Florida Model Task Force

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Integrated ABM-DTA Approach:

SHRP2 C04 Research Status

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1. ABM-DTA INTEGRATION STATE OF THE ART & PRACTICE

Intensive Research and First Practical Applications

Project	Region	ABM	DTA	Status	Integration
SHRP C10A	Jacksonville, FL	DaySim	Transims	Completed	LOS skims
SHRP C10B	Sacramento, CA	DaySim	DynusT	Completed	LOS skims
CMAP	Chicago, IL	CT-RAMP1	DynaSmart	Completed	Individual
SANDAG	San Diego, CA	CT-RAMP1	AimSun	DTA setting	Individual
JTMT	Jerusalem, Israel	CT-RAMP2	Dynameq	DTA setting	Individual
C10/ARC	Atlanta, GA	CT-RAMP1	DynusT	On-going	Individual
C10/ODOT	Columbus, OH	CT-RAMP2	DynusT	On-going	Individual
C10/SFCTA	San-Francisco, CA	CHAMP	FastTrips	On-going	TBD
C10/BMC	Baltimore, MD	TourCast	DTALite	On-going	Individual

Project Ingredients

ABM

- Improvements to match DTA needs:
  - Enhanced temporal resolution
  - Individual schedule consistency
  - Dynamic destination choice sets
  - Explicit driver and passenger roles in carpools

DTA

- Improvements to match ABM needs:
  - Individual route choice (VOT, walk propensity)
  - Database of individual trajectories
  - Selective time-dependent shortest paths (TDSP)

Integration

- 3 levels (loops):
  - Level 1 (global demand response)
  - Level 2 (temporal equilibrium, individual schedule consistency)
  - Level 3 (within-day adjustments; trip chain loading)
  - New "Gap" measures for convergence

