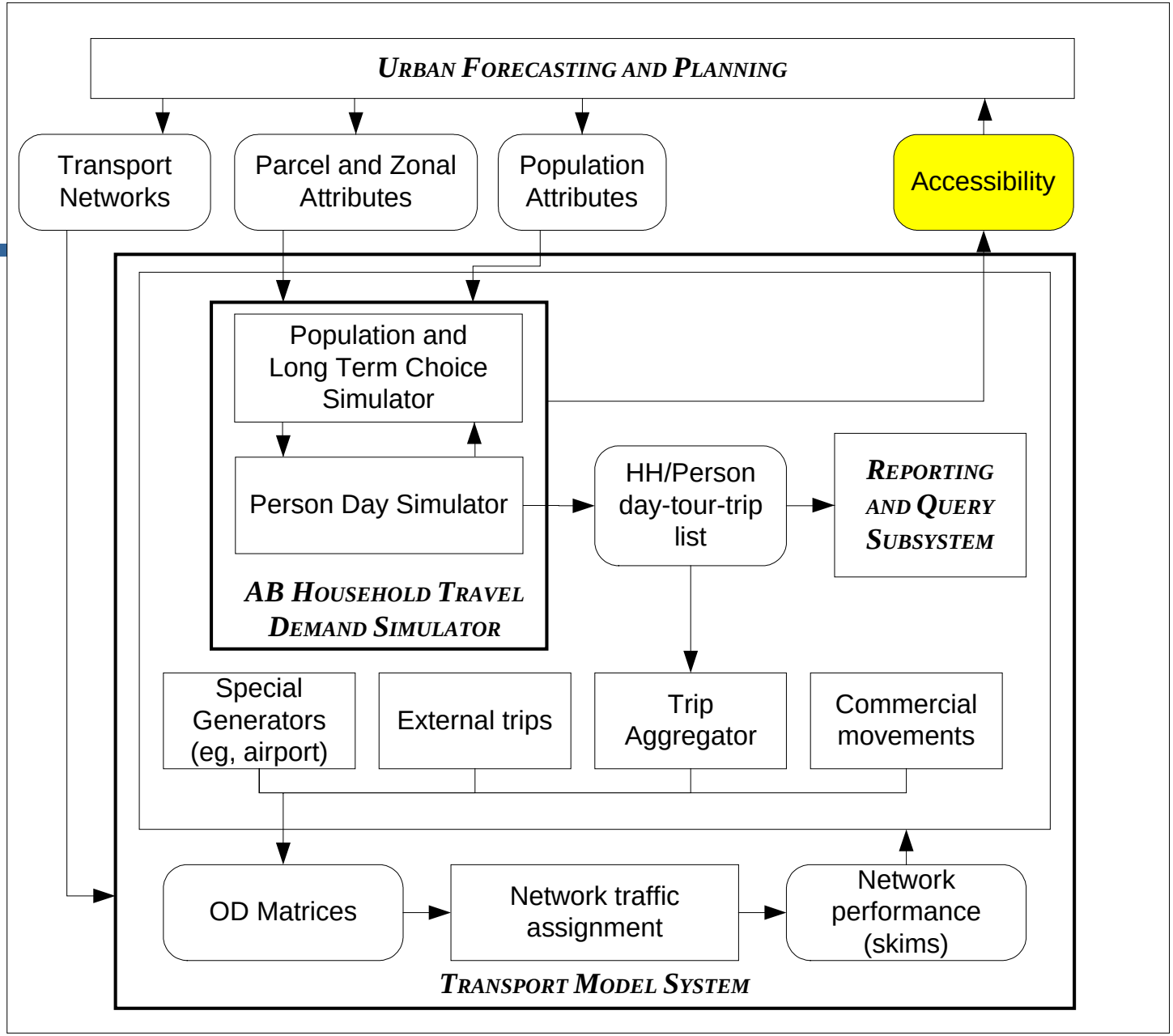

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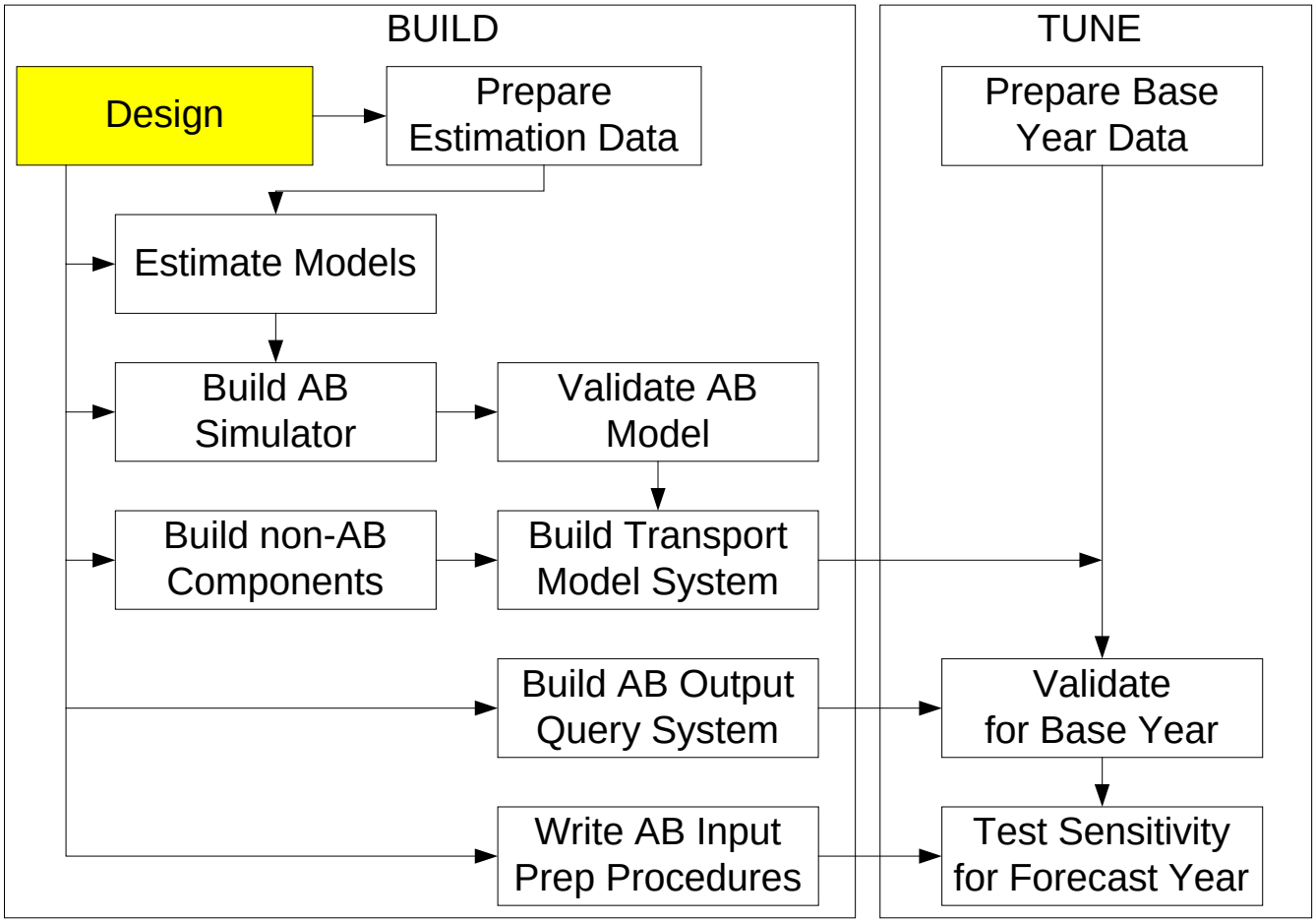

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Design

- AB Model components
- AB Model Integration
  - Downward (conditionality)
  - Upward (accessibility)
- AB Simulator (software)
- Overall transport model system

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Design
AB Model components

	Long Term models	
1.0	Population synthesizer	
1.1	Regular work location	Worker
1.2	Regular school location	Student
1.3	Regular mode to work (optional)	Worker
1.4	Transit pass (optional)	Person
1.5	Auto Availability	HH
1.6	Auto type (optional)	Vehicle

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Design
AB Model components

	Day-level models	
2.1	Household day pattern (optional)	HH-day
2.2	Household joint tour generation (optional)	HH-day
2.3	Joint tour participation (optional)	HH-day
2.4	Person day pattern	Person-day
2.5	Exact Number of Tours	Person-day

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Design
AB Model components

	Tour-level models	
3.1	Tour Destination	Tour
3.2	Work-Based Subtour Generation	Work Tour
3.3	Tour Main Mode	Tour
3.4	Tour vehicle (optional)	Tour
3.5	Tour Time of Day	Tour

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Design
AB Model components

	Trip/stop-level models	
4.1	Intermediate Stop Generation	Half Tour
4.2	Linked Escort Trips (optional)	Half-tour
4.3	Intermediate Stop Location	Trip
4.4	Trip Mode Choice	Trip
4.5	Trip Departure Time	Trip

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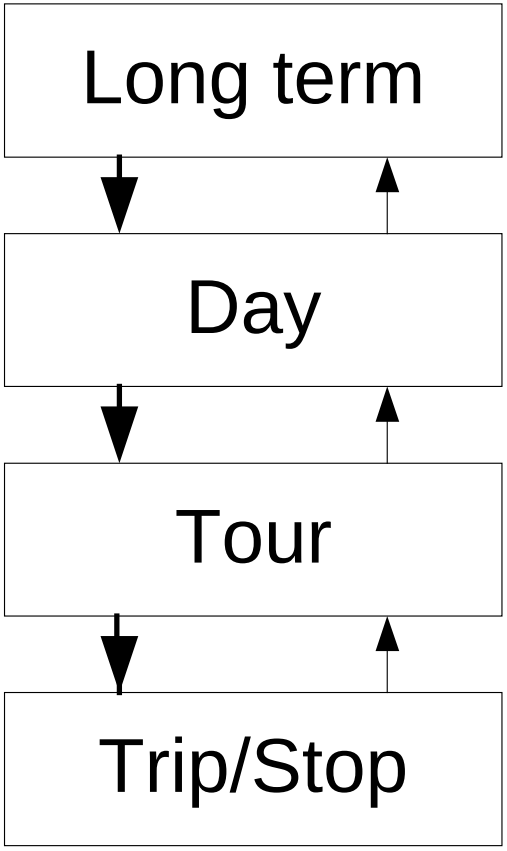
Downward Integration

Lower models take upper outcomes as given



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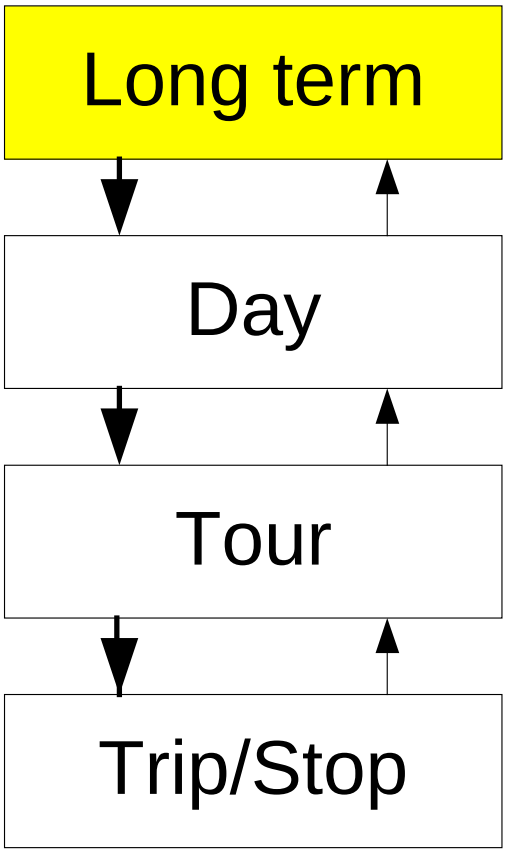

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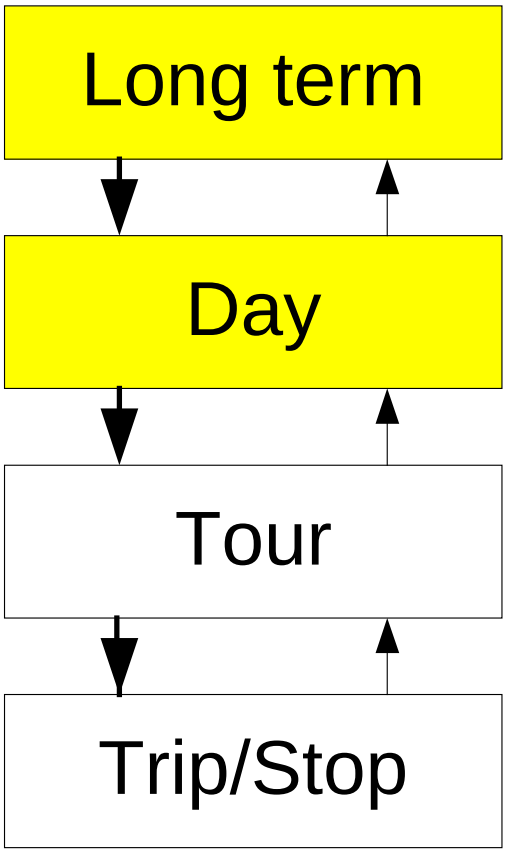

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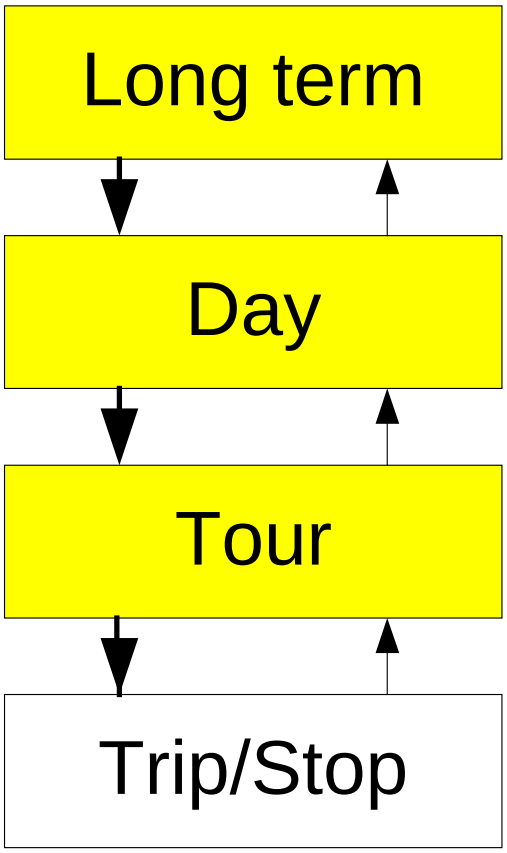

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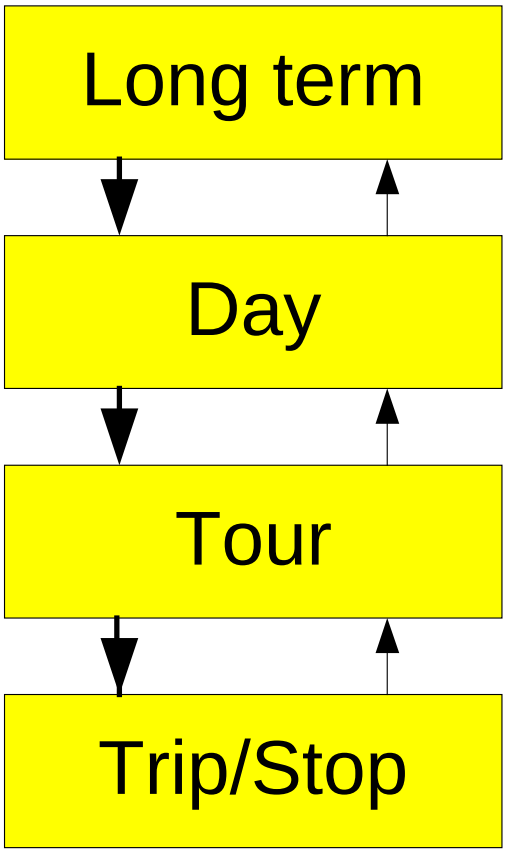

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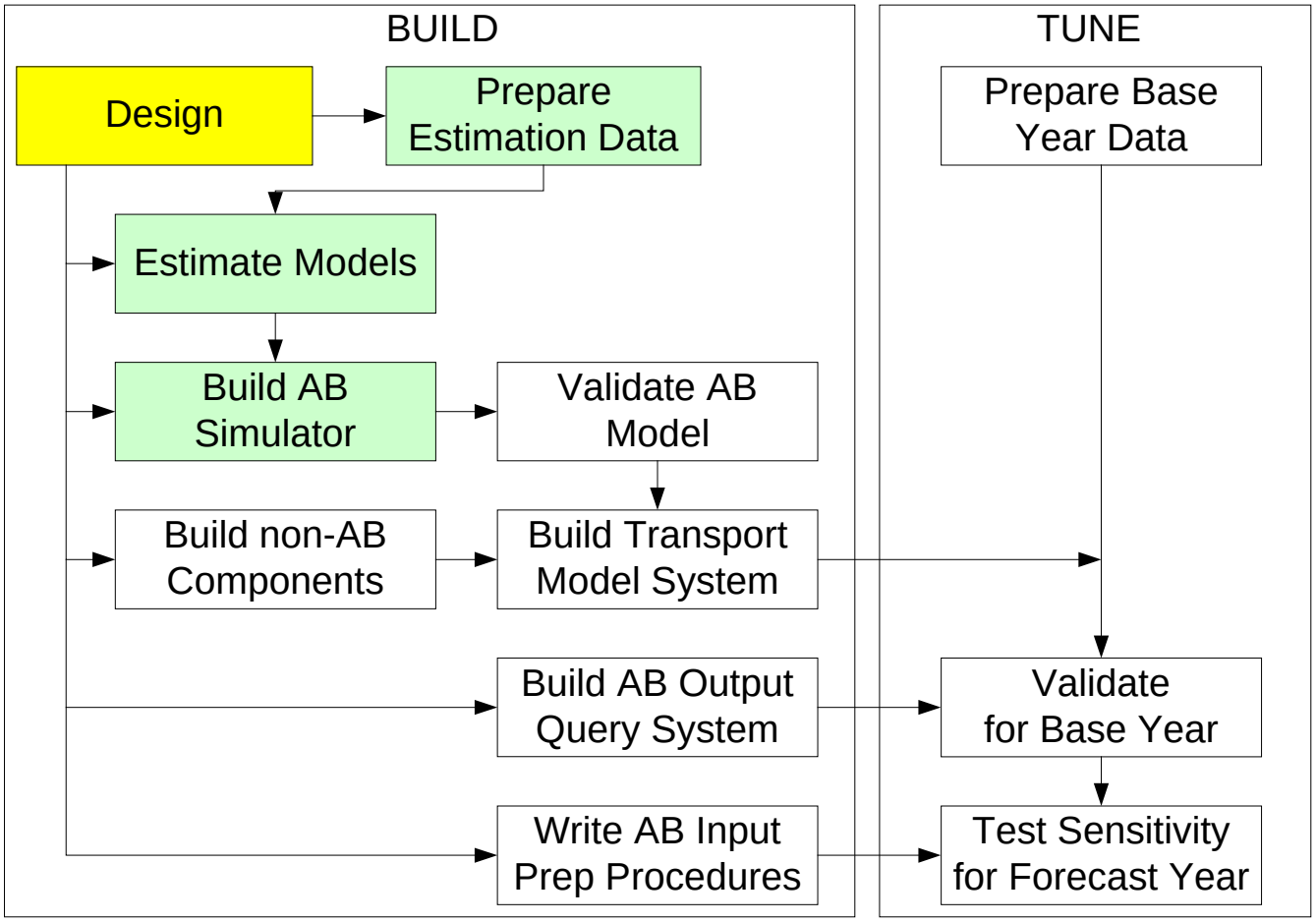
Consistent Design of Downward Integration



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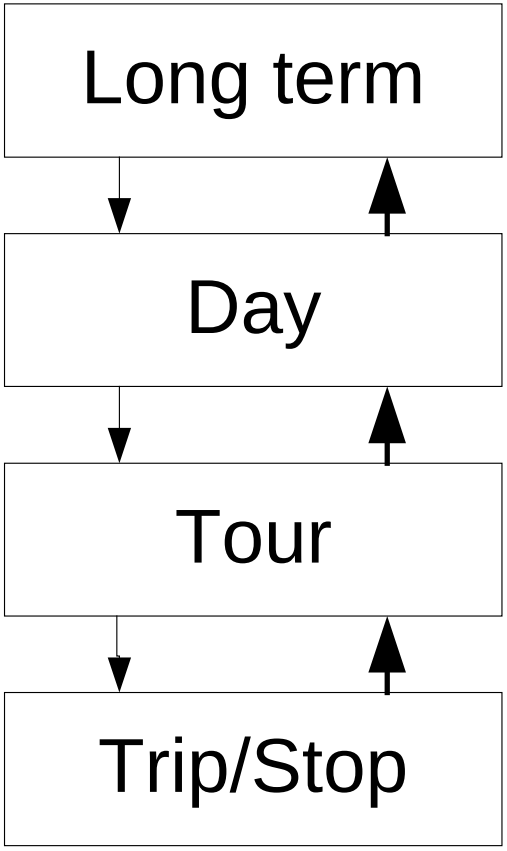
Upward Integration

Upper models should be sensitive to conditions affecting lower models



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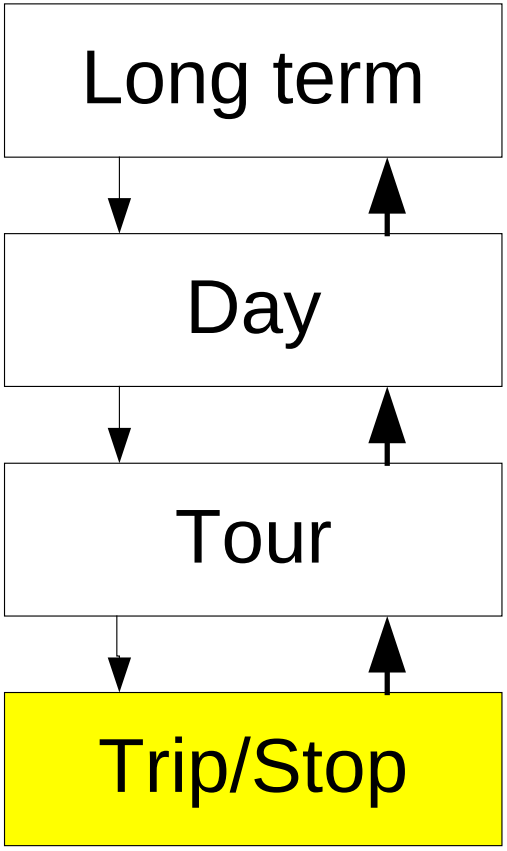

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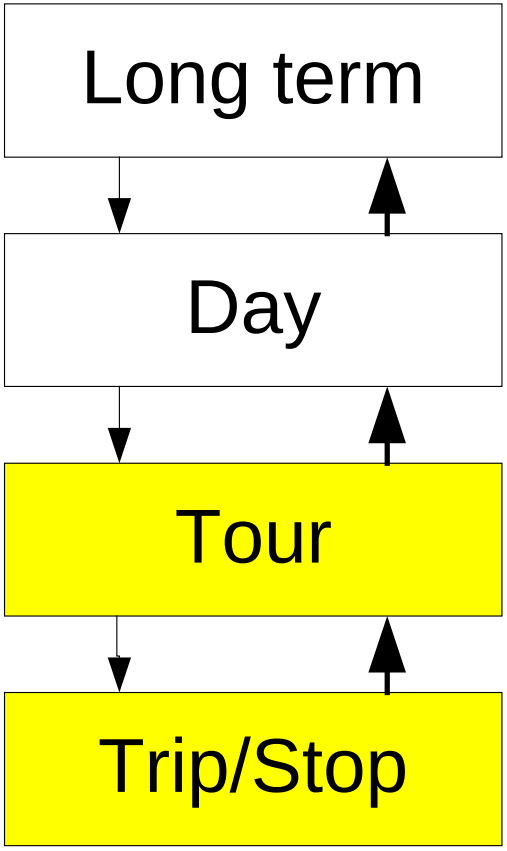

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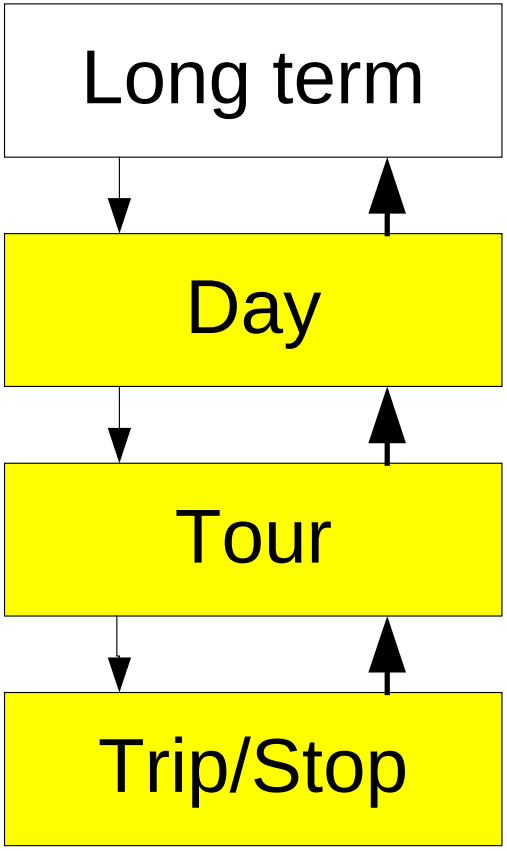

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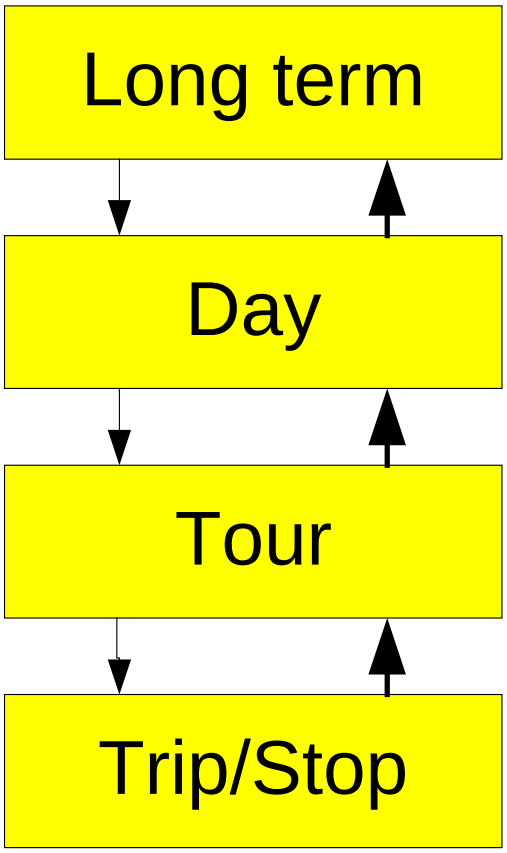

