TMIP Webinar Series

Activity-Based Modeling

Session 11: Network Integration

The Travel Model Improvement Program

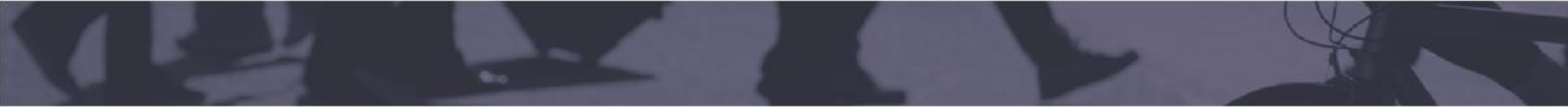
Speakers: Joe Castiglione and Peter Vovsha

August 30, 2012

Acknowledgments

This presentation was prepared through the collaborative efforts of Resource Systems Group, Inc. and Parsons Brinckerhoff.

– Presenters
    • Joe Castiglione and Peter Vovsha
– Moderator
    • John Gliebe
– Content Development, Review and Editing
    • Joe Castiglione, Peter Vovsha, John Gliebe, Jason Chen, Joel Freedman, Rosella Picado, John Bowman, Mark Bradley
– Media Production
    • Bhargava Sana



2012 Activity-Based Modeling Webinar Series

Executive and Management Sessions	
Executive Perspective	February 2
Institutional Topics for Managers	February 23
Technical Issues for Managers	March 15
Technical Sessions	
Activity-Based Model Framework	April 5
Population Synthesis and Household Evolution	April 26
Accessibility and Treatment of Space	May 17
Long-Term and Medium Term Mobility Models	June 7
Activity Pattern Generation	June 28
Scheduling and Time of Day Choice	July 19
Tour and Trip Mode, Intermediate Stop Location	August 9
Network Integration	**August 30**
Forecasting, Performance Measures and Software	September 20

Learning Outcomes

- What is network integration?
- Why is network integration important?
- How is network integration achieved?
- What is different about network integration with activity-based models?
- What are the benefits, costs and key challenges of network integration with activity-based models?
- What are emerging practices in network integration?

What do we mean by network integration?

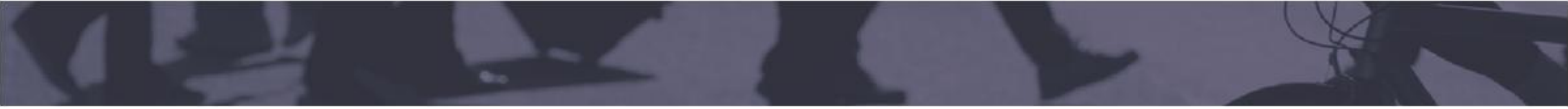
- A desired outcome:
  - Network-derived level of service variables used to predict destination, mode, and trip timing decisions are consistent with the level of service predicted by the network assignment
- A system of program structures carefully designed to achieve this outcome
  - Decision modules, variable specifications, data structures, procedures

Outline

- Basic terminology
- Why network integration is important
- Where network integration fits into travel model systems
- Theory and model formulation
- Data sources
- Benefits and costs of network integration
- Ongoing research
- Questions and Answers

Terminology

- Demand Models
- Supply Models
- Feedback
- Convergence
- Equilibrium



Demand Models

- Predict dimensions of travel demand (activity generation, destination, mode)
- Comprised of linked demand model components
- May be applied at aggregate (zones) or disaggregate levels (persons, HHs)
- Transportation supply availability and network performance variables derived from supply model may appear in the utility expressions of any of these components
- Accessibility variables (simplified log-sums) typically used to represent complex hierarchical travel choices
- Model components interact, causing second-order effects on model components that do not use network variables directly

Network / Supply Models

- Represent system capacity and level of service under different levels of congestion
- Require details of demand (location, timing, mode) from demand model
- Network structures composed of links and nodes, with demand loading points
- Link performance functions estimate congested travel times
- Tolls – convert monetary cost to travel time using value of time estimates and add to link travel times

Feedback

- Use of outputs from a later ("lower") model component as input into an earlier ("higher") model component
- Intended to ensure that the final model outputs are consistent with the model system inputs and assumptions
- Extent of feedback and equilibration rules relate to structure of model
- Necessary in both traditional trip-based models as well as activity-based models

Convergence & Equilibrium

- Convergence necessary to
  - Ensure behavioral integrity of the model system
  - Achieve consistent and repeatable results
- Two types of convergence in model system
  - …to an equilibrium condition (network convergence)
  - …to a stable condition (system convergence)
- System convergence is predicated on network convergence

Importance of Network Integration

- Behavioral
  - Demand patterns produce supply cost
  - Supply costs influence demand patterns
- Structural
  - Demand models results are input to supply model
  - Supply model results are input to demand model
- Practical
  - Policy/investment choices must be informed by stable, repeatable results
  - Exchange of consistent information required to produce stable, repeatable results

Repeatable & Stable Results

- Repeated application of the same model and inputs results in same outcomes, within an acceptable range
- Results **SHOULD**:
  - Reflect meaningful differences in input assumptions
- Results **SHOULD NOT**:
  - Depend on network starting conditions
  - Oscillate between multiple outcomes with decision-making consequences
  - Reflect model errors or other sources of randomness pertinent to microsimulation
- Influenced by
  - Demand model methods
  - Supply model methods
  - Model integration methods

Consistent Representation of Choices

- Complex policy questions require simultaneous consideration of demand and supply conditions
  - Capacity improvements (release latent demand?)
  - HOV lanes, tolling, and time-varying congesting pricing
  - TDM policies, such as flexible work schedules
  - Transit-oriented land use / compact growth
- Need to ensure that
  - Change in network performance produces a theoretically plausible response in demand
  - Change in demand produces a theoretically plausible response in network performance
- Requires consistent representation of choices

Maintain Budgets & Constraints

- No "extreme" behavior prevails
- Examples to avoid
  - many people coming home really late… or working very short days
  - transferring 3 times… or walking long distances after disembarking from transit
  - leaving young children stranded at school… or home alone
- Faithful to calibration targets

Bridge Expansion Example

- No Build Alternative
  - 4 lanes (2 in each direction, no occupancy restrictions)
  - No tolls
  - Regional transit prices do not change by time of day
- Build Alternative(s)
  - Add 1 lane in each direction (total of 6)
  - New lanes will be HOV (peak period or all day?)
  - Tolling (flat rate or time/congestion-based)
  - Regional transit fares priced higher during peak periods

Bridge Expansion Mobility Effects

Vehicle ownership may decrease with tolls or new HOV and transit options

New school locations may be possible due to changes in traffic using the new bridge

Work location may change due to tolls or new HOV and transit lanes

Vehicle type may change to take advantage of fuel efficient vehicle toll red

Owning a transponder may encourage more use of the bridge

Owning a transit pass may increase with new transit lanes

Bridge Expansion Short Term Effects

- New destinations for purposes such as shopping and personal business may occur in response to tolls, fares, congestion levels
- Different modes of travel may be selected, with people taking advantage of newly available HOV lanes, choosing (or not) to pay tolls and different transit fares
- Travel by time-of-day may change, reflecting tradeoffs between tolls/fares and travel times
- Different routes may be used, reflecting tradeoffs between tolls/fares and travel times

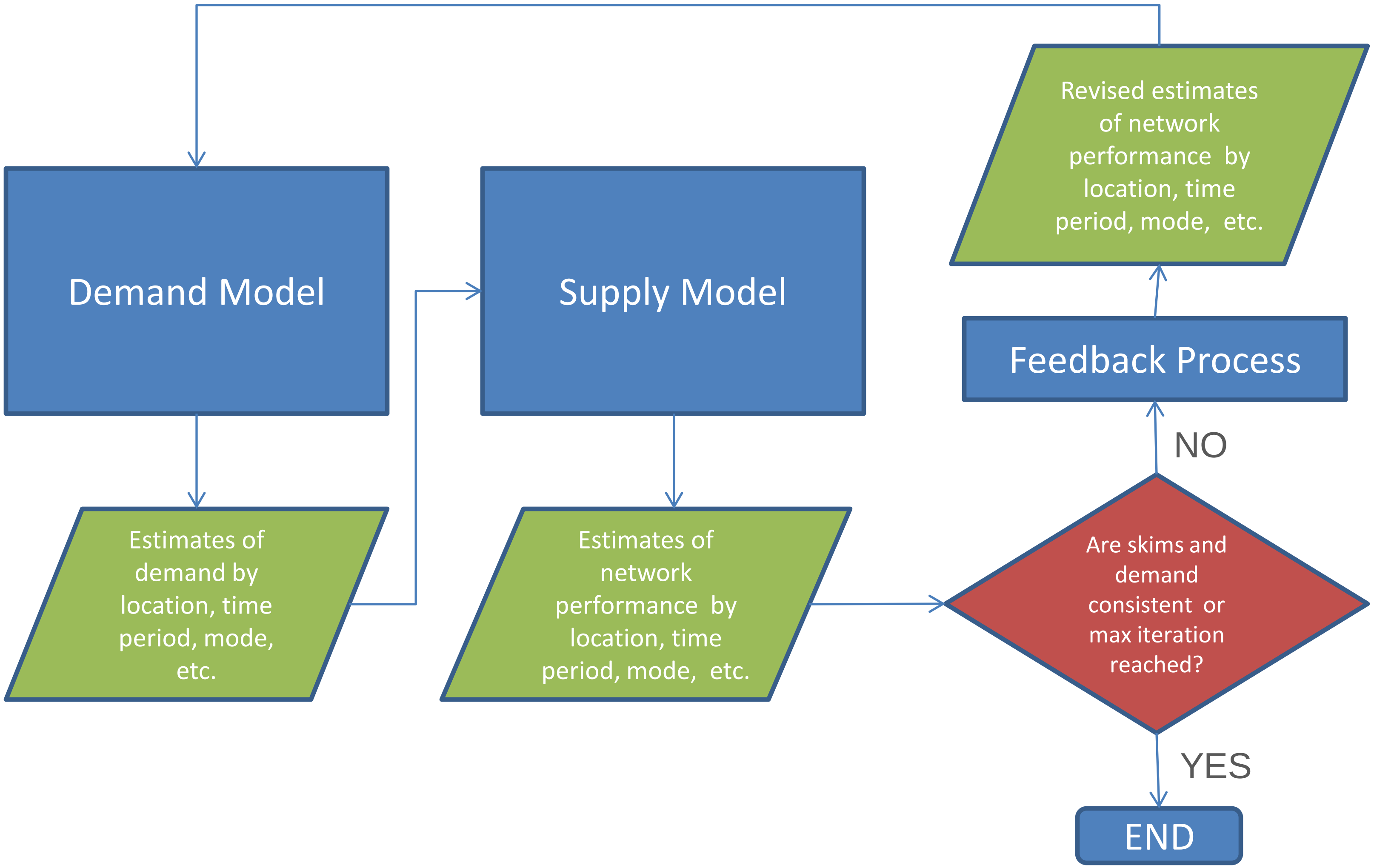
Bridge Expansion Network Integration Issues

