Developing a Large Scale Hybrid Simulation Model of the Minneapolis Metropolitan Area

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Overview

- Objectives
- Methodology
  - Geometry
  - Demand
  - Control
  - Calibration
- Lessons Learned
- Conclusions
Project Objectives

2. Introduce dynamic components in the Regional Planning Model (RPM) Mode Choice step.

- Use it to evaluate impact on the network from the implementation of the Green line LRT.
Methodology

- Build a multi-resolution traffic simulation model of the Twin Cities metropolitan network or a large part of it.
  - High resolution (Microscopic) representation of the two LRT corridors and surrounding roadways
  - Medium (Mesoscopic) resolution on rest of region
  - Utilize equilibrium based DTA to represent stable but dynamic route choice behavior
Methodology: Multilevel Hybrid Simulation

- **Static Traffic Assignment (Macro)**
  - Replicate RPM results
  - Generate best guess static routes
- **Utilize entire network to run a Hybrid Dynamic User Equilibrium simulation**
  - Study area is microscopic
  - Border of study area is mesoscopic-fine
  - Greater network is mesoscopic-rough
- **Lessons learned:**
  - Having all levels under the same application greatly reduces build effort and duplication
  - Need to upgrade to a multiuser environment so modelers can work in parallel.
Introduce dynamic components in the RPM Mode Choice step.

Step A: CUBE Iterations

1. Trip Generation
   - Census data
   - Socio-economic data
   # of trips desired from each centroid

2. Trip Distribution
   - Job data
   - Gravity model
   # of trips from/to all centroid pairs

3. Mode Choice
   - Census data
   - Socio-economic data
   - Transit network/schedules
   # of trips per O/D per mode

4. Traffic Assignment
   - Macroscopic
   - Static Traffic Assignment

5. Traffic Assignment
   - Hybrid (Micro/Meso)
   - Dynamic User Equilibrium

Step A – Use Cube four-step model to converge to a stable macroscopic traffic assignment by iterating 1-4.

Step B – Use Aimsun Hybrid DUE to loop with Cube step 3 to refine mode choice.

Replace the Traffic Assignment step in the RPM and form a loop with the Mode Choice step.

LL: Make sure there is a formed relationship between the two models before you start building them.
Geometry: Entire Network

- 24 Hour Demand
  - 9,126,634 Total Trips
- 1630 Centroids
- 28,500 Individual Sections
- 10,500 Nodes
Lesson learned:
Sometimes too much detail is not a good thing. Neighborhood streets did not offer much utility and increased routing calibration effort.
Demand

- Demand generated by the RPM
  - 3 vehicle matrices for each demand interval (72 total)
    - SOV, HOV, Truck
  - LRT lines simulated based on schedules
  - Combined Multiple RPM demand intervals to form peak period demands
    - AM Peak (6:00am – 8:30am)
    - PM Peak (3:30pm – 6:00pm)
Demand Segmentation

Original and Adjusted Demand - 6:00 AM to 10:30 AM

Entrance Volume (Vehicles per 15-minutes)

Interval Start Time

6:00 6:15 6:30 6:45 7:00 7:15 7:30 7:45 8:00 8:15 8:30 8:45 9:00 9:15 9:30 9:45 10:00 10:15
Traffic Control

- 798 signals in Hybrid Network
  - 3 Time periods (AM, PM, Off-Peak)

- Light Rail Control
  - 11+ preemption
    - Full interruption of signal and immediately advancing to the LRT movement. LRT does not have to stop
  - 40+ Actuated LRT phase (Transit Signal Priority)
    - Reduces phases before LRT movement to minimum green time. LRT may come to a complete stop at the intersection
    - Skip left turn phase if no vehicle present
    - Signal timings constantly adjusted

- Lesson learned: Need to organize traffic control information and promote a unified, electronic format. No PDFs!
Real Data for calibration

- MnDOT Freeway detector counts/speeds/flows
- Turning movement counts
  - Minneapolis from TCMS
  - University Ave from City of Saint Paul Traffic Operations
- Tube counts for CCLRT Corridor
- Data available is concentrated heavily around AM and PM peak hours
- Counts do not agree with each other. Need methodology to make adjustments.
Results: Hybrid model validation

• 7:30am to 8:30am
Implementation of the Hybrid Model

- Evaluate the impact on the network from the implementation of the Green line LRT.
  - Develop two alternatives, before Green line and after Green line
  - Use to evaluate the changes in traffic conditions on surrounding roadways

- Full Report on the impact is available through the CTS website
  - *Evaluating Twin Cities Transitways Performance and their Interaction with Traffic on Neighboring Major Roads*
  
  [Link](http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=2410)
Lessons Learned: Sensitivity

- Effect of Mesoscopic model parameters

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<th>Speed (km/h)</th>
<th>Travel Time (sec/km)</th>
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Lessons and bugs

- Meso-rough intersection conflicts
- Jam density gridlock
Lessons and bugs

- Long run times make calibration difficult
- Large memory requirements restrict simulation duration

<table>
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<th>Demand Interval</th>
<th>Pre Green Line Network</th>
<th>Green Line Network</th>
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| Multi-Demand    |          |            |              |          |            |             |
| 6-8             | 291      | 27         | 92.2         | 261      | 26         | 86.1        |
| 16-18           | 356      | 27         | 114.14       | 331      | 25         | 78.7        |

- Have a good Database and GIS based container to store and visualize the results. Too big for native programs and traditional methods.
Conclusions

- Large scale simulation is feasible
- Interfacing with Travel Demand Model also feasible
- Requires more work in streamlining calibration
- One must be careful of the software used. All have bugs that are accentuated with network size.
- Process can be institutionalized like the RPM and generate a Dynamic Traffic Assignment Regional Simulation Model
  - Improve resolution with each project
  - Provide model as a cost saving resource
  - Open source paradigm
Questions?

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