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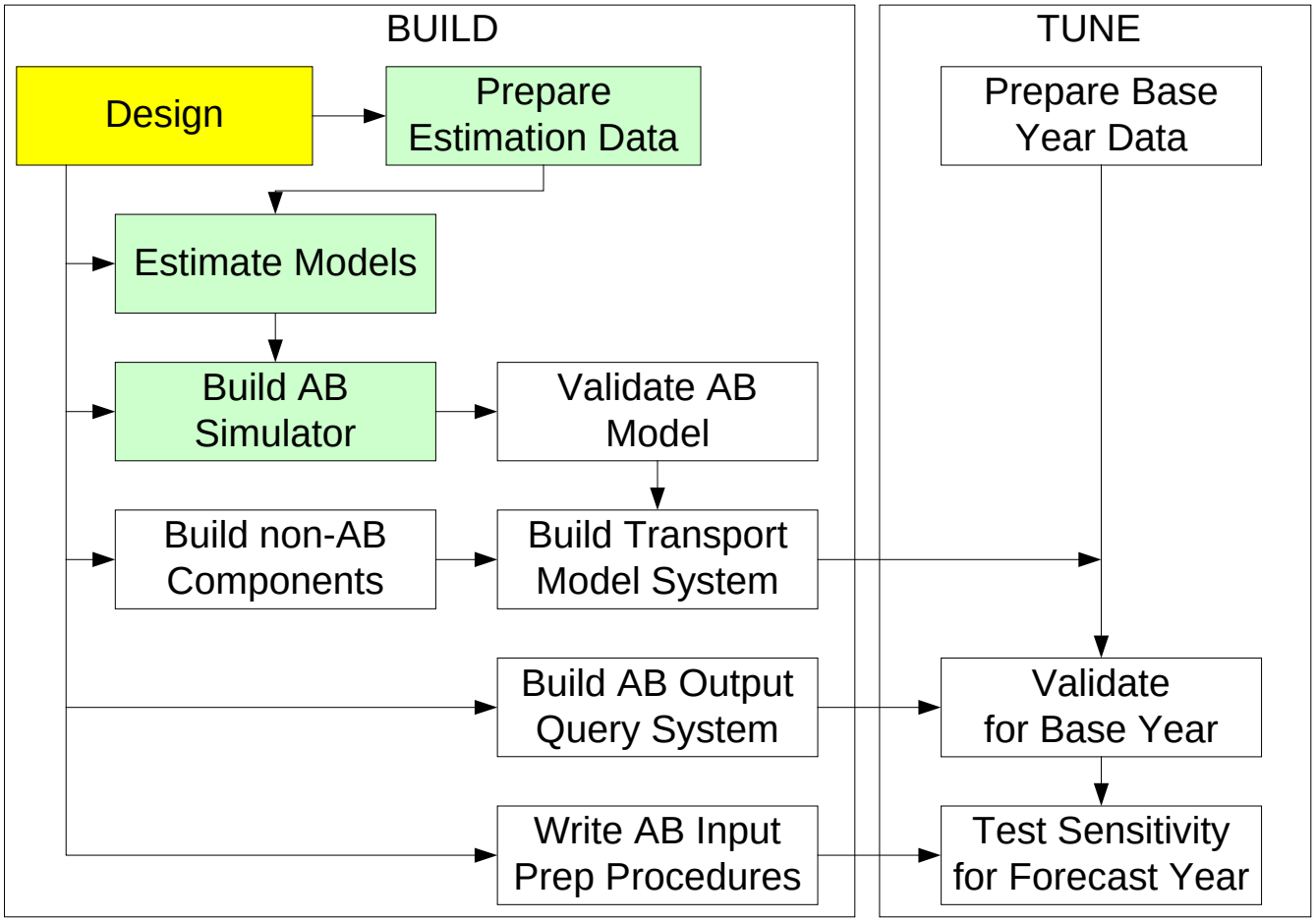
Consistent Design of Upward Integration



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Design

- AB Model components
- AB Model Integration
  - Downward (conditionality)
  - Upward (accessibility)
- AB Simulator (software)
- Overall transport model system

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AB Simulator

Begin
{Read run controls, model coefficients, TAZ data, LOS matrices, population controls, and Parcel data into memory}
{Draw a synthetic household sample if specified}
{Pre-calculate destination sampling probabilities}
{Pre-calculate (or read in) TAZ aggregate accessibility arrays}
{Open other input and output files}
{Main loop on households}
{Loop on persons in HH}
{Apply model **1.1 Work Location for workers**}
{Apply model **1.2 School Location for students**}
{Apply model **1.1 Work Location for students**}
{End loop on persons in HH}
{Apply model **1.3 Household Auto Availability** }
{Loop on all persons within HH}
{Apply model **2.1 Activity Pattern** (0/1+ tours and 0/1+ stops) and model **2.2 Exact Number of Tours** for 7 purposes}
{Count total home-based tours and assign purposes}
{Initialize tour and stop counters and time window for the person-day before looping on tours}
{If there are tours, loop on home-based tours within person in tour priority sequence, with tour priority determined by purpose and person type}
{Increment number of home-based tours simulated for tour purpose (including current)}
{Apply model **3.1 Tour destination**}

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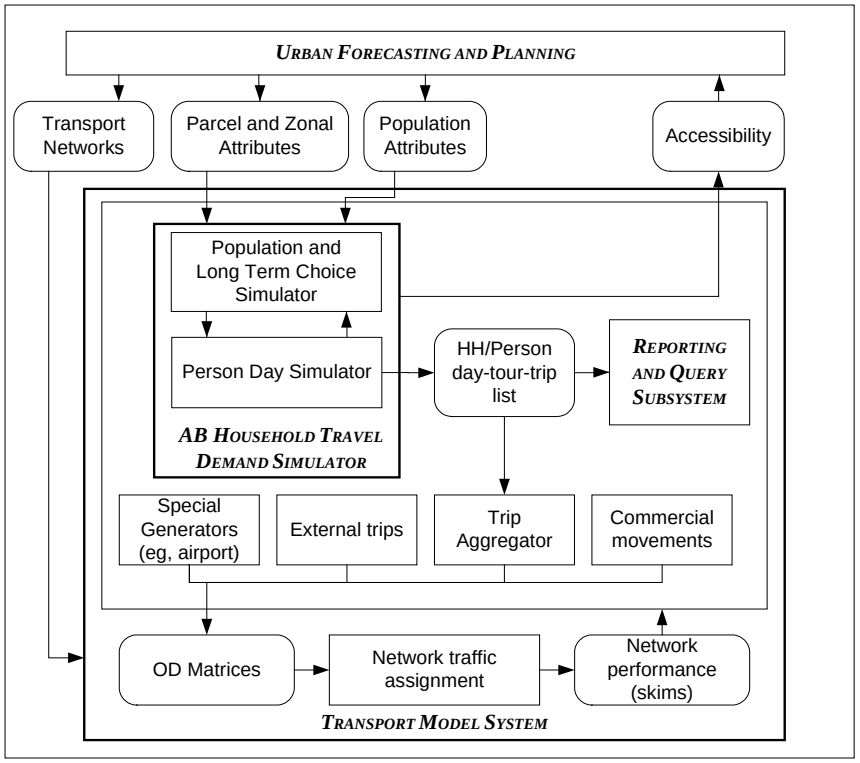
Design of overall transport model system

- Equilibration
- Performance



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AB Model Design Issues

- Differences among existing models
  - Parcel data
  - Intra-household interactions
- Innovative features
  - Parking
  - Vehicles
  - Pricing
  - Transit
  - Other?

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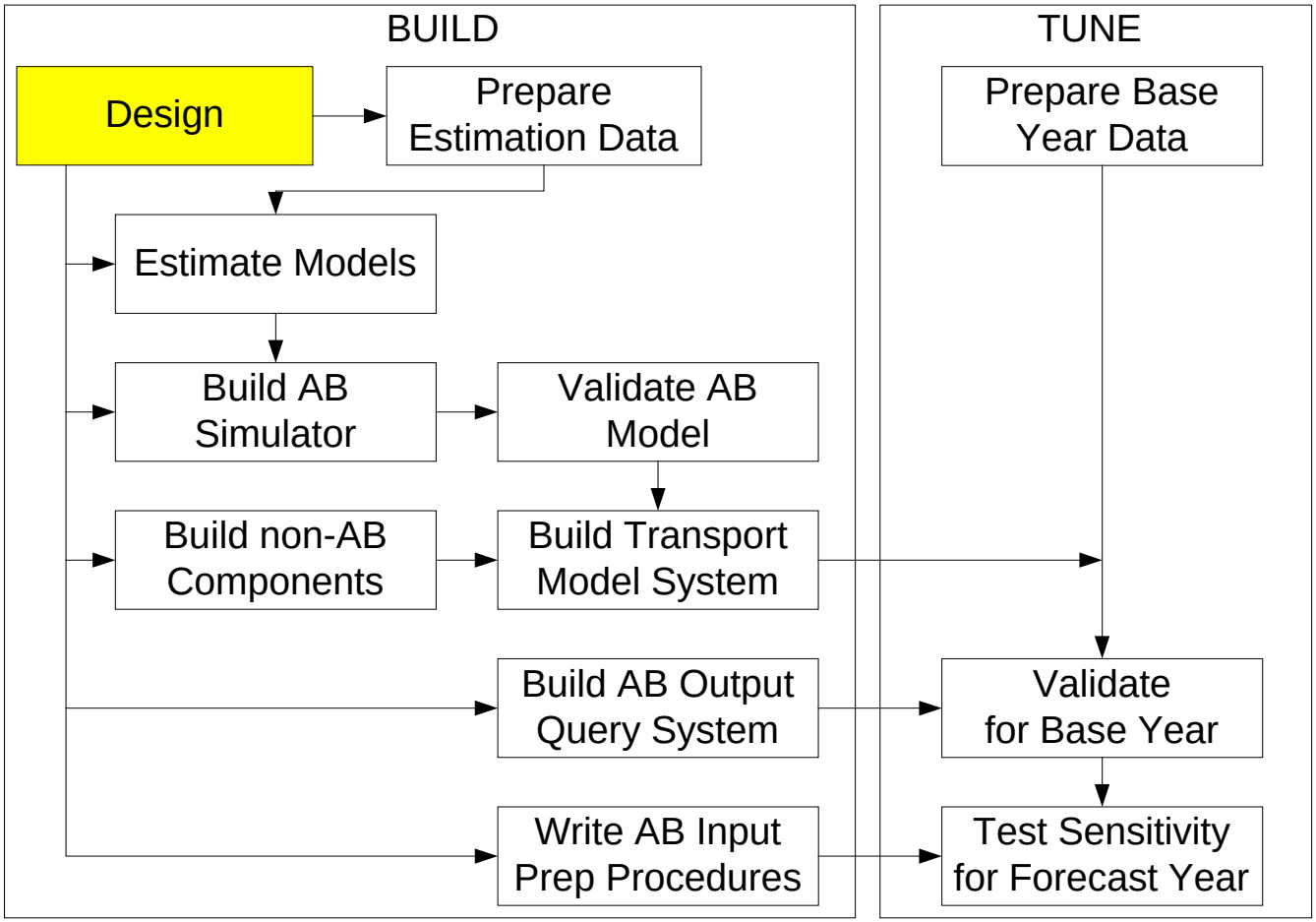
Design



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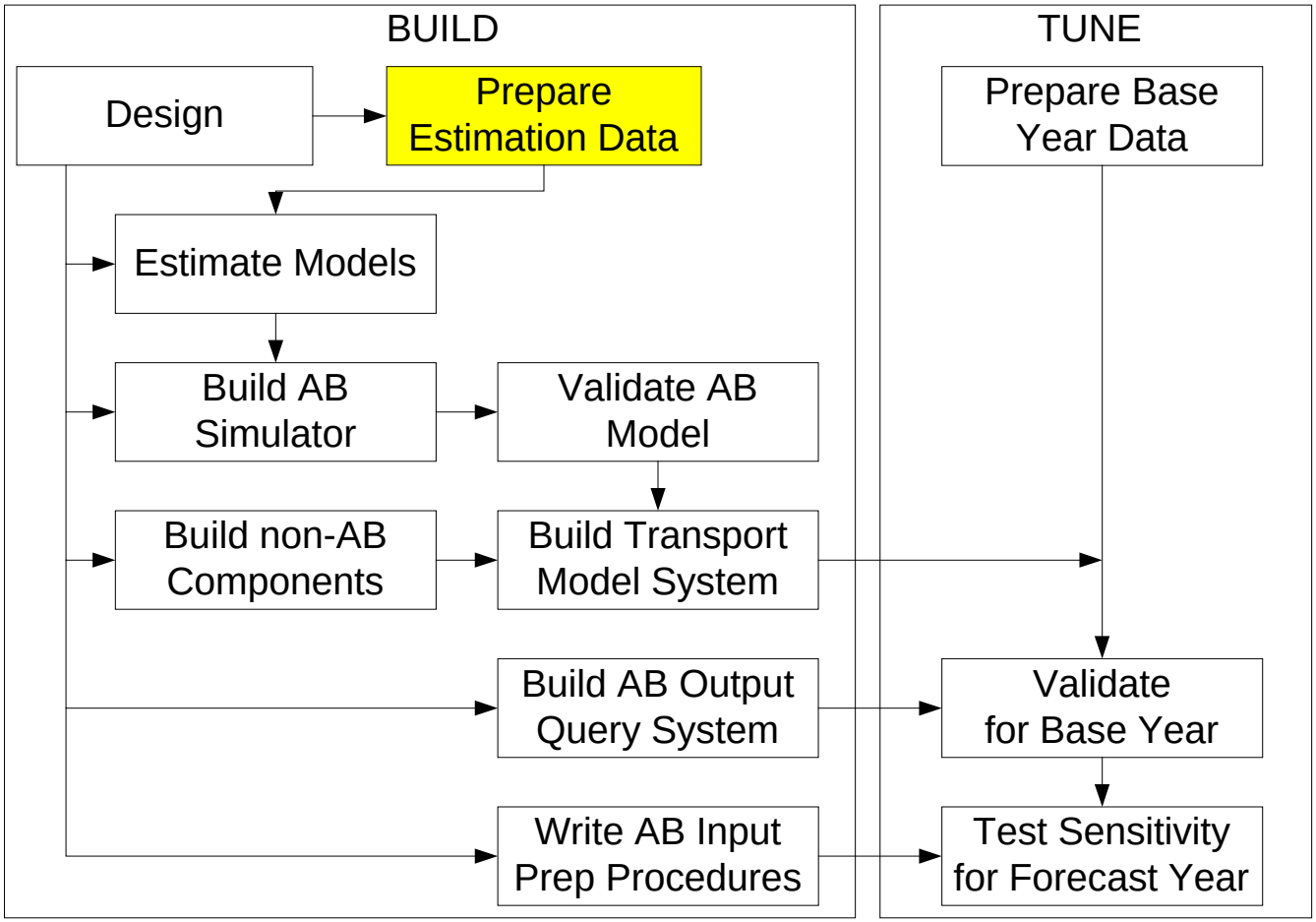
Prepare Estimation Data



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Prepare Estimation Data

- Household survey data
- LOS data (skims)
- Zonal/parcel data

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Prepare Estimation Data

- Household survey data
- LOS data (skims)
- Zonal/parcel data

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Prepare Estimation Data

- Household survey data
- LOS data (skims)
- Zonal/parcel data
  - Employment
  - School enrollment
  - Housing units
  - Network attributes

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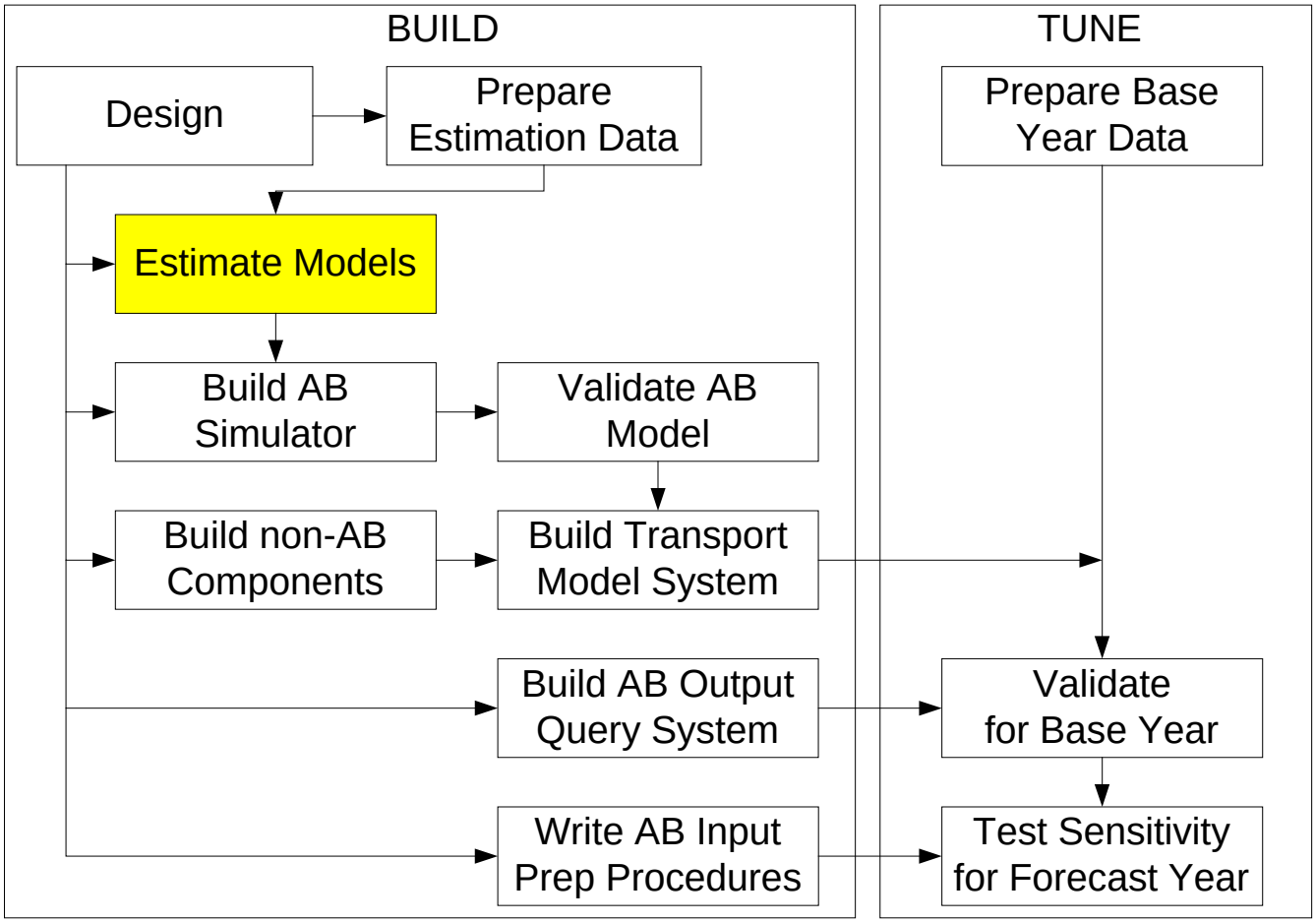
Estimate Models



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Estimate Models

- Specify
- Estimate
- Test

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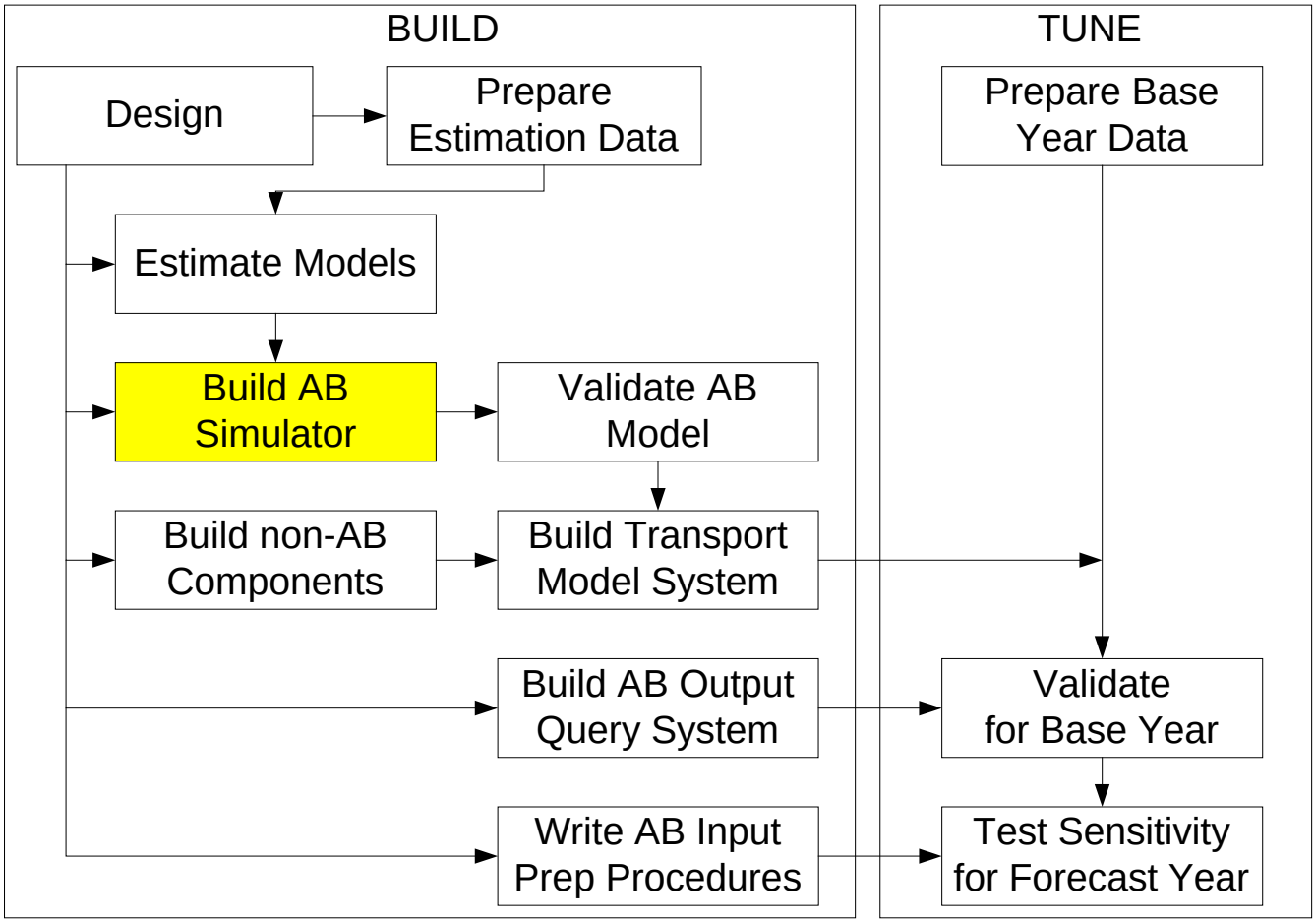
Build AB Simulator



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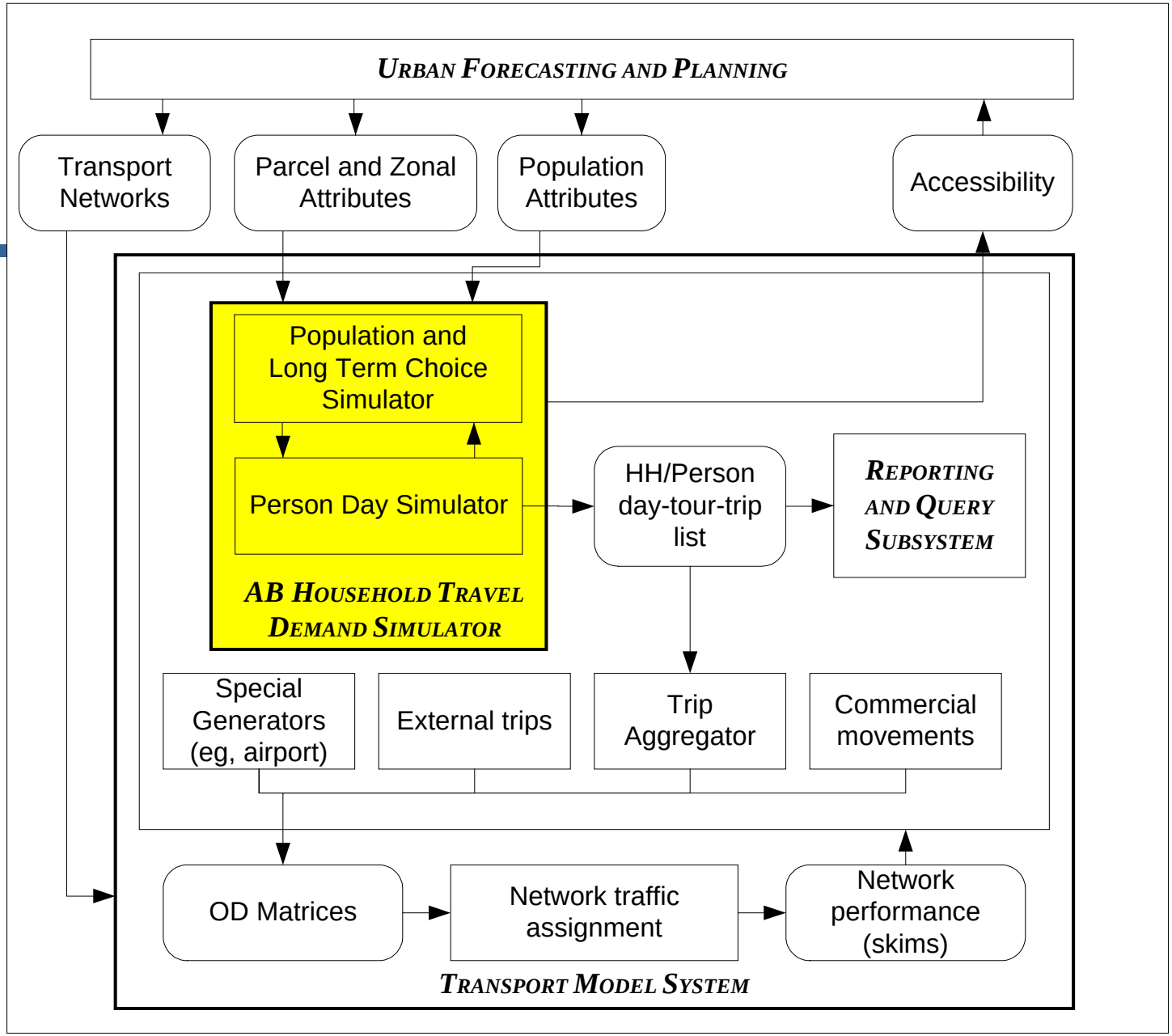

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Build AB Simulator

- Creates synthetic population
- Applies all models
- Constructs detailed one-day itinerary for each person

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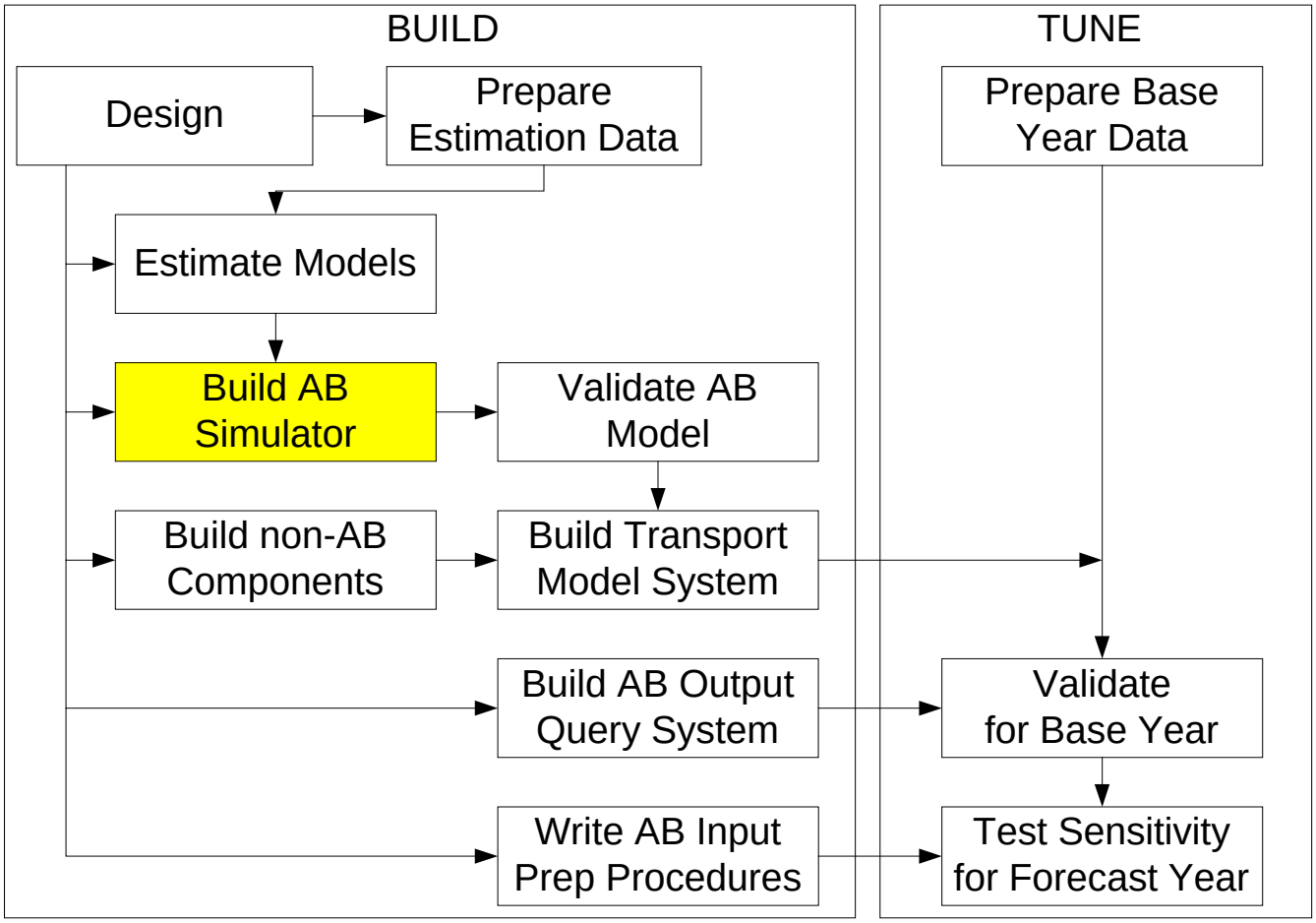
Build AB Simulator