- Demand model
  - Accessibility measures reflect changes by time-of-day and incorporating all modes
  - Temporal resolution detailed enough to represent policies and consistent with network performance by time-of-day information from supply model
  - Modal resolution of model to capture differences in SOV/HOV, free/toll
  - Behavioral resolution of the model to be sensitive to different responses to congestion/tolls/fares dependent on different values of time (purpose, income)
- Supply model
  - Roadway and transit network coding by time-of-day to reflect changes in modal availability and costs, and addressing key issues such as directionality by TOD
  - Assignment and skim processes that reflects variations in times and costs by time-of-day, segmentation by mode (SOV/HOV, toll/free), and market (VOT class)
- Integration
  - Data exchange
  - Feedback / iteration

Integrated Model System Components

- Demand Models
  - Activity generation and scheduling (timing, location, mode)
- Supply Models
  - Highway and transit assignment, traffic simulation by time periods
- Integration / Connectors
  - Feedback loops, convergence monitoring

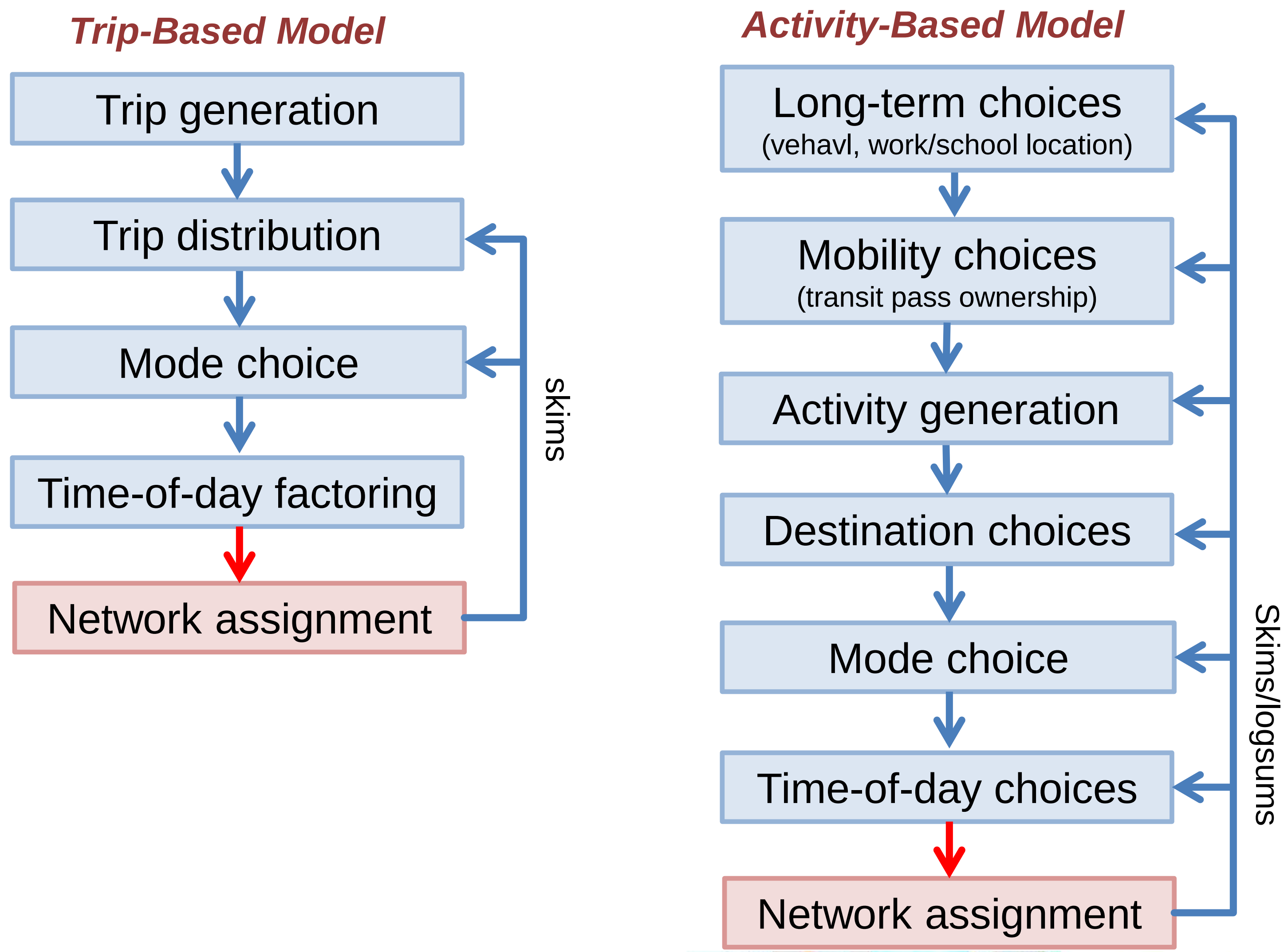
Typical Integrated Model System Flow



More Choice Dimensions

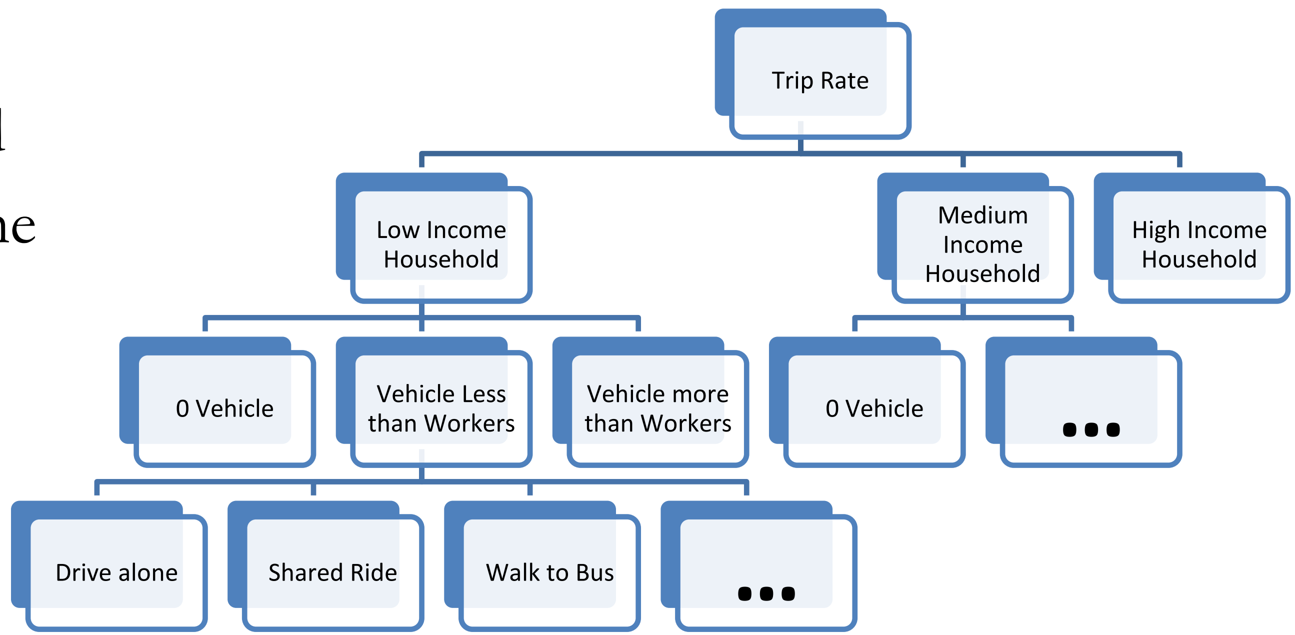
- More model system components
  - Activity generation
  - Tour and stop location
  - Tour and trip mode
  - Time-of-day
- System components are more complex
  - Incorporate constraints (time of day, mode)
  - Incorporate fine-grained resolution (behavioral, temporal, spatial)
- Linkages amounted system components are more detailed
  - Types of information
  - Amount of information

Demand Model ➔ Network Supply Model



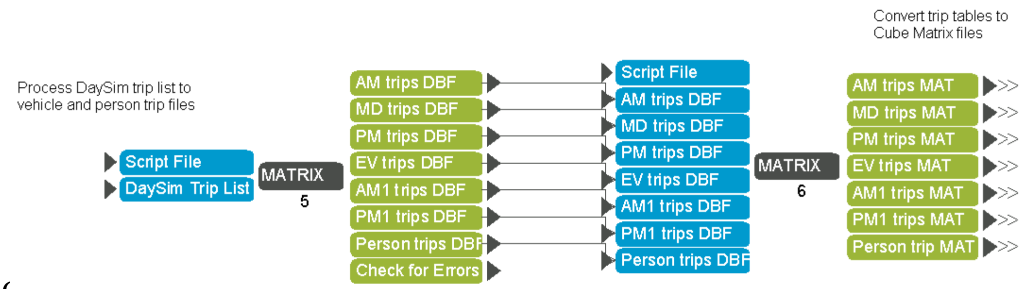
Market Segmentation

- Overall travel market is comprised of submarkets
- Activity-based models provide more flexibility and efficiency in handling market segmentation
- Submarkets are differentiated by key attributes, such as:
  - Mode
  - Time-period
  - Value-of-time



