TRANSIMS Training Course at TRACC
Transportation Research and Analysis Computing Center

Part 7

Convergence Control Using the Feedback (Alexandria Network Example)

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- Alexandria Model Example
- Feedback Process
  - Router Stabilization
  - Microsimulation Stabilization
  - Microsimulation User Equilibration
- Credits and Acknowledgement
Introduction to Feedback

- The goal is to load traffic onto the network and iterating towards the Nash equilibrium
  - Final Goal: Travelers cannot achieve significantly better routes when trying to choose a shorter path, meaning that each traveler chooses the route that’s best for the overall population
- Important constraint
  - Travelers choose a mode of transportation according to travel surveys; they are not optimizing their travel by choosing modes
- This is simplified
  - Typically, some activities will need to be modified as well to avoid unrealistic travel constraints
Feedback

- The TRANSIMS equilibration process iterates between router and microsimulator (details follow later)

- Some routes are not feasible, e.g.
  - Significantly longer than dictated by the survey data
  - Not feasible based on the given transportation mode
  - These trips or activities are passed back to the activity generator to determine appropriate alternatives

- In the Microsimulator, vehicles can stall because they are unable to change lanes or make turns
  - Passing the households that own the vehicle back to the router for new routing suggestions may solve the problem
  - Some plans cannot be followed because of time-dependent road closures and other triggers

- Tools are available to select households for rerouting based on many criteria
Program Flow

![Program Flow Diagram]

- Router
  - Plans
  - PlanPrep
    - Whole Plans
    - Microsimulator
      - PlanSelect
      - ProblemSelect
      - Link Delay
      - Household List
    - PlanSum
      - PlanCompare
      - LinkSum

Done?
Feedback Procedures

- Router Stabilization
  - Distribute traffic more logically prior to simulation
- Microsimulator Stabilization
  - Debug network and address simulation problems
- User Equilibrium
  - Equilibrate paths (Router) and travel times (Microsimulator)
- System Equilibrium
  - Stabilize link volumes and speed
- Link Delay Averaging
  - Dampen travel time fluctuations to reduce path oscillation and the number of iterations required to convergence
Alexandria Traffic Model Example

- Alexandria.zip
- C:\TransimsWork\Alexandria\n  - activity\ : Trip files and Activity Files are stored
  - control\ : control (*.ctl), batch (*.bat), and report (*.prn) files
  - household\ : Household files are stored
  - model\ : user scripts that implements various model algorithms
  - network\ : Various network data tables are stored
    - arcview\ : Arc View shape files are stored here
  - plans\ : Travel Plan files generated from Router are stored here
  - results\ : Link_Delay files are stored here
  - skims\ : relevant only for activity-based methods
  - survey\ : Surveys (e.g. diurnal distributions) are stored here
  - trips\ : Input Trip Tables are here
  - vehicle\ : Vehicle files are stored
Network Input Files

- **Node Data** *(Input_Node.txt)*

  NODE | X_COORD | Y_COORD |
  ----|---------|---------|
  70  | 323511.8| 4296015.8|
  71  | 323535.8| 4295682.3|

- **Link Data** *(Input_Link.txt)*

<table>
<thead>
<tr>
<th>LINK</th>
<th>STREET</th>
<th>ANODE</th>
<th>BNODE</th>
<th>LENGTH</th>
<th>TYPE</th>
<th>LANES_AB</th>
<th>SPEED_AB</th>
<th>LANES BA</th>
<th>SPEED BA</th>
<th>USE</th>
</tr>
</thead>
</table>
  1    | EXTERNAL | 70    | 2545  | 336   | EXTERNAL | 4     | 37.5     | 0        | 0        | ANY     |
  2    | EXTERNAL | 71    | 999   | 316   | EXTERNAL | 0     | 0        | 4        | 37.5     | ANY     |
  3    | EXTERNAL | 72    | 2746  | 151   | EXTERNAL | 3     | 37.5     | 0        | 0        | ANY     |

  - **Link Length** is defined in meters
  - **Speed** is defined in meters/second
  - **Facility Types**: FREEWAY, EXPRESSWAY, PRINCIPAL, MAJOR, MINOR, COLLECTOR, LOCAL, FRONTAGE, RAMP, BRIDGE, EXTERNAL, XPRESSWAY, PRIARTER, SECARTER, ZONECONN, OTHER, WALKWAY, BIKEWAY, BUSWAY, LIGHTRAIL, HEAVYRAIL, FERRY
  - **Vehicle use code**: combination of the following separated by slashes (e.g. CAR/TRUCK/BUS)
    - ANY, WALK, BIKE, CAR, TRUCK, BUS, RAIL, SOV, HOV2, HOV3, HOV4, LIGHTTRUCK, HEAVYTRUCK, RESTRICTED, AUTO, BICYCLE, TAXI, TROLLEY, STREETCAR, LIGHTRAIL, RAPIDRAIL, REGIONRAIL