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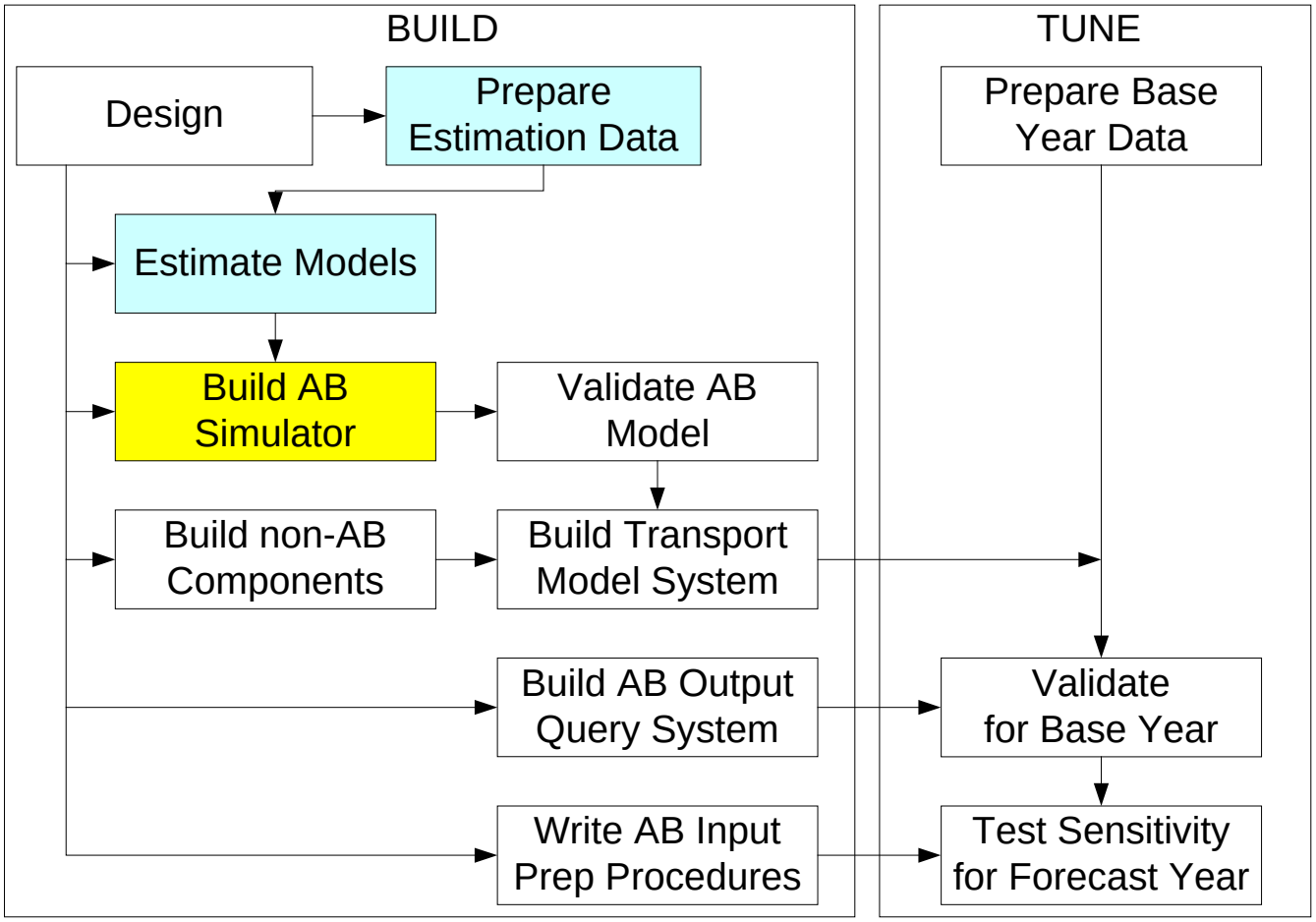
Build AB Simulator



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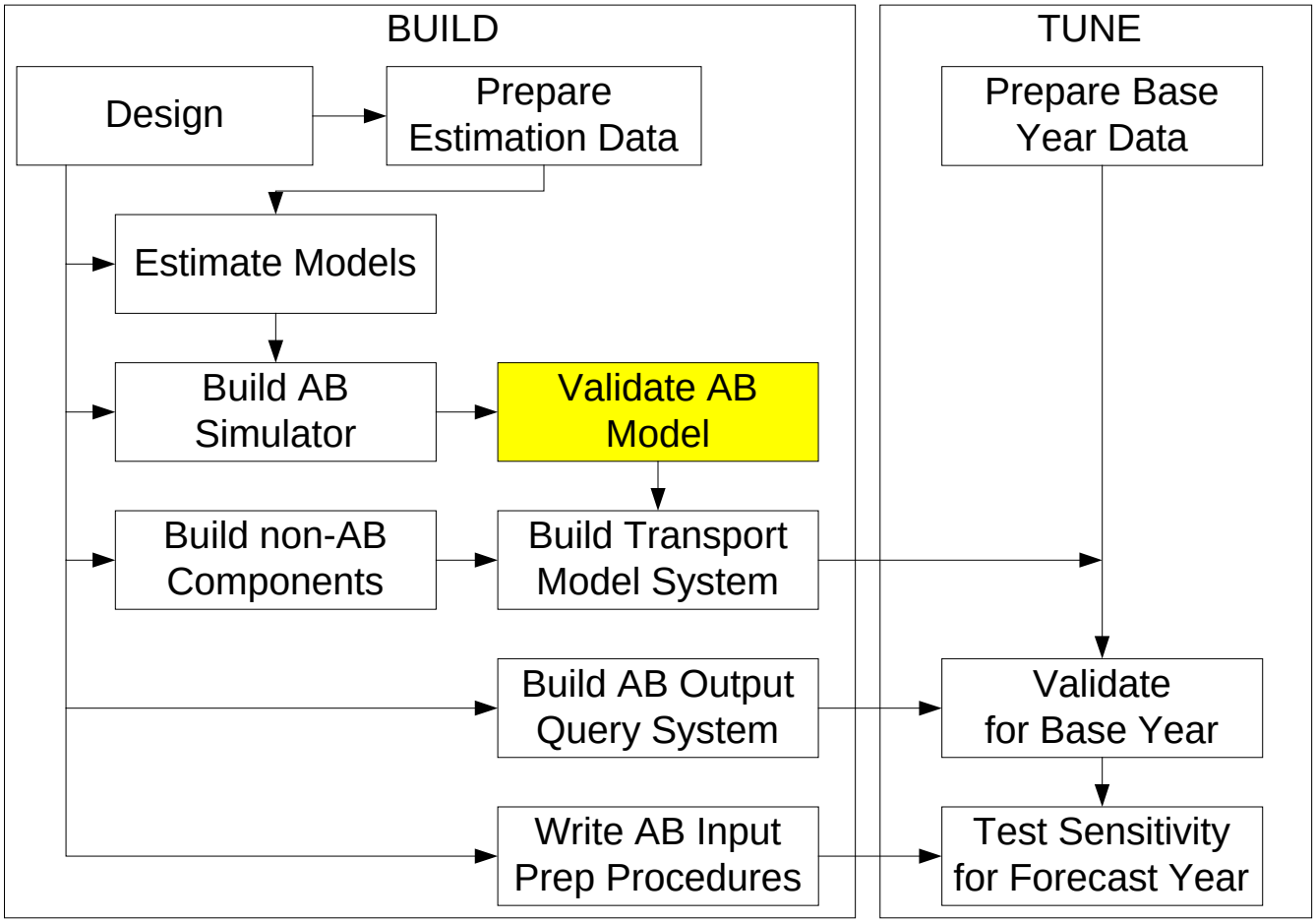
Validate AB Model



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Validate AB Model

- Compare results to expanded HH survey
- Calibrate constants
- Re-estimate if needed
- Debug AB simulator

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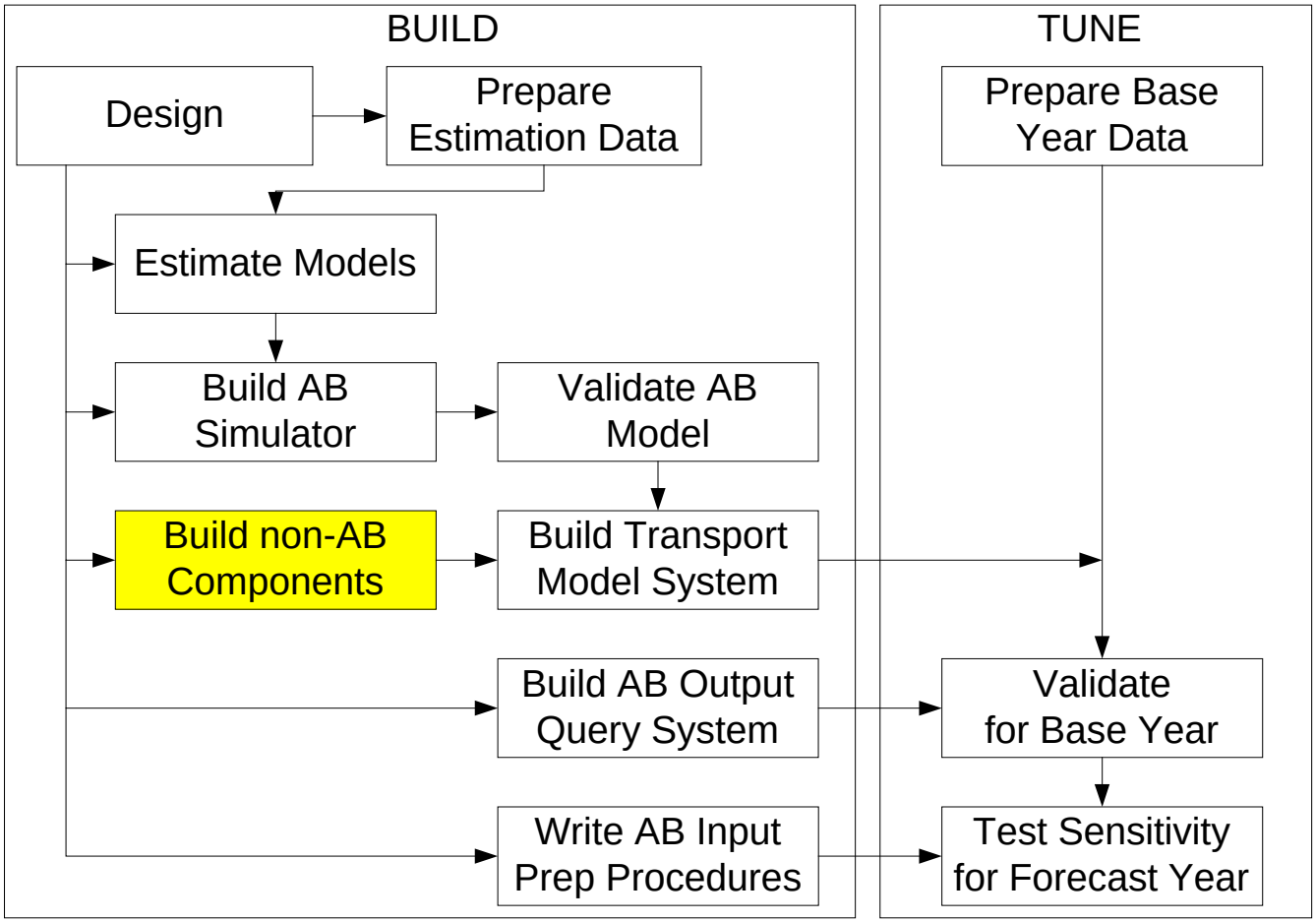
Build Non-AB Components



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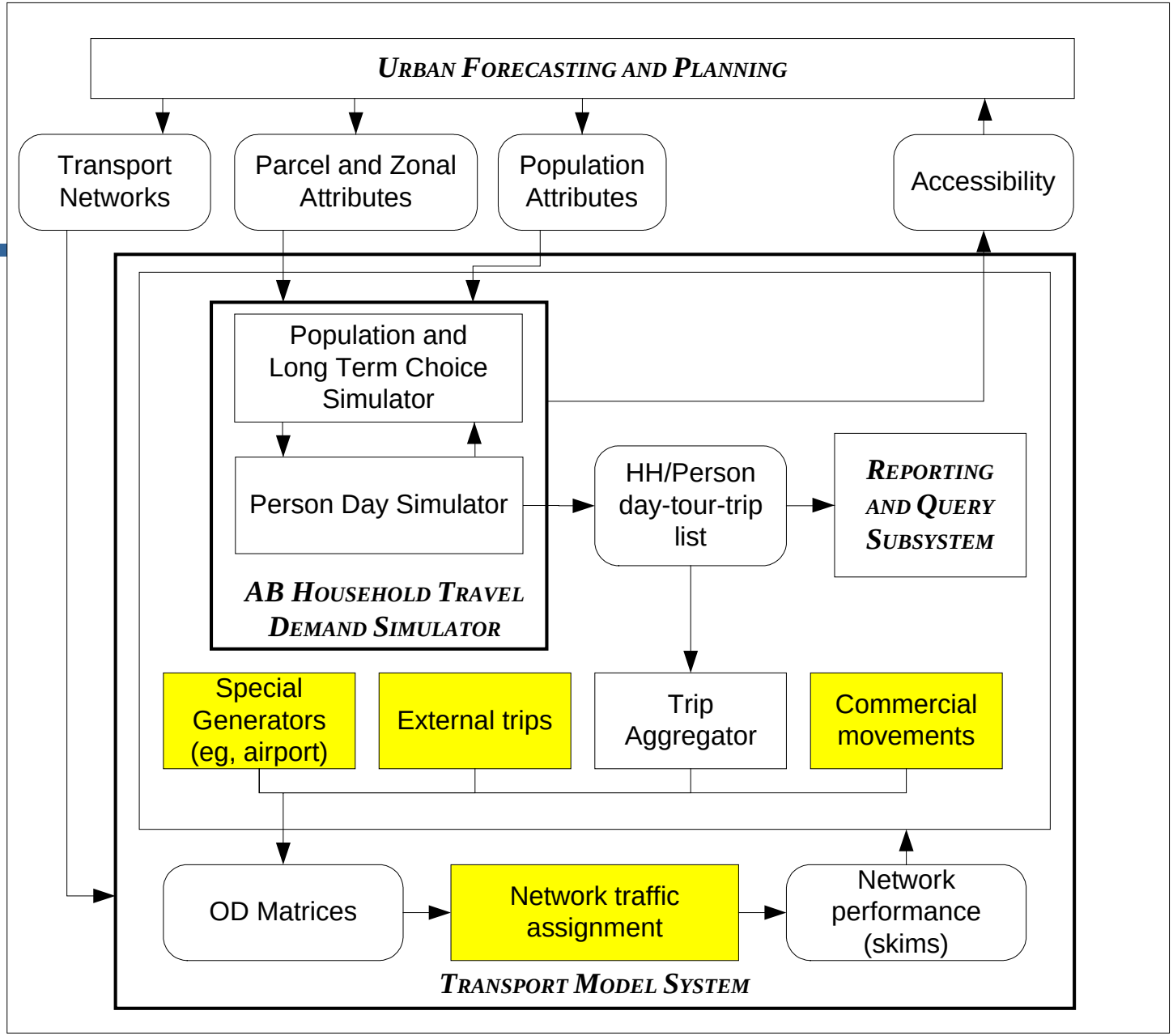

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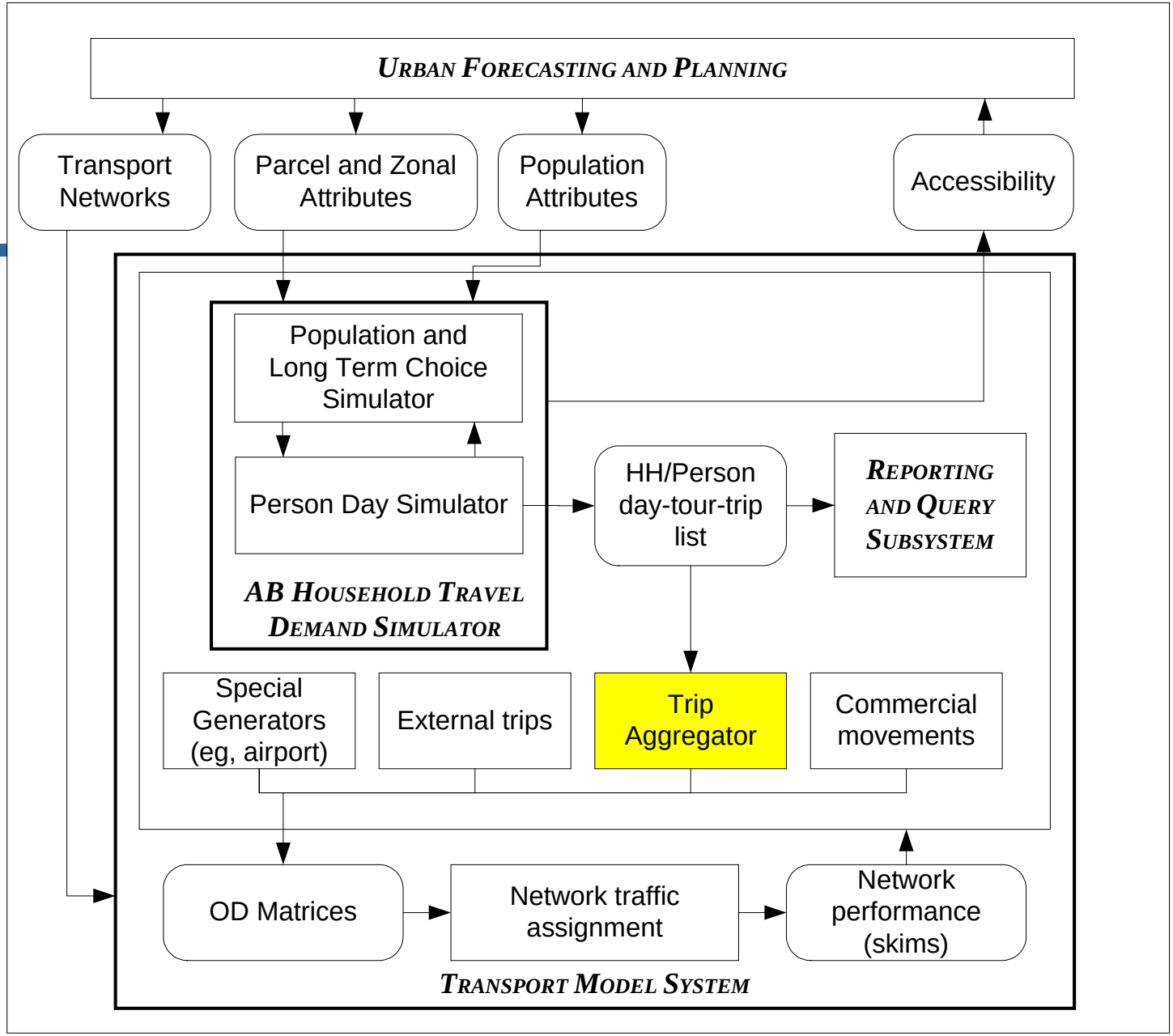

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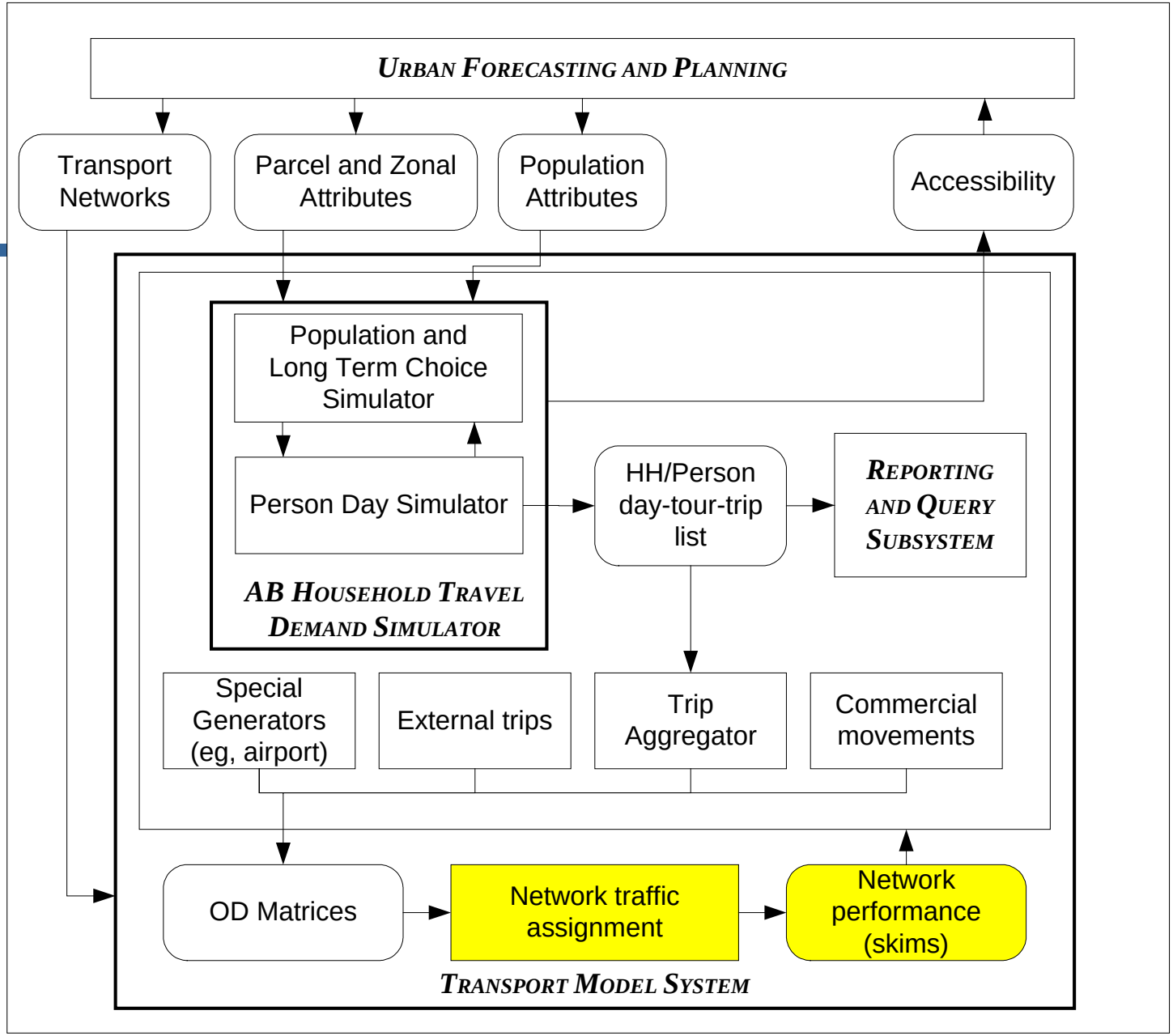

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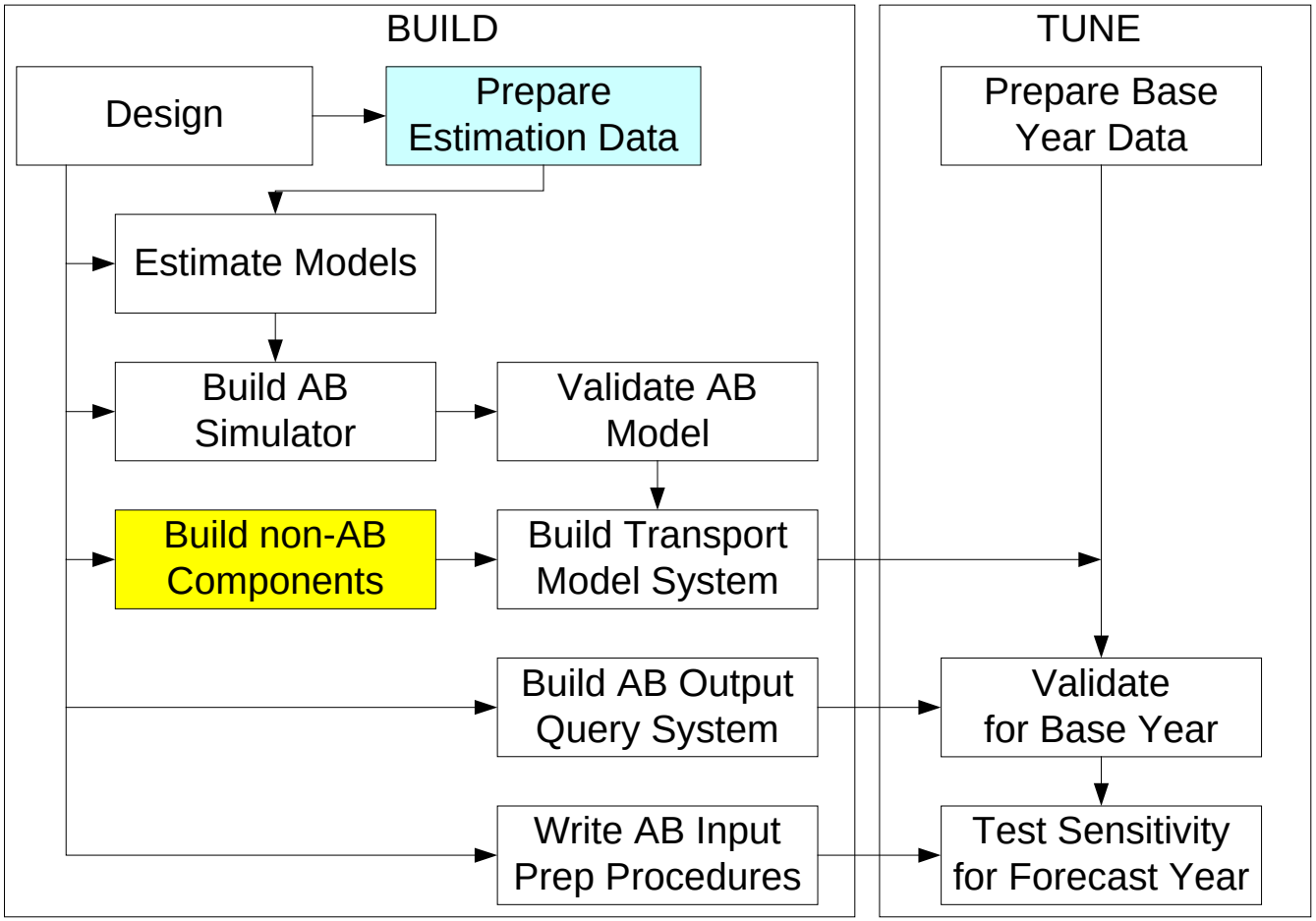
Build Non-AB Components