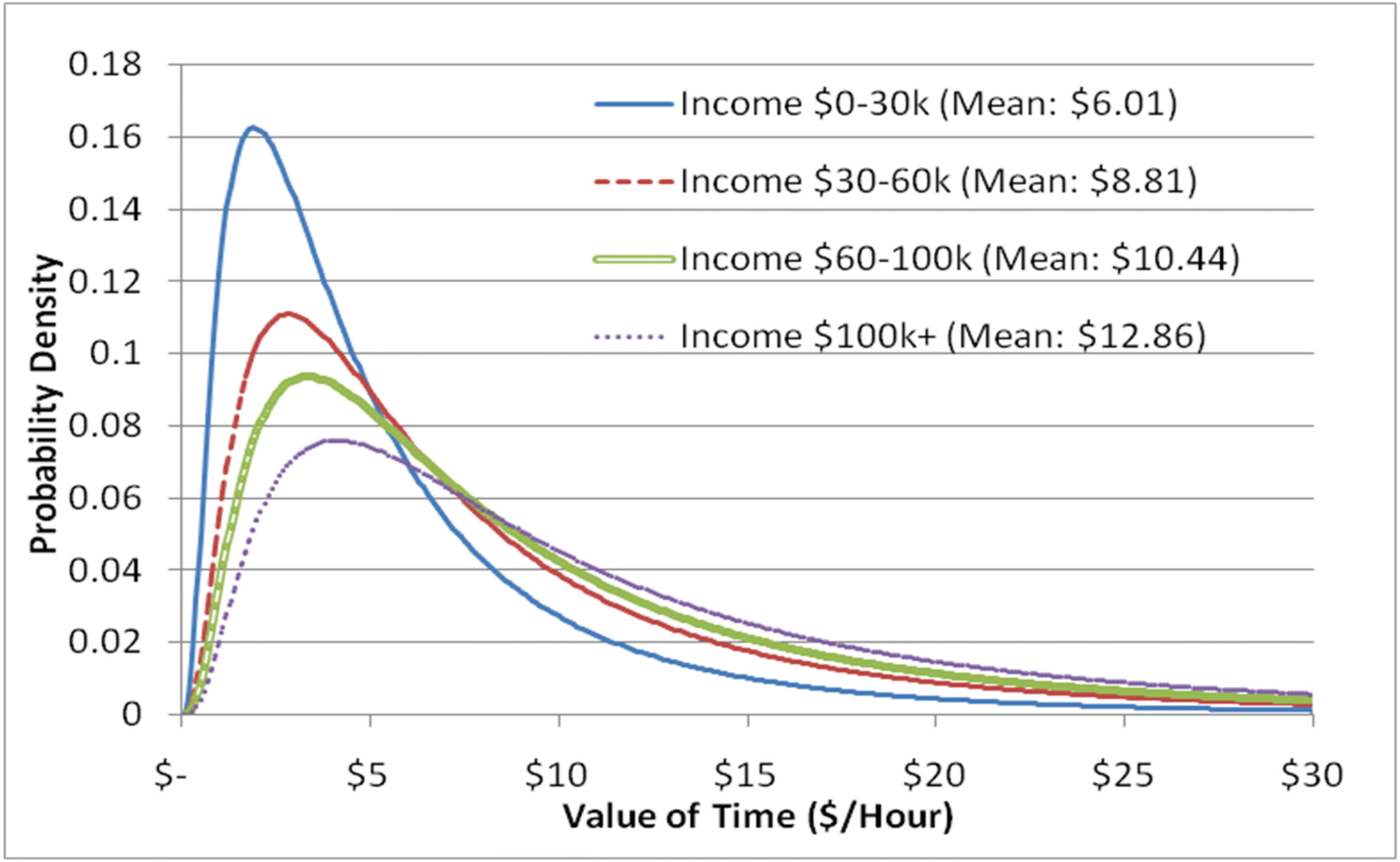
New CT-RAMP "Integrable" w/DTA

- Enhanced temporal resolution:
  - Continuous trip departure time choice
- Individual schedule consistency:
  - Trip departure time and activity duration generated by ABM consistent with travel time generated by DTA
  - Additional important constraint on the state of the system
- Dynamically updated destination choice sets:
  - Individual learning and adaptation instead of random sampling
  - Moving towards AgBM
- Explicit driver and passenger roles in carpools:
  - Translation of person trips and tours into vehicle trip and tours

