Multi - Resolution Research

presented by
Mohammed Hadi, Ph.D., PE
Florida International University

Date
March 26, 2014

Need for Multi-Resolution Analysis

• Congested conditions
• Advanced strategies
• Different modeling levels and combinations of these levels are needed for different applications
Analysis Levels

- Regional demand forecasting models
- Sketch planning tools
- Analytical-based DTA
- Mesoscopic simulation-based DTA
- Microscopic simulation (with and without DTA)

MRA Decision Issues

- Need for informative decisions to select the levels of tools for different applications
- How can different tools be combined in the analysis framework
- How can information be passed between different levels
- What data, other information, and methods are needed to support the analysis
Potential Application of MRA

• Bottleneck removal and additional capacity studies
• Pricing, managed lanes, reversible lanes and tolling projects
• Active Transportation and Demand Management (ATDM)
• Integrated Corridor Management (ICM)
• Incident management and diversions
• Special events
• Work zone impacts
• Improved public transportation
• Real-time applications
• Demand management strategies
• Other ITS, automated vehicle, and operational strategies

Model Selection Consideration

![Diagram showing model selection criteria based on time frames and model type size.](image-url)
Analysis Scales

Levels of Multi-Resolution Analysis

Isolated Models
- Regional Demand Model
  - Meso
  - Micro

Partial Multiresolution Models
- Trip tables from Regional Models feeding either Meso or Micro
- Regional Demand Model
  - Meso-DTA
  - Micro-DTA

Full Multiresolution Models
- Interactions between Regional Demands to Meso and Meso to Micro
  - Regional Demand Model
    - Meso-DTA
  - Micro-DTA
Simulation Levels

- Macroscopic: based on the relationships of flow, speed, and density parameters; queuing capacity; link capacity, and spillback effects
- Mesoscopic: follow individual vehicles but move them using macroscopic relationships
- Microscopic: simulate individual movement of vehicles using microscopic models (car following, lane changing, etc.)

Traffic Flow Dynamics Analysis

- Should be able to accurately simulate recurrent congestion
- Should be able to simulate special conditions
- Should be able to simulate dynamic control, pricing, and management strategy
- Details depending on application
Why Using Simulation

What Data Available and Needed?

- Demand model
- Surveys
- Previous counts
- Point detectors, AVI, and AVL data
- Private sector data
- Incident data
- Work zone data
- Weather data
- Pricing data
- Traffic management data
Data Validation

What Day to Choose?
Good Calibration is Essential

- Traffic flow model, demand, assignment
  – Sequential and iterative approach

<table>
<thead>
<tr>
<th>Goodness of Fit Statistics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMSE</td>
<td>113</td>
</tr>
<tr>
<td>% RMSE</td>
<td>13.6</td>
</tr>
<tr>
<td>MAE</td>
<td>77</td>
</tr>
<tr>
<td>R squared</td>
<td>0.976</td>
</tr>
<tr>
<td>GEH &lt;5</td>
<td>87</td>
</tr>
<tr>
<td>GEH &lt;10</td>
<td>100</td>
</tr>
</tbody>
</table>

Bottleneck Calibration

- Capacity and traffic flow parameter estimation is critical

<table>
<thead>
<tr>
<th>Different methods</th>
<th>St. 14</th>
<th>St. 44</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCM (6% truck, f_w=0.975, f_p=0.98)</td>
<td>2.210</td>
<td>2.210</td>
<td>IJCM, 2010</td>
</tr>
<tr>
<td>HCM (6% truck, f_w=0.975, f_p=0.95)</td>
<td>2.140</td>
<td>2.140</td>
<td>IJCM, 2010</td>
</tr>
<tr>
<td>SERPM coded</td>
<td>2.142</td>
<td>2.142</td>
<td>Cambridge Systems, 2008</td>
</tr>
</tbody>
</table>
Estimation of Demand

- Factorization
- Static Matrix Estimation
- Dynamic Matrix Estimation

Assignment

- ML pricing – willingness to pay versus generalized functions
- Utility function parameters
- Equilibrium vs. one shot
- Convergence
Validation and Sensitivity Analysis

Power of DTA

Generalized Cost Function

Willingness-to-Pay Curve
Questions

Regional Scale

Sub-Regional Scale

Corridor Level