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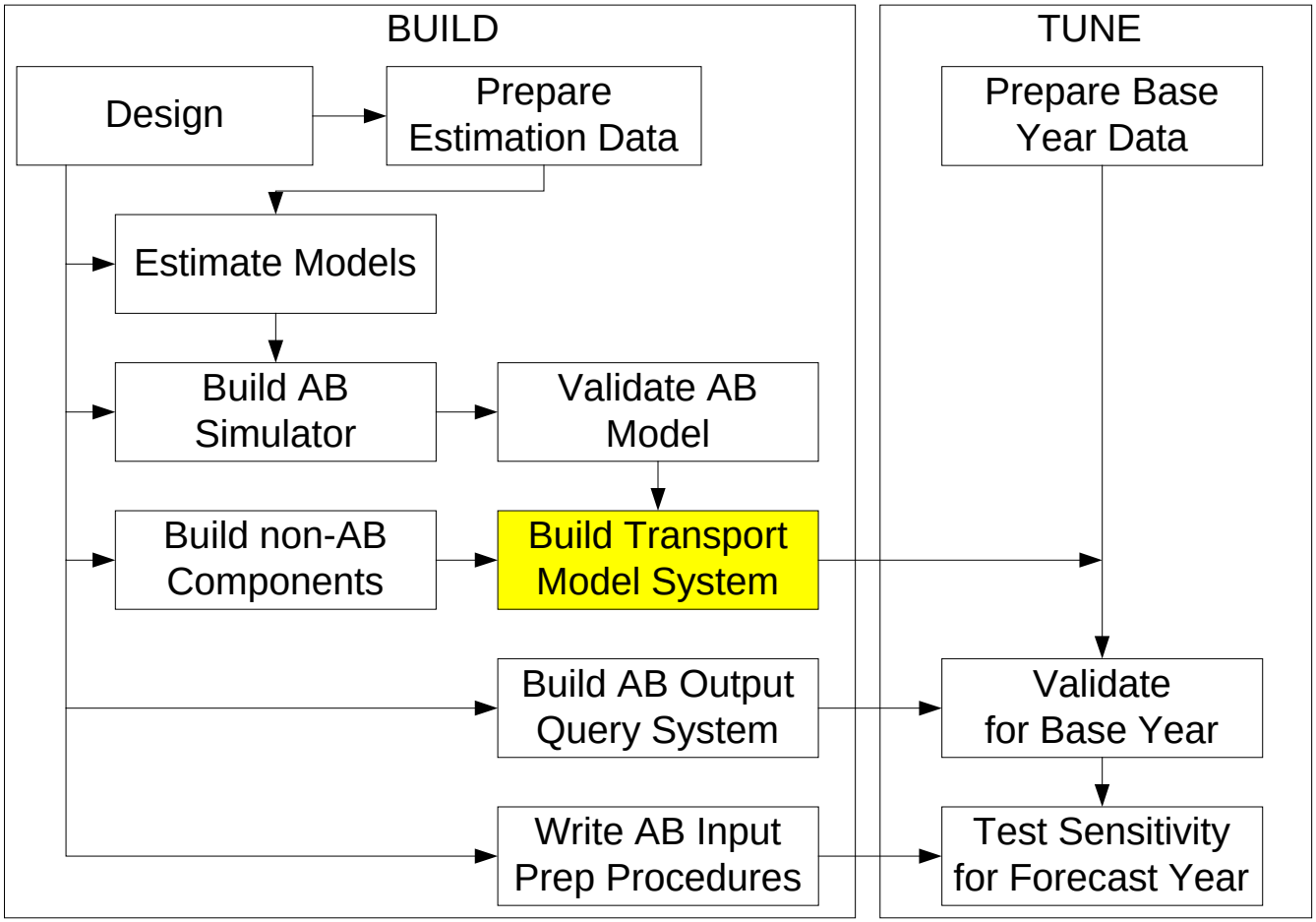
Build Transport Model System



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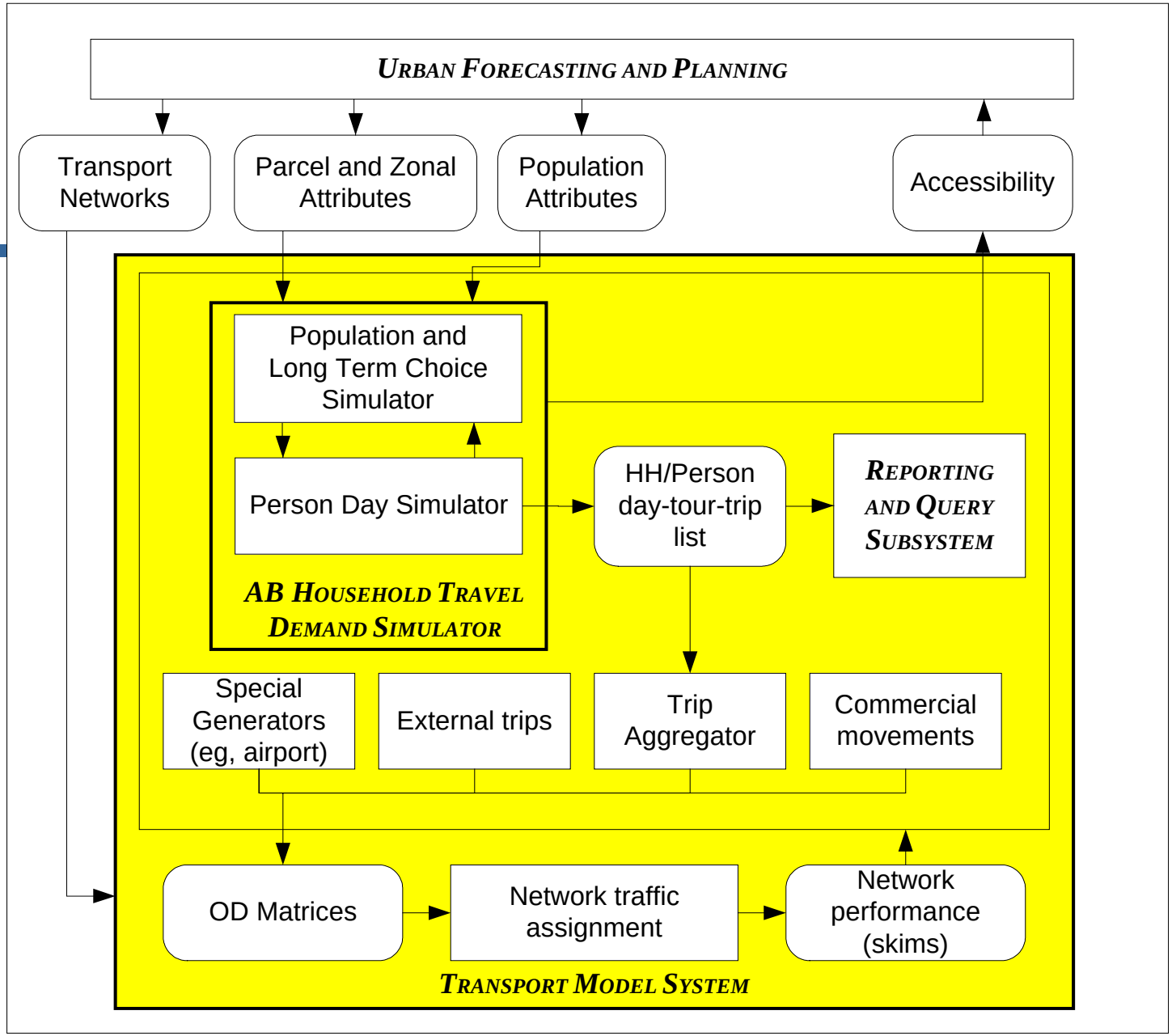

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Build Transport Model System

- Install hardware if needed
- Assemble scripts
  - Non-AB components
  - AB simulator
  - Iteration scheme
- Test and tune
  - Convergence
  - Performance

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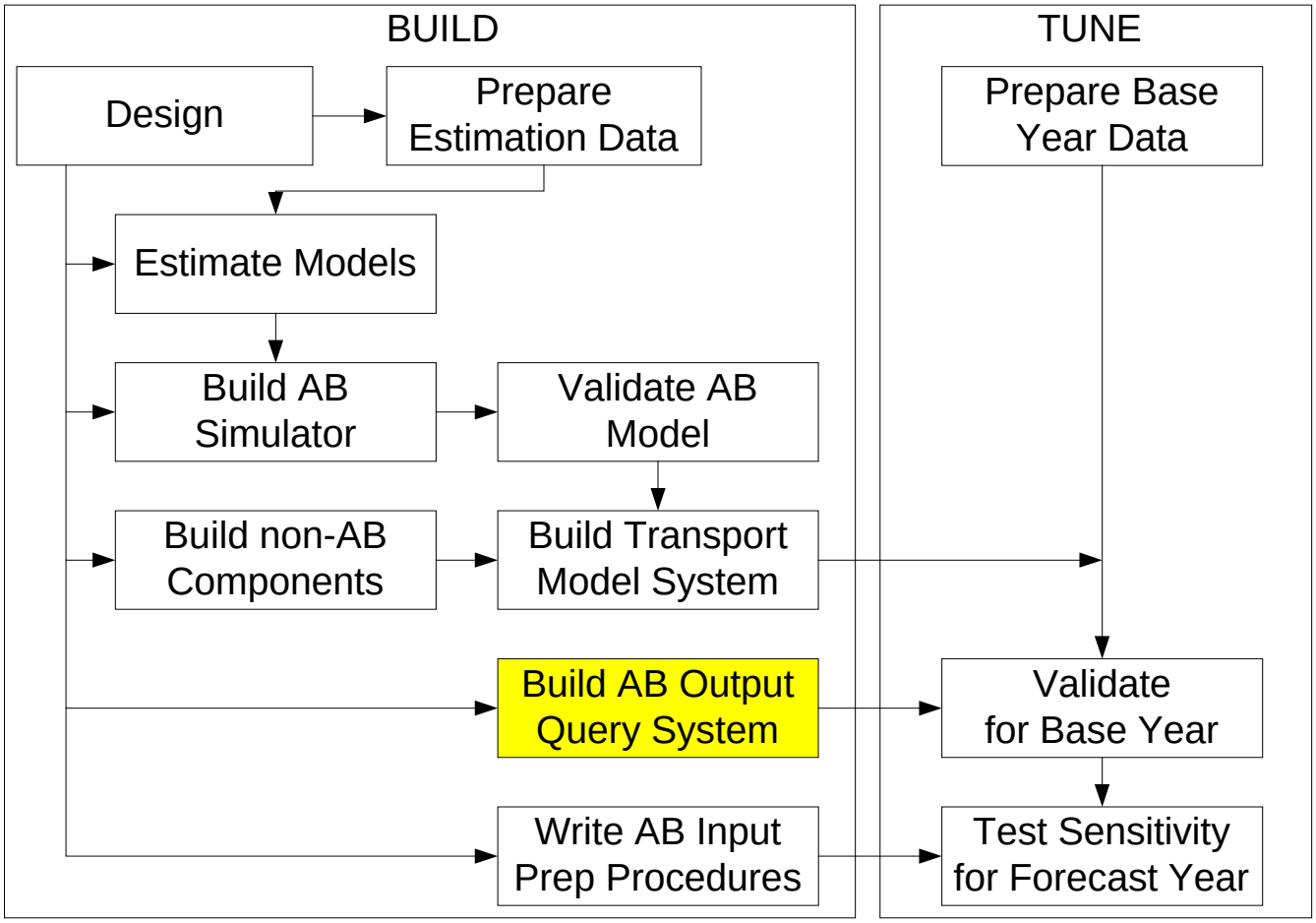
Build
AB Output Query System



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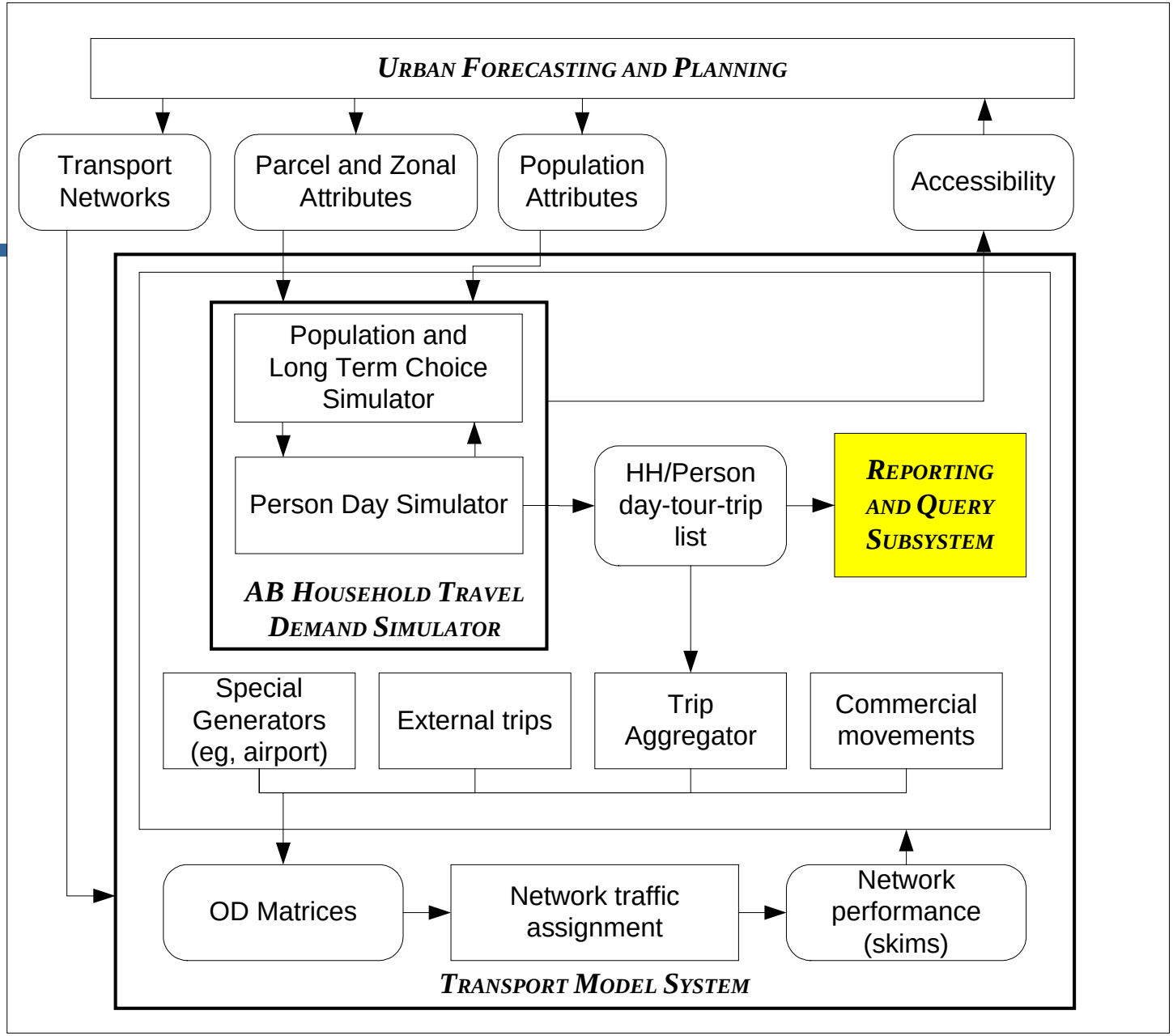

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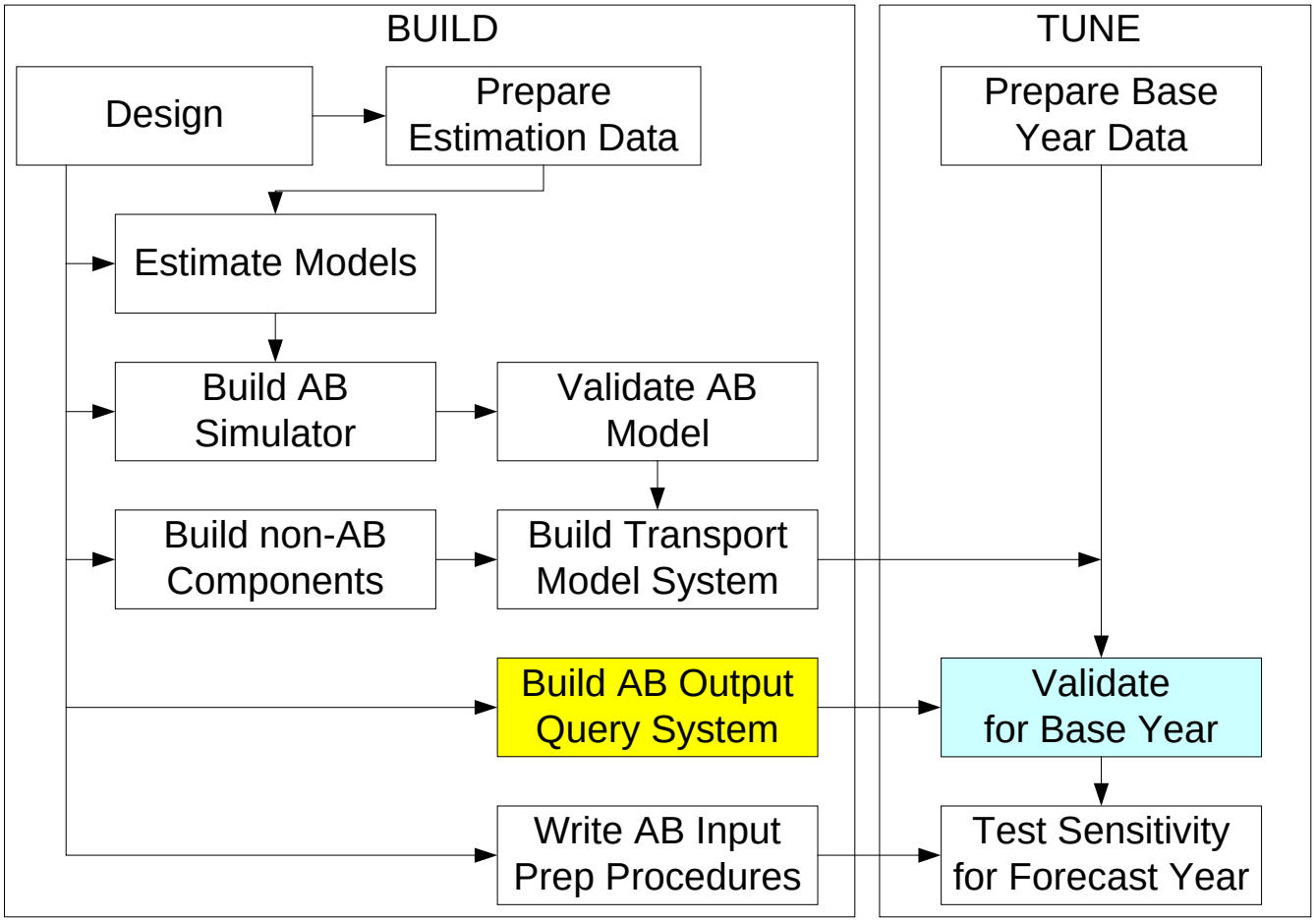
Build
AB Output Query System



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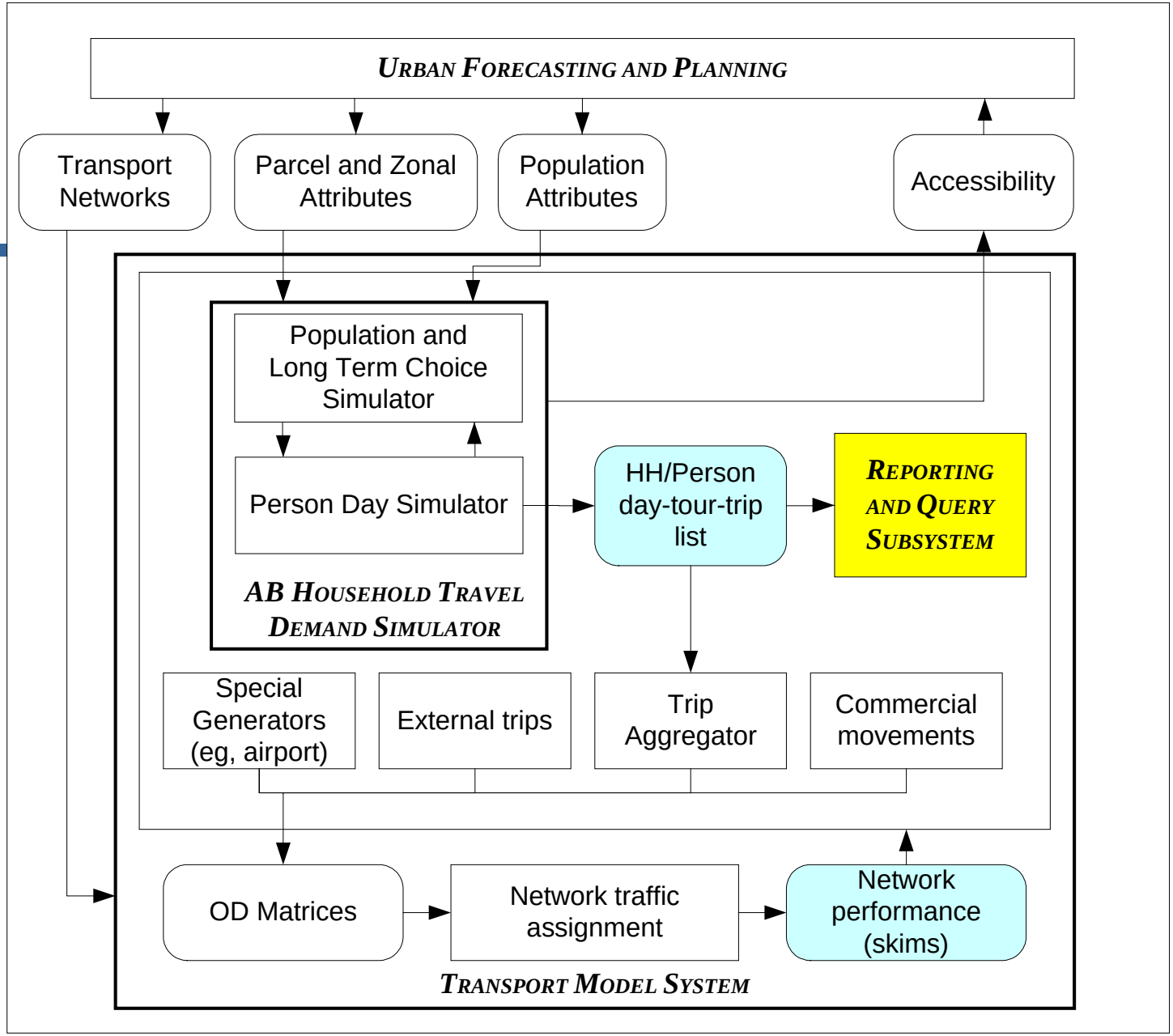

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Build
AB Output Query System

- Aggregate the AB trip lists as needed
  - Customary reports
  - Queries by chosen population segments
  - Merge with GIS for visual outputs

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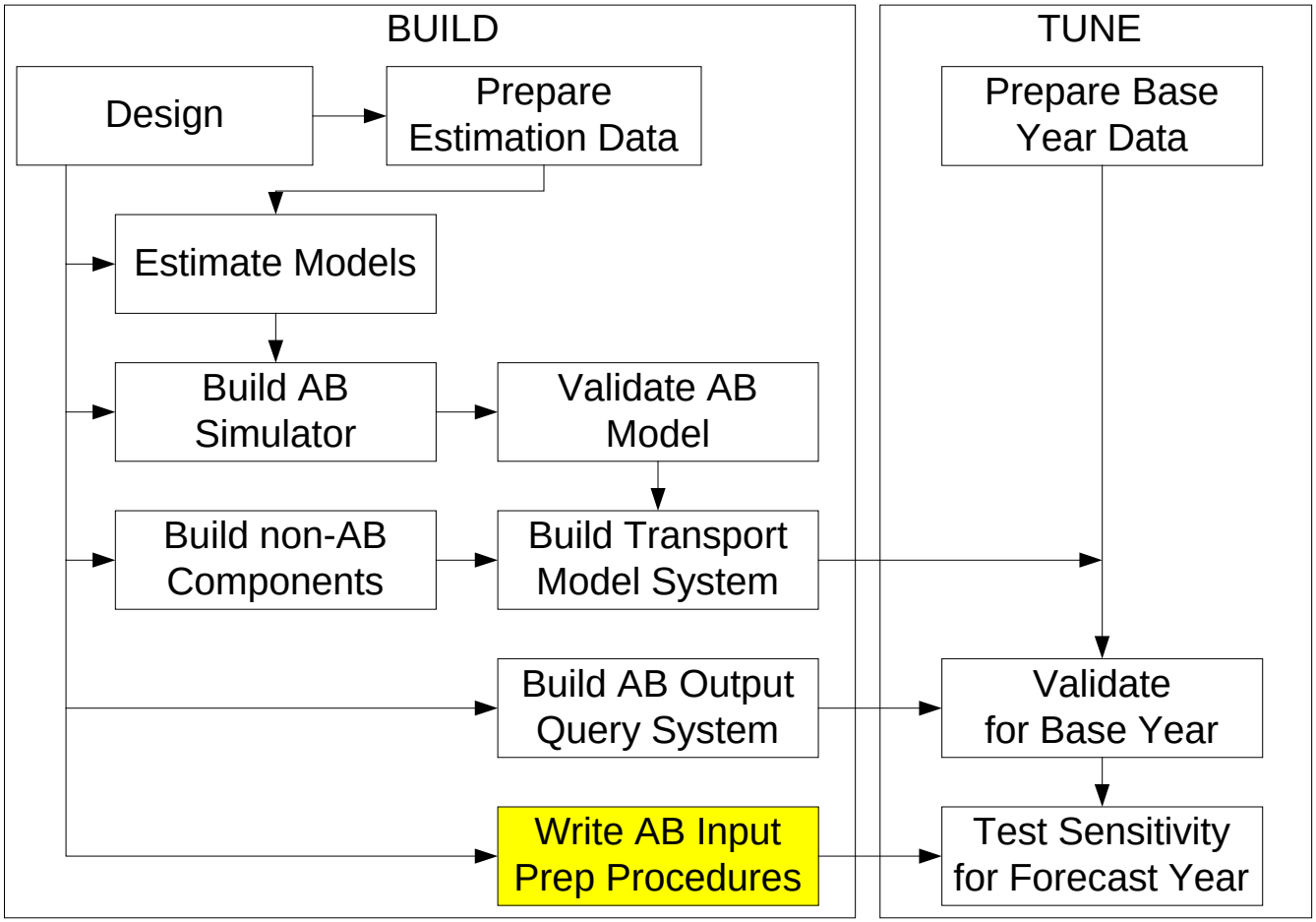
Write
AB Input Prep Procedures



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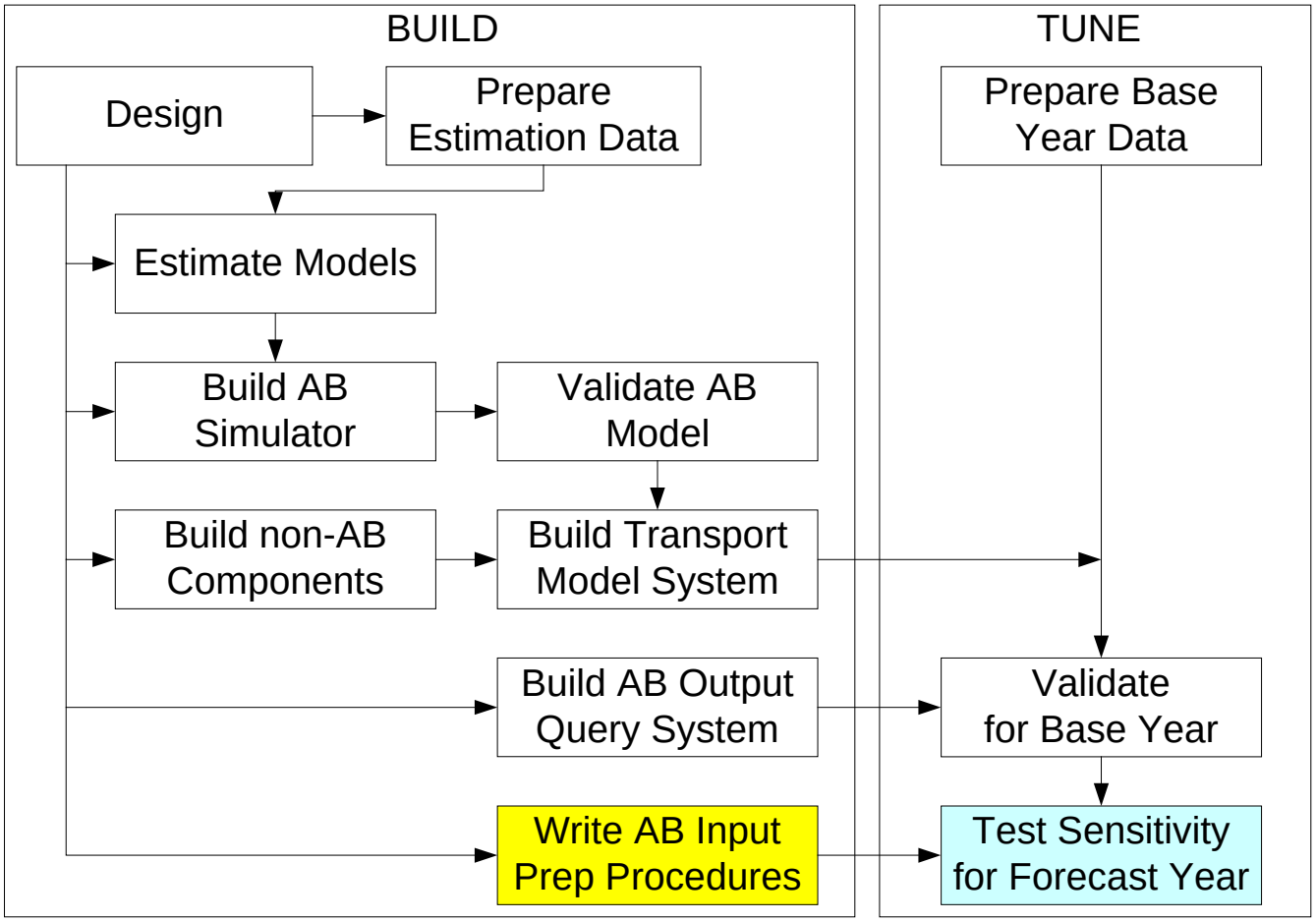
Write
AB Input Prep Procedures