New DTA “Integrable” w/ABM

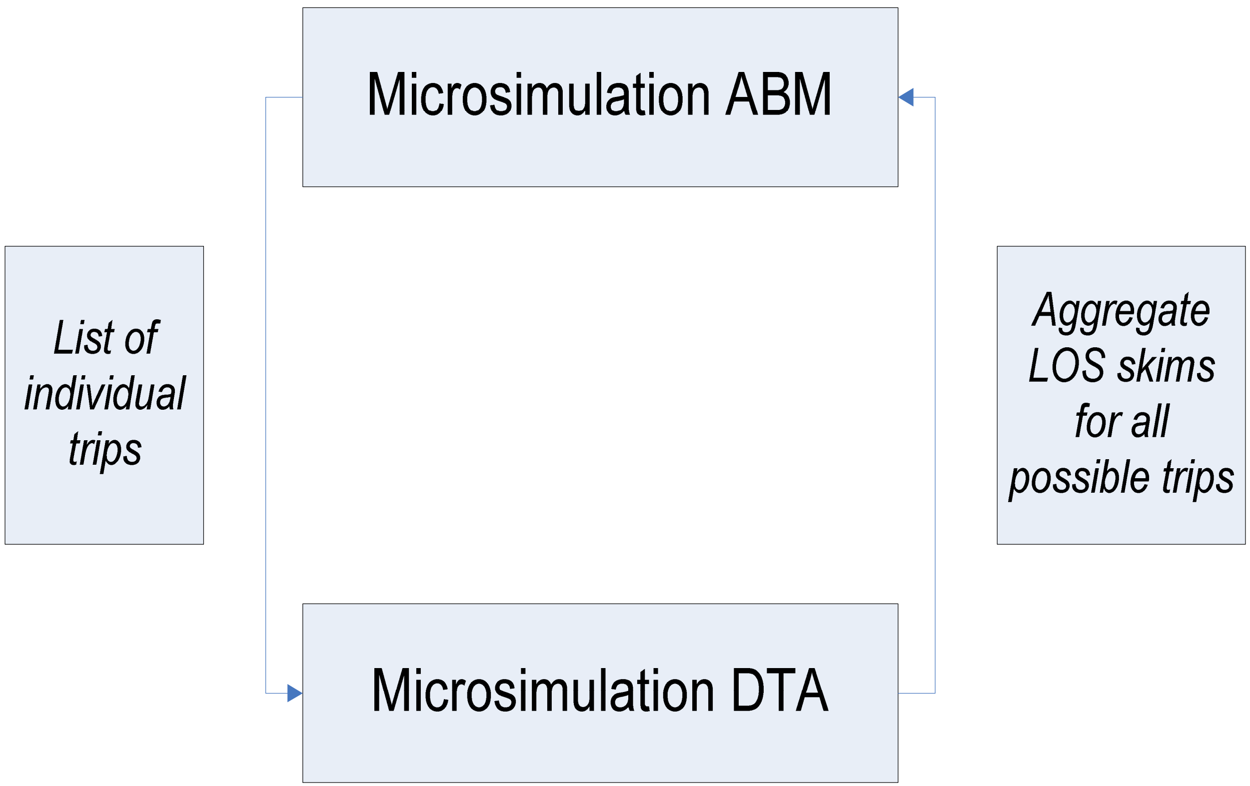
- Meso-level DTA for regional planning models:
  - More detail for route choice (occupancy, VOT)
  - Less detail for vehicle simulation
- Individual route choice (VOT):
  - VOT distribution essential for pricing studies
  - Consistency between mode choice in ABM and route choice in DTA
- Database of individual trajectories:
  - Mining individual trajectories and sub-trajectories (experienced individual LOS)
- Selective TDSP:
  - API for selective TDSP call (expected individual LOS)

