MICROSCOPIC SIMULATION WITH AIMSUN
FOR THE ASSESSMENT OF
INCIDENT MANAGEMENT STRATEGIES

J. Barceló, J. Ferrer and J. Casas
TSS-Transport Simulation Systems
http://www.tss-bcn.com

L. Montero and J. Perarnau
Universitat Politècnica de Catalunya
Department of Statistics and Operations Research
PRESENTATION OUTLINE

• Objectives of the PRIME Project
• The Incident Management Functions
• Off-line testing by simulation in Barcelona
  – Site description and selected scenarios
  – Data sets
  – Experimental design
  – Results, analysis and conclusions
OBJECTIVES OF PRIME PROJECT

• PRIME (Prediction of Congestion and Incidents in Real-Time for Intelligent Incident Management and Emergency Traffic Management) European Commission, 5th Framework Programme, Reference IST 13036
• Develop methods for estimating incident probability in real time
• Develop improved systems and algorithms for detecting incidents
• Develop integrated strategies for incident and traffic management
THE INCIDENT MANAGEMENT FUNCTION

- The objective of an incident management system is to reduce incident related delay and its adverse impacts. Consist on three main functions
  - **Detection**: methods to identify spatial, temporal and severity characteristics of an incident (*Ad hoc version of Persaud AID algorithm, Hierarchical Logit Algorithm to estimate incident probability*)
  - **Verification**: methods and actions for ascertaining that a detected incident is to be accepted
  - **Response**: Actions for the Incident Management Operations, incident clearance, restoring roadway capacity,...
PRIME

CONCEPTUAL FRAMEWORK FOR
THE EVALUATION OF
INTEGRATED INCIDENT
MANAGEMENT STRATEGIES BY
SIMULATION
AIMSUN site model (1)

Emulation of Detector Measurements (2)

DLL Interfaces (GETRAM extensions) (3)

ID/EIP GUI (7)

RTDB (4)

DLL Interface (11)

Selected Strategy (10)

Integrated Incident Management Strategies Module

Decision Tables (e.g.)

<table>
<thead>
<tr>
<th>ID</th>
<th>MOE 1</th>
<th>MOE 2</th>
<th>MOE 3</th>
<th>VMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>“5 min Delay”</td>
</tr>
<tr>
<td>2</td>
<td>B1</td>
<td>B2</td>
<td>B3</td>
<td>“10 min Delay”</td>
</tr>
<tr>
<td>3</td>
<td>C1</td>
<td>C2</td>
<td>C3</td>
<td>“Speed ≤ 50”</td>
</tr>
<tr>
<td>4</td>
<td>D1</td>
<td>D2</td>
<td>D3</td>
<td>“Take exit N”</td>
</tr>
</tbody>
</table>

Alarm

MDB (8)
BARCELONA SITE

• Road Network Geometry
  – 11 Km. Of “Ronda de Dalt” (Barcelona’s Ring Roads)
  – Urban motorway and adjacent urban network with signalized intersections
  – Heavy traffic, high rate of incidents, management capabilities: VMS, metering
BARCELONA SITE: Testing Area 1

Rovira Tunnel
Karl-Marx Round About/Valldaura
Via Julia

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e-SAFETY, LYON, September 2002
DATA COLLECTION

• Collected Data
  – Detection Station ID
  – Aggregated Flow at the detection Station in Vehicles/hour
  – Aggregated % Occupancy at the Detection Station
  – Aggregated Mean Speed at the Detection Station in Km/h
  – Flow in Vehicles/hour at loop detector
  – % Occupancy at loop detector
  – Mean Speed in Km/h at loop detector

• Data have been in 1 minute intervals for 24 hours (00:00 to 24:00), Monday to Sunday inclusive.

• Incidents: Time stamp, location, duration

• Number of Data Sets
  – 1st Data set: field data from 1.09.00 until 31.12.00: used for calibration
  – 2nd Data set: field data from 1.01.01 until 31.03.01 used for testing
  – 3rd Data set: field data from 1.04.01 until 30.06.01 used for evaluation
  – 4th Data set: field data from 1.07.01 until 31.08.01 used for evaluation

• Incidents Per Data Set:
  – 1st 246 / 2nd 295 / 3rd 235 / 4th 170
INCIDENT MANAGEMENT STRATEGIES AT BCN SITE

• STRATEGY 1:
  • Display information messages on the VMS informing on the presence of congestion, incidents, etc.
  • Make recommendations on speeds
  • Alternate the information messages with warnings

• STRATEGY 2
  • Display more dissuasive information messages on the VMS informing on the presence of congestion, incidents, etc.
  • Provide also delay and travel time estimates
  • Variable speed limits compulsory

• STRATEGY 3
  • The same as Strategy 2 and
  • Rerouting information (try to force the use of specific off-ramps leading to alternative routes)

• STRATEGY 4
  • The same as Strategy 3, and
  • Ramp metering at On-rams upstream of the incident / congestion location.
EMULATION OF RECORDED INCIDENT ID = 312

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SIMULATION EXPERIMENTS

• TEST 1
  – Based on Data Set 1: do nothing scenario, strategies 2 and 3
  – Primary version of Persaud AID

• TESTS 2 and 3
  – Based on Data Sets 2 and 3 respectively
  – Refined version of Persaud AID
  – Strategy 3

