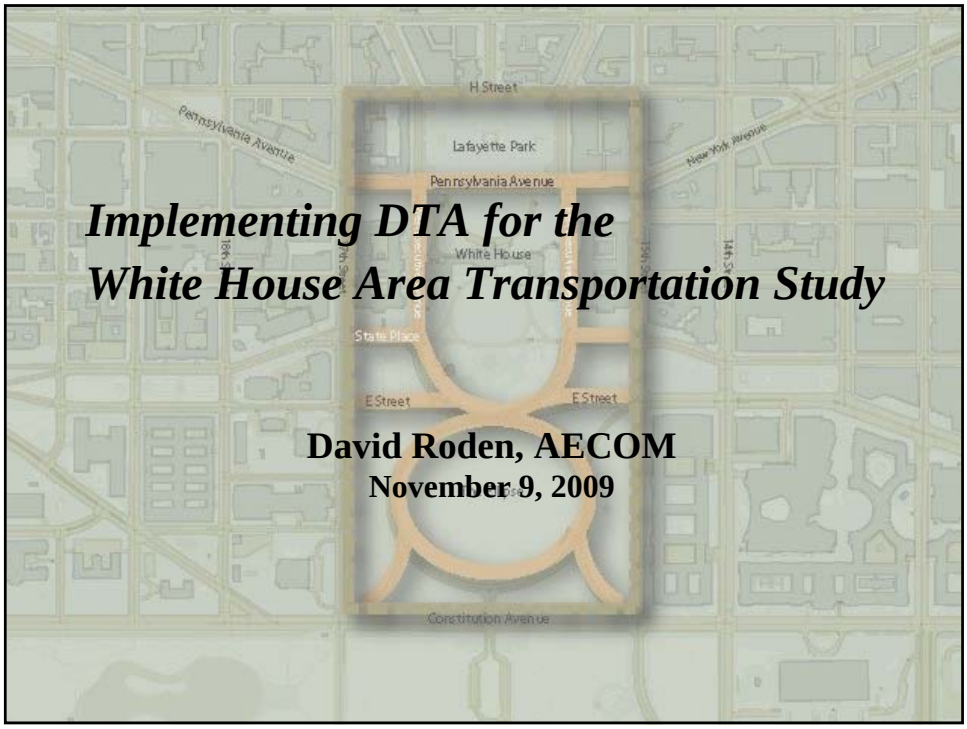


Implementing DTA for the White House Area Transportation Study

David Roden, AECOM

November 9, 2009

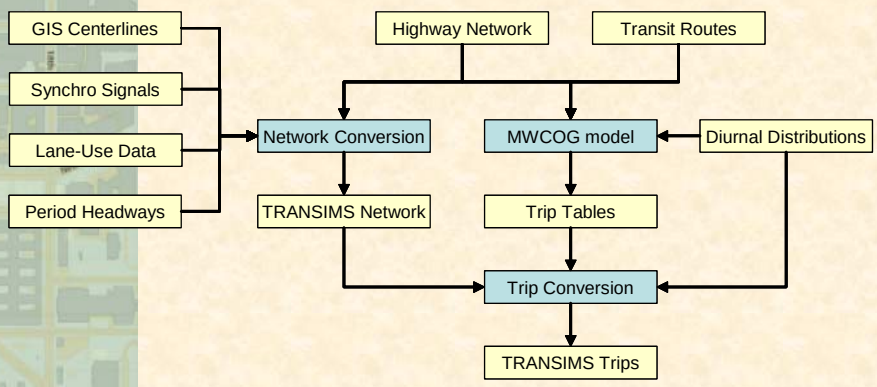
Outline

- Developing and calibrating dynamic network assignments
  - Converting and refining supply and demand from traditional models
  - Adding temporal sensitivities and traffic controls
  - Achieving dynamic user equilibrium and network stability within a multi-modal environment

Keys to DTA Success

- Key differences between Simulation-based DTA and traditional models
  - Travel at specific points in time
    - Dynamic networks and travel demand
      - Use restrictions and traffic controls
      - Arrival time at each point along the path
      - Consistency/compatibility critical
  - True capacity constraint (i.e., V/C <= 1.0)
    - Impacts user equilibrium methods
      - All-or-nothing assignments don't work
      - Realistic network performance is key