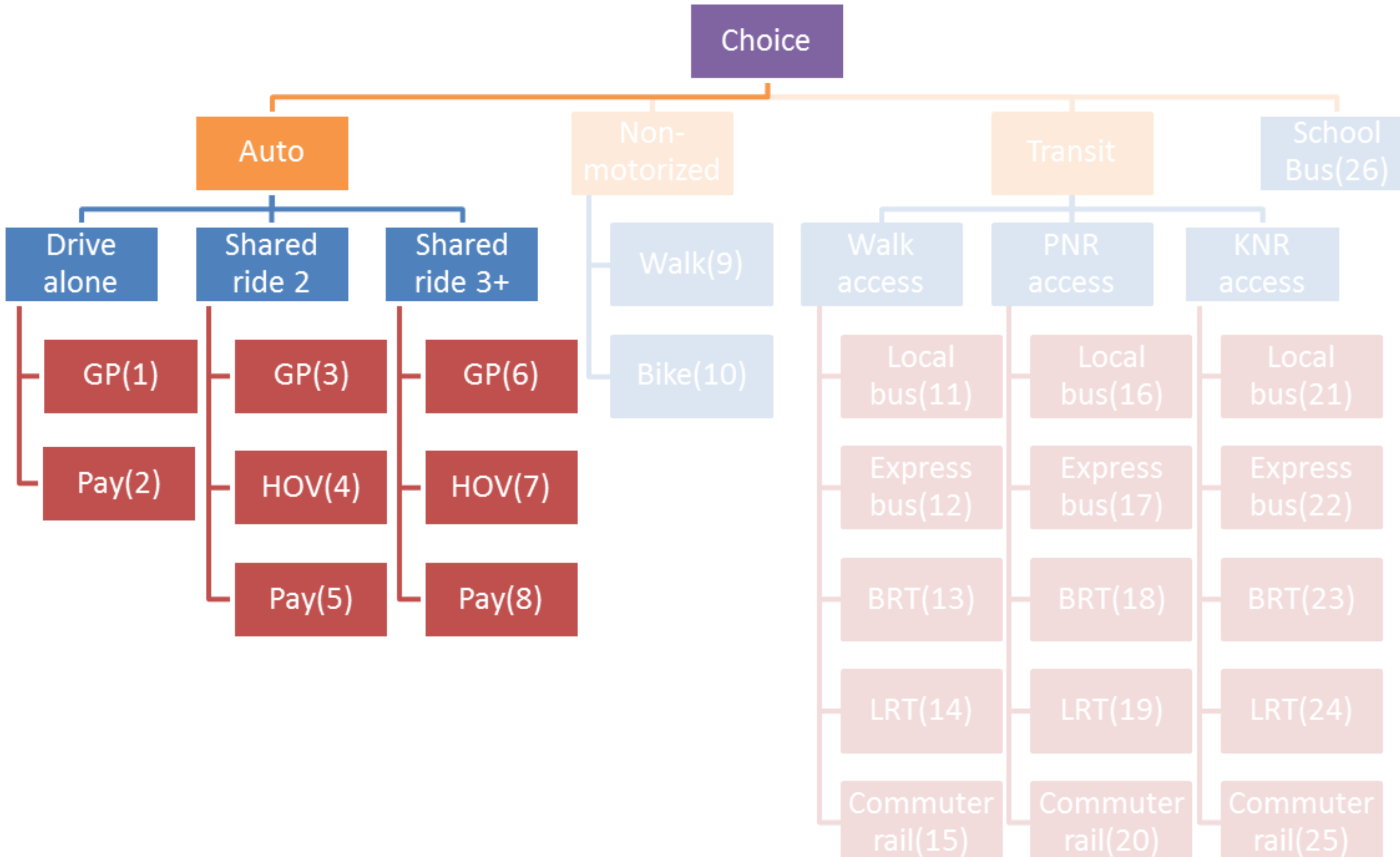
Activity Trip Lists & Segmentation

- Trip tables not produced until assignment step, more flexibly specified
- Trip lists may be converted to trip tables by aggregating over multiple dimensions
  - Time of day
  - Activity types
  - Person types
  - occupancy class
  - Transit submode /access mo
  - Other… EZ pass, transit and parking pass holders, etc.

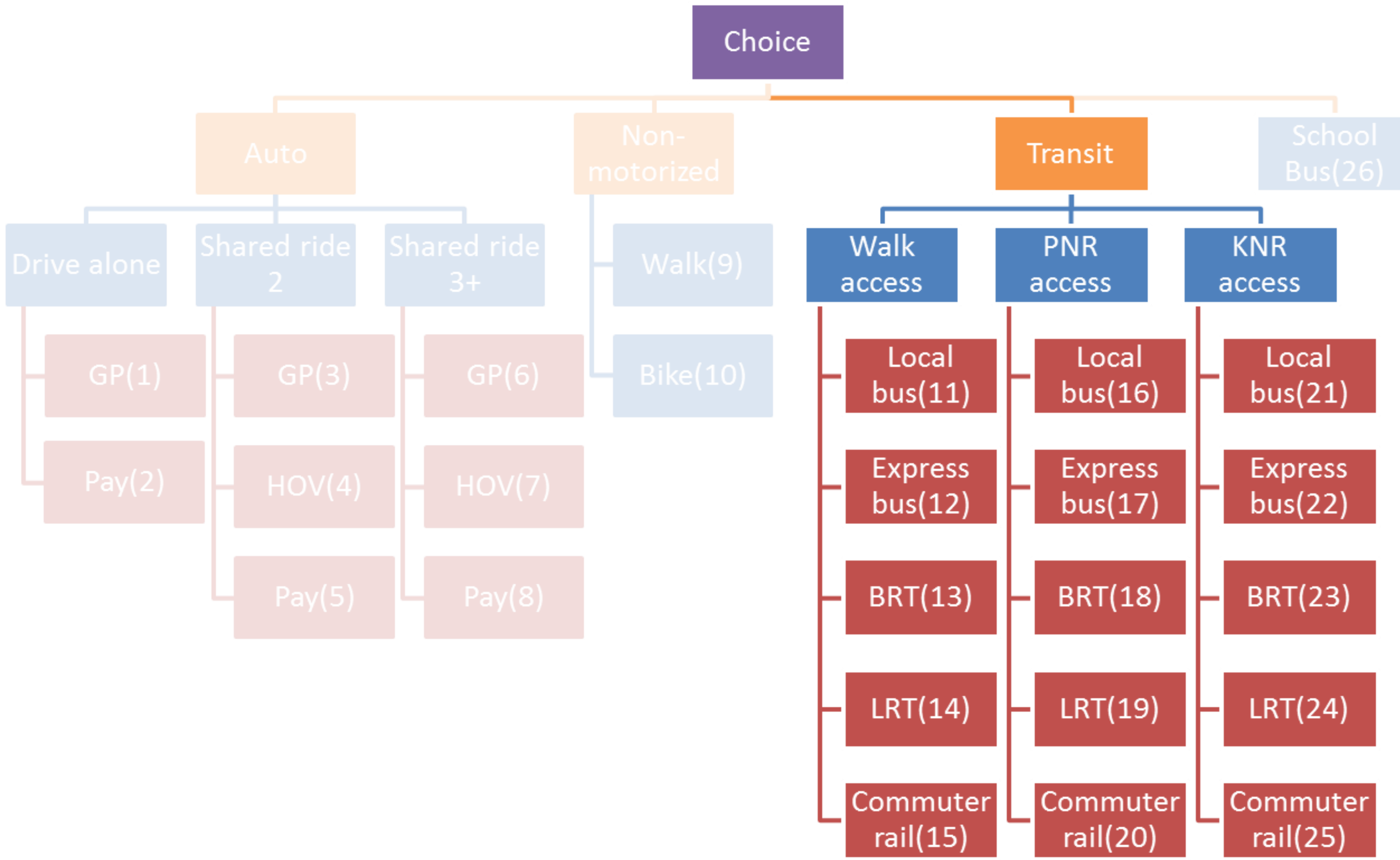


id	tour_id	hhno	pno	day	tour	half	tseg	tsvid	opurp	dpurp	oadtyp	dadtyp	opcl	otaz	dpcl	dtaz	mode	pathtype	dorp	deptm
1	1	1	1	1	1	1	1	0	0	5	1	4	2	101	4349	513	4	1	2	787
2	1	1	1	1	1	2	1	0	5	5	4	4	4349	513	3258	434	4	1	2	886
3	1	1	1	1	1	2	2	0	5	0	4	1	3258	434	2	101	4	1	2	979
4	2	2	1	1	1	1	1	0	0	1	1	4	2	101	37564	4352	3	1	1	399
5	2	2	1	1	1	2	1	0	1	0	4	1	37564	4352	2	101	3	1	1	1037
6	3	3	1	1	1	1	1	0	0	1	1	2	13	101	203	110	3	1	1	488

Highway Market Segmentation



Transit Market Segmentation



Questions and Answers

The Travel Model Improvement Program

Network Performance (LOS) Measures in Activity-Based Model Components

- Auto ownership and other mobility attributes
- Activity pattern generation
- Destination and mode/occupancy choice
- Time of day choice
- Intra-household joint tour frequency choice

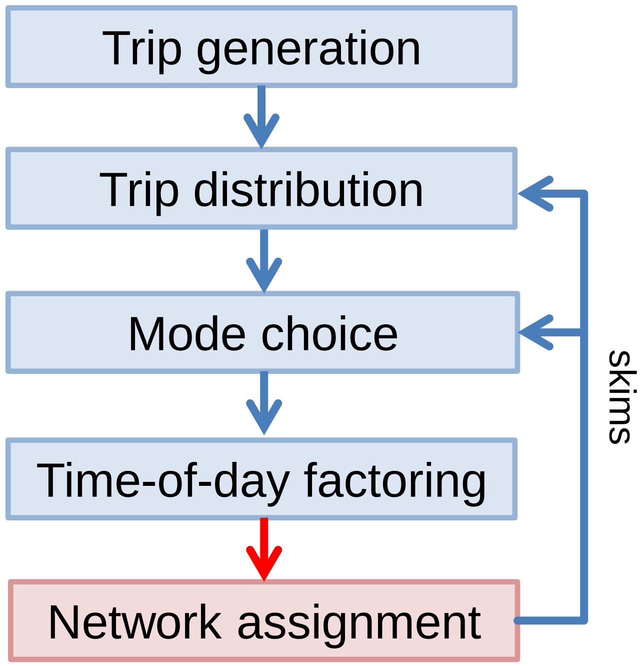
Trip-based Assignment/Skim Time Periods

- Minimum assignment periods (small urban areas)
  - AM Peak and/or PM Peak highway assignment (2-3 hours of demand)
    - Sometimes transposing one to represent the other
  - Mid-day off-peak highway assignment (5-6 hours of demand)
  - Often no transit assignment, or AM Peak only
  - No non-motorized assignment
- More typical assignment periods (medium-large urban areas)
  - AM Peak, PM Peak, Mid-day off-peak highway assignment
  - Sometimes evening off-peak highway assignment
  - Peak/Off-peak transit assignment
    - AM peak transposed to represent PM peak
  - No non-motorized assignment