- **Zone Data** *(Input_Zone.txt)*

<table>
<thead>
<tr>
<th>ZONE</th>
<th>X_COORD</th>
<th>Y_COORD</th>
<th>AREATYPE</th>
</tr>
</thead>
</table>
  1    | 322817.6| 4298231.2| 2        |
  2    | 322705.5| 4297360.2| 2        |
  3    | 322529.4| 4296728.4| 2        |

- **Shape Data** *(Input_Shape.txt)*

<table>
<thead>
<tr>
<th>LINK</th>
<th>POINTS</th>
<th>NOTES</th>
</tr>
</thead>
</table>
  102  | 44     |       |
  316814.3 | 4301507.9 |   |
  316810.7  | 4301502.0 |   |
Network Input Files (Alexandria)

- Network Data Display with ArcGIS
■ Prepares and Converts Network Data to the format required by TRANSIMS programs.

DataPrep.bat
set BINDIR="C:\TRANSIMS40\bin"
%BINDIR%\TransimsNet.exe TransimsNet.ctl
%BINDIR%\IntControl.exe IntControl.ctl
%BINDIR%\TransitNet.exe TransitNet.ctl
%BINDIR%\ArcNet.exe ArcNet.ctl
**Output Files from TransimsNet.ctl**

- **/network/**

  **Node**
  
<table>
<thead>
<tr>
<th>NODE</th>
<th>XCOORD</th>
<th>YCOORD</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>323511.80</td>
<td>4296015.80</td>
<td>External Station</td>
</tr>
<tr>
<td>71</td>
<td>323535.80</td>
<td>4295682.30</td>
<td>External Station</td>
</tr>
<tr>
<td>72</td>
<td>322196.10</td>
<td>4301400.80</td>
<td>External Station</td>
</tr>
</tbody>
</table>

  **Link**
  
  | LINK | STREET | ANODE | BNODE | LENGTH | SETBACK_A | SETBACK_B | BEARING_A | BEARING_B | TYPE | LANES_AB | LEFT_AB | RIGHT_AB | SPEED_AB | FSPD_AB | CAP_AB | LANES_BA | LEFT_BA | RIGHT_BA | SPEED_BA | FSPD_BA | CAP_BA | USE | NOTES          |
  |------|--------|-------|-------|--------|-----------|-----------|-----------|-----------|------|---------|--------|---------|----------|--------|--------|---------|--------|---------|----------|--------|--------|--------|-------|-------|-----|----------------|
  | 1    | EXTERNAL | 70    | 2545  | 336.00 | 0.0       | 0.0       | 233       | 233       | EXTERNAL | 4       | 0       | 0       | 45.0    | 37.5    | 8000    | 0       | 0       | 0       | 0       | 0       | ANY     | External Connector |

  **Activity_Location**
  
<table>
<thead>
<tr>
<th>ZONE</th>
<th>XCOORD</th>
<th>YCOORD</th>
<th>AREATYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>322817.6</td>
<td>4298231.2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>322705.5</td>
<td>4297360.2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>322529.4</td>
<td>4296728.4</td>
<td>2</td>
</tr>
</tbody>
</table>

  **Pocket Lane**
  
<table>
<thead>
<tr>
<th>POCKET</th>
<th>LINK</th>
<th>NODE</th>
<th>OFFSET</th>
<th>LANES</th>
<th>TYPE</th>
<th>LENGTH</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>112</td>
<td>118</td>
<td>0.0</td>
<td>3</td>
<td>T</td>
<td>40.0</td>
<td>Right Turn Lane</td>
</tr>
<tr>
<td>2</td>
<td>207</td>
<td>1496</td>
<td>0.0</td>
<td>1</td>
<td>T</td>
<td>40.0</td>
<td>Left Turn Lane</td>
</tr>
<tr>
<td>3</td>
<td>207</td>
<td>1496</td>
<td>0.0</td>
<td>4</td>
<td>T</td>
<td>40.0</td>
<td>Right Turn Lane</td>
</tr>
</tbody>
</table>

  And more…
Traffic Network Components
Transit Routes and Transit Stops
A Few Caveats

- **Warning and Error Messages**
  - “Nodes Missing” error when executing TransimsNet
    - **Cause:** Input_Nodes includes nodes for Transits nodes that do not have connecting road links
    - **Fix:**
      - Make a list of those nodes, e.g. ‘Input_Keep_Nodes.txt’
      - Add a line in TransimsNe.ctl
      - Run TransimsNet again

- **TransitNet generates *_2 files**
  - Activity_Location_2
  - Parking_2
  - Process_Link_2
Network Error Debugging

- Warnings encountered during TransitNet Execution
  - Warning: Node 112 has Exit Links but No Entry Links
  - Warning: Node 1034 has Entry Links but No Exit Links
  - Warning: Node 2540 has Entry Links but No Exit Links
  - Warning: Node 3625 has Entry Links but No Exit Links
  - Warning: Link 4526 @ Node 1691 has no exit links.