MWCOG Model Inputs

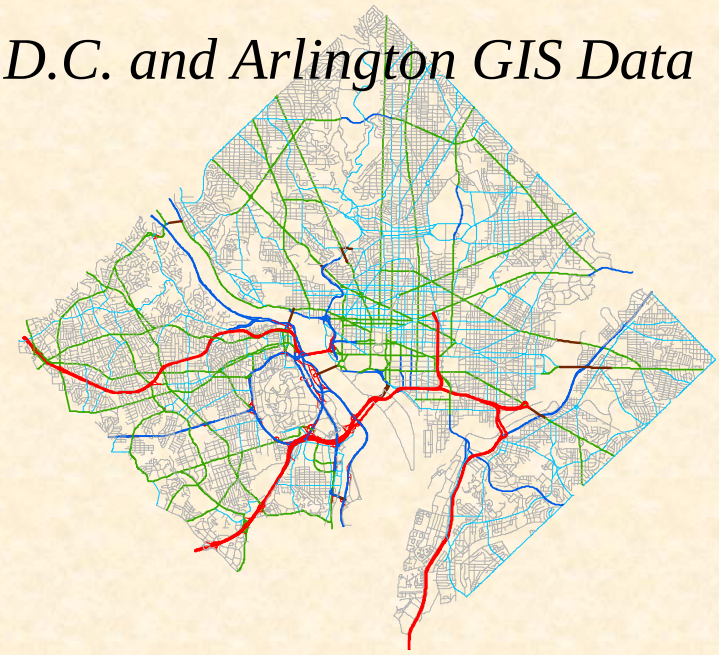


Supply-Side Inputs

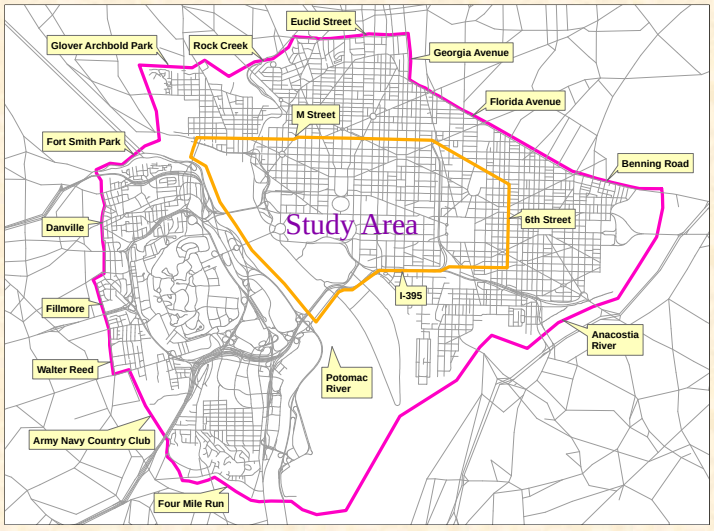
- Converting and refining supply from traditional models
  - Convert MWCOG network
    - Regional highway and transit networks
  - Add study area details
    - Literal coding with geometric shapes
    - Cutting and splicing networks
  - Refine facility types, number of lanes, pocket lanes, lane connections, free flow and maximum speeds