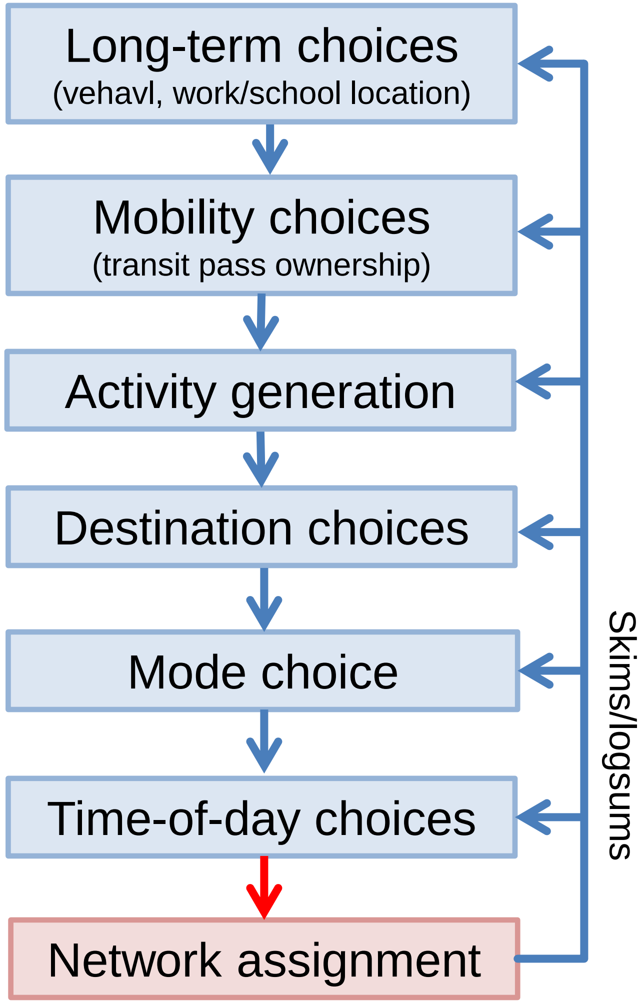
Assignment /Skim Time Periods

- Ideally, want time period resolution to be consistent across demand and network supply components, but challenges with:
  - Generating, storing, accessing large LOS matrices
  - Using small time periods with static assignment (DTA better)
- More detailed assignment and skim periods provide better model sensitivity
- Time period definitions should reflect potential policy applications
  - Consideration of variable tolls, reversible lanes, transit service differentials
- Function of network size, complexity, population/demand
  - Larger areas, more complex systems – congestion spreading across longer time periods

Modules & Feedback Pathways – 4 Step



Modules & Feedback Pathways – ABM



Assignment/Skim Segmentation Examples

- SFCTA
  - 6 time periods used in skimming and assignment (temporal resolution of the demand component are same broad time periods)
  - Detailed auto and transit sub-modes
  - Detailed zone structure
- CMAP
  - 8 time periods used in assignment and skimming (temporal resolution of demand component is half-hour)
  - Detailed auto and transit sub-modes
- SACOG
  - 12 time periods in skimming and assignment (temporal resolution of model is half-hour)
  - Detailed auto and transit submodes
  - Network skimming and assignment at zone level, enhanced with parcel-level geographic information

More Assignment Strategies

- Multiple time periods representing AM/PM Peaks, shoulders before and after peaks, evening off-peaks, overnight off-peaks
  - CMAP (8 time periods)
- Multiple transit assignment periods--AM Peak, PM Peak, Mid-day
  - NYMTC (4 periods parallel to highway assignments)
  - CMAP (8 periods parallel to highway assignments)
- Non-motorized assignment first attempts:
  - SFCTA & Portland
- VOT classes in addition to vehicle type and occupancy
  - CMAP Pricing ABM

CMAP Multi-Class Assignment Classes

Vehicle Type & Value-Of-Time	Non-toll SOV	Non-toll HOV2	Non-toll HOV3+	Toll SOV	Toll HOV2	Toll HOV3+
Auto + external + airport low VOT	1	3	5	2	4	6
Auto + external + airport high VOT	7	9	11	8	10	12
Commercial	13			14		
Light truck	15			16		
Medium truck	17			18		
Heavy truck	19			20		

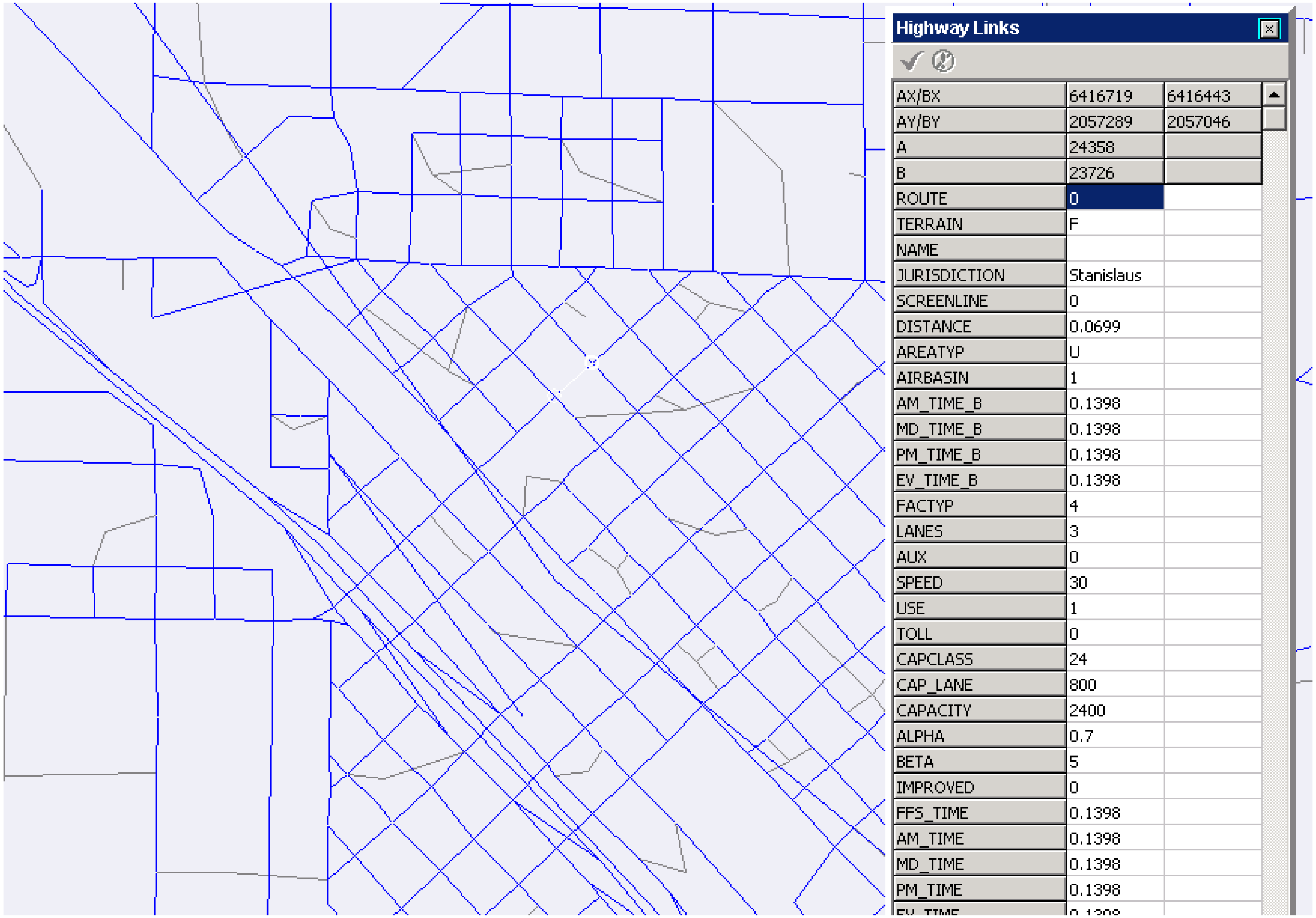
Differences in Accessing Skim Information

- Trip-based models access skims in limited ways-usually just destination and mode choice; time of day choice if present
  - Matrix processing enables efficient access of skim values for large batches of trips in a single operation (full OD loop)
- Activity-based models are based on individual micro-simulation
  - Rather than looping on all ODs for skim access and use, need selected skims within the loop over millions of individual records
  - Many more model components use skims
  - Computationally challenging
    - Much greater memory requirements with efficient random access
    - Some pre-computing of accessibility log-sums necessary