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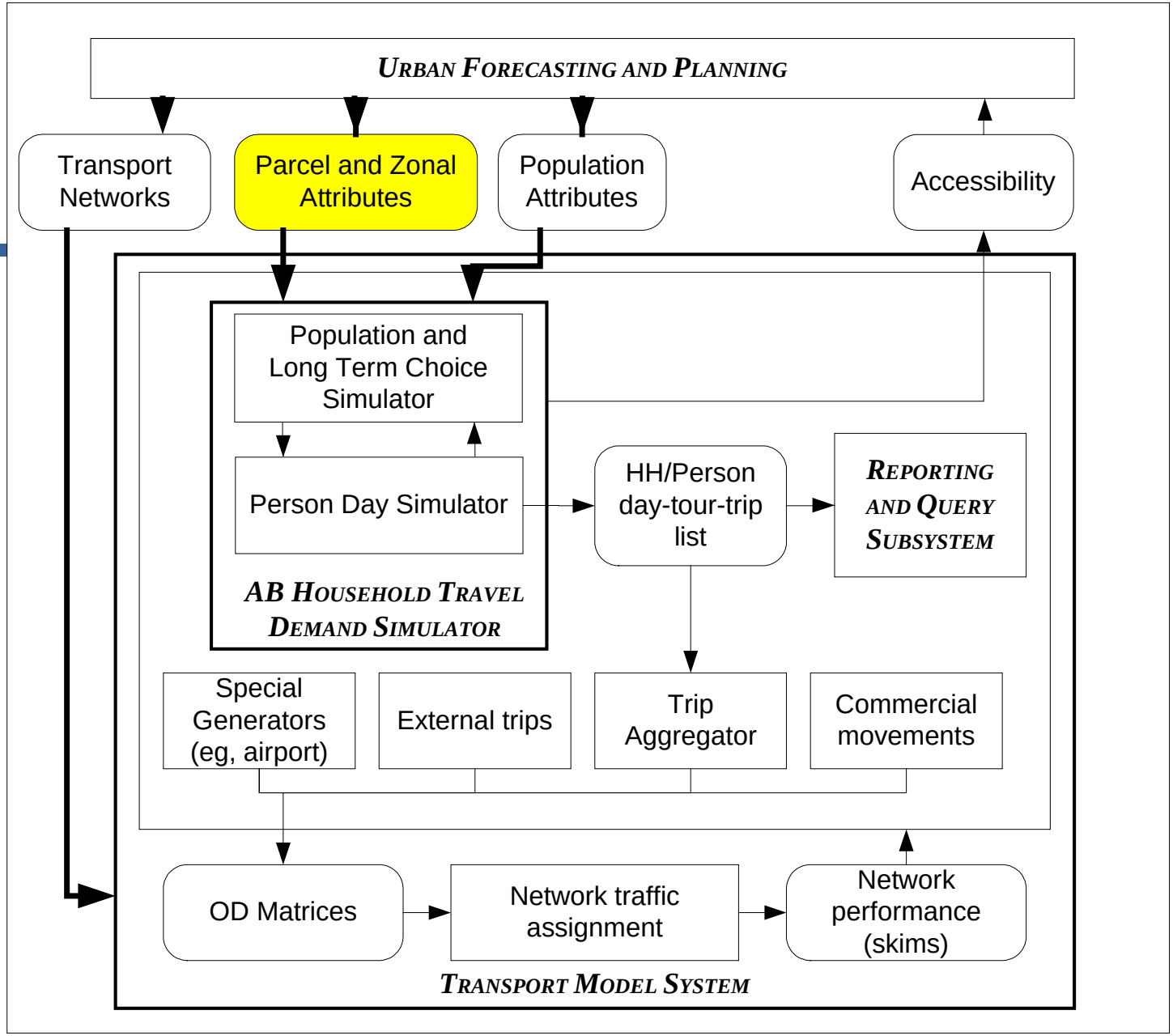

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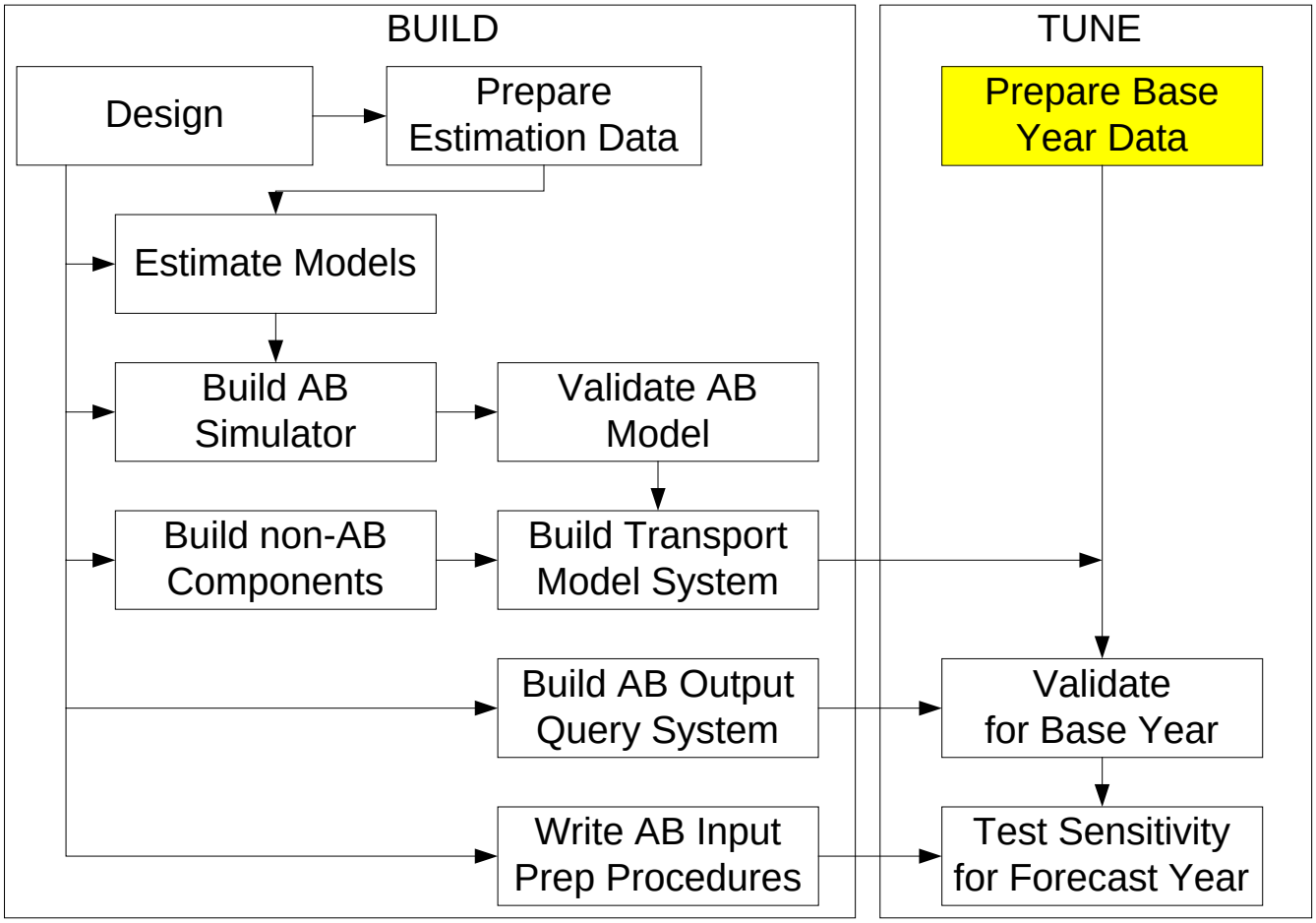
Prepare Base Year Data



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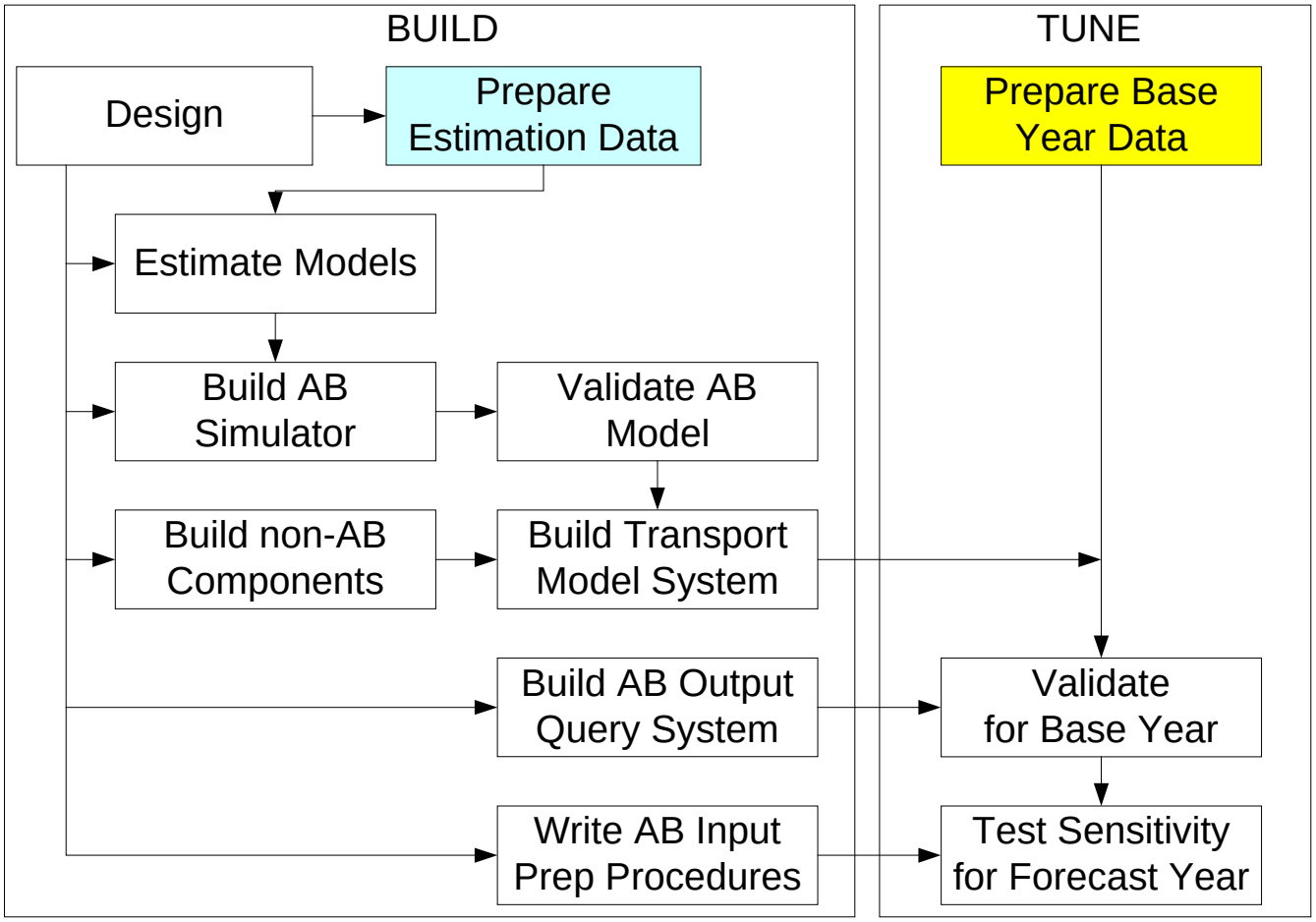
Prepare Base Year Data



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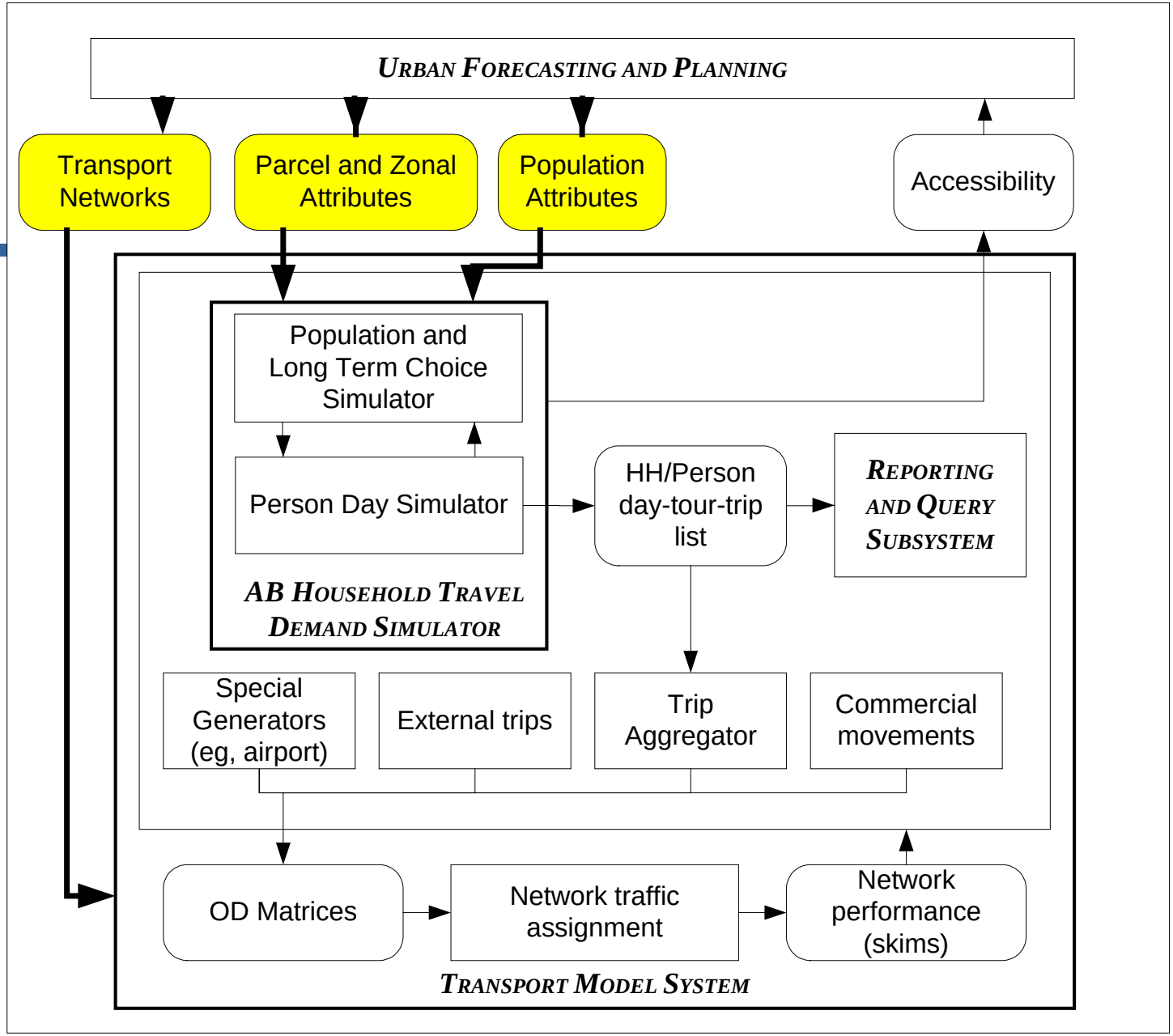

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Prepare Base Year Data

- AB Input data
- Validation data (by time of day)
  - employment and school enrollment
  - work and school trip lengths
  - vehicle availability
  - transit counts
  - screenline counts

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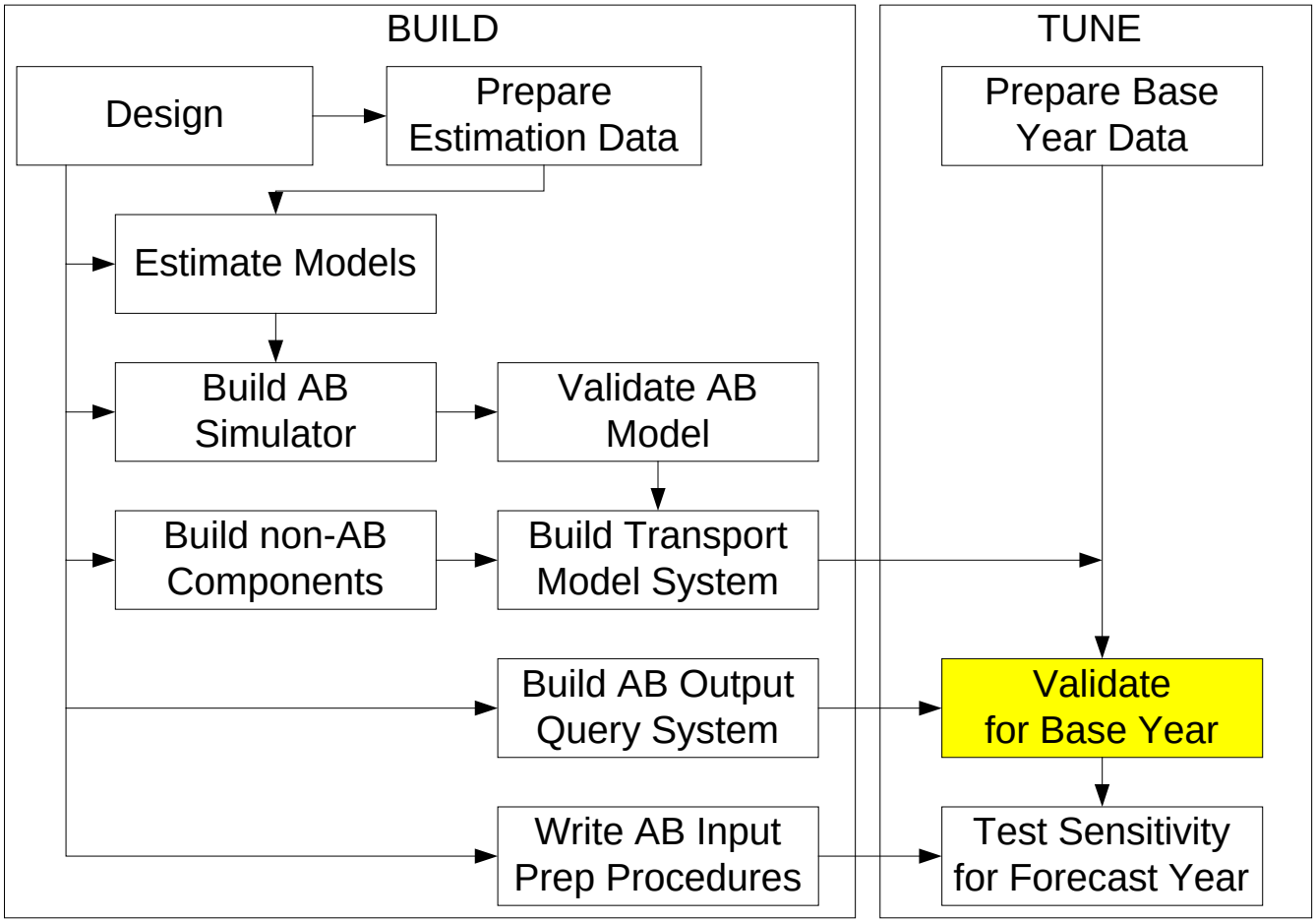
Validate for Base Year



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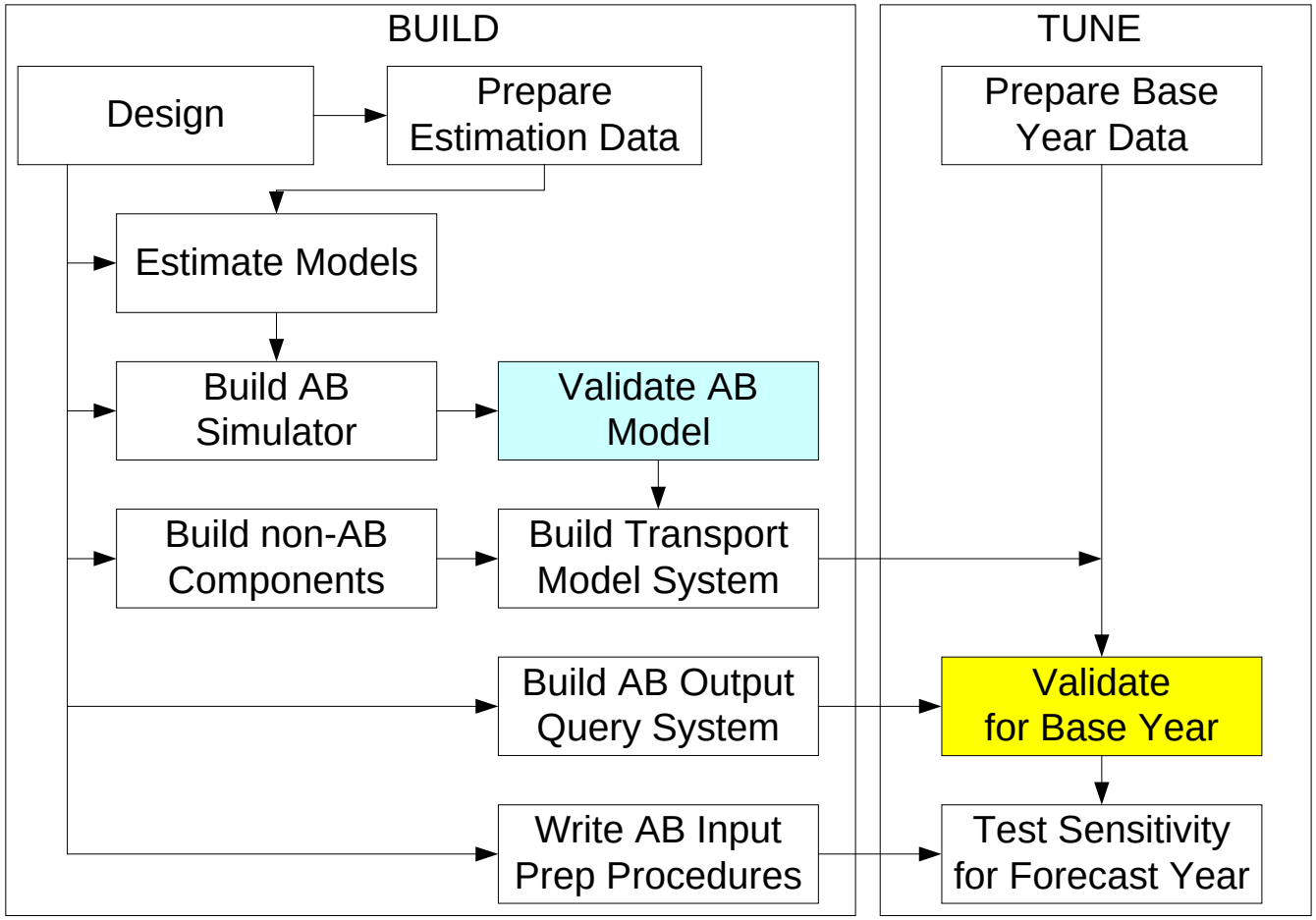
Validate for Base Year



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Validate for Base Year

- Much like trip-based model validation
  - Run model system on base year
  - Compare to validation data
- By time of day
- May require
  - calibration constants
  - Adjustment of models

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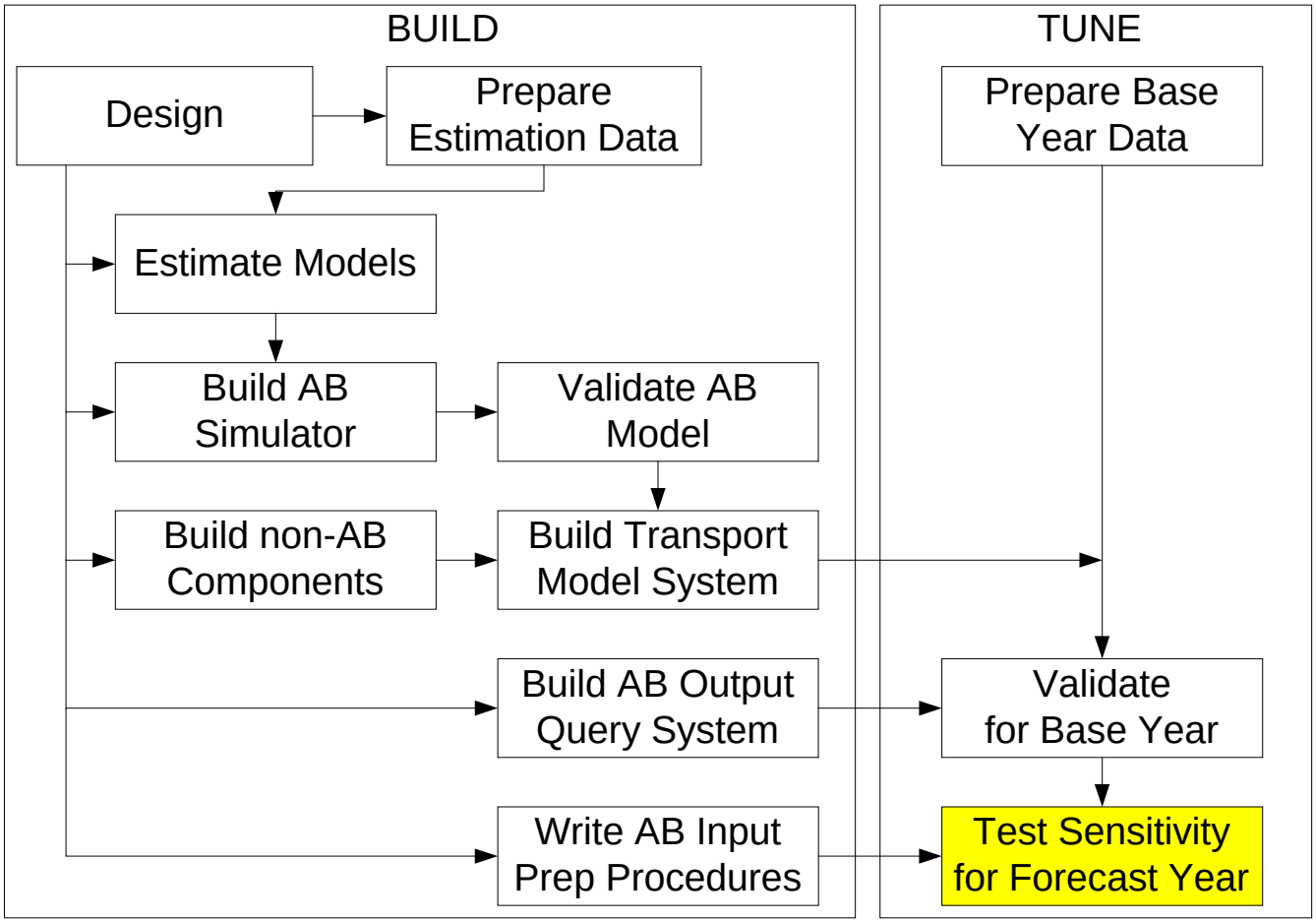
Test Sensitivity for Forecast Year



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Test Sensitivity for Forecast Year

- Test on scenarios of interest
  - Generate validation statistics
  - Check elasticities
- May require enhancement of models
- Train users
- Familiarize clients

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Outline

- Activity-Based (AB) Model System
- Development Tasks
- Basic Build Approaches
- Development Roles
- Management Keys to Success