Regional Routing

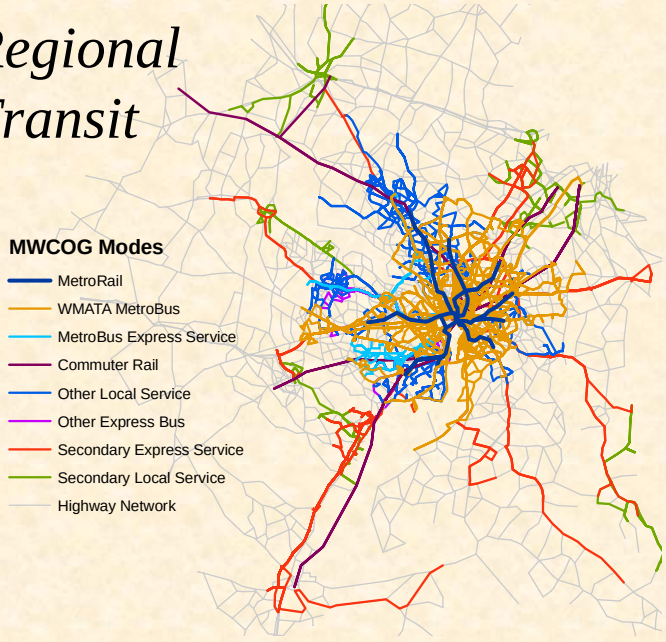
D.C. and Arlington GIS Data



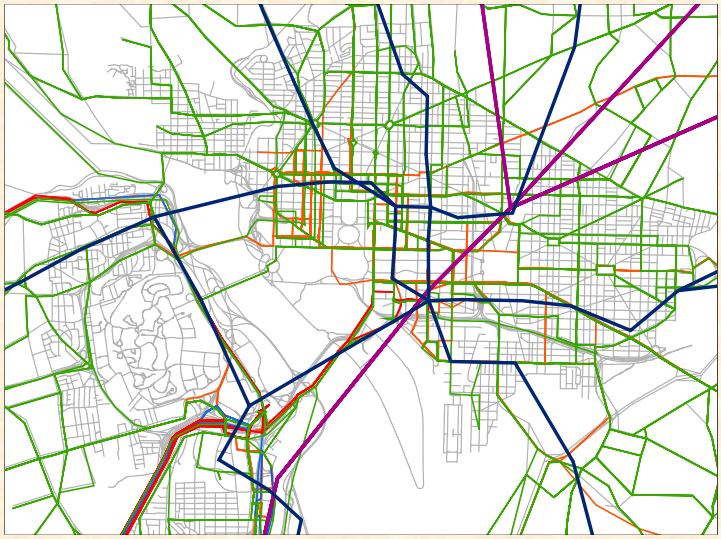
Subarea Simulation



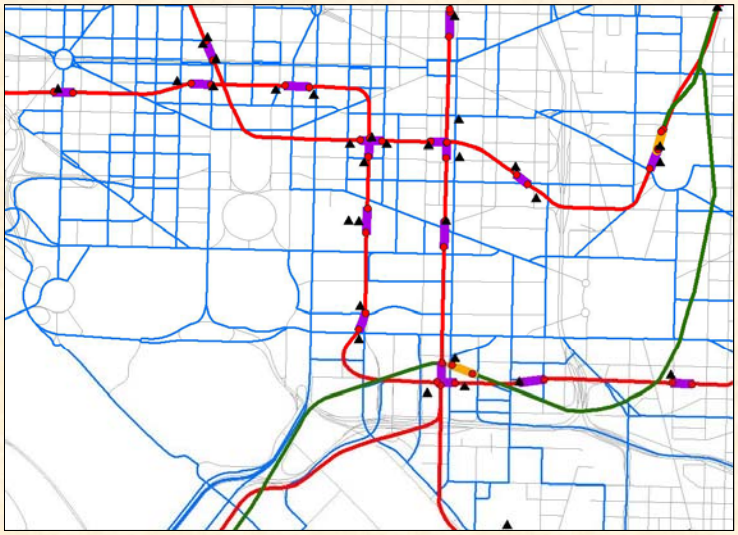
Regional Transit



Simulation Area Integration



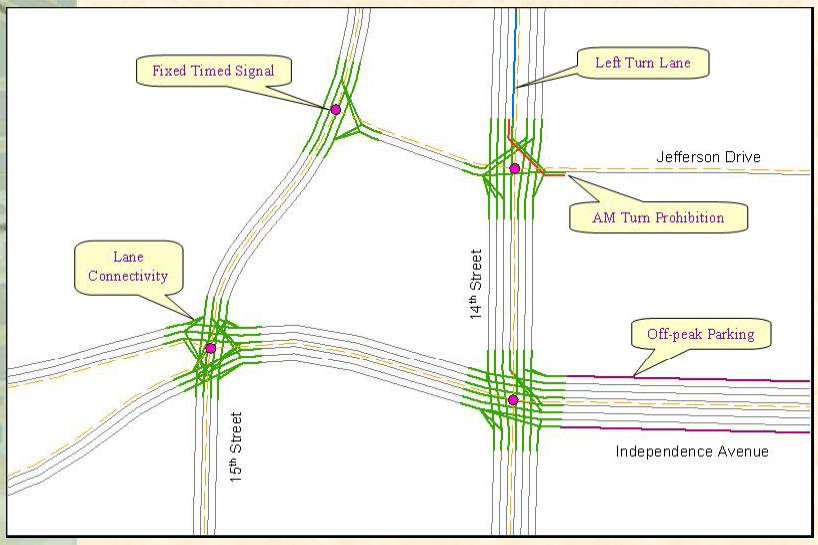
Transit Network



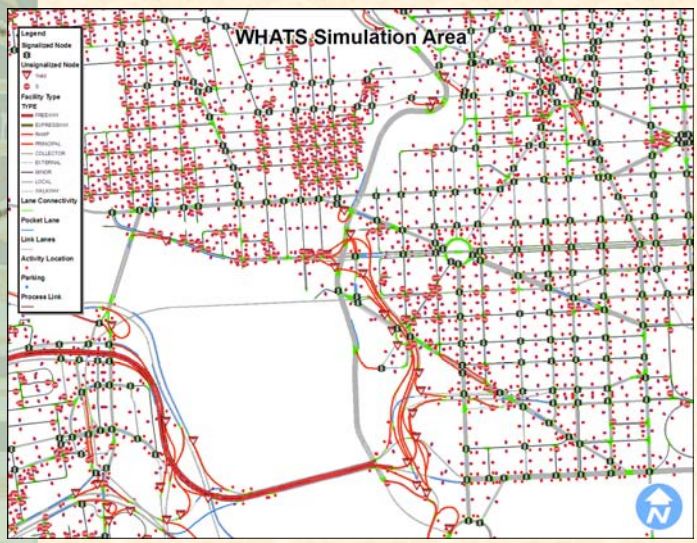
Adding Temporal Sensitivities

- Roadway capacity and use restrictions change considerably by time of day
  - HOV lanes, reversible roadways, street parking restrictions, turning movement restrictions, vehicle use restrictions, tolls and parking costs
- Transit routes and service levels
  - Run frequency and scheduled run times
  - Transit fares and park-&-ride lots

Network Coding Details



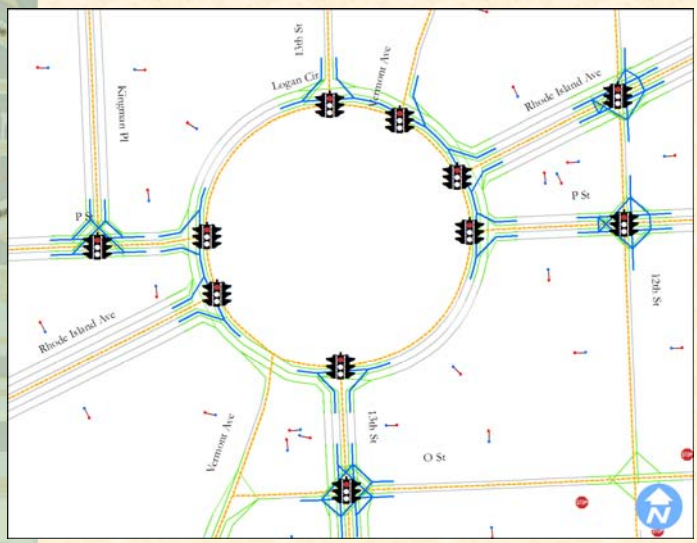
Activity Locations



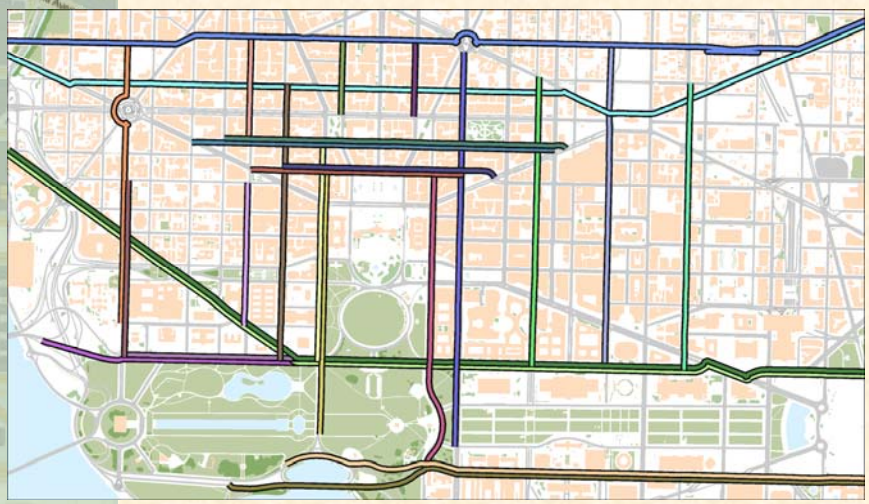
Adding Traffic Controls

- Synthesizing traffic signals
  - Facility and area types, number of lanes, pocket lanes, intersection geometry to define signal location warrants
  - Vary by time of day and demand
    - Turning volume-based adjustments
  - Signal progression and coordination
    - Circles and E-W/N-S/route priorities
  - Pedestrian and transit impacts
    - all reds and transit focused progression

Logan Circle Signals



Signal Progression Corridors



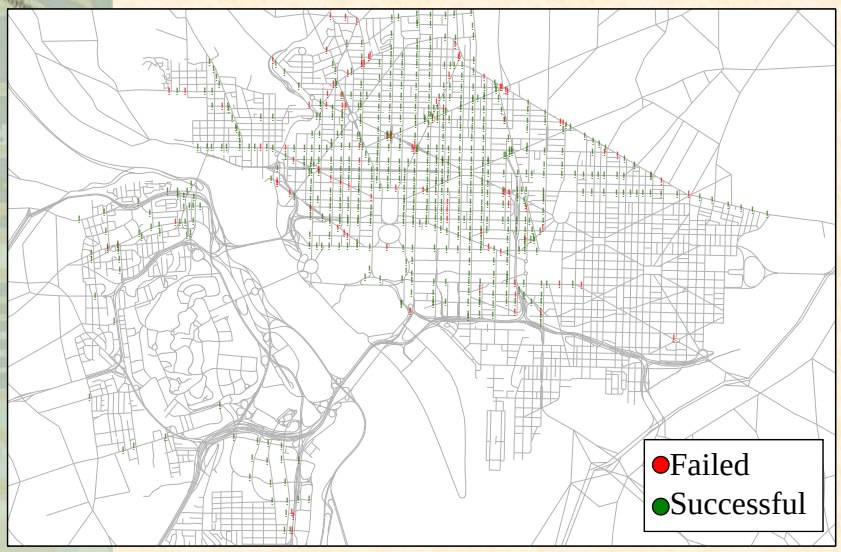
Import Synchro Signal Plans

- Replace synthetic signals with “actual” signal timing plans
  - Limited coverage and not always accurate
  - Matching links/nodes/directions/phases often difficult
    - Network details / reasons missing
- Mixing synthetic with “actual” often resulted in simulation problems
- Future forecasting issues / concerns