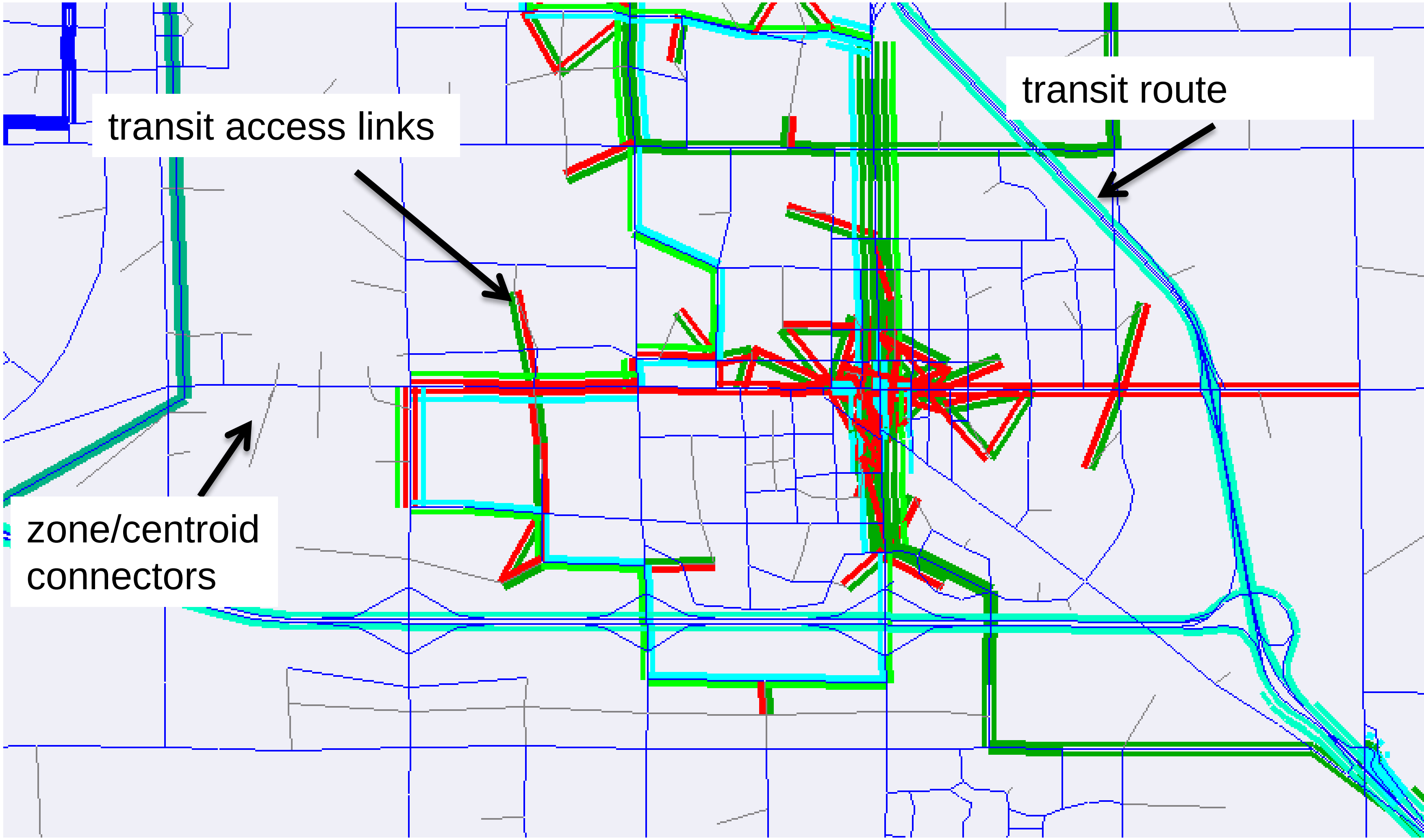
Input Data Source Needs

- Consistent treatment of time and space in ABMs reflects realistic availability constraints
- Need data on changes in network supply by time-of-day
  - HOV lane status
  - Reversible lanes
  - Variable road pricing
  - Transit service headways, fares and coverage
- Maintaining roadway supply by time-of-day is relatively straightforward
- Maintaining transit supply by time-of-day can be onerous, and simplifying assumptions frequently made (i.e. PM supply impedances are a transpose of AM)
- New promising sources of network information and technologies (NavTech, GoogleTransit)

Roadway Network Structures



Transit Network Structures



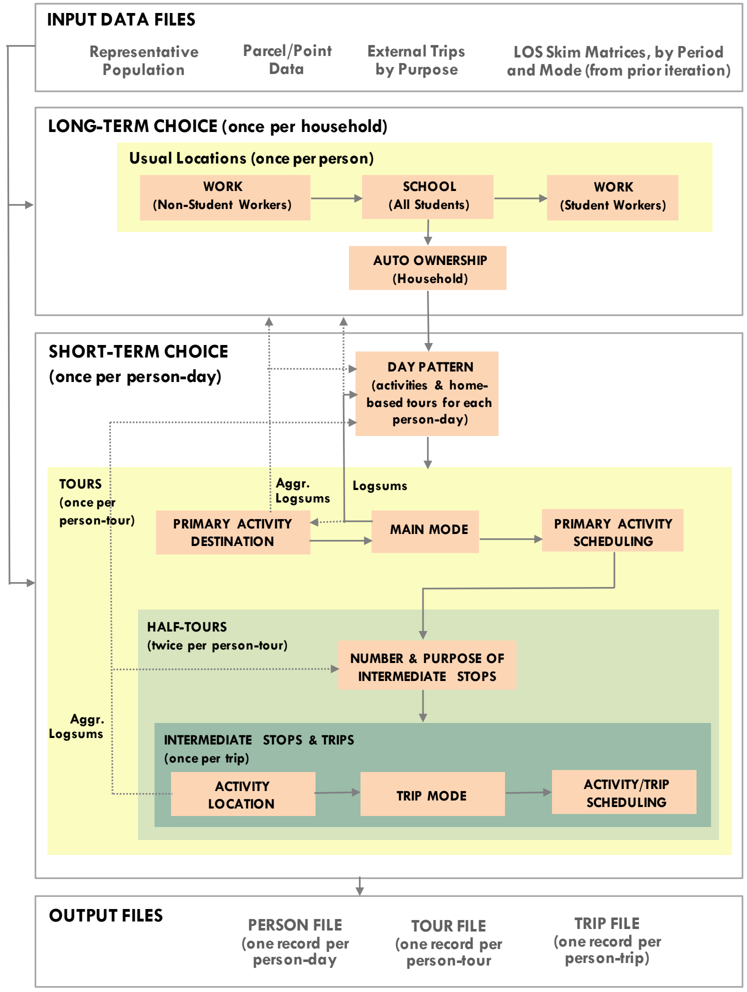
Network Validation Needs

- Network supply model outputs
  - Level of service skims
  - Link volumes / speeds / times
- Calibration / validation needs
  - Good data coverage critical
  - More temporal detail, possibly more spatial, vehicle class, facility type detail
- Similar measures to trip-based models
  - Counts, screenlines
  - VMT / VHT
  - Speeds, travel times – archived ITS data
  - Transit boardings / alightings
  - Transit ridership by line
- Parking lot utilization rates

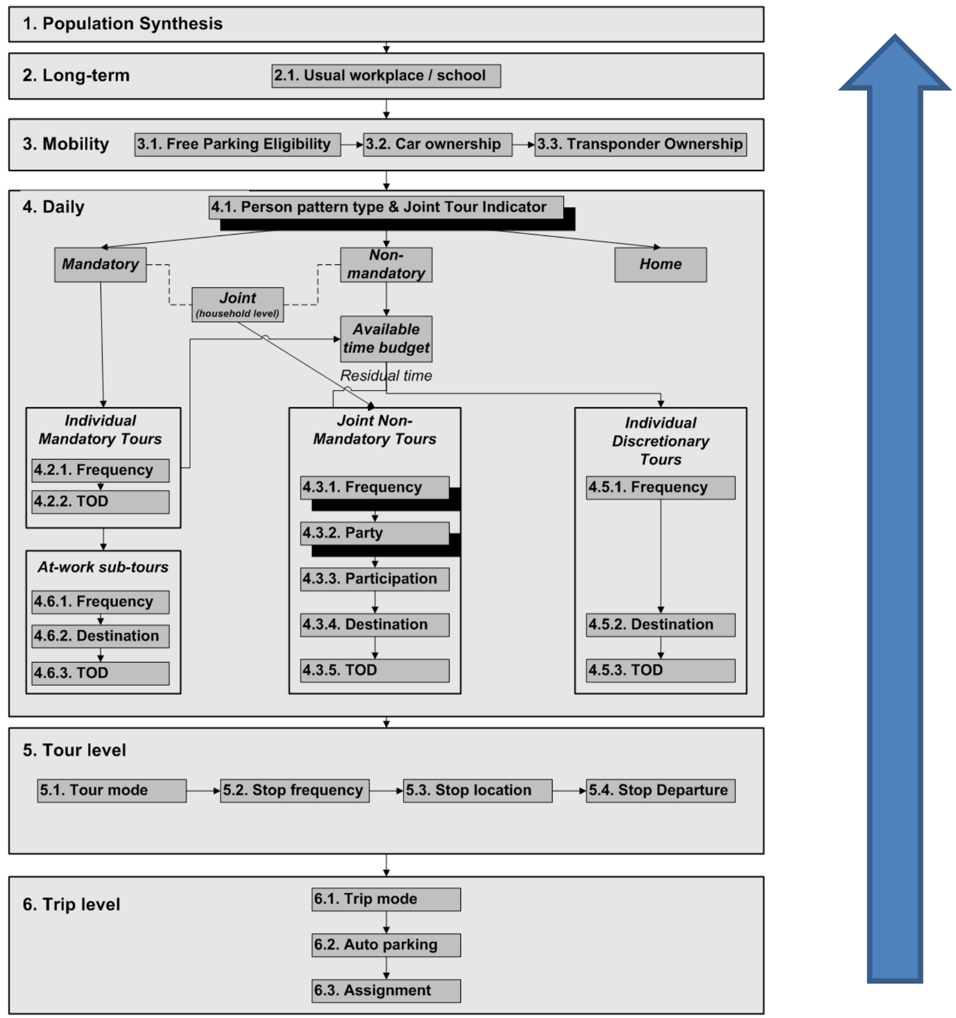
Network Supply Model Issues

- Special consideration in coding networks for tour/ activity-based models
  - Transit-drive access connectors must be bi-directional (SFCTA)
  - Parking supply and Park-and-Ride lot capacities coded as special network attributes (SFCTA, ARC, MTC, SANDAG, SACOG)
- Demand access points are more detailed in advanced model systems
  - Better capture non-motorized, shorter trips, urban form effects
  - Traditional zone-based systems (SFCTA)
  - “Transit access point” virtual path skims (SANDAG, MAG, CMAP)
  - Parcel-based and subzone-based systems (SACOG, PSRC, SANDAG)
- User Equilibrium
  - Static definition
  - Implies convergence criteria – relative gap
  - Analogous to what we want to achieve at a system level

Modules & Feedback Pathways - ABM



Modules & Feedback Pathways - ABM



Additional Considerations

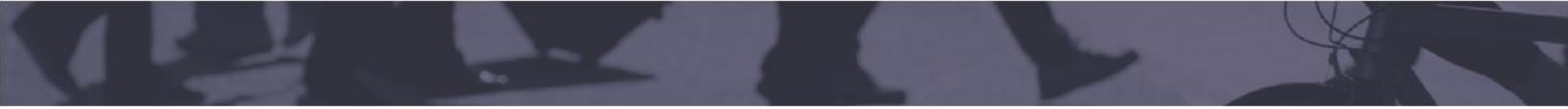
- Integration of activity-based models with other model components
  - Freight/truck models
  - External models
  - Special market models (airport models/special events)
- Typically just appended trips to ABM output prior to assignment
- More tightly integrated schemas:
  - External workers competing for regional jobs (SANDAG)
  - Special event participation integrated in individual daily patterns (MAG)

Post Processing (ABM → DTA)

- Dynamic traffic assignment as a post-process to activity-based-static model:
  - Demand adjustments due to static flows exceed capacity
- Partial integration / post-processing
  - Activity-based model provides demand, but no feedback loop
  - Example: SFCTA
- "One way" linkages do not represent true integration:
  - Still useful for comparing network scenarios but of limited value

Behavioral Theory of Learning & Adaptation

- Traveler decisions based on expected travel times and costs
  - Expectations formed by prior experience, influenced by new information
  - Expectations evolve over time as conditions change (learning)
- Travelers adapt to transportation system changes across multiple choice dimensions:
  - Short-term: activity/trip frequency, timing, route, location, mode, tour/pattern formation, intra-household linkages
  - Long-term: potential changes to workplace, school, residential locations; auto ownership
- Solution outcome represents a stable pattern once this adaptation has occurred:
  - Tempting to associate system equilibrium with adaptation but strict analogy does not work here