Probabilistic VOT



2. ABM-DTA INTEGRATION PRINCIPLES

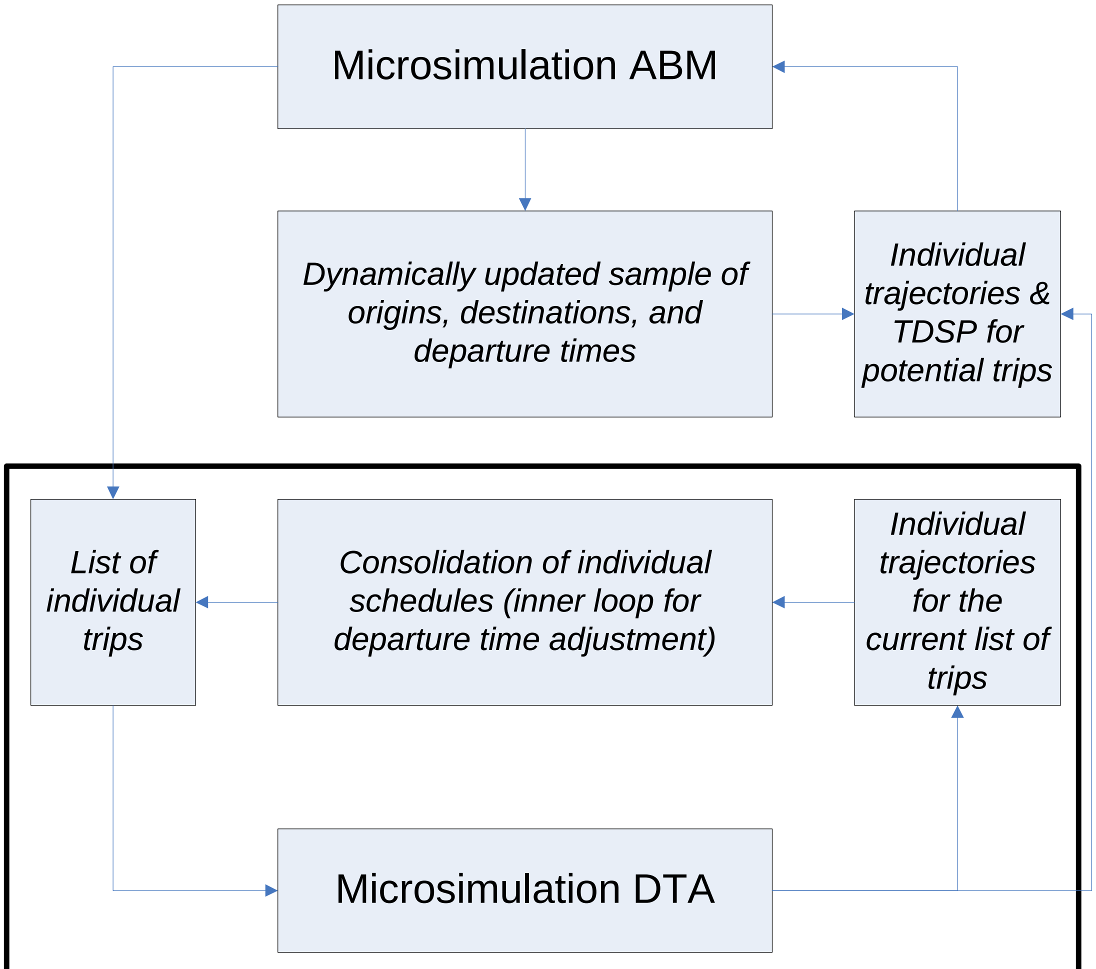
Conventional integration



Limitations of feeding back aggregate LOS OD skims

- Skims is only a surrogate for consistent individual path LOS:
  - Back to 4-step resolution and aggregation biases
- Infeasible to support segmentation pertinent to ABM ("curse of dimensionality"):
  - VOT categories (7-8 at least)
  - Occupancy categories (3 at least)
  - Departure time bins (15 min at least)
  - All this for $(\#TAZs)^2$
- Behaviorally non-appealing:
  - No relation to individual experience, learning, or adaptation

Proposed Approach for Day-Level Integration



Temporal equilibrium to achieve individual schedule consistency

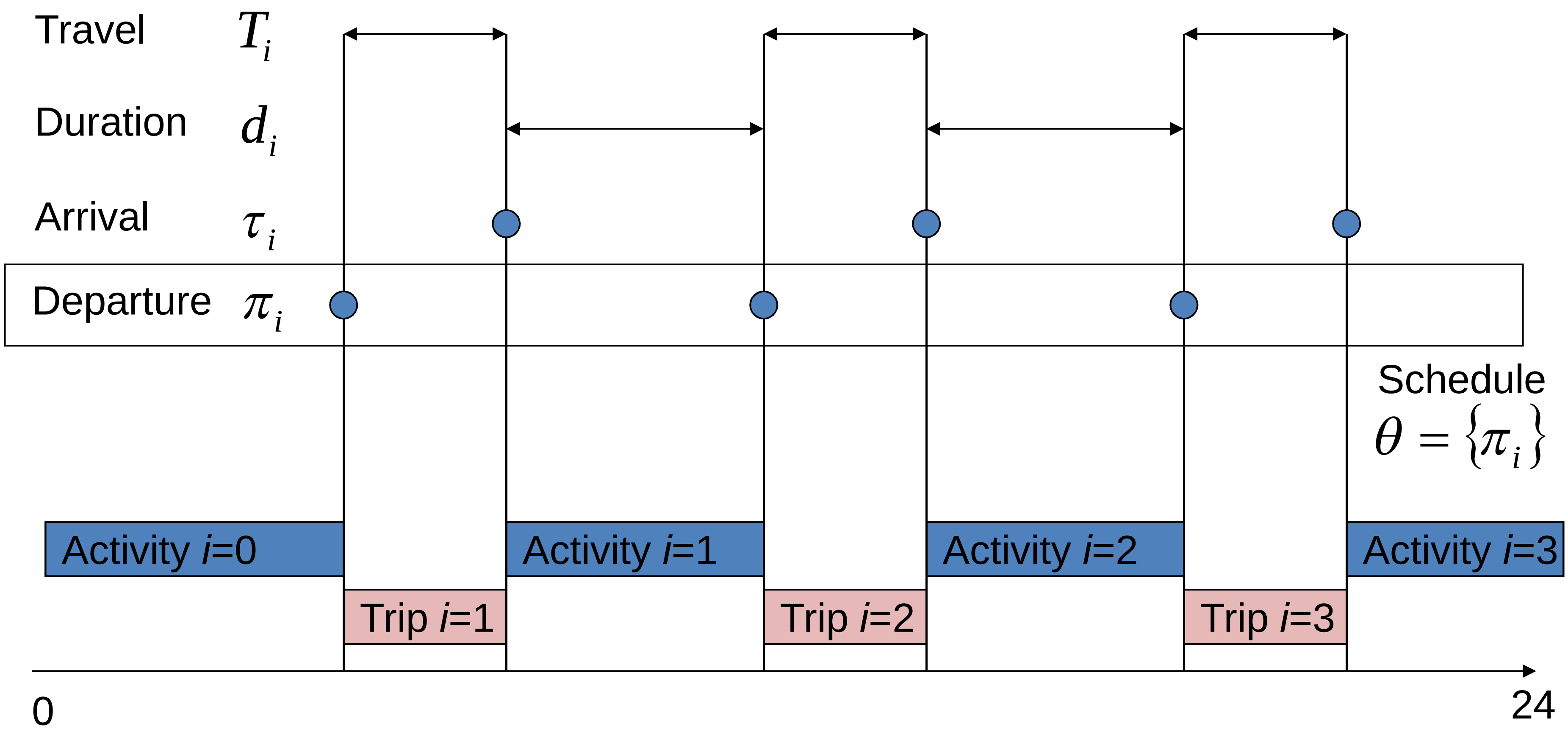
Taking advantage of individual trajectories