Synchro Timing Plans

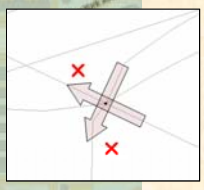
- Plans for five time periods
- Input Synchro signals = 631
- Successfully converted = 537 (85%)
- Types of errors
  - Intersection geometry mismatch
  - Lane-connections and signal phasing mismatch
  - Input data inconsistency
  - Coordinated actuated signals

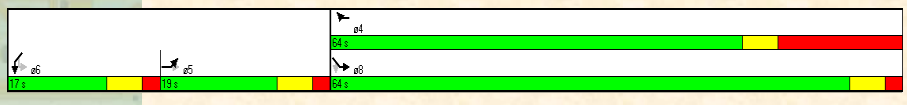
Synchro Problem Locations



Example Problem

- H Street and Massachusetts Ave.
  - The Synchro phasing did not include all of the lane-connectivity options at this intersection in the PM peak period.
    - West-bound through on Massachusetts and South-bound from H St to I-395 were missing





Demand-Side Inputs

- Converting and refining demand from traditional models
  - Convert MWCOG trip tables
    - Trip purpose and orientation important for time of day distributions
    - Review / refine based on CTPP data
  - Diurnal distribution curves
    - Smooth household survey data with 15-30 minute time periods
    - Adjust for regional / subarea variations

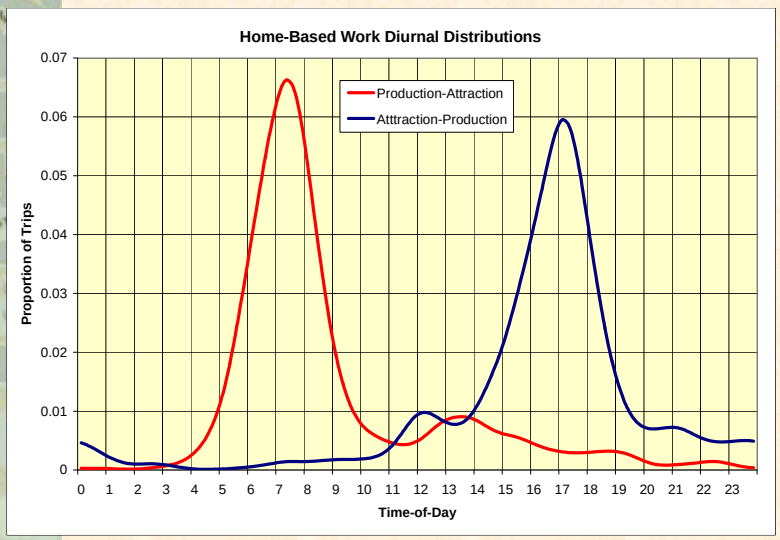
MWCOG Trip Tables

6-9 AM
HBW-SOV-PK-PA
HBW-HOV2-PK-PA
HBW-HOV3-PK-PA
HBW-WALK-PK-PA
HBW-P&R-PK-PA
HBO-SOV-PK-PA
HBO-HOV2-PK-PA
HBO-HOV3-PK-PA
HBO-WALK-PK-PA
HBO-P&R-PK-PA
NHB-SOV-PK-PA
NHB-HOV2-PK-PA
NHB-HOV3-PK-PA
NHB-WALK-PK-PA
NHB-P&R-PK-PA
THRU-TRUCK-AM
THRU-AUTO-AM
TAXI-AM
SCHOOL-AM
MED-TRUCK-AM
HVY-TRUCK-AM
AIRPORT-AM
VISITOR-AM

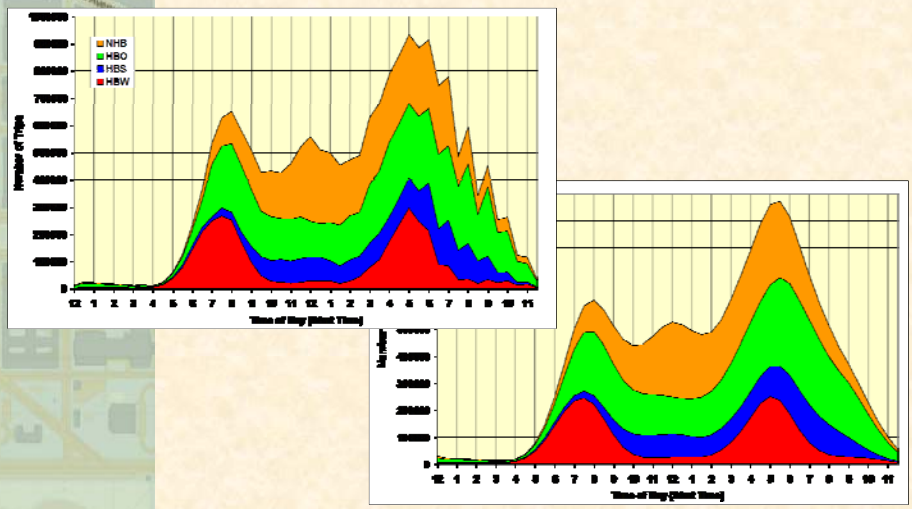
4-7 PM
HBW-SOV-PK-AP
HBW-HOV2-PK-AP
HBW-HOV3-PK-AP
HBW-WALK-PK-AP
HBW-P&R-PK-AP
HBO-SOV-PK-AP
HBO-HOV2-PK-AP
HBO-HOV3-PK-AP
HBO-WALK-PK-AP
HBO-P&R-PK-AP
NHB-SOV-PK-AP
NHB-HOV2-PK-AP
NHB-HOV3-PK-AP
NHB-WALK-PK-AP
NHB-P&R-PK-AP
THRU-TRUCK-PM
THRU-AUTO-PM
TAXI-PM
SCHOOL-PM
MED-TRUCK-PM
HVY-TRUCK-PM
AIRPORT-PM
VISITOR-PM