Convergence & Equilibrium

- Convergence necessary to
  - Ensure behavioral integrity of the model system
  - Achieve consistent and repeatable results
- Two primary types of convergence in model system
  - (network convergence) to an equilibrium condition given the demand
  - (system convergence) to a stable condition with variable demand
- System convergence is predicated on network convergence

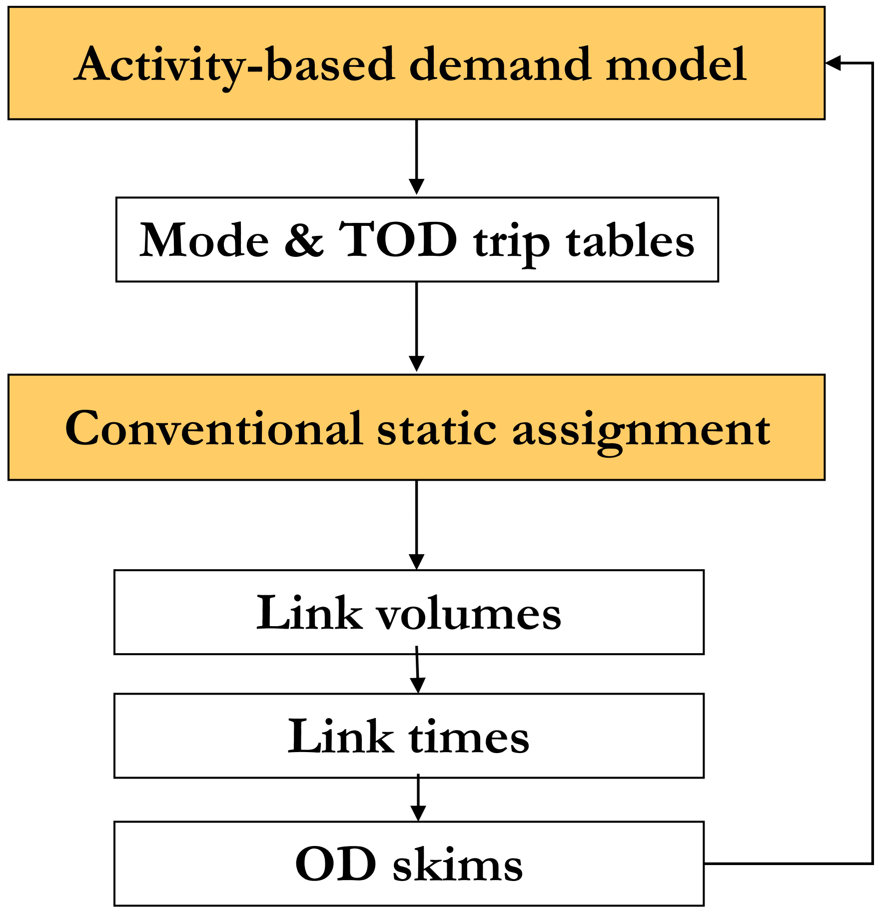
Convergence Challenges

- Mathematically, is it always possible to converge to a single, stable solution?
  - Requires existence of stationary points
  - Uniqueness—a single solution
    - Readily derived for aggregate demand systems using static network assignment
    - Theoretically possible, more difficult to achieve with microsimulation ABM-DTA
- Solving integrated demand and supply problem is a challenge:
  - Many rule-based schemes based on method of successive averages
  - Analytically derived "combined model" systems have been formulated in research settings based on a 4-step, trip-based paradigm:
    - e.g., S. Evans, D. Boyce, N. Oppenheim, M. Florian
    - Closed mathematical programming formulation
  - Activity-based models:
    - No closed analytical solution has been developed
    - Variations include satisfaction of agent-specific objective functions rather than system-level objective functions-- e.g., MATSIM re-planning paradigm
    - Some new approaches and paradigms emerge (SHRP 2 L04)

Achieving Convergence

- Methods for overcoming stochastic variation in achieving system convergence
  - "Warm start" the initial network assignment with trip tables/congested travel times from a previous run
  - Averaging trip tables and link volumes and produced from lists of successive iterations (similar to trip-based models)
  - Random number seeds enforcements
    - Fixing seeds for certain modules or sequences of processes
    - Storing arrays of random numbers generated for each module/process
  - Discretization methods to eliminate Monte-Carlo variability (intelligent bucket-rounding of fractional probabilities)
  - Targeted re-simulation of sub-samples (e.g., 20% of population)
  - "Freezing" parts of the model system (subsets of agents)

"Averaging" Options for Method of Successive Averages (MSA)



Stopping Criteria

- Based on either changes to link volumes and/or trip tables… usually both
- Comparisons made for each relevant demand segment
  - E.g., SOV, HOV, Large trucks, Small/Medium trucks
- Link volume criteria example
  - Stop when 90% of link volumes change by less than 5%
  - Often limited to higher-level facilities (e.g., freeways and arterials)
- Trip table criteria example
  - Stop when 80% of table cells change by less than 10%
  - Often limited to minimum number of trips per cell (e.g., 100)

Recommended Strategy in Practice

- "Cold" start:
  - 9-10 iterations (1, ½, 1/3, ¼, …)
  - Any reasonable starting skims (for year/level of demand)
  - Prior trip tables are not used in the process
  - Run for each Base scenario / year
  - Run only for exceptional Build scenarios with global regional impacts (like Manhattan area pricing)
- "Warm" start:
  - 3 iterations (1, ½, 1/3)
  - Input skims for Base of final (last iteration) are used as starting skims for Build transit and highway projects
  - Run for Build scenarios
- "Hot" start:
  - FTA New Start Methods
  - 1 iteration only

Ongoing Research

- Linking ABMs with DTA and schedule-based/dynamic transit assignment
- Current research efforts
  - SHRP 2 C10 (SACOG, Jacksonville)
  - SHRP 2 L04 (New York sub-area)
  - FHWA SimTRAVEL (MAG)
  - SFCTA (City-wide DTA based on ABM demand)

Dynamic Traffic Assignment (DTA)

- Advantages: capture time-varying network and demand interactions in a more realistic way
- Sensitive to…
  - Time-varying demand
  - Operational attributes (signal coordination, optimization, priorities)
  - Traffic dynamics (car following, queuing)
  - True capacity constraints
- Deployment scales
  - Project/corridor-level
  - Regional-level (supports integration with regional demand model)

Dynamic Network Assignment Algorithms

- Do away with V/C ratios—capacity constraints strictly enforced through queuing and car following
- Intersection signal timing, lane geometries exert control
- Queuing behavior emerges
- Analytical solutions possible but difficult to implement due to computational costs (memory and run-time)
- Heuristic solutions more practical, common in practice
  - Simulation of flows plus successive averaging
  - Convergence not as "sure" as static assignment--difficult to achieve small relative gaps (2% considered "good", 5% "acceptable")

ABM/DTA Integration

- Activity-based model provides demand to dynamic traffic assignment
  - Disaggregate trip list
  - Aggregate matrices at fine temporal resolution
- Dynamic traffic assignment provides temporally detailed network performance indicators to activity-based model
  - In practice, 22-48 time periods has been accomplished
  - Ideally, “on-the-fly” impedances
  - Examples: C10, MORPC