Inconsistencies at the Network Boundary Node-Links

Our Approach to Resolution:
- Add new external nodes and links
TRANSIMS Training Course at TRACC
Inconsistent Network Data Entries
Trip Generation

- Generates Trips from Activity or Zone-to-Zone trip table

set BINDIR="C:\TRANSIMS40\bin"

%BINDIR%\ConvertTrips.exe ConvertTrips.ctl
Trip Generation

- ConvertTrip
  - Convert Zone-to-Zone Traffic Table to Location-to-Location Trips

### Zone-to-Zone Trip Table

<table>
<thead>
<tr>
<th>ORG</th>
<th>DES</th>
<th>TRIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>450</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>440</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>208</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>614</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>429</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>446</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>213</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>638</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>203</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>209</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>112</td>
</tr>
</tbody>
</table>

### Diurnal Distribution

```
0 5 10 15 20 25 30
```

- Trips
- Household
- Population
- Vehicle

Traffic Zones & Activity Locations
ConvertTrip.ctl

**NET_ACTIVITY_LOCATION**

**PROCESS_LINK**

**Daily_Trips**

**Smooth_Diurnal**

**Transit_Trips**

**TripTime (Survey)**

**ConvertTrip**

**TRIP_FILE**

**POPULATION_FILE**

**HOUSEHOLD_FILE**

**VEHICLE_FILE**

**STARTING_HOUSEHOLD_ID**

**STARTING_VEHICLE_ID**

**TIME_OF_DAY_FORMAT**

**MINIMUM_TRAVEL_TIME**

**RANDOM_NUMBER_SEED**

**TITLE** Convert Alexandria Trip Tables

**DEFAULT_FILE_FORMAT** TAB_DELIMITED

**PROJECT.Directory** ../

**NET_DIRECTORY** .. network

**NET.Activity_Location_Table** Activity_Location_2

**NET.Process_Link_Table** Process_Link_2

**TRIP_TABLE_FILE_1** trips/HBW_SOV_PA.txt

**TRIP_TIME_FILE_1** survey/HBW_SOV_PA_Diurnal.txt

**TIME_CONTROL_POINT_1** DESTINATION

**ORIGIN_WEIGHT_FIELD_1** NULL

**DESTINATION_WEIGHT_FIELD_1** NULL

**TRIP_PURPOSE_CODE_1** 1

**TRAVEL_MODE_CODE_1** 2

**AVERAGE_TRAVEL_SPEED_1** 15

**VEHICLE_TYPE_1** 1

**VEHICLE_SUBTYPE_1** 0

**TRIP_TABLE_FILE_7** trips/HBW_TRN_PA.txt

**TRIP_TIME_FILE_7** survey/HBW_TRN_PA_Diurnal.txt

**TIME_CONTROL_POINT_7** DESTINATION

**ORIGIN_WEIGHT_FIELD_7** NULL

**DESTINATION_WEIGHT_FIELD_7** NULL

**TRIP_PURPOSE_CODE_7** 1

**TRAVEL_MODE_CODE_7** 3

**AVERAGE_TRAVEL_SPEED_7** 10

**VEHICLE_TYPE_7** 4

**VEHICLE_SUBTYPE_7** 0

**TRIP_FILE** activity/Trip

**POPULATION_FILE** household/Population

**HOUSEHOLD_FILE** household/Household

**VEHICLE_FILE** vehicle/Vehicle

**STARTING_HOUSEHOLD_ID** 1

**STARTING_VEHICLE_ID** 1

**TIME_OF_DAY_FORMAT** SECONDS

**MINIMUM_TRAVEL_TIME** 180

**RANDOM_NUMBER_SEED** 14445
## Output:

### Trip

<table>
<thead>
<tr>
<th>HHOLD</th>
<th>PERSON</th>
<th>TRIP</th>
<th>PURPOSE</th>
<th>MODE</th>
<th>VEHICLE</th>
<th>START</th>
<th>ORIGIN</th>
<th>ARRIVE</th>
<th>DESTINATION</th>
<th>CONSTRAINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>30342</td>
<td>1877</td>
<td>31049</td>
<td>4159</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>29133</td>
<td>3178</td>
<td>29918</td>
<td>6947</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>26788</td>
<td>1890</td>
<td>27513</td>
<td>2956</td>
<td>1</td>
</tr>
</tbody>
</table>