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Basic Build Approaches

- Invent
- Adapt
- Adopt

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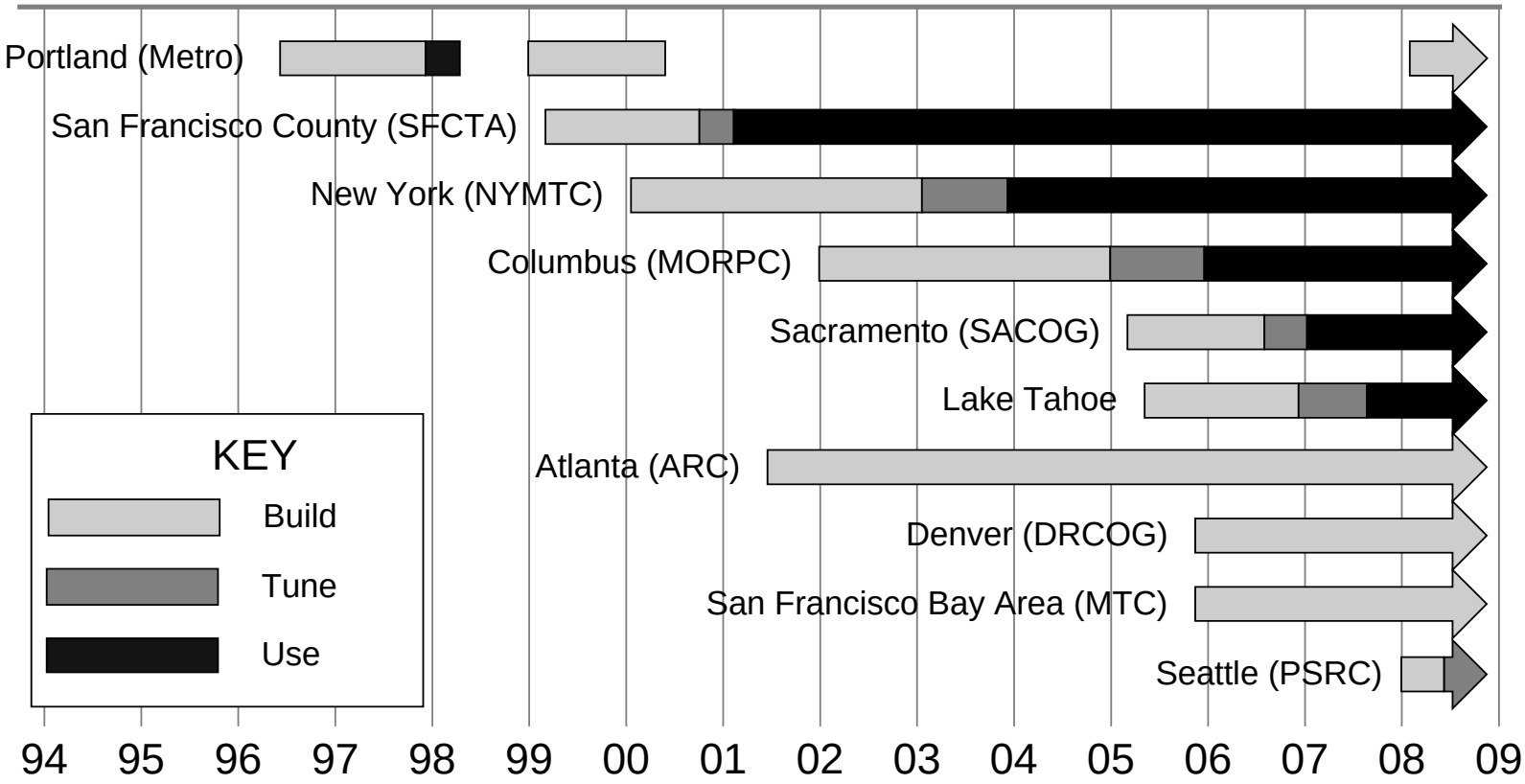
U.S. Projects



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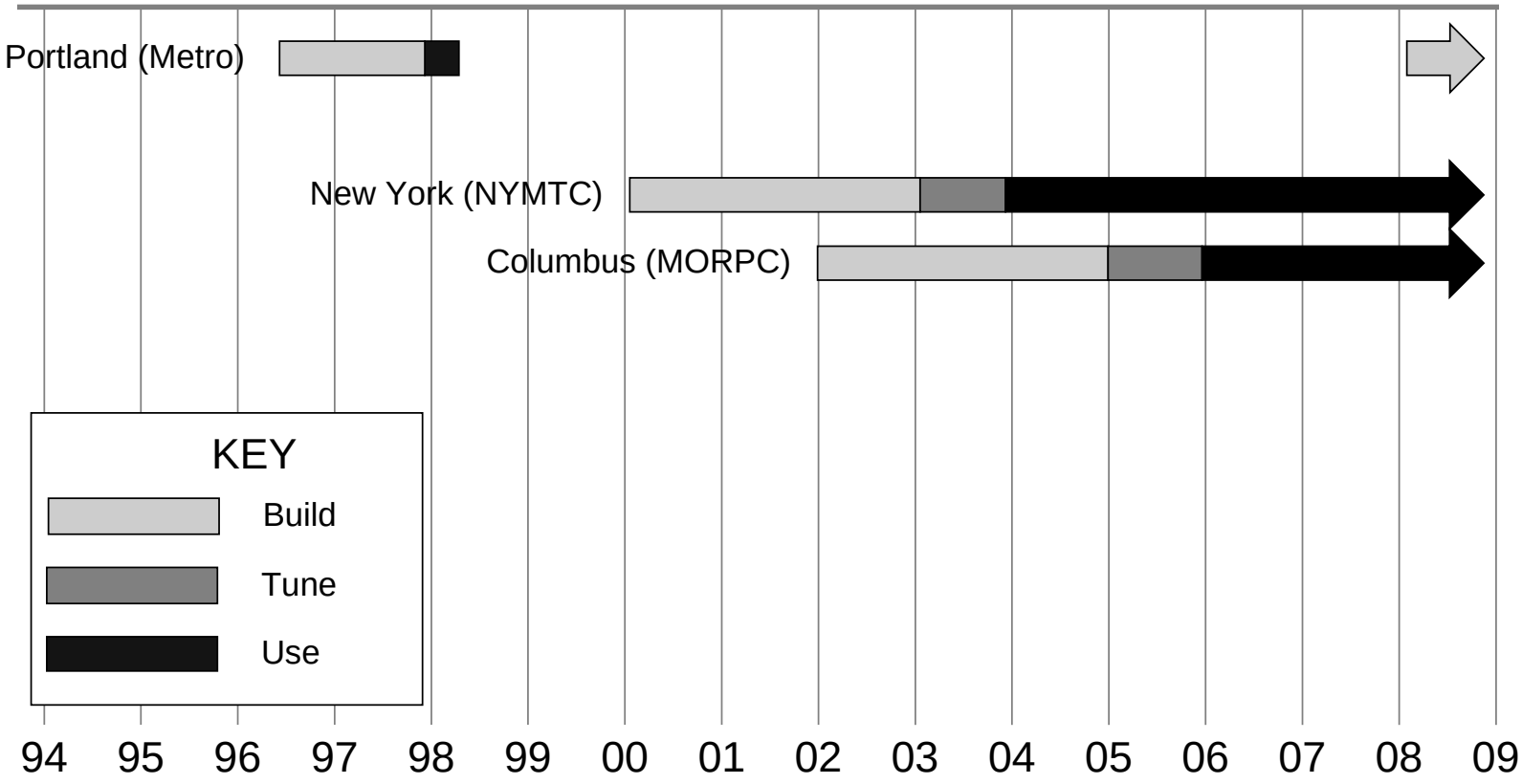
Invent



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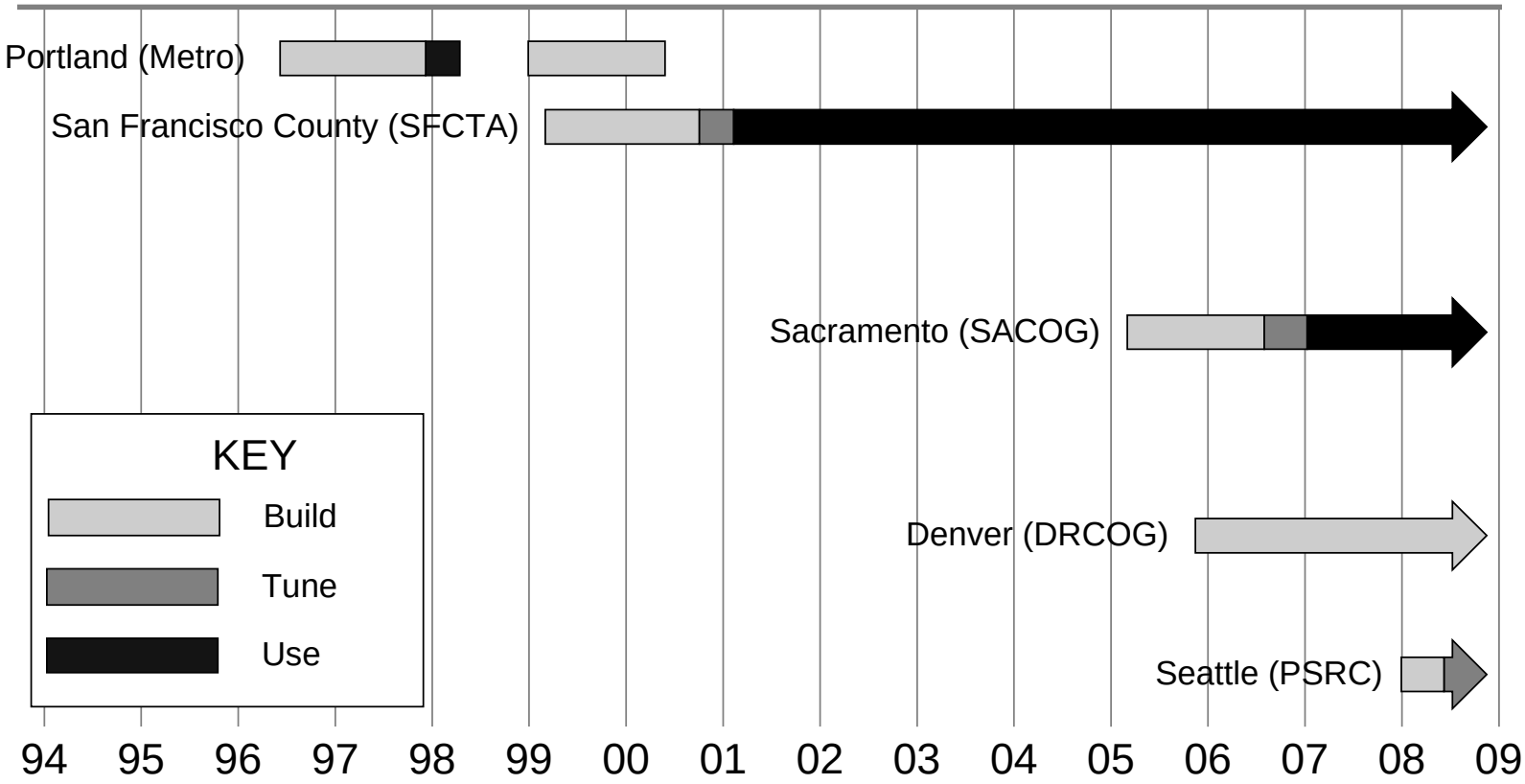
Adapt Metro



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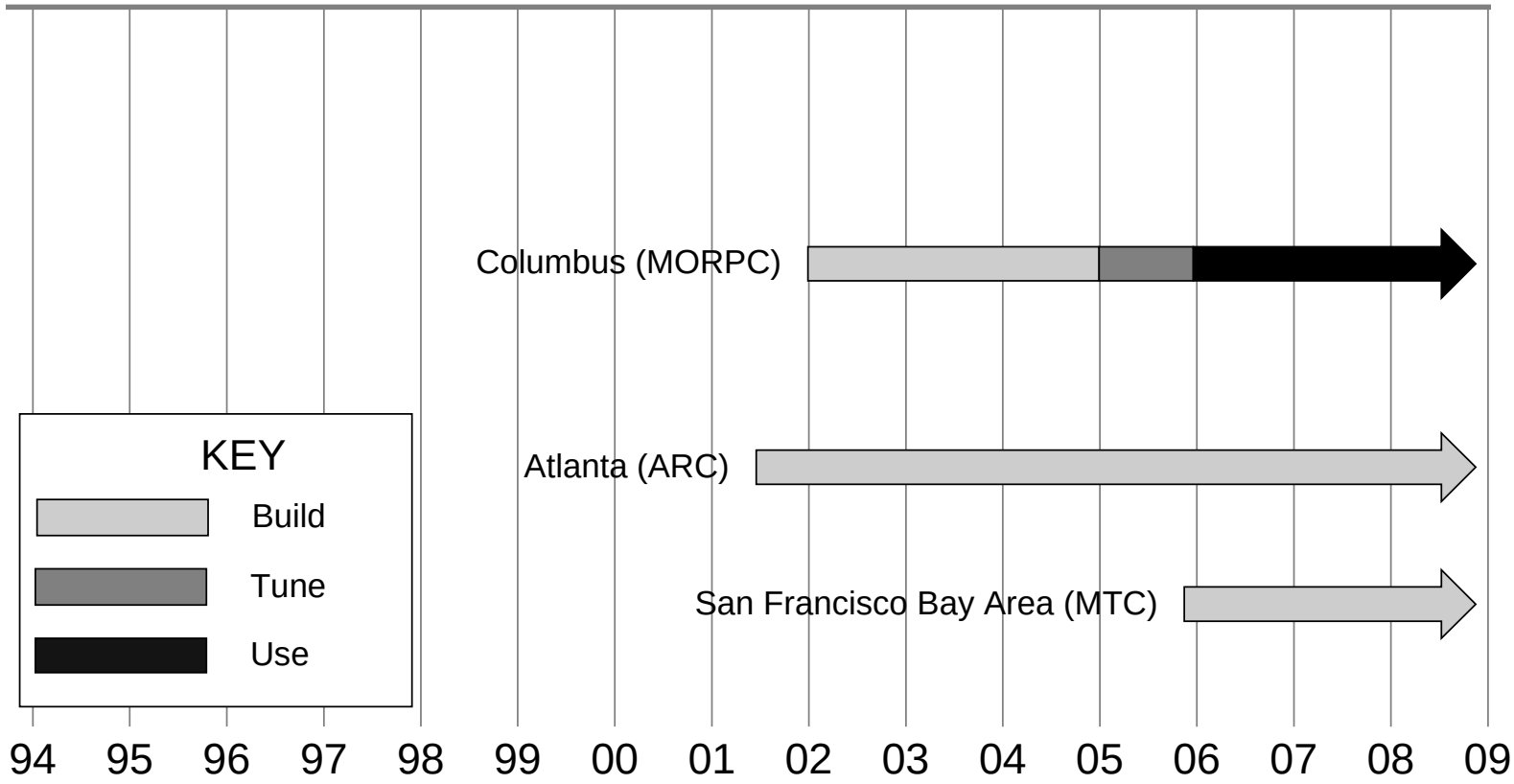
Adapt MORPC



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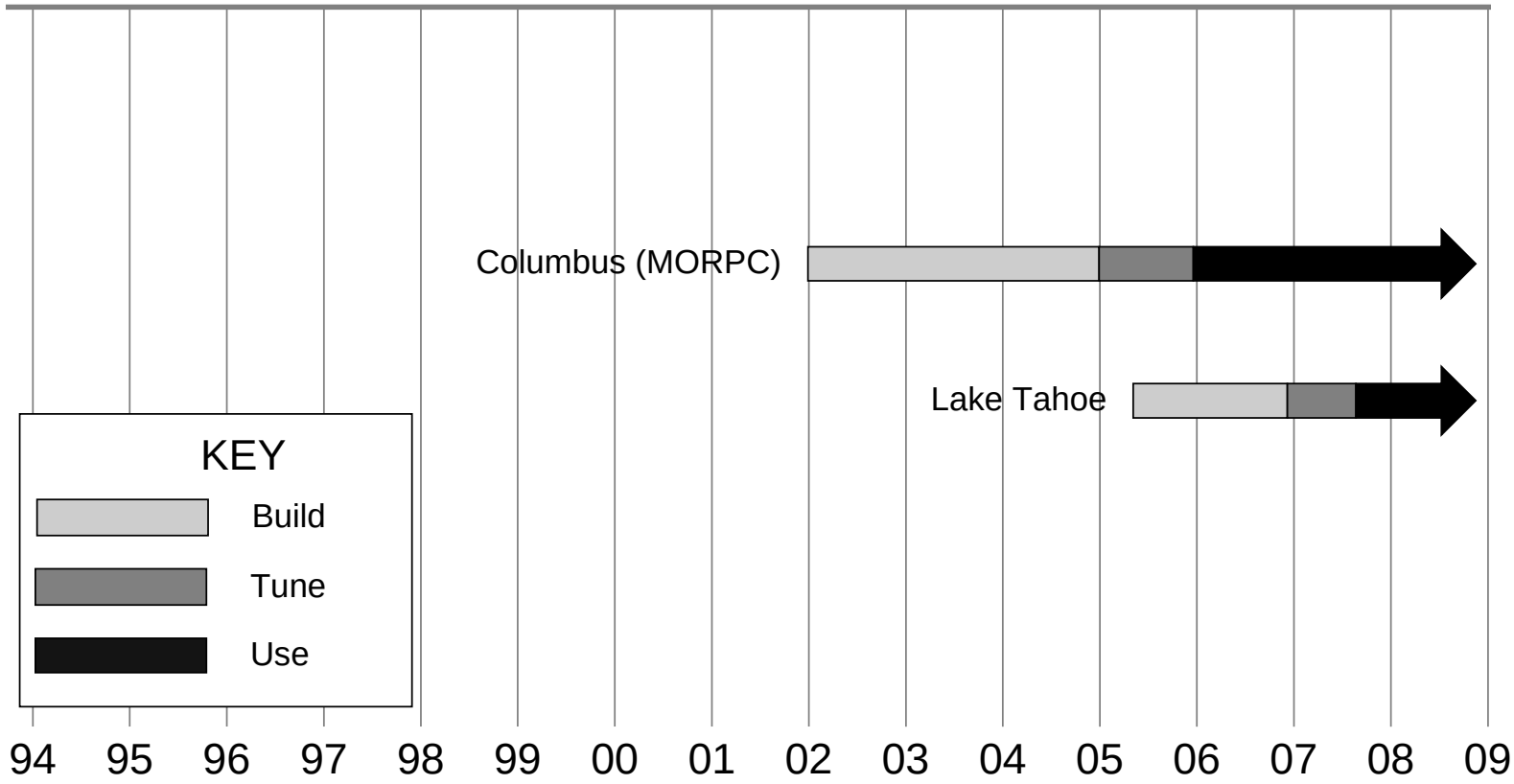
Adopt MORPC



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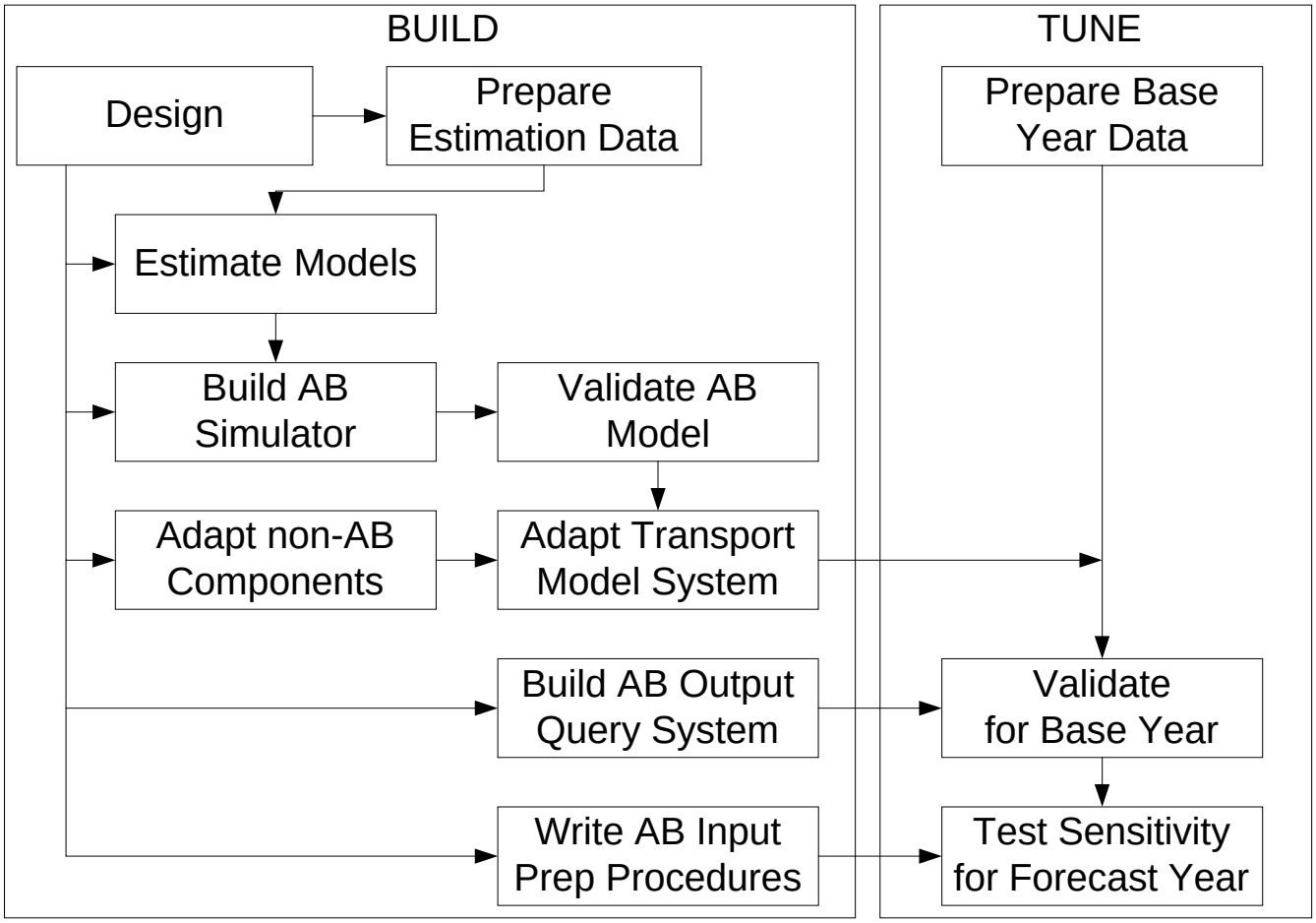
Basic Build Approaches
Invent



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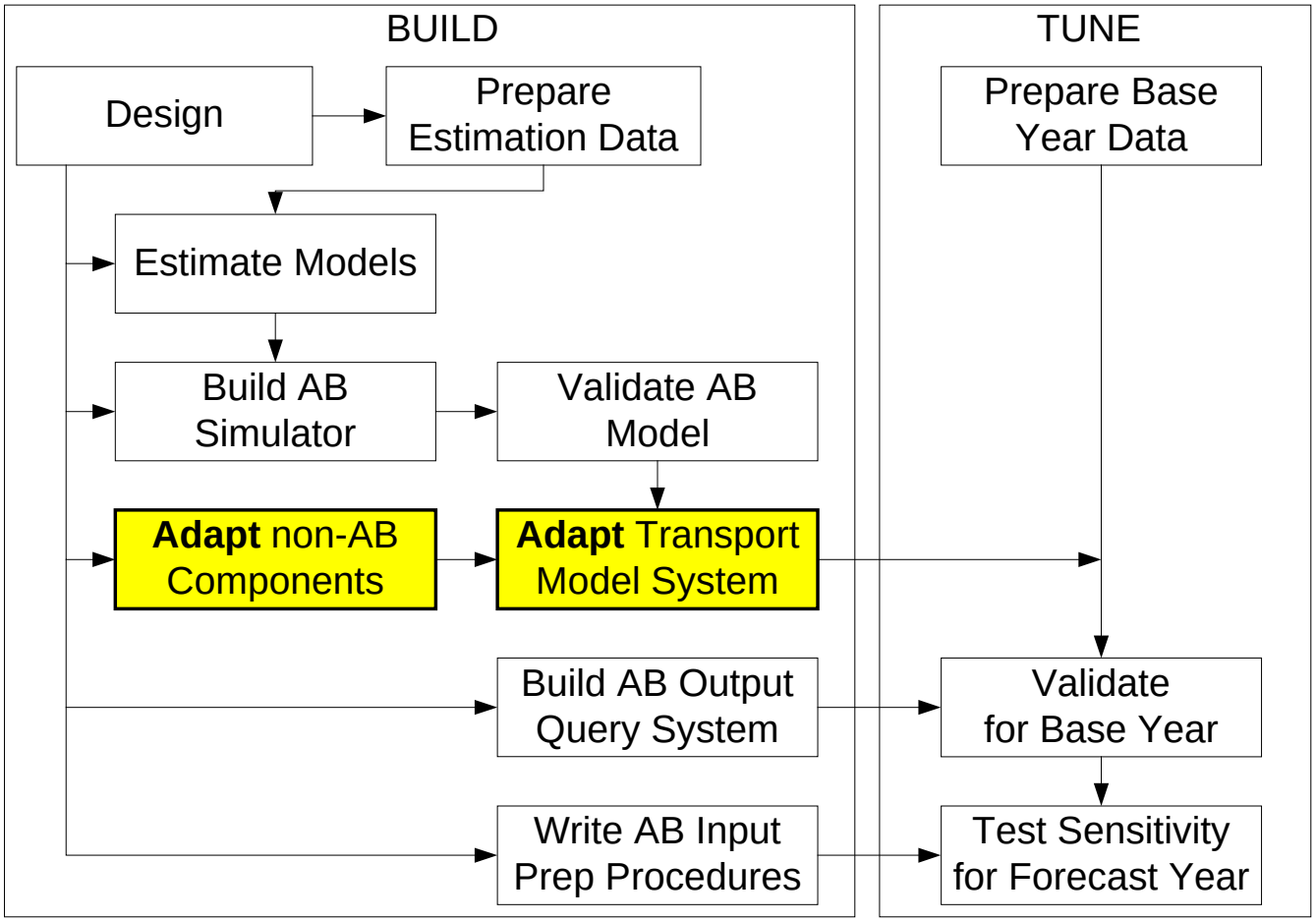
Basic Build Approaches
Invent



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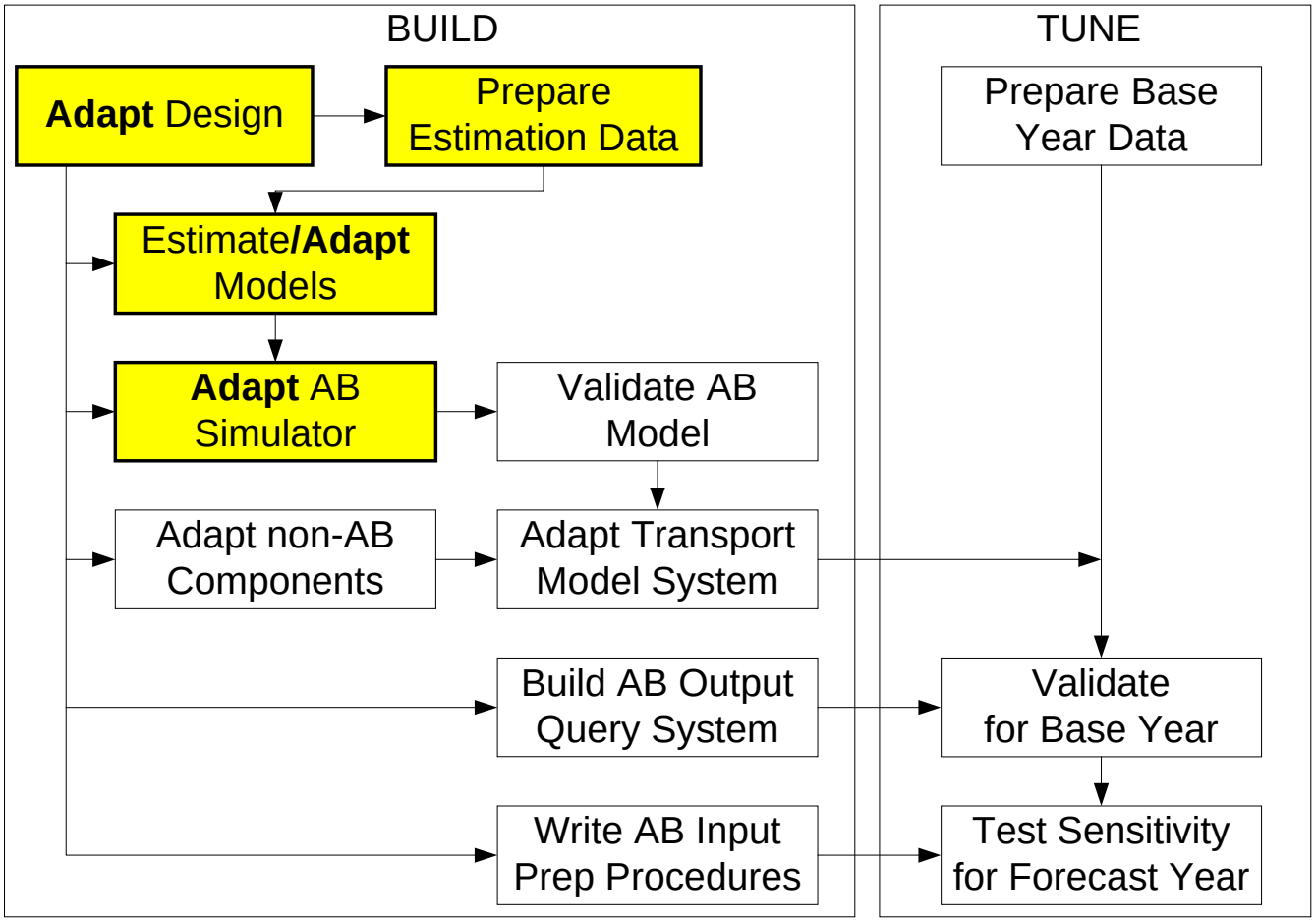
Basic Build Approaches
Adapt