Other	
HBW-SOV-OP-PA	HBW-SOV-OP-AP
HBW-HOV2-OP-PA	HBW-HOV2-OP-AP
HBW-HOV3-OP-PA	HBW-HOV3-OP-AP
HBW-WALK-OP-PA	HBW-WALK-OP-AP
HBW-P&R-OP-PA	HBW-P&R-OP-AP
HBO-SOV-OP-PA	HBO-SOV-OP-AP
HBO-HOV2-OP-PA	HBO-HOV2-OP-AP
HBO-HOV3-OP-PA	HBO-HOV3-OP-AP
HBO-WALK-OP-PA	HBO-WALK-OP-AP
HBO-P&R-OP-PA	HBO-P&R-OP-AP
NHB-SOV-OP-PA	NHB-SOV-OP-AP
NHB-HOV2-OP-PA	NHB-HOV2-OP-AP
NHB-HOV3-OP-PA	NHB-HOV3-OP-AP
NHB-WALK-OP-PA	NHB-WALK-OP-AP
NHB-P&R-OP-PA	NHB-P&R-OP-AP
THRU-TRUCK-OP	
THRU-AUTO-OP	
TAXI-OP	
SCHOOL-OP	
MED-TRUCK-OP	
HVY-TRUCK-OP	
AIRPORT-OP	
VISITOR-OP	