### Household

<table>
<thead>
<tr>
<th>HHOLD</th>
<th>LOCATION</th>
<th>PERSONS</th>
<th>WORKERS</th>
<th>VEHICLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1877</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3178</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1890</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### Population

<table>
<thead>
<tr>
<th>HHOLD</th>
<th>PERSON</th>
<th>AGE</th>
<th>GENDER</th>
<th>WORK</th>
<th>DRIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>25</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<td>25</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>25</td>
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<tr>
<td>4</td>
<td>1</td>
<td>25</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### Vehicle

<table>
<thead>
<tr>
<th>VEHICLE</th>
<th>HHOLD</th>
<th>LOCATION</th>
<th>TYPE</th>
<th>SUBTYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1877</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3178</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>1890</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4167</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Feedback Process

Router Stabilization
- Router
  - PlanPrep (Merge)
    - PlanSum
      - PlanSelect
        - Done? yes
          - Microsimulator Stabilization
            - Router
              - PlanPrep (Merge/Sort)
                - Microsimulator
                  - PlanCompare
                    - Done? yes
                      - User Equilibrium
                        - Microsimulator
                          - PlanPrep (merge/sort)
    - Done? no
      - Router
        - PlanPrep (Merge)
          - PlanSum
            - PlanSelect
              - Done? no
                - Router
                  - PlanPrep (Merge)
                    - PlanSum
                      - PlanSelect
                        - Done? yes
                          - Microsimulator
                            - PlanPrep (Merge/Sort)
                              - Microsimulator
                                - PlanCompare
                                  - Done? yes
                                    - User Equilibrium
                                      - Microsimulator
                                        - PlanPrep (merge/sort)
**Router Stabilization**

- **Objectives**
  - Resolve Network Problems
  - Refine Travel Plans to logically distribute traffic prior to Microsimulation

- **Feedback Process**
  - Route (*Router*)
  - Merge (*PlanPrep* with ‘Traveler’ option)
  - Estimate Link Delay (*PlanSum*)
  - Select (*PlanSelect*)
Router

- Builds **Time dependent Minimum Impedance** Travel Paths (**Plans**) for Trips or Activities belonging to a specified list of Households
  - *Impedance: Time, Cost, Penalty*
- 294362 households processed
- You will get many problems

![Diagram of Router]

<table>
<thead>
<tr>
<th>HHOLD</th>
<th>PERSON</th>
<th>TRIP</th>
<th>MODE</th>
<th>PROBLEM</th>
<th>START</th>
<th>ORIGIN</th>
<th>ARRIVE</th>
<th>DESTINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>489</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>25064</td>
<td>1894</td>
<td>26660</td>
<td>32</td>
</tr>
<tr>
<td>490</td>
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<td>1</td>
<td>2</td>
<td>1</td>
<td>29876</td>
<td>4147</td>
<td>31446</td>
<td>32</td>
</tr>
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<td>668</td>
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<td>1</td>
<td>2</td>
<td>1</td>
<td>33911</td>
<td>871</td>
<td>35893</td>
<td>3</td>
</tr>
<tr>
<td>672</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>38629</td>
<td>3709</td>
<td>40664</td>
<td>3</td>
</tr>
<tr>
<td>693</td>
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<td>1</td>
<td>2</td>
<td>1</td>
<td>32564</td>
<td>3707</td>
<td>34589</td>
<td>3</td>
</tr>
<tr>
<td>1013</td>
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<td>2</td>
<td>1</td>
<td>29235</td>
<td>3834</td>
<td>30669</td>
<td>32</td>
</tr>
</tbody>
</table>
Path Building Problem
  - **Cause:** Inconsistent trip assignment to one-way segment of external links
  - **Resolution:** Modify Activity location table & ConvertTrip
    - **Origin/destination weight key**
    - **Disable return trip offset**
  - Routing Problems: 20855 -> 1091
Another Path Building Problem

- **Problem**: Link 4030 (Jefferson Davis) had a missing link. This resulted in problems for the nearby activity locations.

- **Solution**: Bnode value of link 4030 was changed from 2631 to 2384. This completed the link and continuation of the road.
Another Path Building Problem

- **Problem**: Here the link 198 (Commonwealth) was connected from Node 150 to Node 225 but, because of this there was no connection of that link with link 4391 (Luna Park). This created lot of access restriction and path building problems for activity locations that were around that area.

- **Solution**: Link 198 was changed to be connected to Node 150 to Node 161. Another link called 204 (Commonwealth) was introduced to be connected from Node 225 to Node 161, thus making the traffic flow freely from Luna Park to Commonwealth.
Another Path Building Problem

- **Problem**: Link 4572 was going in the wrong direction. This created Path building problems for the activity locations in the nearby area.