3. INTERNAL LOOP OF INDIVIDUAL SCHEDULE ADJUSTMENTS

Essence of Internal Loop (Level 2)

- Sequence of trips, destinations, and modes is fixed for each individual
- Joint equilibration of trip departure time and route choices (“extended DTA”)
- Take full advantage of individual trajectories generated by DTA as the best measure of LOS
- Ensure individual schedule consistency and evaluate schedule feasibility/desirability

Individual Schedule Consistency



Schedule Delay Cost

- ***$U = \alpha \times T + \beta \times SDE + \gamma \times SDL + \delta \times L$***
- In presence of random travel times:
  - *f(T)* – travel time distribution
  - *E(U)* – expected utility dependent on *f(T)* and departure time/*PAT*
  - Improvement of reliability in terms of *f(T)* can be evaluated in terms of *E(U)*
- Considerable body of literature:
  - SP estimates: $\gamma \geq \alpha$

Individual Schedule Adjustment

- Schedule deviation minimization approach:
  - Generalization of schedule delay approach developed by K. Small for a single trip
  - Objective function terms with importance weights summed over all trips/activities:
    - **α × Max(PlanActDur-AdjActDur,0)** // shorter
    - **β × Max(AdjActDur-PlanActDur,0)** // longer
    - **λ × Max(PlanTripDep-AdjTripDep,0)** // depart earlier
    - **γ × Max(PlanTripDep-AdjTripDep,0)** // depart later
    - **μ × Max(PlanTripArr-AdjTripArr,0)** // arrive earlier
    - **ν × Max(PlanTripArr-AdjTripArr,0)** // arrive later