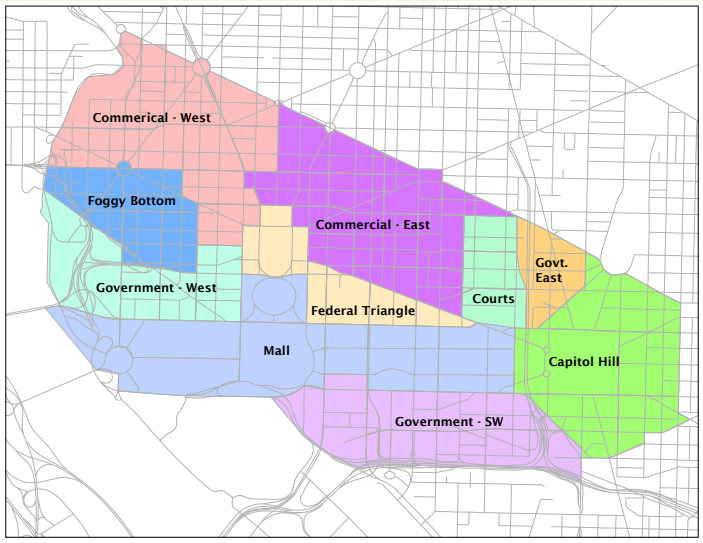
Diurnal Distributions



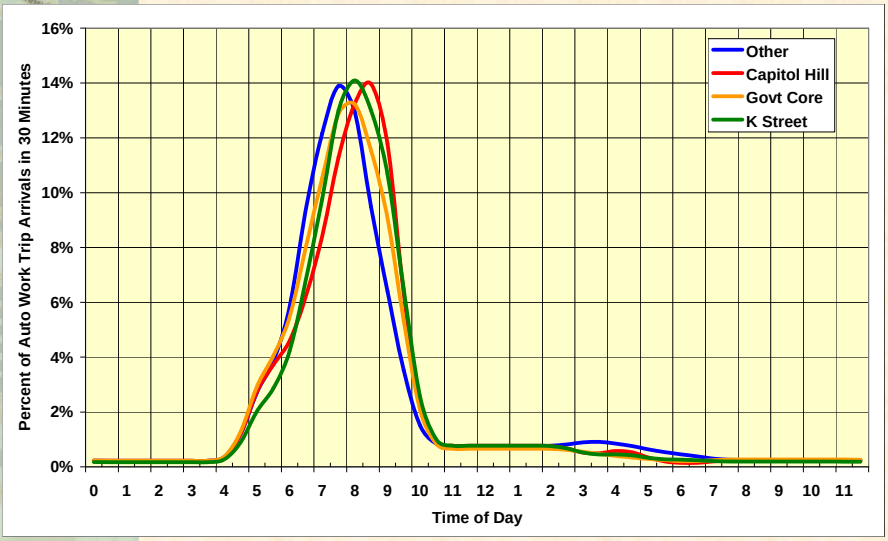
Household Survey Smoothing



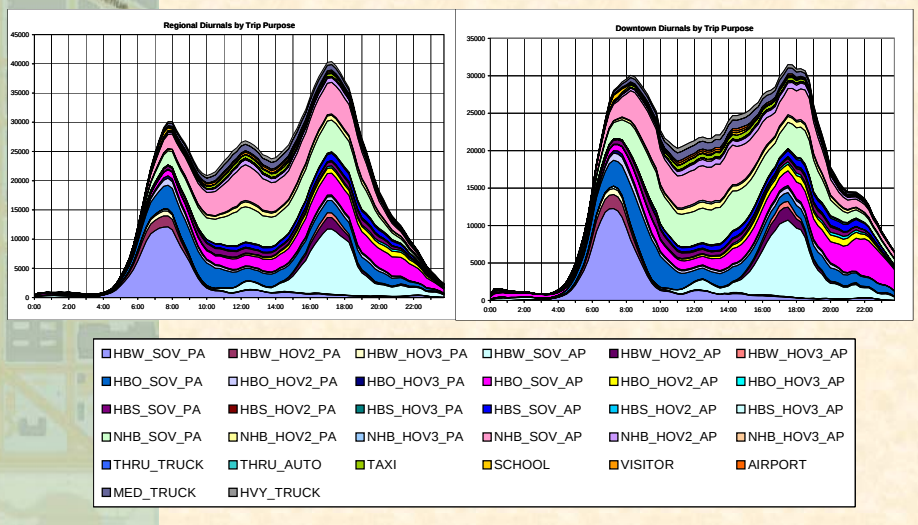
Arrival Time Distributions



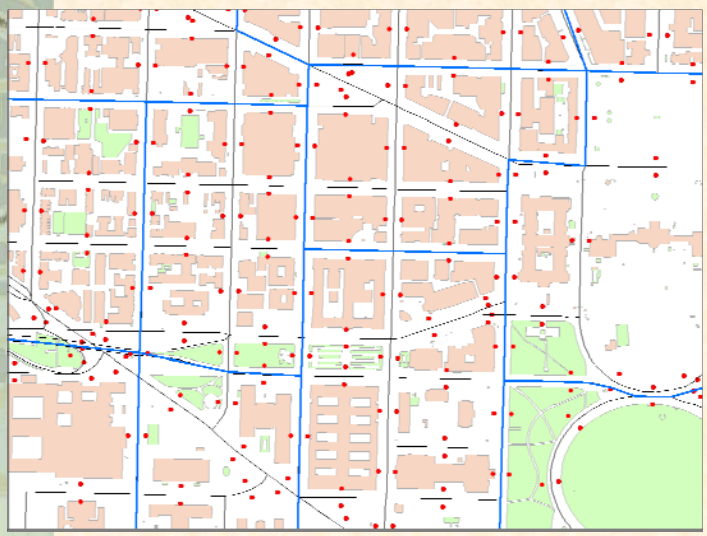
CTPP Arrival Times



Region vs. Downtown



TAZ Activity Allocation



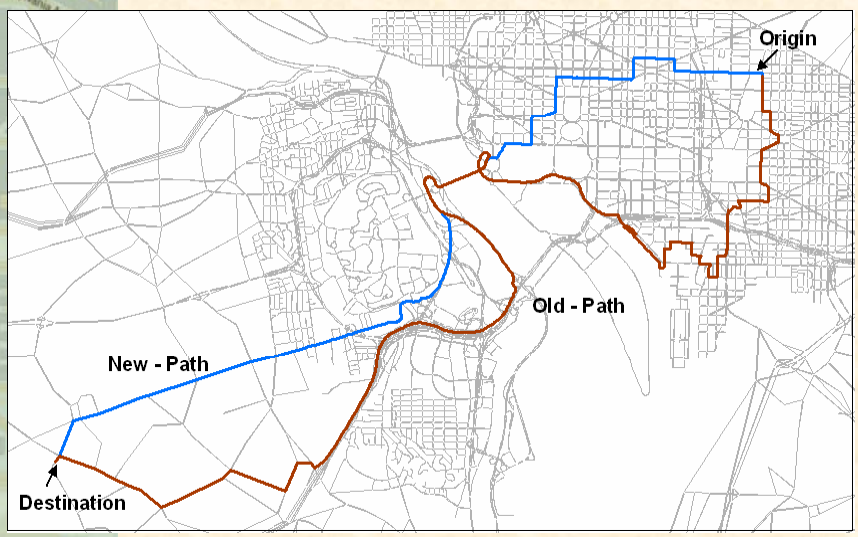
Stabilizing a Simulation

- Debug network coding problems
- Calibrate traveler behavior
  - Path weights and driver behavior
- "Optimize" traffic controls
  - Alternative specific / local policies
- Reconcile bus schedules and capacity
  - Travel times, load factors, park-&-ride
- Validate the network performance

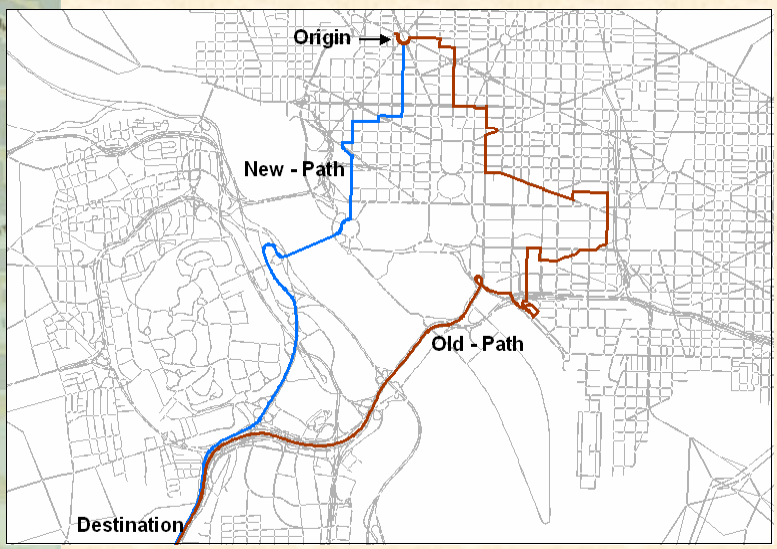
Calibration

- Logical travel paths
  - Impedance factors and constraints
  - Lane changing difficulties
- Intersection capacity / signal timing
  - Volume, queues and cycle failures
- Driver behavior
  - Logical volume – speed relationships
- Transit passenger processing delays