- **Solution**: The direction was changed. Lanes AB and SpeedAB were filled with 1 and 22.5 respectively while Lanes BA and SpeedBA parameters were made 0.
- Debug Network Errors (cont’d)
  - Access Restriction Problem
    - **Cause:** The road is restricted to a certain vehicle type only
    - **Resolution:** Change the access type of the link
  - Zero Node Problem
    - **Cause:** Origin and Destination in the same link
    - **Resolution:** Practically not worth it
  - Circuity Problem
    - **Cause:** Cannot find path in given circuity
    - **Resolution:** Increase circuity ratio or Give up
Router Run Try 1:
- **Conditions:**
  - `ConvertTrip.ctl` – No Mid-trip data, the block which deals with `Return_Trip_Offset` key was also commented out.
  - Router run gave 23 Problems, which had only 2 path related problems.

Router Run Try 2:
- **Conditions:**
  - `ConvertTrip.ctl` – No Mid-trip data, the block which deals with `Return_Trip_Offset` key is **not** commented out, but `Return_trip_offset` key is commented out.
  - Router run gave 244 Problems, which had 17 path related problems at activity locations 7236 and 7237. Here is where Link 4572 is fixed, which is described in the following section.
**Other Path Building Problem**

- **Problem**: Activity Locations 1 and 42 are both External Origin Activity Locations. The problems file showed that problems were created when activity location 1 and 42 were used as destinations. This means that even though it was origin traffic tried to go there which is not possible.

- **Solution**: Activity Location 1 falls in Zone 70. All of the trip table files that ConvertTrip.ctl uses, namely HBW_HOV__AP.txt, do have some traffic destined for Zone 70 which is incorrect because Location 1 is only an Origin. Similarly, Activity Location 42 falls in Zone 90 and the input data has some traffic destined there. Eliminating this should take care of the path building problems and the network will be left with only Zero Node problems.
### Input_link.txt File Changes

<table>
<thead>
<tr>
<th>Description</th>
<th>Field</th>
<th>Initial</th>
<th>Change</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 3, 4, 5, 9, 13, 14, 15, 18, 19, 31, 34, and 36 (External)</td>
<td>Use</td>
<td>any</td>
<td>car/truck/bus</td>
<td>Any means that people can walk on the freeway</td>
</tr>
<tr>
<td>36 (External)</td>
<td>lanes</td>
<td>BA</td>
<td>1</td>
<td>new</td>
</tr>
<tr>
<td>37, 38, 39, 40 (External)</td>
<td>lanes</td>
<td>BA</td>
<td>1</td>
<td>new</td>
</tr>
<tr>
<td>1129 (George Washington)</td>
<td>Lanes</td>
<td>AB</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1129 (George Washington)</td>
<td>Use</td>
<td>car/bus</td>
<td>car/truck/bus</td>
<td></td>
</tr>
<tr>
<td>1223 (George Washington)</td>
<td>Lanes</td>
<td>AB</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1223 (George Washington)</td>
<td>Use</td>
<td>car/bus</td>
<td>car/truck/bus</td>
<td></td>
</tr>
<tr>
<td>1560 (George Washington)</td>
<td>Lanes</td>
<td>AB</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1560 (George Washington)</td>
<td>Use</td>
<td>car/bus</td>
<td>car/truck/bus</td>
<td></td>
</tr>
<tr>
<td>1731 (George Washington)</td>
<td>Lanes</td>
<td>AB</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1731 (George Washington)</td>
<td>Use</td>
<td>car/bus</td>
<td>car/truck/bus</td>
<td></td>
</tr>
<tr>
<td>2421 (Clermont)</td>
<td>Lanes</td>
<td>AB</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3066 (George Washington)</td>
<td>Lanes</td>
<td>AB</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3066 (George Washington)</td>
<td>Use</td>
<td>car/bus</td>
<td>car/truck/bus</td>
<td></td>
</tr>
<tr>
<td>3069 (George Washington)</td>
<td>Lanes</td>
<td>AB</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3069 (George Washington)</td>
<td>Use</td>
<td>car/bus</td>
<td>car/truck/bus</td>
<td></td>
</tr>
<tr>
<td>3300 (Jefferson Davis)</td>
<td>lanes</td>
<td>ab&amp;ba</td>
<td>1ba</td>
<td>1ab</td>
</tr>
<tr>
<td>3349 (Kenmore)</td>
<td>lanes</td>
<td>ab&amp;ba</td>
<td>1ba</td>
<td>1ab</td>
</tr>
<tr>
<td>3350 (Van Dorn)</td>
<td>lanes</td>
<td>ab&amp;ba</td>
<td>1ba</td>
<td>1ab</td>
</tr>
<tr>
<td>4029 (Jefferson Davis)</td>
<td>node</td>
<td>2631</td>
<td>3428</td>
<td>traffic over flow due to over extended link</td>
</tr>
<tr>
<td>4029 (Jefferson Davis)</td>
<td>length</td>
<td>569</td>
<td>455</td>
<td>traffic over flow due to over extended link</td>
</tr>
<tr>
<td>4030 (Jefferson Davis)</td>
<td>node</td>
<td>2631</td>
<td>2384</td>
<td>missing link between nodes</td>
</tr>
<tr>
<td>4716 (Edsall)</td>
<td>node</td>
<td>3627</td>
<td>3625</td>
<td>traffic over flow due to over extended link at intersection</td>
</tr>
<tr>
<td>4716 (Edsall)</td>
<td>length</td>
<td>912</td>
<td>871</td>
<td>traffic over flow due to over extended link at intersection</td>
</tr>
<tr>
<td>4771 (Edsall)</td>
<td>link</td>
<td>new</td>
<td>connect between two nodes</td>
<td></td>
</tr>
<tr>
<td>4796 (Clermont)</td>
<td>lanes</td>
<td>ab</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6000 (External)</td>
<td>link</td>
<td>6000</td>
<td>40</td>
<td>link did not connect to a node in the middle</td>
</tr>
<tr>
<td>198 (Commonwealth)</td>
<td>node</td>
<td>225</td>
<td>161</td>
<td>link added as changes were made in link 198</td>
</tr>
<tr>
<td>204 (Commonwealth)</td>
<td>new</td>
<td></td>
<td></td>
<td>link added as changes were made in link 198</td>
</tr>
<tr>
<td>4572 (Abingdon)</td>
<td>AB</td>
<td>1</td>
<td>0</td>
<td>going in wrong direction</td>
</tr>
<tr>
<td>4573 and 4574</td>
<td>AB</td>
<td>1</td>
<td>0</td>
<td>going in wrong direction</td>
</tr>
</tbody>
</table>
### Input_node.txt File Changes