• TESTS 4, 5, 6, 7
  – Replication of test 2 and 3 with Data Set 3, More combinations for Strategy 3

• TESTS 8, 9
  – Replication of 4 and 5 with Strategy 4 version 1 (Ramp metering)

• TESTS 10, 11
  – Replication of 4 and 5 with Strategy 4 version 2 (Ramp metering + adaptive control)
METERING SCENARIO (STRATEGY 4, Version 1)
### SIMULATION RESULTS: TESTS 8,9,10,11

<table>
<thead>
<tr>
<th>Measure Of Effectiveness</th>
<th>Definition</th>
<th>Values</th>
<th>Test 8th</th>
<th>Test 9th</th>
<th>Test 10th</th>
<th>Test 11th</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IIMS MOE 1.2</strong></td>
<td>Delays in Vehicle-Hours over the main motorway section Trinitat -Túnel Rovira, Problem Area</td>
<td>515.33</td>
<td>324.10</td>
<td>346.336</td>
<td>447.15</td>
<td>347.25</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>-37.1%</td>
<td>-32.8%</td>
<td>-13.2%</td>
<td>-32.6%</td>
</tr>
<tr>
<td><strong>IIMS MOE 1.4</strong></td>
<td>Delays in Vehicle-Hours over the arterial Trinitat -Túnel Rovira, Problem Area</td>
<td>199.72</td>
<td>187.83</td>
<td>168.50</td>
<td>165.21</td>
<td>175.24</td>
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<tr>
<td></td>
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<td></td>
<td>-5.95%</td>
<td>-15.6%</td>
<td>-17.2%</td>
<td>-12.2%</td>
</tr>
<tr>
<td><strong>IIMS MOE 2.2</strong></td>
<td>Total travel time in Vehicle-Hours over the main motorway section Trinitat -Túnel Rovira, Problem Area.</td>
<td>1988</td>
<td>1526</td>
<td>1585</td>
<td>1828</td>
<td>1605</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>-23.2%</td>
<td>-20.2%</td>
<td>-8.04%</td>
<td>-19.2%</td>
</tr>
<tr>
<td><strong>IIMS MOE 2.4</strong></td>
<td>Total travel time in Vehicle-Hours over the arterial Trinitat-Túnel Rovira, Problem Area.</td>
<td>458.06</td>
<td>440.2</td>
<td>456.33</td>
<td>449.2</td>
<td>457.13</td>
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<td></td>
<td>-3.89%</td>
<td>-0.37%</td>
<td>-1.93%</td>
<td>-0.20%</td>
</tr>
<tr>
<td><strong>IIMS MOE 3.2</strong></td>
<td>Total travel distance in Vehicle-Kilometres Hours over the main motorway section Trinitat -Túnel Rovira, Problem Area..</td>
<td>53810.4</td>
<td>36785.8</td>
<td>35760</td>
<td>34763.8</td>
<td>34652.7</td>
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<tr>
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<td></td>
<td></td>
<td>-31.6%</td>
<td>-33.5%</td>
<td>-35.4%</td>
<td>-35.6</td>
</tr>
<tr>
<td><strong>IIMS MOE 3.4</strong></td>
<td>Total travel distance in Vehicle-Kilometres Hours over the arterial Trinitat -Túnel Rovira, Problem Area..</td>
<td>11347.0</td>
<td>11935.4</td>
<td>12273.4</td>
<td>12111</td>
<td>11893.0</td>
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<tr>
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<td></td>
<td>+5.18%</td>
<td>+8.16%</td>
<td>+6.73%</td>
<td>+4.81%</td>
</tr>
<tr>
<td><strong>IIMS MOE 4.2</strong></td>
<td>Journey Time (hr) over the main motorway section Trinitat -Túnel Rovira, Problem Area.</td>
<td>0.1955</td>
<td>0.1541</td>
<td>0.1652</td>
<td>0.1811</td>
<td>0.1958</td>
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<td>-21.1%</td>
<td>-15.6%</td>
<td>-7.36%</td>
<td>+0.15%</td>
</tr>
<tr>
<td><strong>IIMS MOE 4.4</strong></td>
<td>Journey Time (hr) over the arterial Trinitat -Túnel Rovira-, Problem Area.</td>
<td>0.1869</td>
<td>0.1983</td>
<td>0.1969</td>
<td>0.1877</td>
<td>0.2047</td>
</tr>
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<td></td>
<td>+6.09%</td>
<td>+5.35%</td>
<td>+0.42%</td>
<td>+9.52%</td>
</tr>
</tbody>
</table>
THE ROLE OF MICROSIMULATION IN CONFLICT ANALYSIS

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THE ROLE OF MICROSIMULATION (I)

• Detailed analysis of the IIMS impacts distinguishing main sections from On/Off accounting for queue lengths, implications of the signal timings of the adjacent urban roads, etc.

• CAVEAT: Global MOE’s can be misleading
CONCLUSIONS: THE ROLE OF MICROSIMULATION (I)

• Fine tuning of the parameters of the Incident Detection Algorithms by replication of observed incidents and variation of parameter values: distance between detectors, detection frequency, aggregated/desaggregated detection,...

• Complementary analysis for alternative data (i.e. headways)
CONCLUSIONS: THE ROLE OF MICROSIMULATION (II)
CONCLUSIONS: THE ROLE OF MICROSIMULATION (III)

- Detailed analysis of queues and travel times at On-ramps