Conventional Integration Scheme

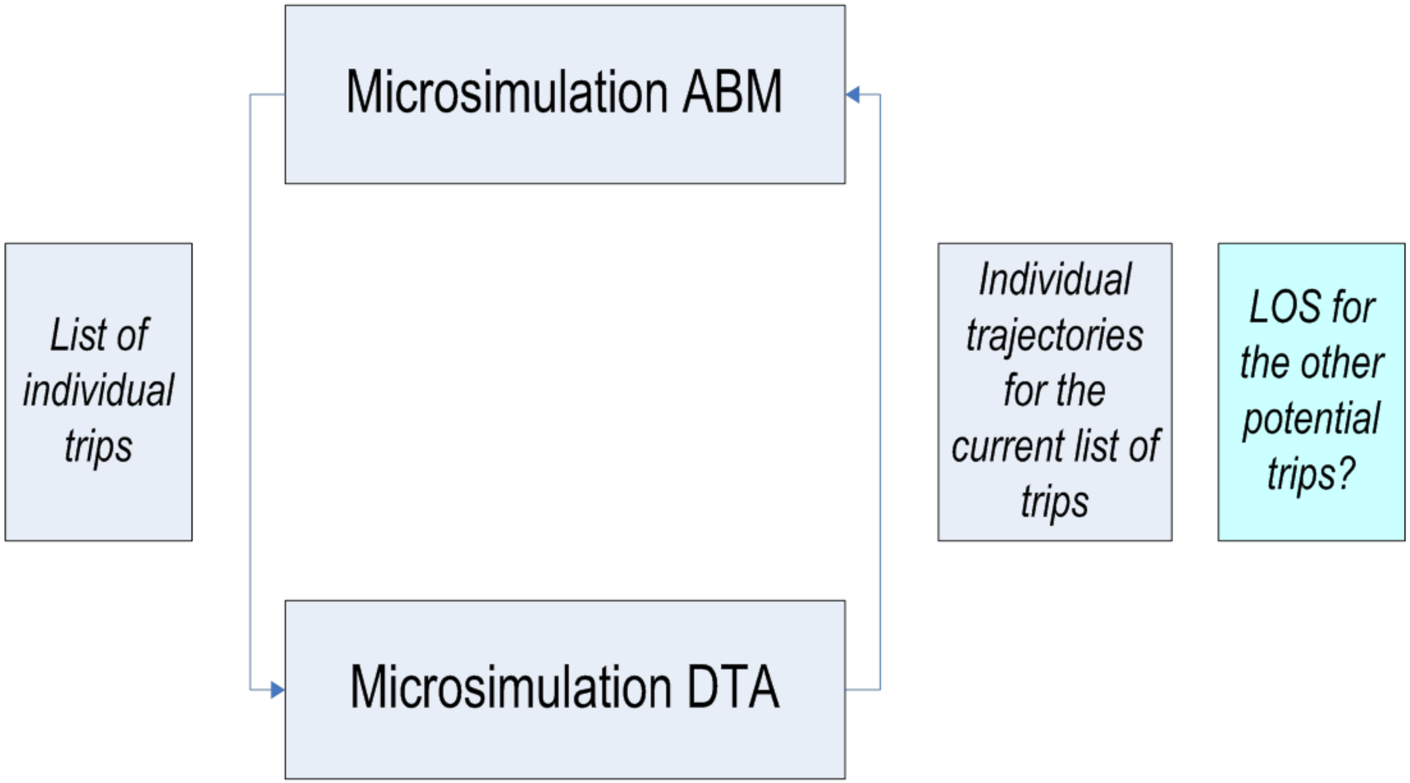
4-step demand model

Trip tables

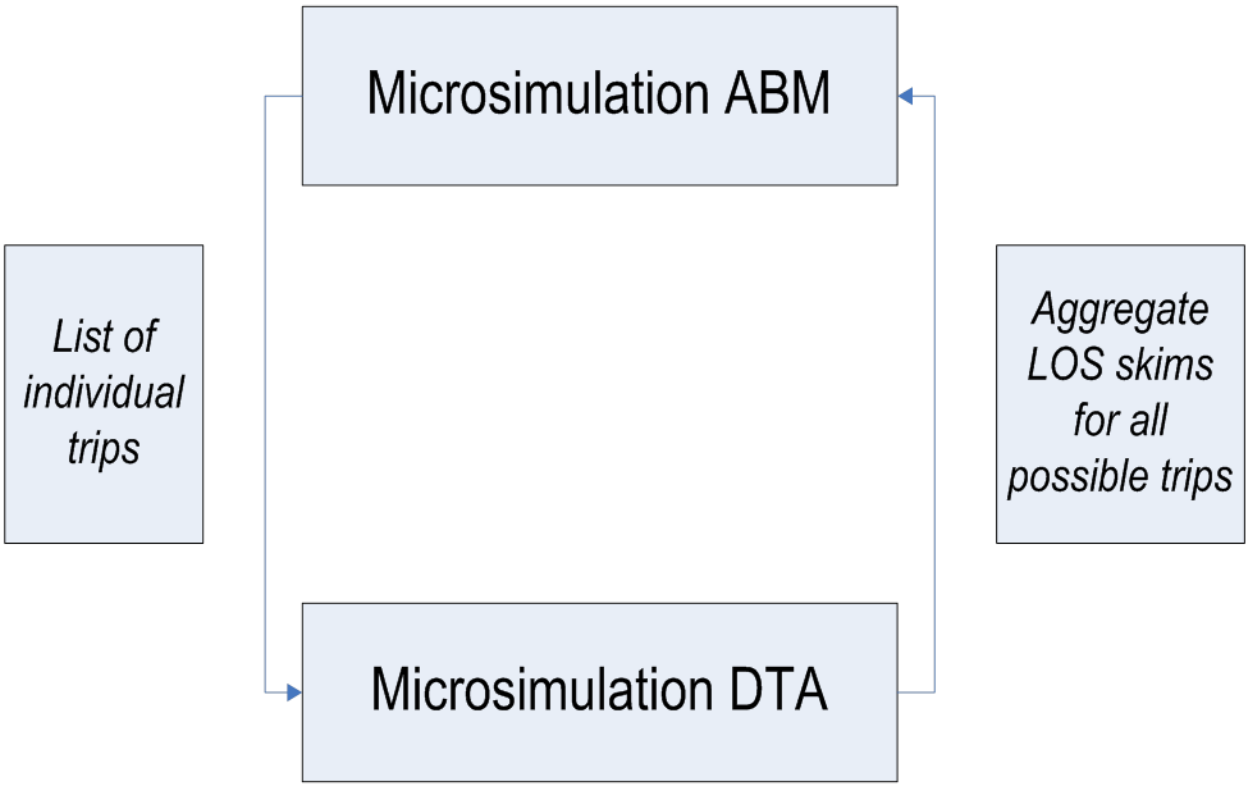
LOS skims for all possible trips

Static assignment

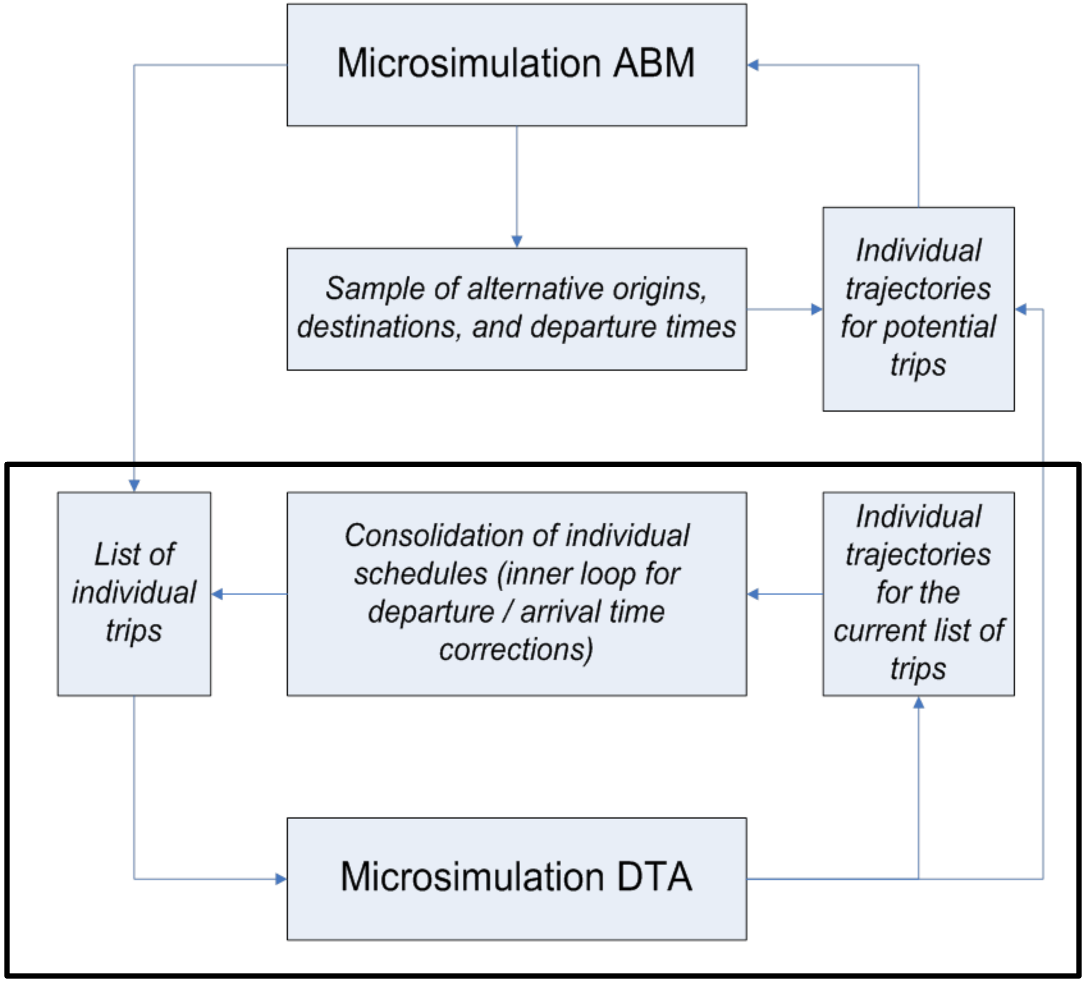
Integration Issue DTA-to-ABM



Possible Surrogate

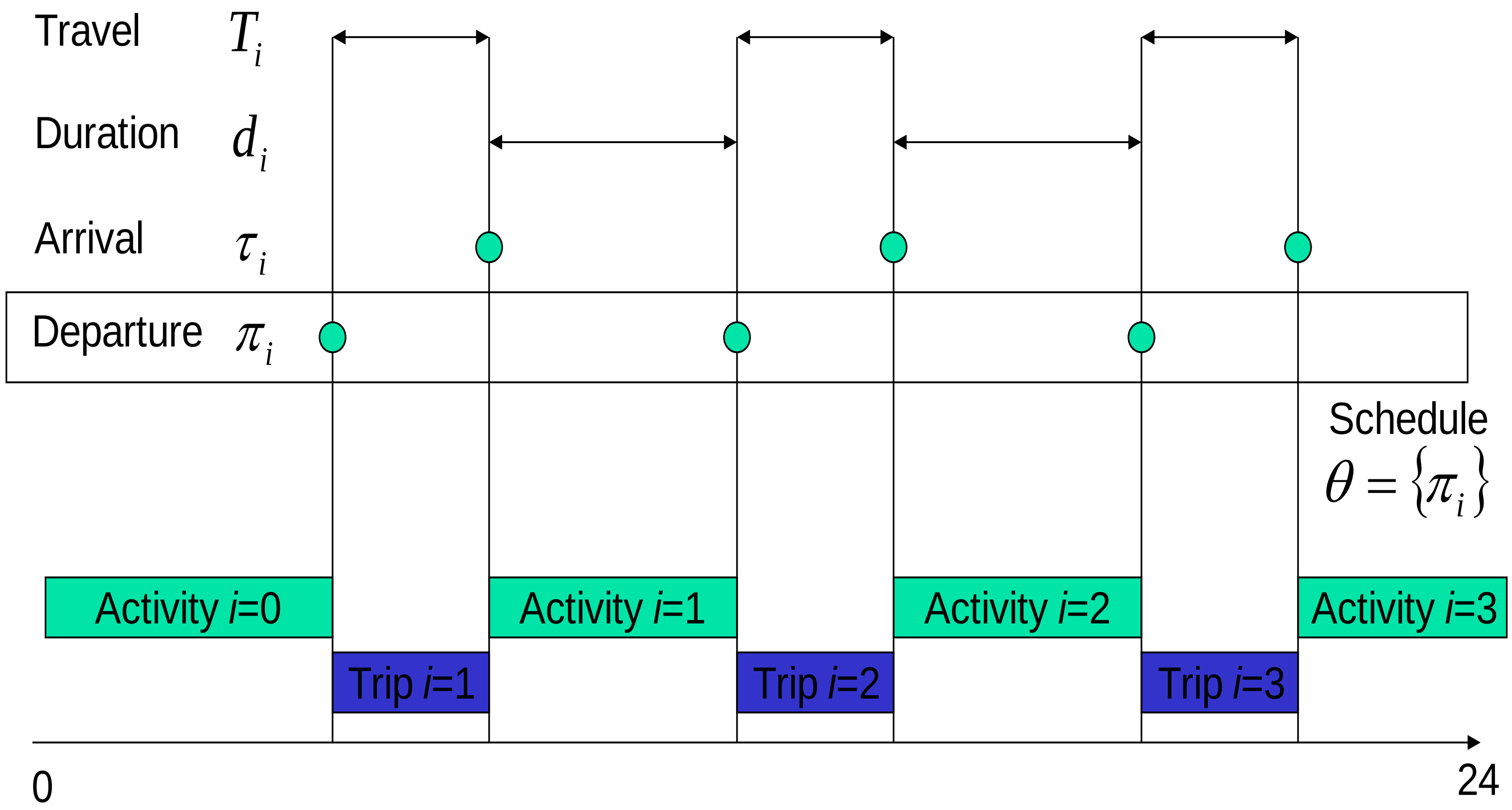


Suggested Alternative Approach (SHRP 2 L04)