<table>
<thead>
<tr>
<th>Description</th>
<th>Field</th>
<th>Initial</th>
<th>Change</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>92, 93, and 94 (External)</td>
<td>node</td>
<td></td>
<td>car/truck/bus</td>
<td>Any means that people can walk on the freeway</td>
</tr>
</tbody>
</table>

### Input_shape.txt File Changes

<table>
<thead>
<tr>
<th>Description</th>
<th>Field</th>
<th>Initial</th>
<th>Change</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>4029</td>
<td>points</td>
<td>10</td>
<td>7</td>
<td>removed last three x_coord and y_coord</td>
</tr>
<tr>
<td>4716</td>
<td>points</td>
<td>51</td>
<td>48</td>
<td>removed last three x_coord and y_coord</td>
</tr>
</tbody>
</table>
Router Stabilization – Feedback

- Refine Travel Plans to logically distribute traffic prior to Microsimulation

- Feedback Process
  - Router
  - PlanPrep with ‘Traveler’ option (Merge)
  - PlanSum (Estimate Link Delay)
  - PlanSelect (Select household for feedback)
    - Random Re-Routes
    - VC Ratio
      - Re-route travelers whose path includes high V/C ratio links
    - Time Difference
      - Re-route travelers whose trip duration in the Plan file is significantly different from the travel time calculated from the path
PlanSelect Control Keys

- Random re-routes
  - SELECTION_PERCENTAGE: <= 10%

- VC Ratio stabilization
  - SELECT_VC_RATIO: >= 1.5
  - SELECTION_PERCENTAGE: >= 50%
  - MAXIMUM_PERCENT_SELECTED: <= 10%

- Plan Time stabilization
  - PERCENT_TIME_DIFFERENCE: >= 10%
  - MINIMUM_TIME_DIFFERENCE: ~2 minutes
  - MAXIMUM_TIME_DIFFERENCE: 30+ minutes
  - SELECTION_PERCENTAGE: >= 50% or more
  - MAXIMUM_PERCENT_SELECTED: <= 10%
Router Stabilization Batch Script
Router Stabilization (continued)

- Refine Travel Plans to logically distribute traffic prior to Microsimulation

Table 1. Selection Criteria for Router Stabilization

<table>
<thead>
<tr>
<th>Variables</th>
<th>Iterations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-4</td>
</tr>
<tr>
<td>Select_VC_Ratios</td>
<td>2.0</td>
</tr>
<tr>
<td>Percent Time Difference</td>
<td>-</td>
</tr>
<tr>
<td>Minimum Time Difference</td>
<td>-</td>
</tr>
<tr>
<td>Maximum Time Difference</td>
<td>-</td>
</tr>
<tr>
<td>Selection_percentage</td>
<td>50</td>
</tr>
<tr>
<td>Maximum_percent_selected</td>
<td>10</td>
</tr>
<tr>
<td>Select_time_periods</td>
<td>all</td>
</tr>
</tbody>
</table>