Individual Schedule Adjustment

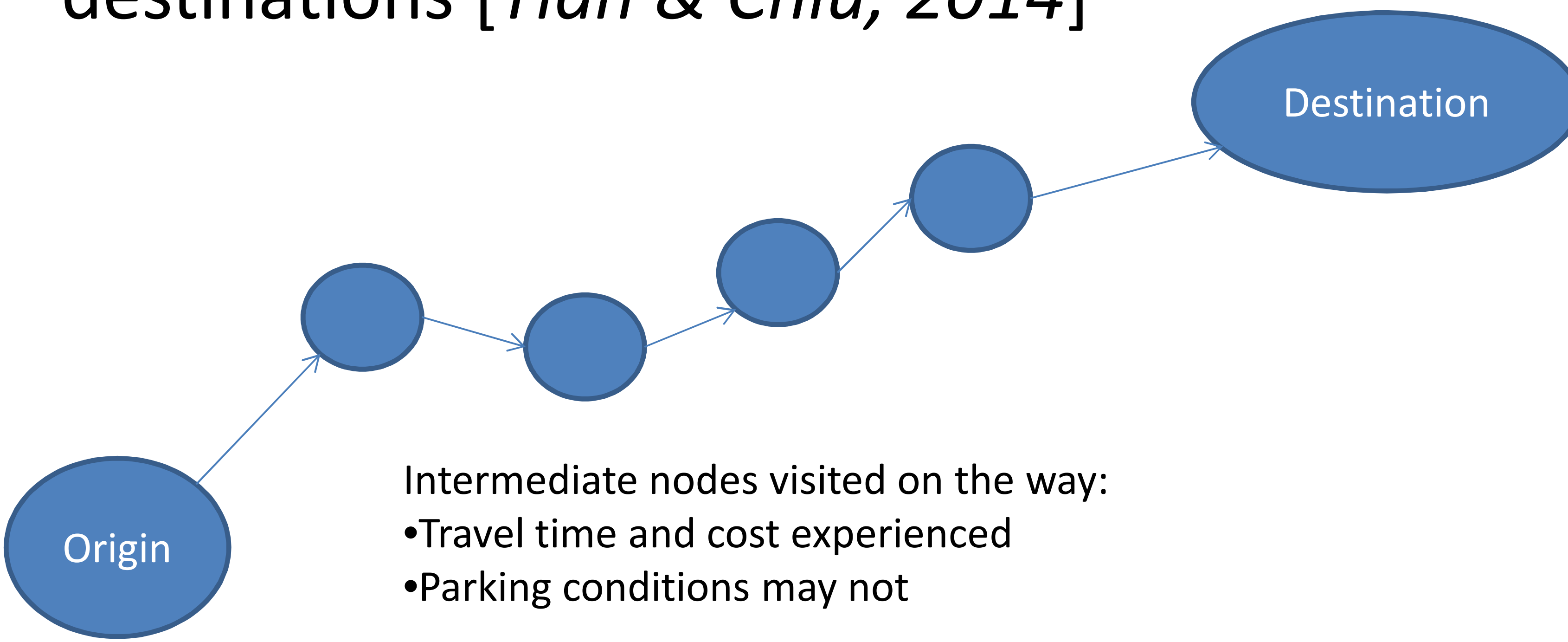
- Results in LP problem with entire-day schedule consistency constraints
- Fully consistent with schedule delay models and TOD choice
- Applied for entire HH and accounts for joint trips
- Works as a natural "randomizer" for trip departure time

Taking advantage of simulated individual trajectories as the best measure of actual LOS

4. MINING AND DISSECTING INDIVIDUAL TRAJECTORIES

Learning about Space from Individual Trajectories (Dynamic Choice Set)

- One implemented trip provides individual learning experience w.r.t. multiple destinations [*Tian & Chiu, 2014*]



Intermediate nodes visited on the way:
•Travel time and cost experienced
•Parking conditions may not

Direct Full Indexing of Trajectories and Sub-Trajectories with LOS Accumulation (Long Format)

- Each trajectory is dissected into N×(N-1)/2 sub-trajectories and each of them is added to the bank:
  - **Car occupancy**
  - **VOT**
  - **OTAZ**
  - **DTAZ**
  - **Departure time**
  - Travel time
  - Travel distance
  - Toll
  - Toll equivalent in min

Bank of Trajectories and Mining

- Quick mining:
  - Filter user(s):
    - Filter trajectories that span departure time bin (TOD)
      - Filter sub-trajectories that start from OTAZ and TOD
        - Filter sub-trajectories that include DTAZ
- Aggregation if more than one found:
  - Give precedence to the modeled individual
  - Give precedence to later iterations
  - Averaging rules (max, min, mean, STD)

How the external and internal loops can be combined

5. EQUILIBRATION

Travel “Stress”

- Behavioral meaning:
  - Experienced travel times unreasonable and/or very different from the expected travel times
  - Individual will seek other travel choices
- Formal meaning for ABM-DTA equilibration:
  - Empirical “gap” measure
  - Generated individual activity-travel pattern does not belong to stationary solution
  - Entire daily pattern has to be re-generated
- Practical daily measures of travel “stress“:
  - Total daily travel time
  - Travel overhead (travel time / out-of-home activity time)
  - More elaborate measures explored

Travel “Stress” Thresholds

Person type	Max total travel time, min	Travel time overhead	Min total activity time for overhead, min
1=Full-time worker	240	0.5	180
2=Part-time worker	180	0.8	120
3=University student	240	0.8	120
4=Non worker U65	180	1.5	60
5=Retiree	150	1.5	60
6=Driving-age school child	150	0.4	120
7=Pre-driving-age school child	120	0.4	120
8=Preschool child	120	0.8	120

- Person is “stressed” if either the max time is reached or max overhead is reached in combination with min activity time
- HH is “stressed” if at least one person is “stressed”

“Stressed” and “Un-stressed” HHs