Temporal equilibrium to achieve individual schedule consistency

Individual Schedule Consistency



Schedule Adjustment Prototype

New durations

New departures

Find new schedule close to previous durations and departures

$$\min\left\{\sum_i \left(x_i \ln \frac{x_i}{d_i} + y_i \ln \frac{y_i}{\pi_i} \right)\right\}$$

Previous durations

Previous departures

Daily consistency

$$\sum_i \left(x_i + t_i\right) = 24$$

Changed travel times

Departure time

$$y_i = \sum_{j \le i} \left(x_j + t_j\right)$$

Solution

$$x_i = k \times d_i \times \prod_{j \ge 1} \frac{\pi_j}{y_j}$$

Schedule Adjustment Extended

$$\min_{\{x_i\}}\left\{\left[\sum_{i=0}^{I} w_i \times x_i \times ln\left(\frac{x_i}{d_i}\right)\right] + \left[\sum_{i=1}^{I+1} u_i \times y_i \times ln\left(\frac{y_i}{\pi_i}\right)\right] + \left[\sum_{i=0}^{I} v_i \times z_i \times ln\left(\frac{z_i}{\tau_i}\right)\right]\right\}$$

$$y_i = \tau_0 + \left(\sum_{j=0}^{i-1} x_j\right) + \left(\sum_{j=0}^{i-1} t_j\right), \quad i = 1,2,\ldots,I+1$$

$$z_i = \tau_0 + \left(\sum_{j=0}^{i-1} x_j\right) + \left(\sum_{j=0}^{i} t_j\right), \quad i = 1,2,\ldots,I$$

$$x_i > 0, \quad i = 0,1,2,\ldots,I$$

$$x_i = d_i \times \left\{\prod_{j>i}\left[\left(\frac{\pi_j}{y_j}\right)^{u_j} \times \left(\frac{\tau_j}{z_j}\right)^{v_j}\right]\right\}^{\frac{1}{w_i}}$$

Weights for Schedule Adjustment

Activity type	Duration	Trip departure (to activity)	Trip arrival (at activity location)
Work (low income)	5	1	20
Work (high income)	5	1	5
School	20	1	20
Last trip to activity at home	1	1	3
Trip after work to NHB activity	1	5	1
Trip after work to NHB activity	1	10	1
NHB activity on at-work sub-tour	1	5	5
Medical	5	1	20
Escorting	1	1	20
Joint discretionary, visiting, eating out	5	5	10
Joint shopping	3	3	5
Any first activity of the day	1	5	1
Other activities	1	1	1

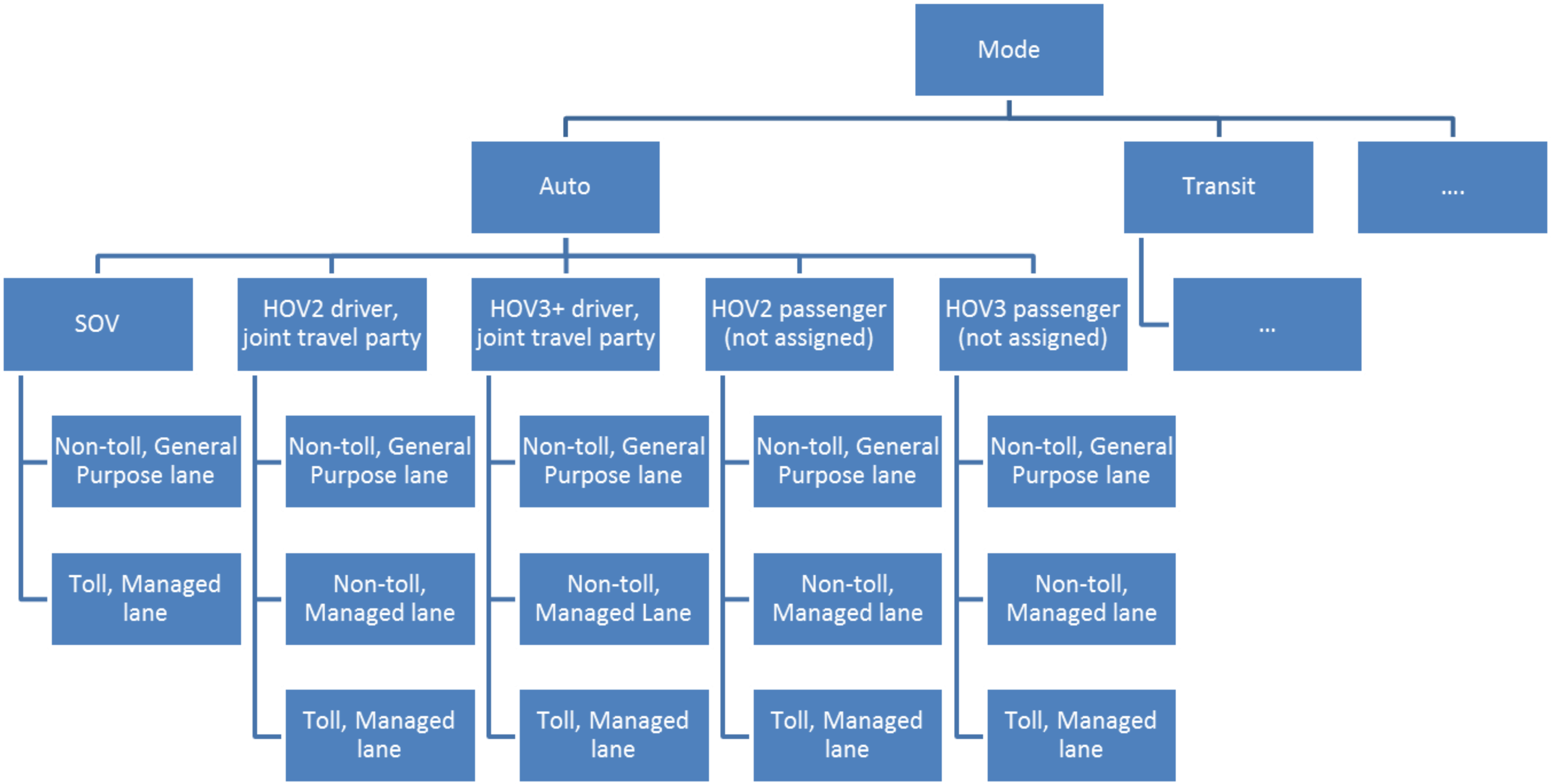
Pre-Sampling of Trip Destinations

- Primary destinations are pre-sampled:
  - 300 out of 30,000 for each origin and travel segment,
  - 30 out of 300 for each individual and travel segment
- Stop locations are pre-sampled:
  - 300 out of 30,000 for each OD pair and travel segment
  - 30 out of 300 for each individual and travel segment
- Importance sampling w/o replacement from expanded set of destinations 300×30,000 and 30×300 to ensure uniform unbiased samples
- Efficient accumulation of individual trajectories in microsimulation process

LOS Skims for Outer Loop

- (1st choice) Individual trajectories by departure time period for the same driver (personal learning experience), if not:
  - (2nd choice) Individual trajectories by departure time period across individuals (what driver can hear from other people through social networks), if not:
    - (3rd choice) Aggregate OD skims by departure time period (advice from navigation device)

Mode Choice Refinement for ABM-DTA Integration: Driver vs. Passenger for HOV



Trip Departure Time Choice Refinement (5 min resolution)

- Tour TOD choice model:
  - bi-directional and has 841 departure-arrival alternatives with 30 min resolution
  - Number of alternatives will quadruple with 15 min resolution
- Trip departure time choice model:
  - One-directional
  - 5 min resolution is feasible and results in under 100 ordered alternatives
  - Multiple Discrete-Continuous approach is being tested for MAG ABM (ASU)

Integration - Continuous Exchange of Data

- Linking an ABM with dynamic traffic and transit assignment
- FHWA SimTRAVEL research project (Arizona State, U. Arizona, U.C. Berkeley)
- Assumes travelers have complete information and react accordingly in real time
- Would require fully integrated demand and supply models in a single program structure

Schedule-based/Dynamic Transit Assignment

- FHWA SimTRAVEL project
- Use actual/realistic transit schedules in conjunction with activity-based models and dynamic traffic assignment
  - Drive access times affected by dynamic traffic assignment
  - Bus transit operating in mixed traffic affected by surrounding traffic stream
    - Boarding and alighting times, crowding affect level of service
    - Capacity constraints may result in bus bunching, travelers having to wait for next bus
  - Fixed guideway transit relatively simple if no-congestion effect modeled
  - Fixed guideway transit with capacity constraints affects boarding and alighting times

Summary of Benefits of ABM Integrated with Network Simulations

- General:
  - Improved policy sensitivity (essential for highway pricing)
  - Greater confidence, reliability in comparing investment and policy alternatives
  - More realistic representation of changes in network performance by time-of-day
- With DTA in particular:
  - Behavioral realisms and consistency at individual level
  - Expanded set of performance measures (for example, reliability)

Costs of Network Integrated ABM

- Data and process development and maintenance:
  – Network inputs
  – Calibration / validation
- Runtime:
  – Stochastic variation may necessitate multiple demand simulations
  – When ABM is integrated with static UE assignment, more detail/resolution means longer runtimes
    - More time periods to assign
    - More market segments to assign
  – In DTA, no additional runtime costs due to demand detail, but assignment runtimes are extremely long to begin with

Questions and Answers

The Travel Model *Improvement* Program

Next Webinar

Executive and Management Sessions	
Executive Perspective	February 2
Institutional Topics for Managers	February 23
Technical Issues for Managers	March 15
Technical Sessions	
Activity-Based Model Framework	April 5
Population Synthesis and Household Evolution	April 26
Accessibility and Treatment of Space	May 17
Long-Term and Medium Term Mobility Models	June 7
Activity Pattern Generation	June 28
Scheduling and Time of Day Choice	July 19
Tour and Trip Mode, Intermediate Stop Location	August 9
Network Integration	August 30
Forecasting, Performance Measures and Software	September 20