Router Stabilization

![Graph showing the effect of router stabilization on traffic distribution](image-url)
Router Feedback Oscillations

- The graphs on the right show 5 cases that ran through 50 iterations between Router and PlanSum (no microsimulation).
- PlanSelect has been instructed to select trips based on volume/capacity ratios:
  - Trips get selected if they go through a link at a time when the V/C ratio is greater than 1.3.
  - Of 28 million trips, about 8 million get selected initially.
  - Rerouting subsets of 2, 4, 6, 8, and 10% in each iteration leads to the results shown on the right.

2%: Slow convergence, but achieves better convergence.
Microsimulator Stabilization

- Purpose
  - Debug further network problems
  - Address simulation problems

- Microsimulator

  ![Diagram showing Microsimulator input and output files]

  - **NET_***
  - **VEHICLE_FILE**
  - **PLAN_FILE**

  - **NEW_PROBLEM_FILE** (e.g. MsimProblems)
  - **OUTPUT_SNAPSHOT_FILE_#** (e.g. Snapshot)
  - **OUTPUT_SUMMARY_FILE_#** (e.g. LinkDelay)
  - **OUTPUT_PROBLEM_FILE_#** (e.g. ProblemLink)
ArcGIS
Network Cleaning

- Plotting of problems from both the router and the microsimulator allows for the identification of many problems, such as
  - Inconsistent network coding
    - Usage restrictions
    - Incorrectly placed signals
    - Link connectivity
  - Traffic flow
    - Unrealistic bottlenecks
    - Signal timing
    - And many more …

ArcGIS visualization is part of a separate training session
- **ProblemSelect**: Travelers with specified problem types
  - Network Connectivity
  - Parking Access:
    - *Bigger ellipse or ENFORCE_PARKING_LANES*
    - Wait time, Departure time, Arrival Time
Microsimulator Stabilization (continued)

- PlanSelect
  - Targeted re-routes
    - Congested time periods
    - Geographic areas / OD patterns
    - Network coding changes / problems
  - Plan Time Stabilization
    - Re-route travelers whose trip duration in the Plan file is significantly different from the travel time calculated from the path

![Diagram of Microsimulator Stabilization process]
Targeted Feedback (PlanSelect)

- Congested time periods
  - SELECT_TIME_PERIODS (e.g. 6:00..10:00)
- Geographic areas / OD patterns
  - SELECT_COORDINATES (e.g., x1, y1, x2, y2)
  - SELECT_OD_COORDINATES
  - EXCLUDE_OD_COORDINATES
- Network coding changes / problems
  - SELECT_NODES_x (e.g., 100, 200, 300)
  - SELECT_PARKING_LOTS
  - SELECT_TRANSIT_STOPS
Identification of Convergence Problems

Several tools exist to identify problems visually and numerically:
- LinkSum, PlanSum, ArcDiff, ArcPlan, ArcProblem, ArcSnapshot, and more
- ArcSnapshot output is shown on the right, vehicles are color-coded by speed
- Video sequences can help identifying problems at intersection, especially with traffic signals
- LinkSum
  - Generates various statistics files for us to analyze traffic conditions

![Diagram showing LinkSum and its outputs:]
- LINK_DELAY_FILE
- NET_LINK_TABLE
- NEW_LINK_VOLUME_FILE
- NEW_LINK_SPEED_FILE
- NEW_LINK_VC_RATIO_FILE
- NEW_LINK_TRAVEL_TIME_FILE
- NEW_LINK_TIME_RATIO_FILE
Microsimulator Stabilization Batch Script
### Microsimulator Stabilization (continued)