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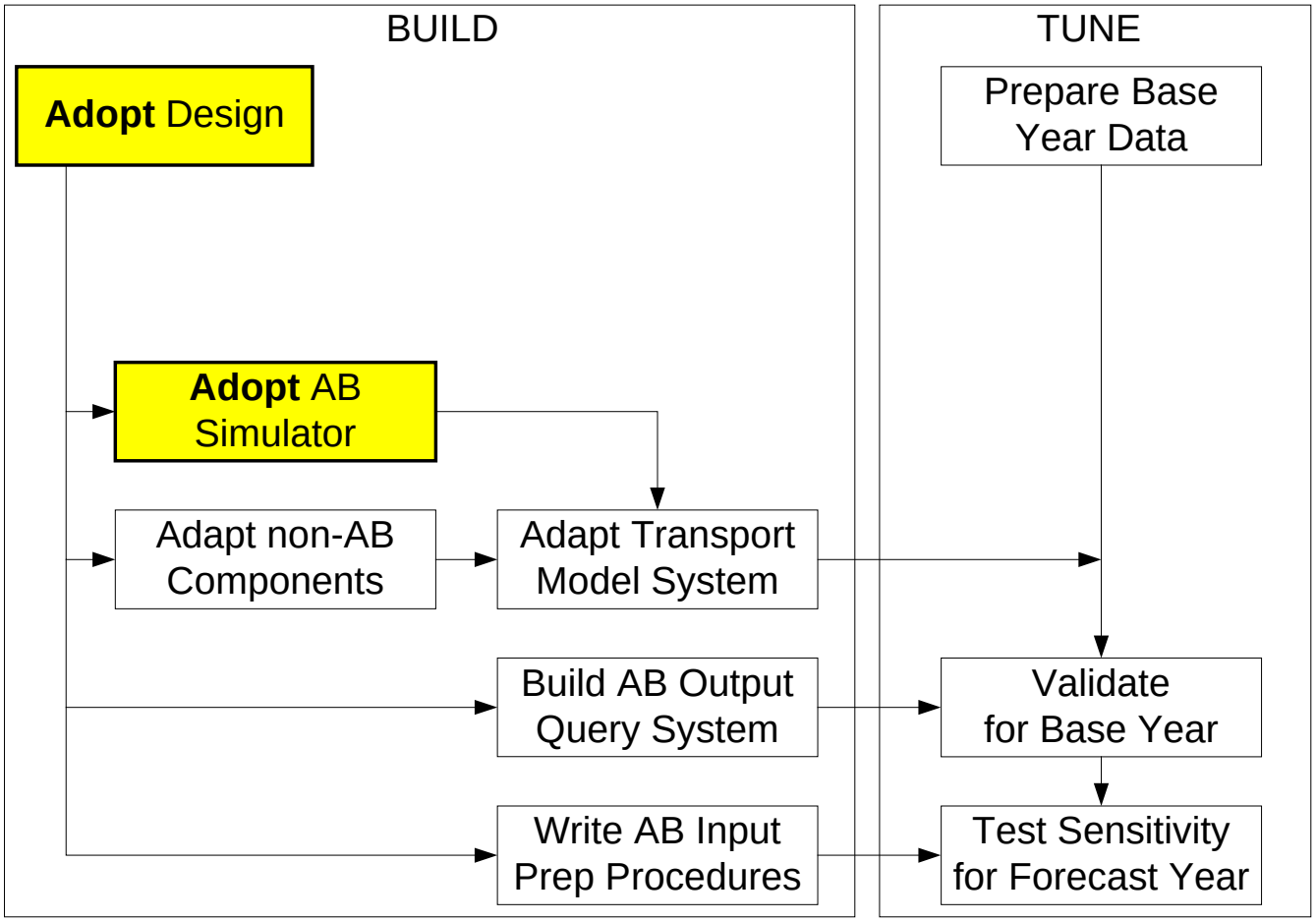
Basic Build Approaches
Adopt



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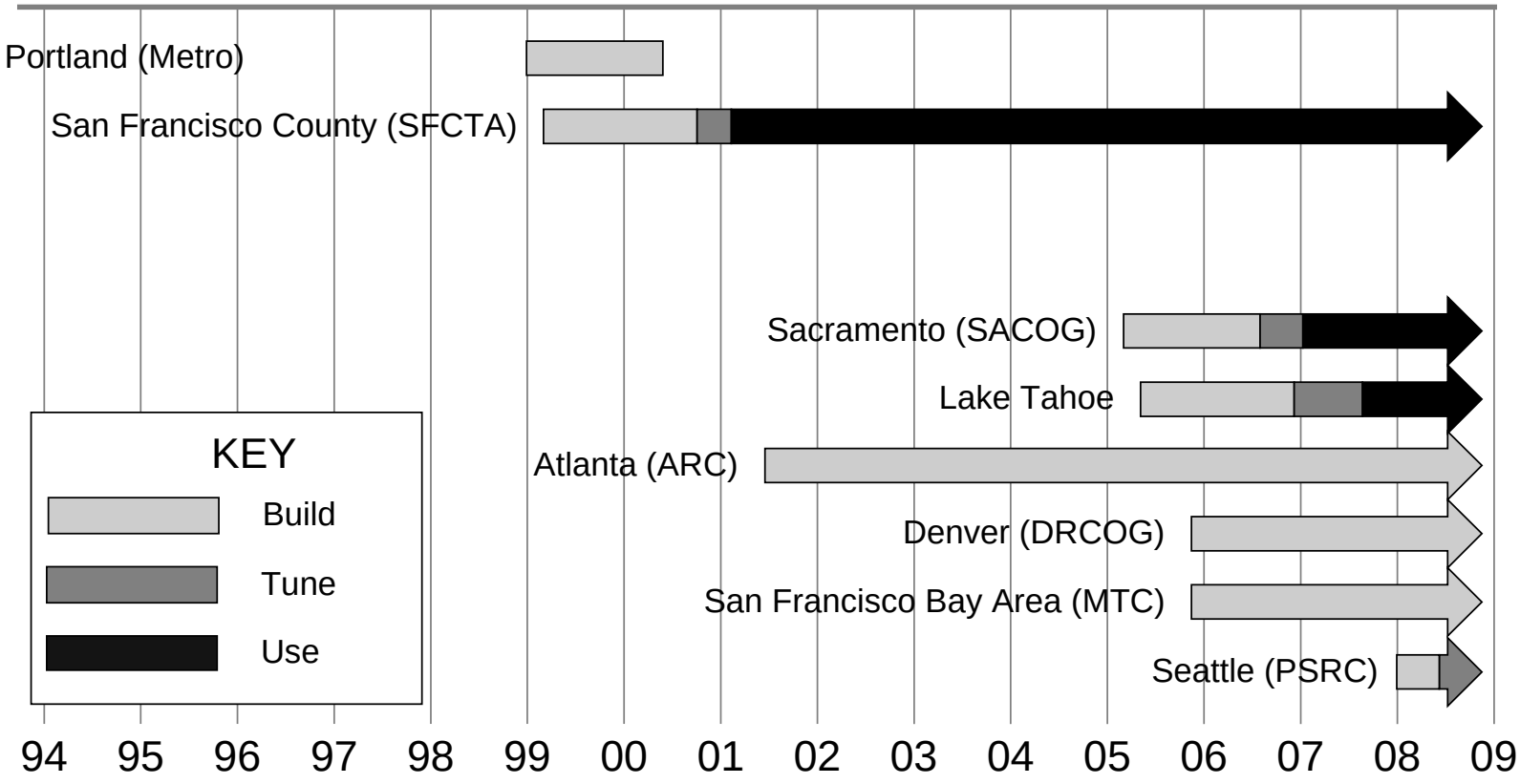
Adaptations and Adoptions



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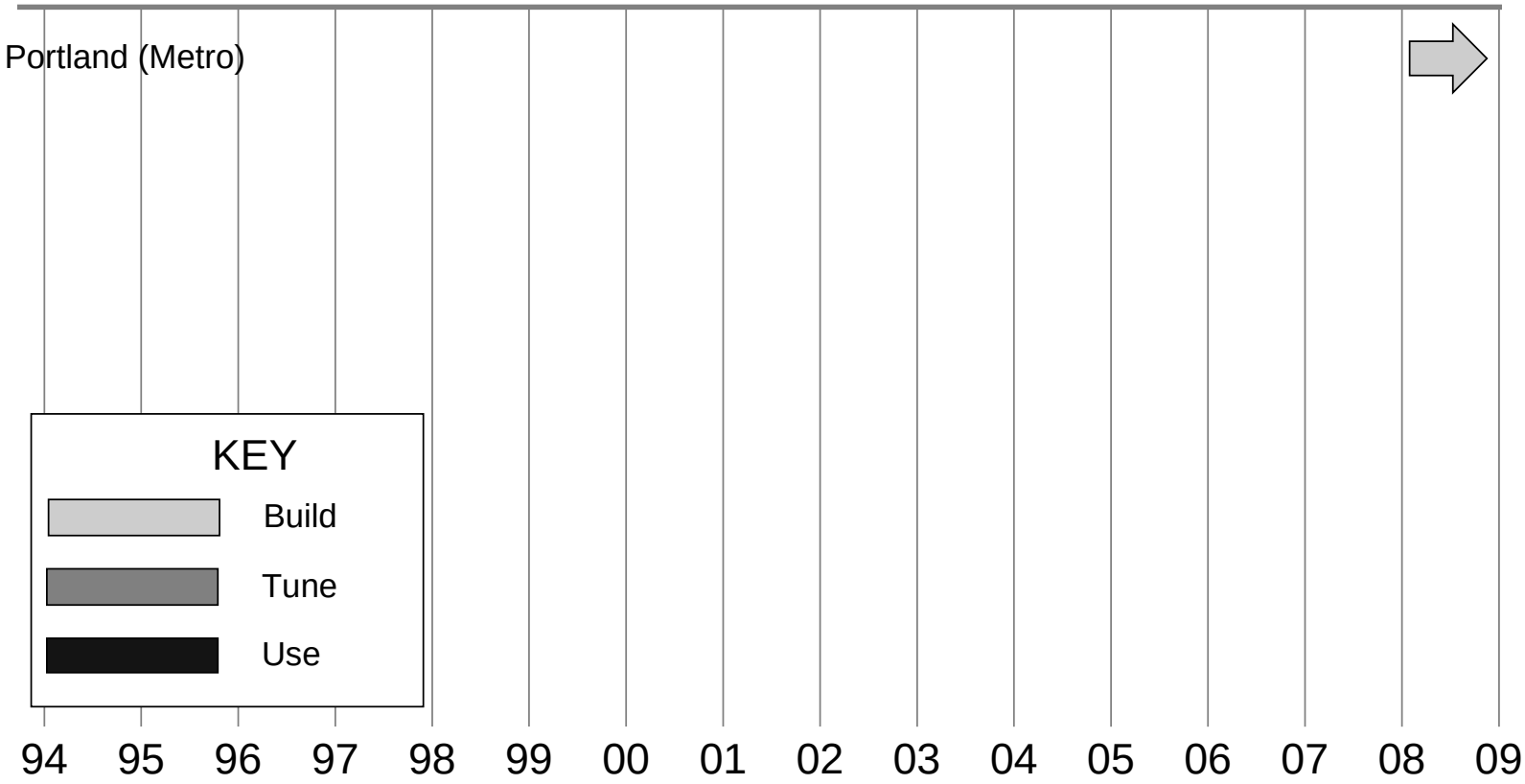
Metro: The Latest Invention



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Outline

- Activity-Based (AB) Model System
- Development Tasks
- Basic Build Approaches
- Development Roles
- Management Keys to Success

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Development Roles

- AB Developer
- Trip-Based Model Expert
- GIS/DB/GUI Expert(s)
- Application Expert

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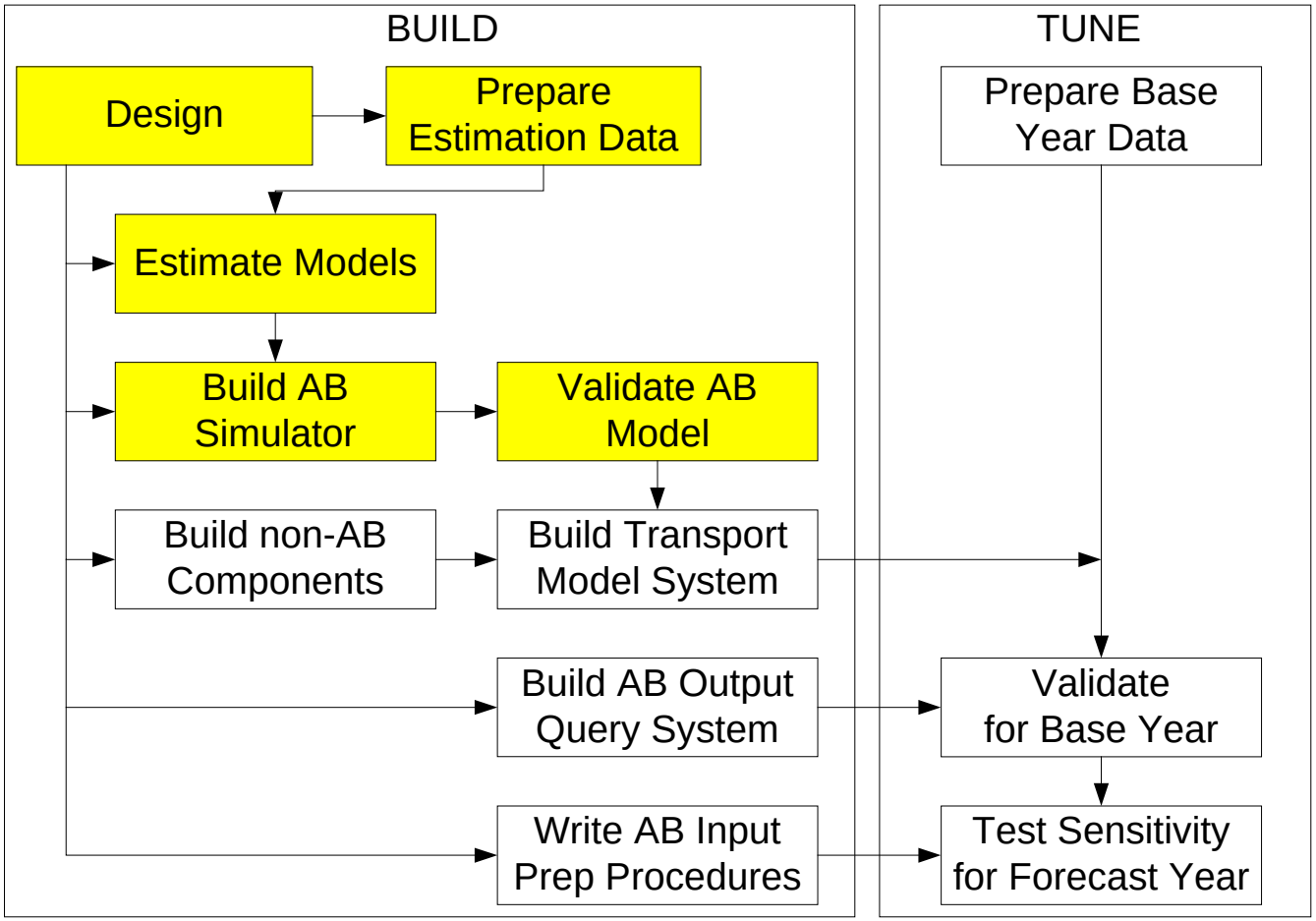
Development Roles
AB Developer



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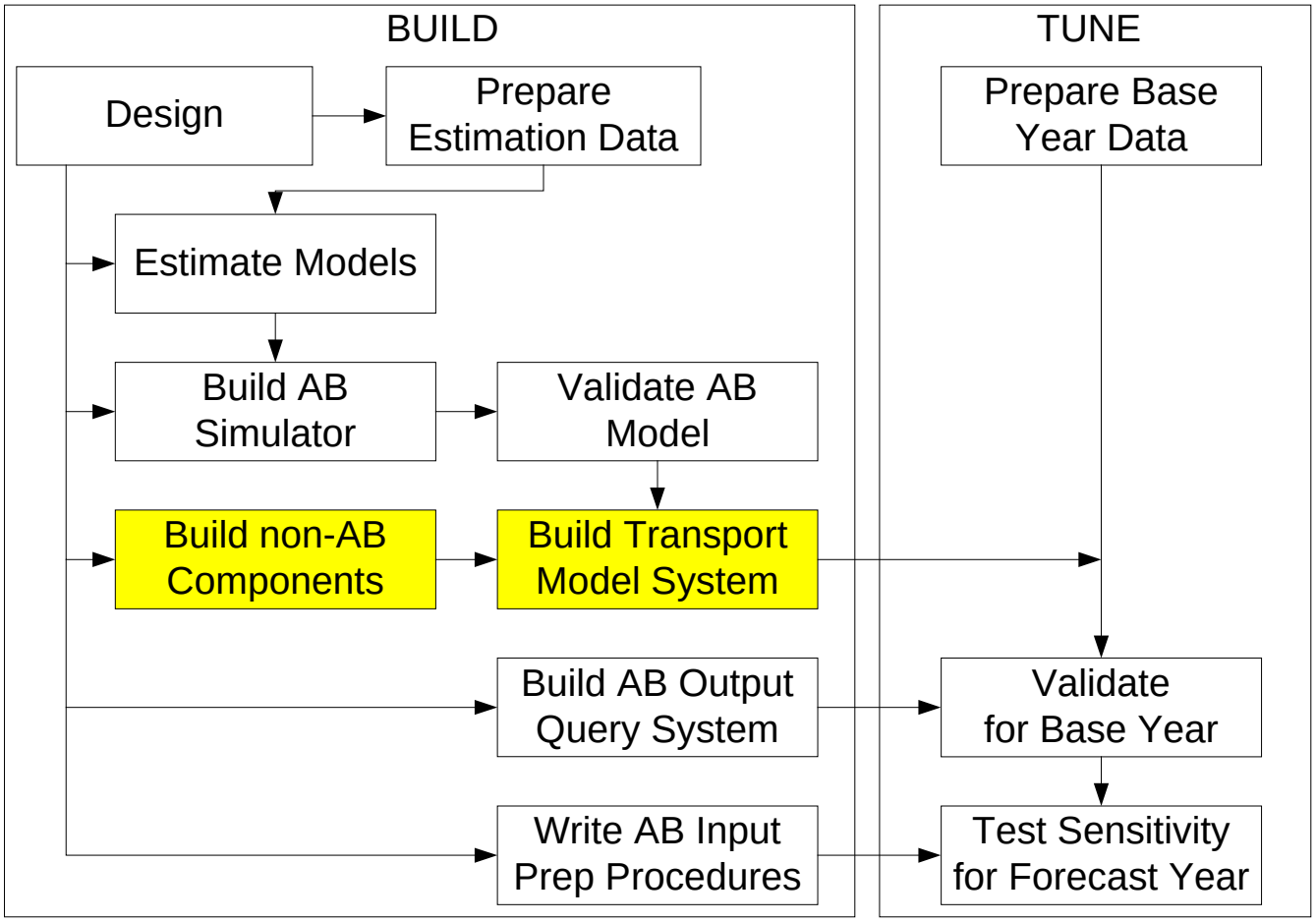
Development Roles
Trip-based Model Expert



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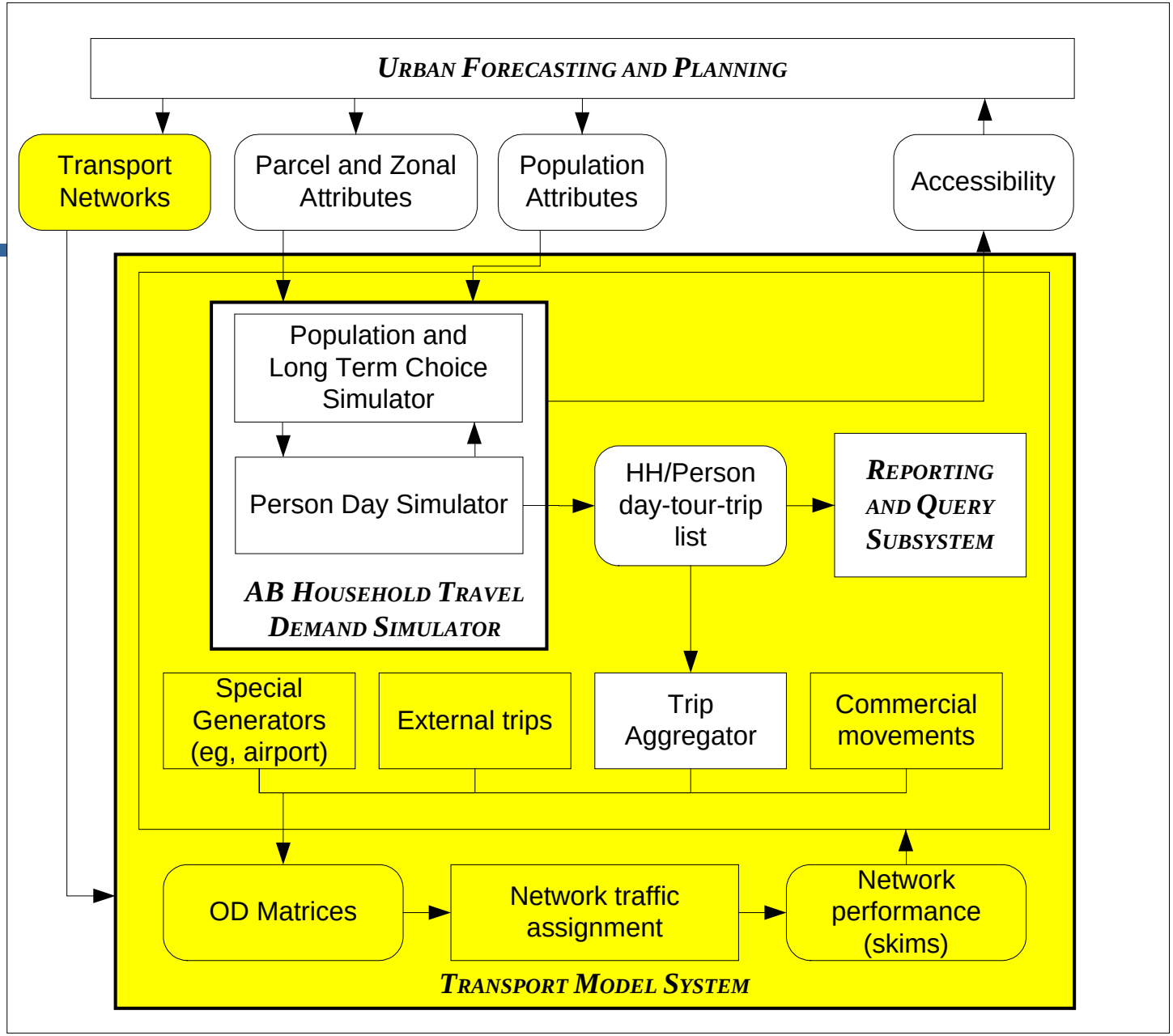

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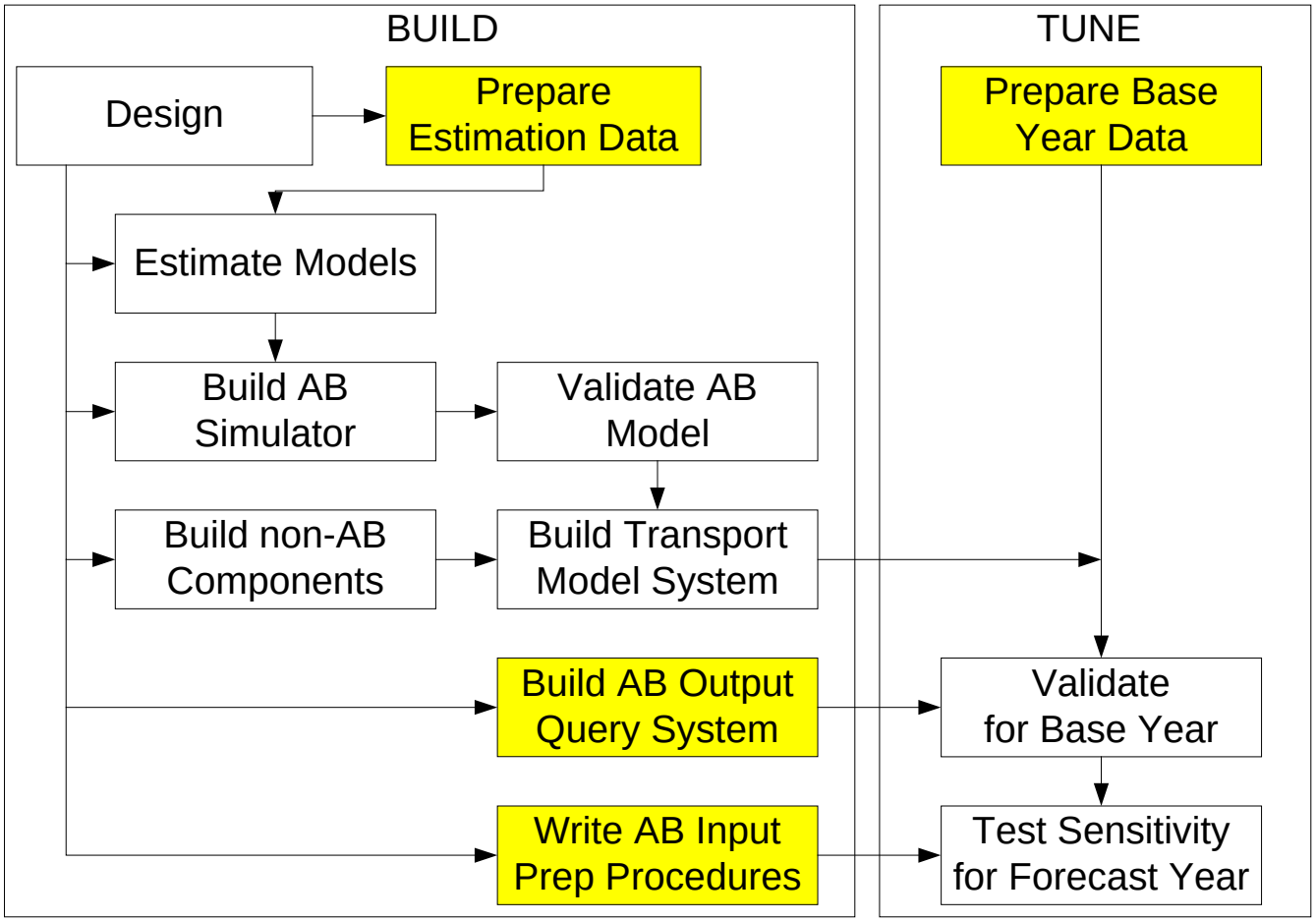
Development Roles
GIS/DB/GUI Expert(s)