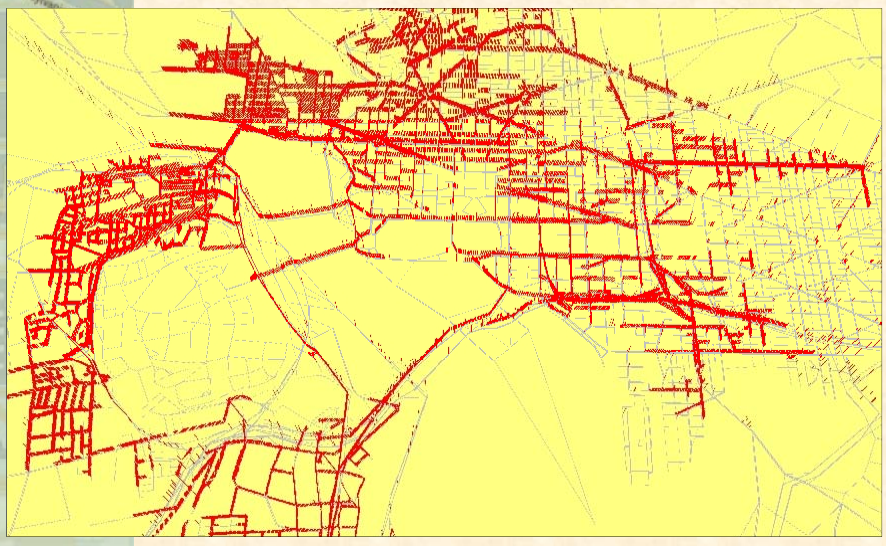
Calibrating Path Parameters



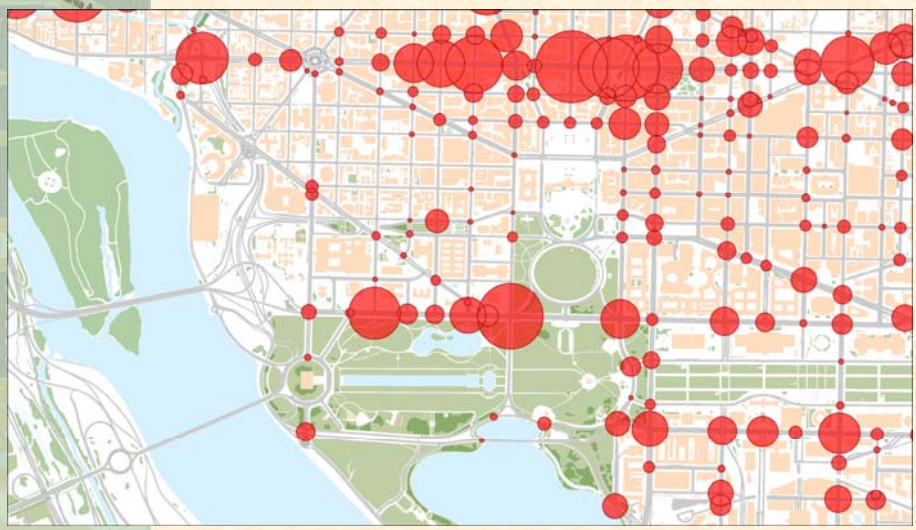
Calibrating Path Parameters



Cascading Queues



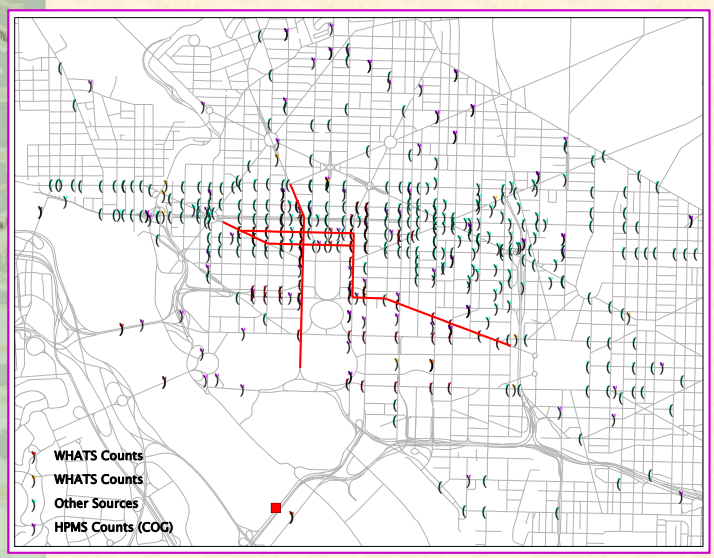
Cycle Failure Distributions



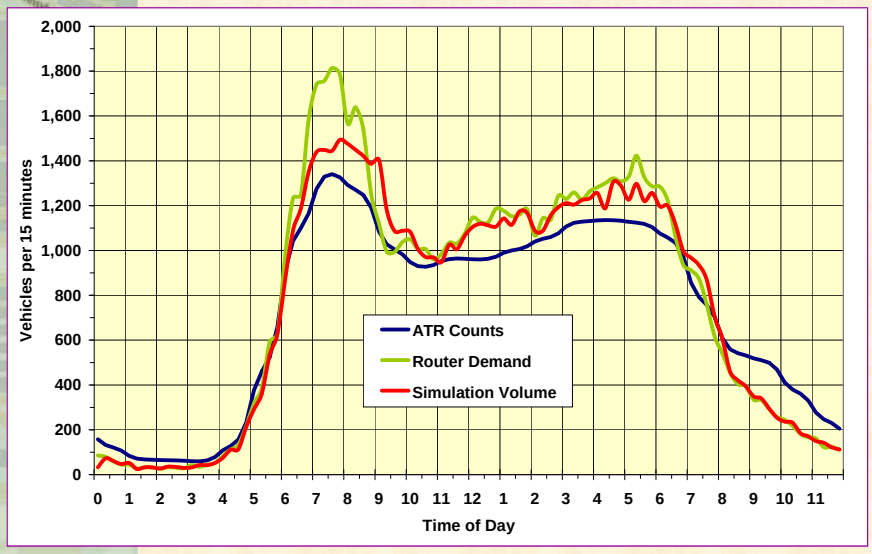
Validation

- 15 minute traffic counts vs. volumes
  - Diurnal distributions
  - Turning movement counts
  - Queue lengths (demand vs. volume)
- Ridership and station boarding counts
- Travel time and speed estimates
- Completed trips – lost vehicles