<table>
<thead>
<tr>
<th>IT</th>
<th>ProblemSelectType</th>
<th>Selected = written</th>
<th>Msim Run time</th>
<th>Msim Total Probs</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>WAIT_TIME</td>
<td>8796</td>
<td>6:10AM</td>
<td>9958</td>
</tr>
<tr>
<td>17</td>
<td>WAIT_TIME</td>
<td>9732</td>
<td>6:10AM</td>
<td>8468</td>
</tr>
<tr>
<td>18</td>
<td>WAIT_TIME, ARRIVAL_TIME, DEPARTURE_TIME</td>
<td>4809</td>
<td>6:10AM</td>
<td>5128</td>
</tr>
<tr>
<td>19</td>
<td>WAIT_TIME, ARRIVAL_TIME, DEPARTURE_TIME</td>
<td>4915</td>
<td>6:10AM</td>
<td>4915</td>
</tr>
<tr>
<td>20</td>
<td>WAIT_TIME, ARRIVAL_TIME</td>
<td>4704</td>
<td>6:10AM</td>
<td>996</td>
</tr>
<tr>
<td>21</td>
<td>WAIT_TIME, ARRIVAL_TIME</td>
<td>827</td>
<td>6:10AM</td>
<td>530</td>
</tr>
<tr>
<td>22</td>
<td>WAIT_TIME, ARRIVAL_TIME</td>
<td>370</td>
<td>6:10AM</td>
<td>462</td>
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<tr>
<td>23</td>
<td>WAIT_TIME, ARRIVAL_TIME</td>
<td>71669</td>
<td>6:10AM</td>
<td>70836</td>
</tr>
<tr>
<td>24</td>
<td>All</td>
<td>62653</td>
<td>Whole Day</td>
<td>44287</td>
</tr>
<tr>
<td>25</td>
<td>ARRIVAL_TIME</td>
<td>37404</td>
<td>Whole Day</td>
<td>32237</td>
</tr>
<tr>
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<td>Whole Day</td>
<td>25744</td>
</tr>
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<td>27</td>
<td>ARRIVAL_TIME</td>
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<td>Whole Day</td>
<td>14391</td>
</tr>
<tr>
<td>28</td>
<td>ARRIVAL_TIME</td>
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<td>Whole Day</td>
<td>595</td>
</tr>
<tr>
<td>29</td>
<td>ARRIVAL_TIME</td>
<td>287</td>
<td>Whole Day</td>
<td>362</td>
</tr>
<tr>
<td>30</td>
<td>WAIT_TIME, VEHICLE_SPACING</td>
<td>287</td>
<td>Whole Day</td>
<td>362</td>
</tr>
</tbody>
</table>
Now, PlanSelect Iterations - all done for the whole day

<table>
<thead>
<tr>
<th>IT</th>
<th>VCRATIO</th>
<th>SELPCT</th>
<th>MAXPCT</th>
<th>TOTAL</th>
<th>SELECTED</th>
<th>WRITTEN</th>
<th>TOTAL_PROBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
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<td>50</td>
<td>10</td>
<td>294362</td>
<td>34645</td>
<td>17424</td>
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</tr>
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<td>32</td>
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<td>10</td>
<td>294362</td>
<td>25238</td>
<td>12655</td>
<td>3049</td>
</tr>
<tr>
<td>33</td>
<td>1</td>
<td>50</td>
<td>10</td>
<td>294362</td>
<td>26713</td>
<td>13405</td>
<td>14534</td>
</tr>
<tr>
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<td>1</td>
<td>50</td>
<td>10</td>
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<td>21086</td>
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</tr>
<tr>
<td>35</td>
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<td>50</td>
<td>10</td>
<td>294362</td>
<td>21487</td>
<td>10804</td>
<td>354</td>
</tr>
</tbody>
</table>
**User Equilibration**

- **User Equilibrium:**
  - A condition where no traveler can reduce their trip travel time by changing paths

- **TRANSIMS approximation procedure**
  - Use Microsimulator Link Delay to re-route all travelers and compare the trip duration to the trip duration stored in the simulated Plan file
  - Replace significantly different plans and resimulate
  - User Equilibrium =<2.0% travelers selected
Microsimulator Equilibration Batch Script

PlanPrep 20b (time-sort) → TimePlans21

MSim 21
LinkDelay21
Router 21 → Plans21
PlanCompare 21 → Retain Plans21
PlanPrep 21a (merge) → TimePlans22
Travel Plans22
PlanPrep 21b (time-sort)

MSim 22
LinkDelay22
Router 22 → Plans22
PlanCompare 22 → Retain Plans22
PlanPrep 22a (merge) → TimePlans23
Travel Plans23
PlanPrep 22b (time-sort)

MSim 23
LinkDelay23

PlanPrep 29b (time-sort) → TimePlans30
Travel Plans30
PlanPrep 30a (merge) → TimePlans31
Travel Plans31
PlanPrep 30b (time-sort)

PlanPrep 21b (merge) → TimePlans21
Credits and Acknowledgements

- Parts of this training materials were based on AECOM training (Traffic Assignment, June 28, 2007)
- GIS visualization materials were mostly developed at Argonne based on the TRANSIMS tools developed by AECOM for USDOT
- Chicago road and transit network data used in some of the examples was provided by the Chicago Metropolitan Agency for Planning
- USDOT provided the funding for the development of these training materials
- USDOT provided the funding for the TRACC computing center and the resources necessary to perform these training session