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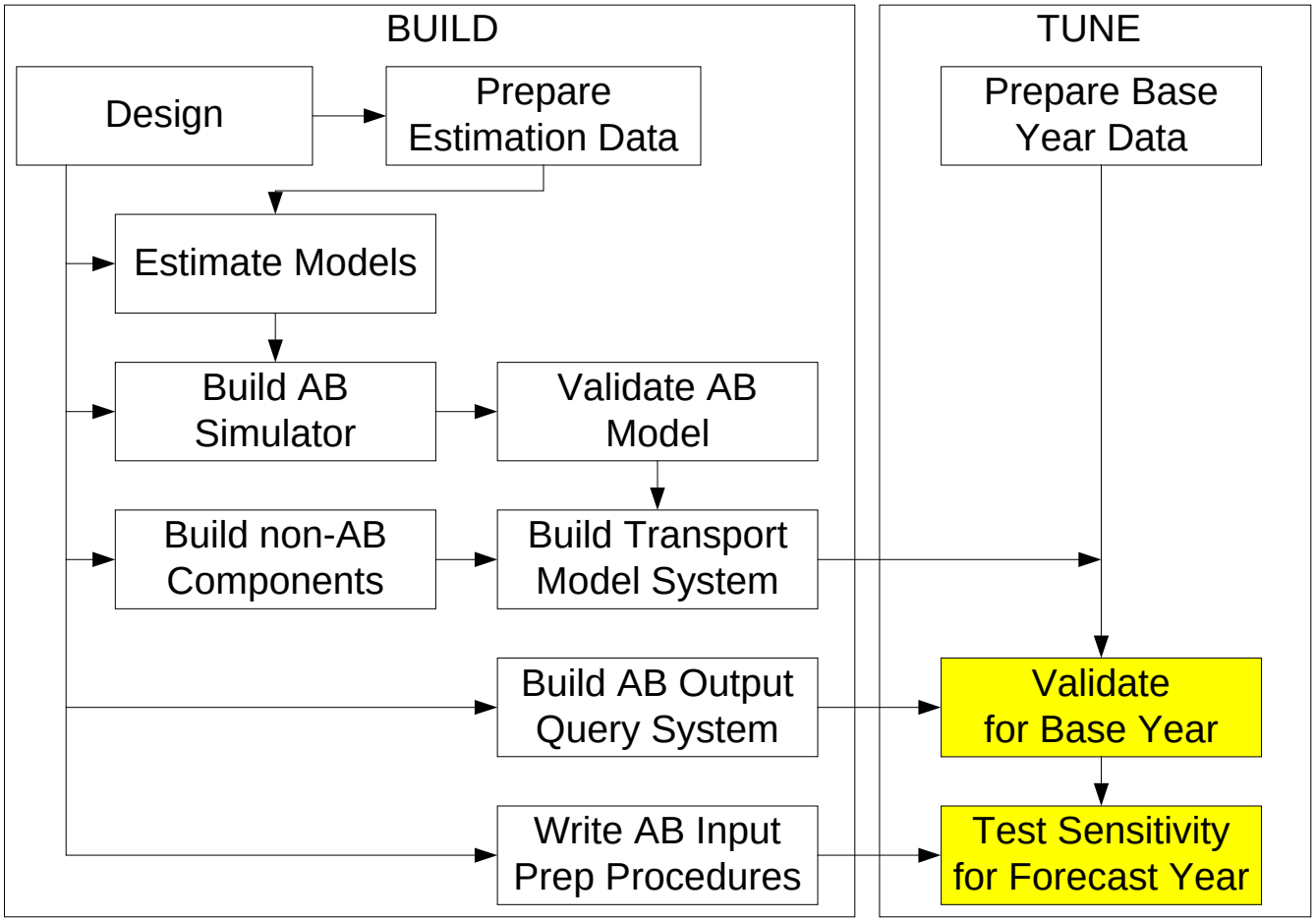
Development Roles
Application Expert



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Consultant Role for All Models Now In Use

- AB developer
  - design
  - survey data prep
  - model estimation
  - AB software
- Other roles as needed
- Involvement after implementation

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DRCOG: Agency is sharing AB Developer Role

- AB developer
  - design—**assist**
  - model estimation—**estimate a few**
  - survey data prep—**augment**
  - AB software—**principal developer**

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Primary Definition of Success

- Model system got fully **implemented**
- Model was implemented consistently with a **sound** design
- Model continues to be **used** for its intended purpose

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Additional Aspects of Success

- Cost effective development
- Timely development
- Useful innovation
- Provides a foundation for ongoing enhancements

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Management
Keys to Success

- A sound design
- Capable innovative developers
- Sustained sponsorship

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Keys to Success
1. A Sound Design

- Workable framework
- Completed up front
- Comprehensive and Integrated
- Implemented consistently

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Workable Design Framework

- Example: Metro started with successful MIT prototype
- What it gives
  - Soundness
  - Vision
  - Confidence
  - Something to build upon

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Management
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Keys to Success
2. Capable Innovative Developers

- AB Developer
- Trip-Based Model Expert
- GIS/DB/GUI Expert(s)
- Application Expert

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Keys to Success
2. Capable Innovative Developers

- What it gives
  - Technical soundness
  - Innovation
  - Usability and usefulness
  - Follow through

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Keys to Success
2. Capable Innovative Developers

- What it gives
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  - Innovation
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  - Follow through

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Management Keys to Success

- A sound design
- Capable innovative developers
- Sustained sponsorship

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Keys to Success
3. Sustained Sponsorship

- Gives: stream of funds
- Requires:
  - Sponsor motivation
  - Instigating Advocate
  - Internal Champion

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Keys to Success
3. Sustained Sponsorship

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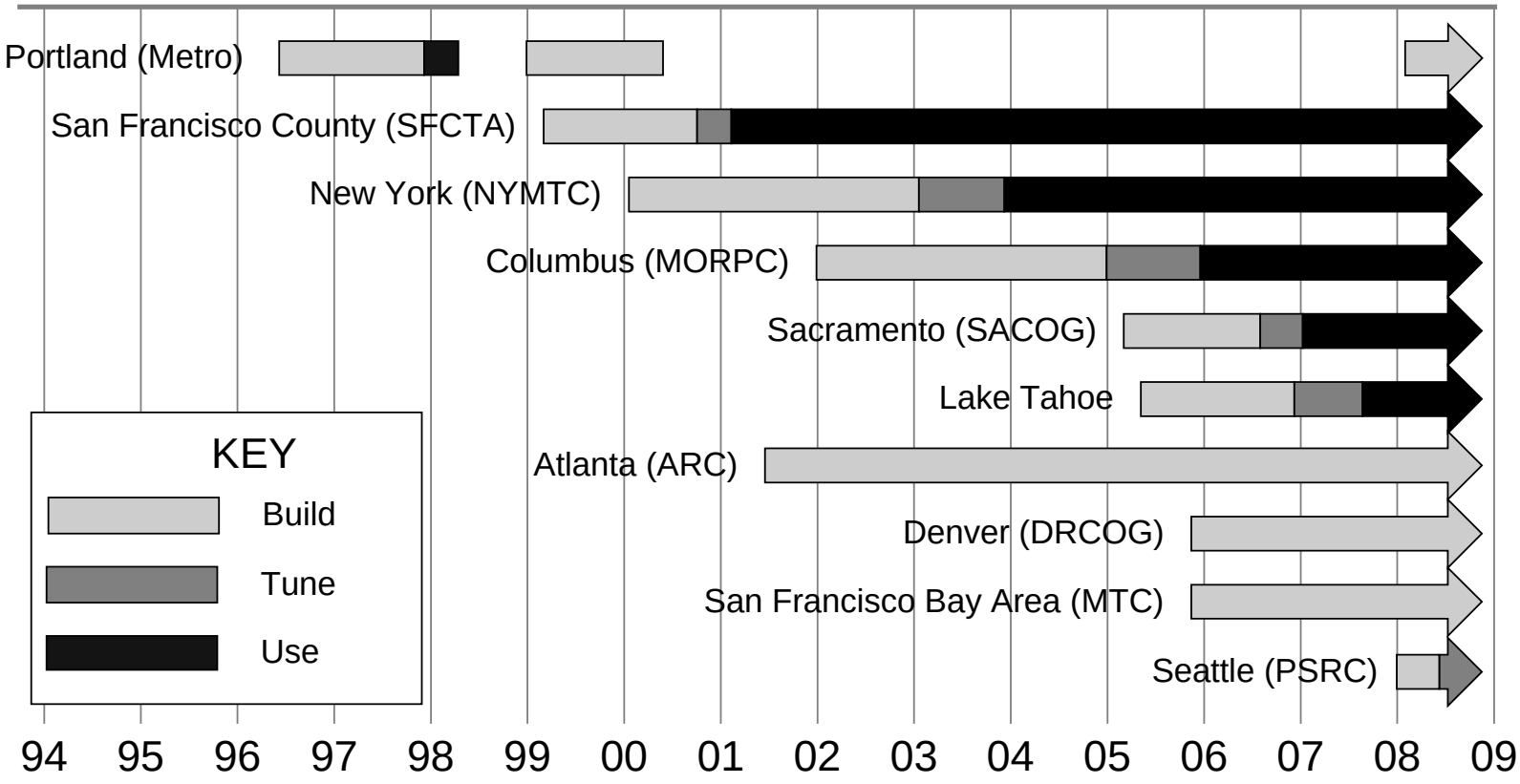
Sustained Sponsorship Counter-examples



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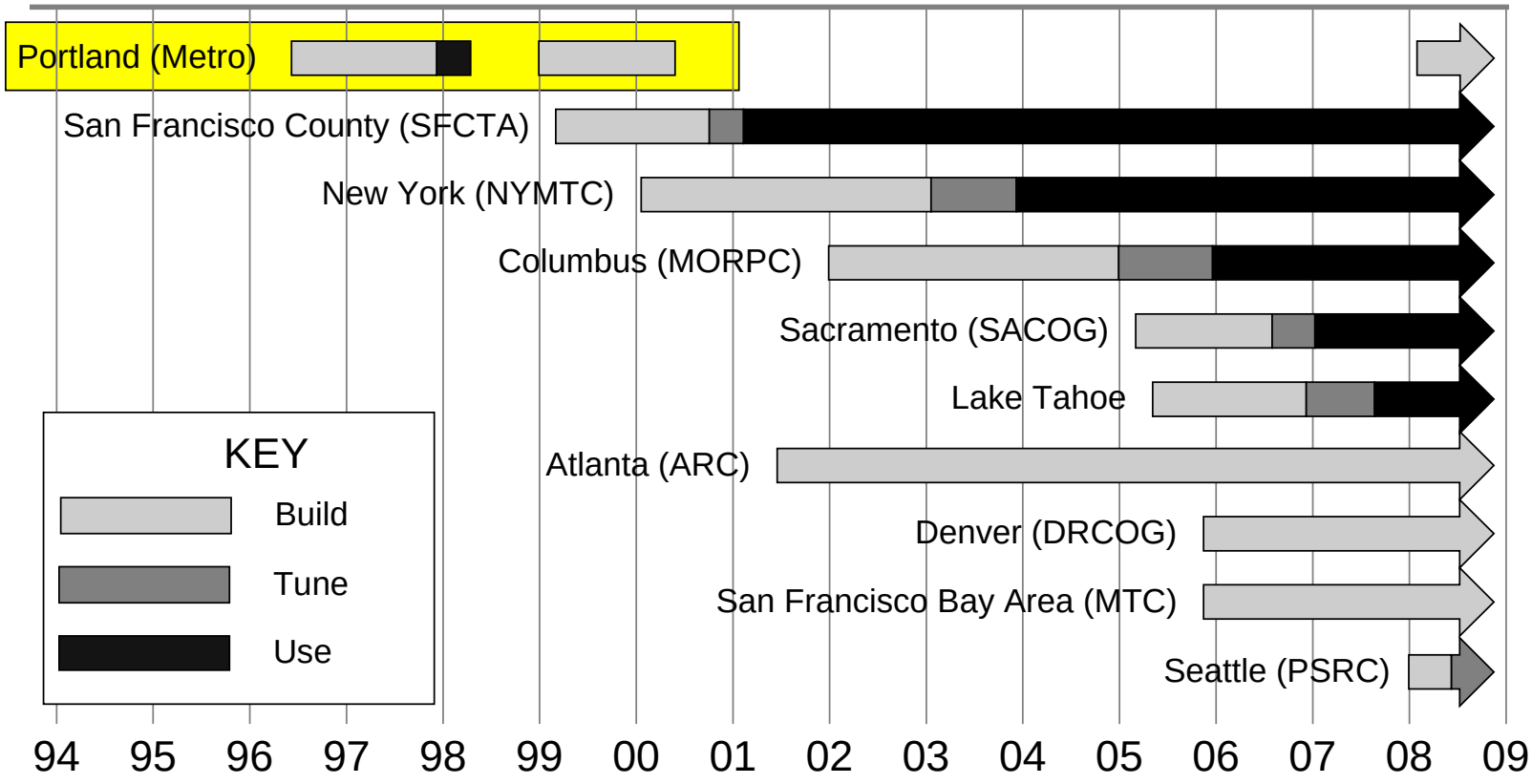
Why didn't Metro keep using their model?



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Why didn't Metro keep using their model?

- Lost Sponsorship
  - MPO struggling financially
  - Federal funds for TranSIMS
  - No money for calibration & validation

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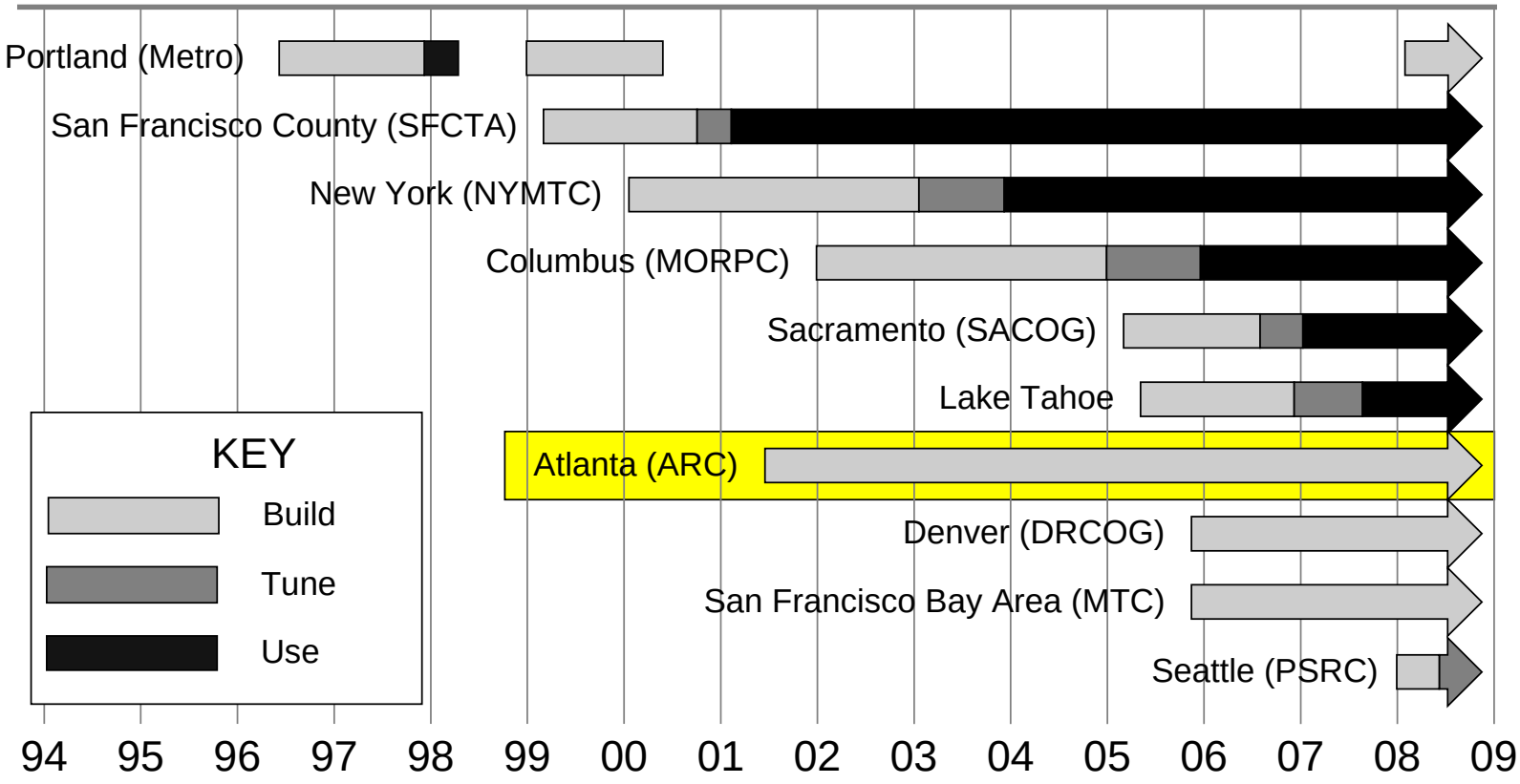
Why is it taking ARC so long?



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Why is it taking ARC so long?

- Sponsorship
  - ARC chose to invest at a slow rate
  - Expanded region from 13 to 20 counties
  - Commitment to implement the models didn't occur until early 2008

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Management
Keys to Success

- A sound design
- Capable innovative developers
- **Sustained sponsorship**

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Outline

- Activity-Based (AB) Model System
- Development Tasks
- Basic Build Approaches
- Development Roles
- Management Keys to Success
- Postscript—A Few Suggestions

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A Few Suggestions for CMAP

1. Adapt

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A Few Suggestions for CMAP

1. Adapt
2. Don’t wait on your HH survey data

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A Few Suggestions for CMAP

1. Adapt
2. Don’t wait on your HH survey data
3. Seriously consider parcel data

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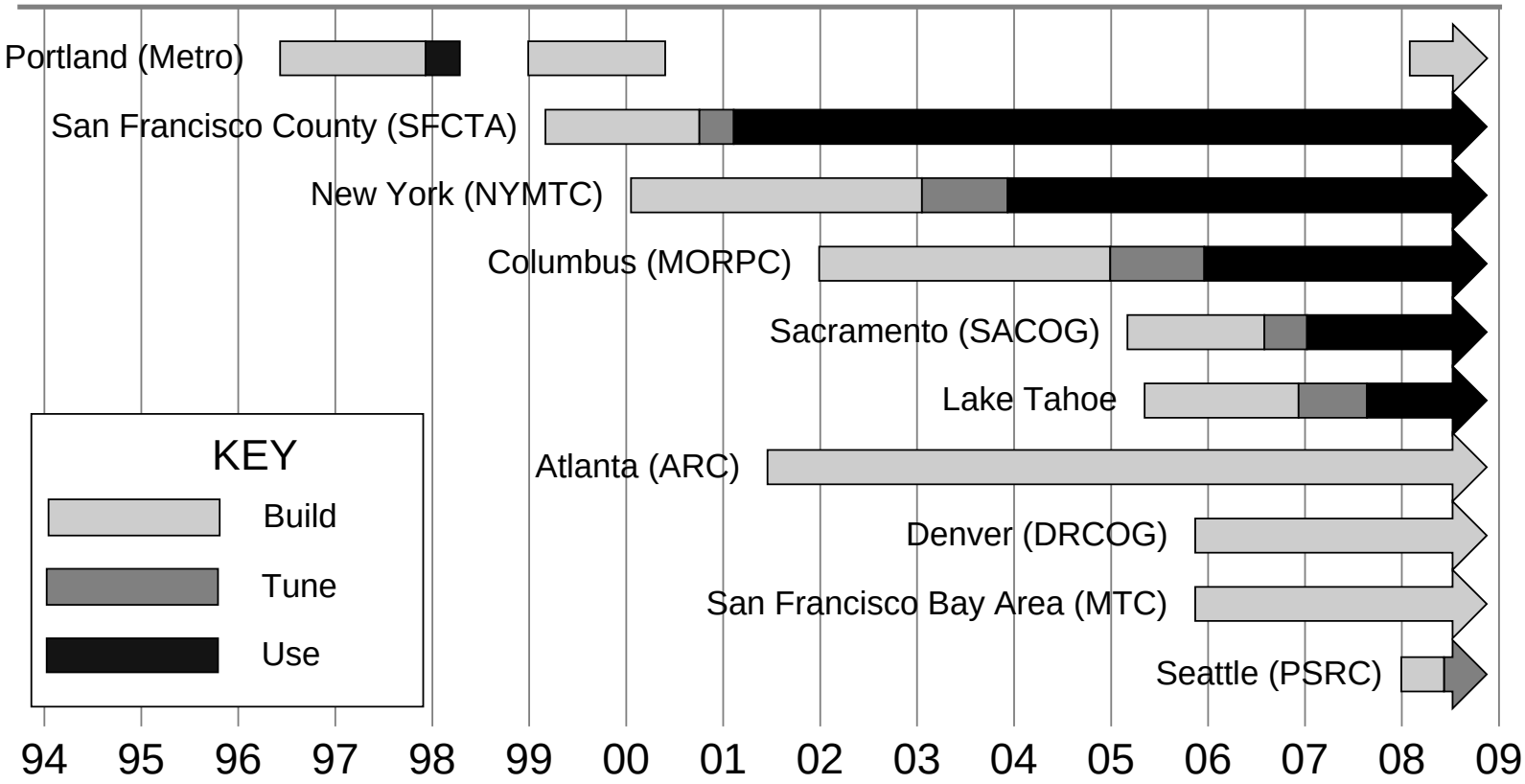
U.S. Projects



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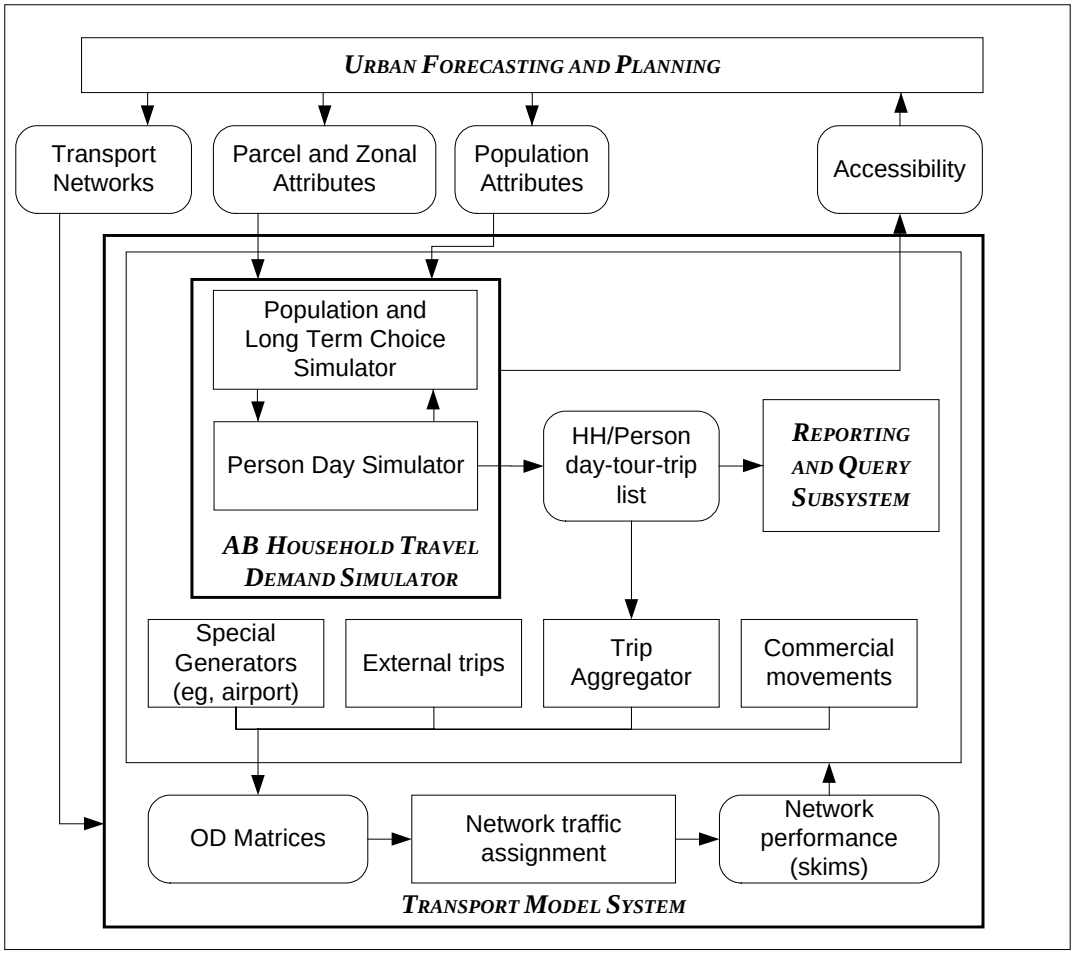
Activity-Based Model System



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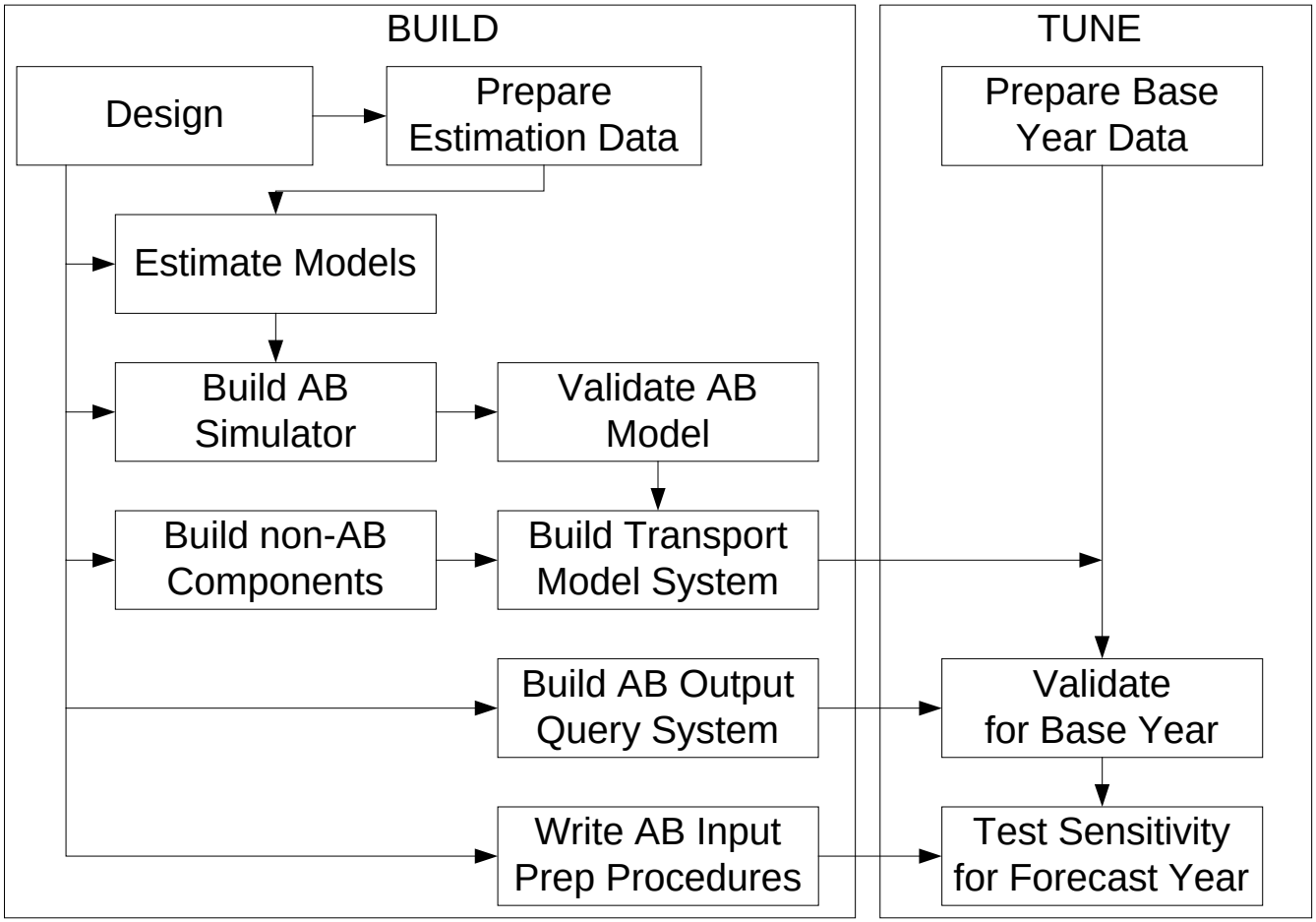
The Tasks



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Basic Build Approaches

- Invent
- Adapt
- Adopt

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Development Roles

- AB Developer
- Trip-Based Model Expert
- GIS/DB/GUI Expert(s)
- Application Expert

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