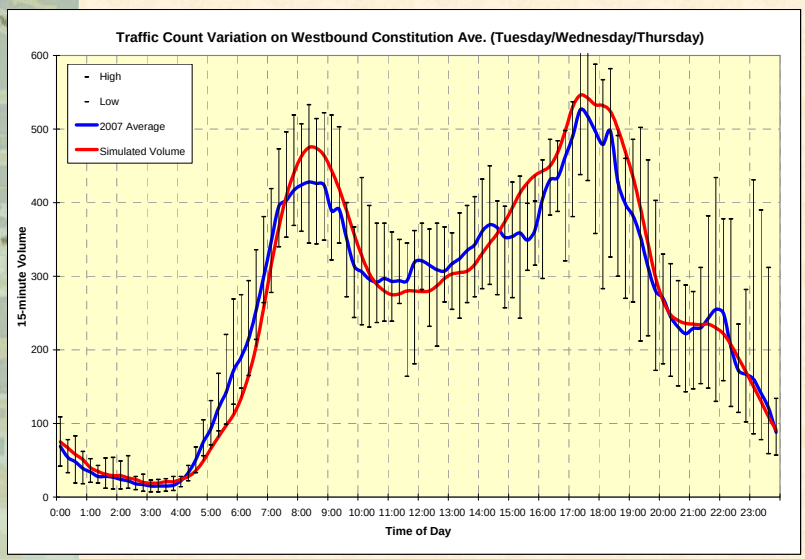
Data Locations



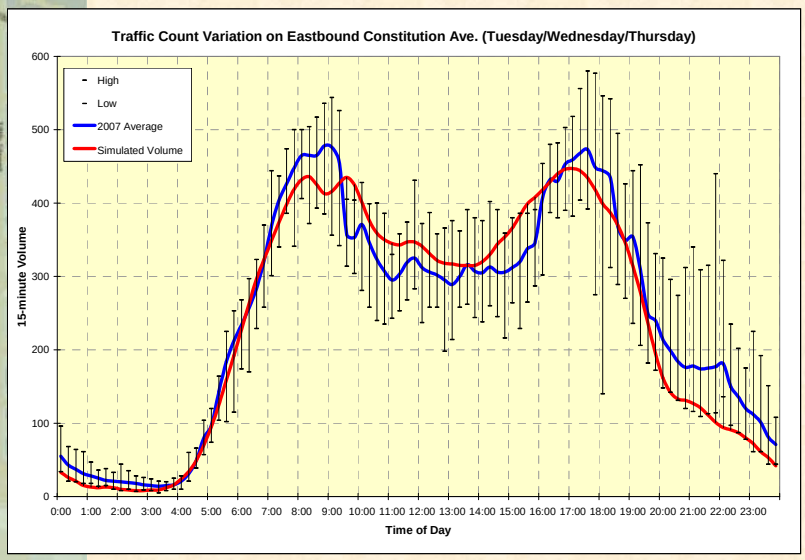
Demand vs. Simulated Counts



Traffic Count Comparison



Traffic Count Comparison



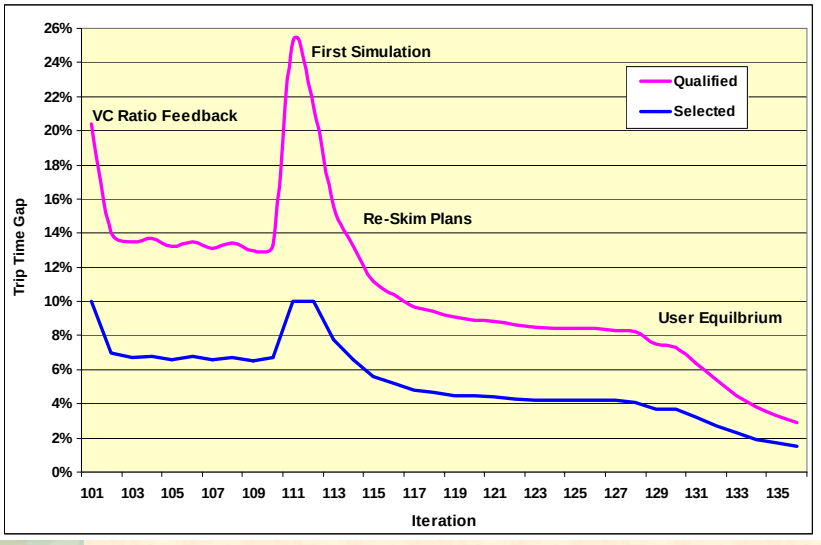
Dynamic User Equilibrium

- Model convergence requires both a stable simulation and individual travel paths that approach user equilibrium
  - Travel time vs. generalized cost
  - Travel times and costs change as a function of time of day (15 minutes)
  - Vehicle simulation requires a specific path for each traveler on a given travel day
  - Path only or trip time/mode/location also?

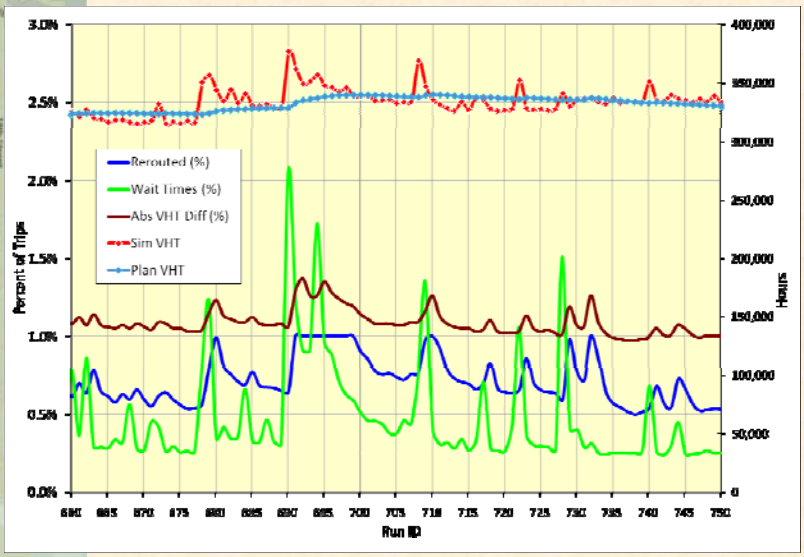
Capacity Constraint Impacts

- DTA / simulation models have true capacity constraints (i.e., V/C <= 1.0)
  - Significant implications for traditional equilibrium assignment methods
    - All-or-nothing assignments don't work
  - Major disruptions in the simulation stability seriously complicate the convergence process
    - "Gently" migrate toward convergence

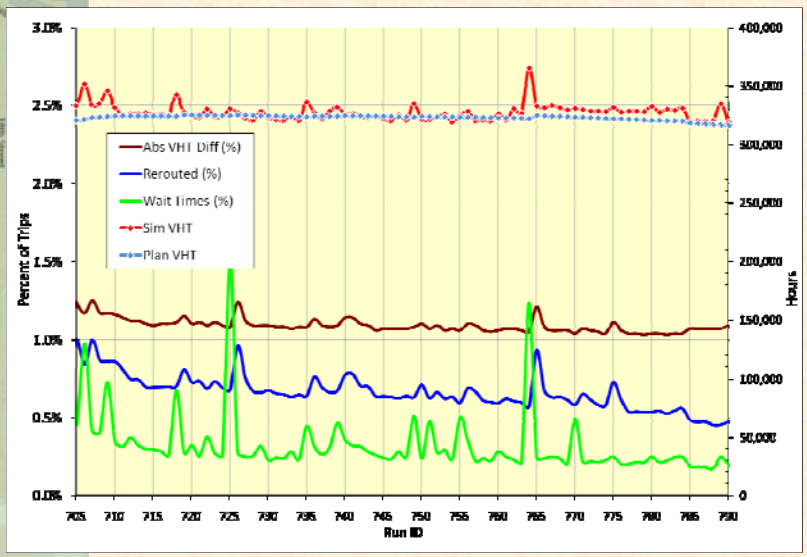
Stages of Convergence



Unstable User Equilibrium



Stable User Equilibrium



General Conclusions

- Temporal details were critical
  - Network coding and demand distribution
  - Validate and verify data sources
- DTA convergence requires both network stability and user equilibrium
  - Minimize problems / unrealistic delays
    - Capacity constraint impacts
  - Minimize the number of travelers who could improve their travel time by changing paths