Comparison of Three Traffic Simulation Packages for Analysis of Access Management Techniques

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Effects (Benefits) of Access Management

Chapter 2 of the Access Management Manual:
- Safety
- Operational
- Economic
- Land Use and Environmental
Chapter 2 of the Access Management Manual:
- Reduced delay (i.e., control delay)
- Increased travel speed (i.e., arrive more quickly at their destinations)

Research
- Kockelman et. al. – control delay, travel speed
- Yang and Zhou – total link delay
- Drummond et. al., - delay, number of stops

Others
- Traffic Impact Studies – LOS (delay, average speed)
Examine the implications of using traffic simulation packages to analyze effects of access management

- Promoting access management
- Sketch planning
- Operational/design analyses
Comparison of three commercially available traffic simulation software packages:

- CORSIM (version 5.1) – developed for the Federal Highway Administration, distributed by McTrans, Gainesville, FL.

- SimTraffic (version 6.0) – developed and distributed by Trafficware Corporation, Albany, CA.

- AIMSUN (version 4.2) – developed by Traffic Simulation Systems, Barcelona, Spain.
Key Issues

- Capabilities
- Algorithms & default parameters
- Performance measures
- Accuracy
- Ease of use
- Visualization
### Capabilities (facilities)

<table>
<thead>
<tr>
<th>Facility</th>
<th>SimTraffic</th>
<th>CORSIM</th>
<th>AIMSUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Street</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Freeways</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Two-way left-turn lanes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

● = full capability, ○ = full capability, [blank] = no capability
## Capabilities (control)

<table>
<thead>
<tr>
<th>Control</th>
<th>SimTraffic</th>
<th>CORSIM</th>
<th>AIMSUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsignalized intersection</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>Actuated signals</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>Coordination</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>All-way stop control</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>Roundabouts</td>
<td>⬤</td>
<td>⬤</td>
<td></td>
</tr>
<tr>
<td>Medians</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
</tbody>
</table>
## Capabilities (operations)

<table>
<thead>
<tr>
<th>Operations</th>
<th>SimTraffic</th>
<th>CORSIM</th>
<th>AIMSUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaving sections</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>U-turns</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit operations</td>
<td>●</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Pedestrians</td>
<td>●</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Parking</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
Once a vehicle is assigned performance and driver characteristics, its movement through the network is determined by three primary algorithms:

- Car following
- Lane changing
- Gap Acceptance
Car Following

Algorithm determines behavior and distribution of vehicles in traffic stream

- CORSIM uses 1.0 second average headways
- Synchro varies headway with driver type, speed and link geometry
- AIMSUN varies driver characteristics (e.g., minimum headway, speed acceptance)
SimTraffic generates saturation flow rates lower than those found in CORSIM
- CORSIM defaults underestimate delay

CORSIM tends to estimate higher link capacities than SimTraffic
- CORSIM defaults underestimate queuing

AIMSUN found to overestimate link capacities under congested conditions. Underestimates signalized intersection capacities under congested conditions.
Lane Changing

Always one of the most temperamental features of simulation models

Three types of lane-changing:
- Mandatory lane changes (e.g., a lane is obstructed or ends)
- Discretionary lane changes (e.g., passing)
- Positioning lane changes (e.g., putting themselves in the correct lane in order to make a turn)
Positioning Lane Changes

Heavy queuing a common problem for modeling positioning lane changes.

Vehicles have often passed back of queue before attempting lane change.

Accuracy related to degree of saturation and number of access points

- Congested conditions require farther look ahead
- Densely-spaced access (i.e. short segments) presents a problem
Lane Changing & AM

- Positioning lane changes
- Differences in default “look-ahead”
  - CORSIM and AIMSUN use 2-segment look ahead
  - SimTraffic defaults to 3-segment look ahead
  - All packages can handle up to 12-segment look ahead
- Driver look ahead and lane changing “urgency” must be set higher under congested conditions. This is a network-wide setting in CORSIM, but can be adjusted at the link level in SimTraffic and AIMSUN.
Gap acceptance affects driver behavior at unsignalized intersections, driveways (e.g., right-in-right-out) and RTOR movements.

If default parameters are too aggressive, vehicle delay will be underestimated. Serious implications for frontage roads.

Conversely, parameters which are too conservative may indicate need for a signal when one isn’t necessary.

Gap acceptance parameters are network-wide in CORSIM and SimTraffic, but can be adjusted by link in AIMSUN.
Reducing the gap acceptance as drivers wait (AIMSUN) is more representative of actual driving behavior.

Ability to adjust gap acceptance by location is useful under conditions with limited sight distance, unique geometry, or congestion. Network-wide adjustments may skew overall system performance.

Problem: On what do you base adjustments to gap acceptance? At critical intersections, model outputs should be carefully compared to field observations.
Delay

- For computing *Stop Delay*, SimTraffic has most conservative definition of queuing.
  - SimTraffic – vehicle stopped once speed falls below 10 fps and remains “queued until speed exceeds 15 fps
  - CORSIM – vehicle stopped when speed below 3 fps
  - AIMSUN - vehicle stopped once speed falls below 3.3 fps and remains “queued until speed exceeds 13.1 fps
Performance measures

Queue length – definition of queued vehicle varies by model as does means of determining “average”.

Does 4 vehicles mean this?

[Diagram of 4 vehicles, each 80 feet]

Or this?

[Diagram of 4 vehicles, each 160 feet]
All models must be carefully calibrated and validated to provide meaningful results, but the reality is that modelers often don’t have good data upon which to base this. The result is that un-calibrated networks are often used.

All models do a pretty good job under light to moderate traffic conditions. Differences appear as networks become more congested.

SimTraffic seemed to provide un-calibrated results that most closely matched observed conditions. AIMSUN was reasonable but required more calibration under congested conditions. CORSIM underestimated congestion.
Highly congested arterial w/ relatively controlled access
Less congested arterial w/ poorly controlled access
## Estimating Queues (un-calibrated)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Traffic</th>
<th>SimTraffic</th>
<th>CORSIM</th>
<th>AIMSUN</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor access management</td>
<td>Light</td>
<td>105</td>
<td>96</td>
<td>88</td>
<td>100</td>
</tr>
<tr>
<td>Poor access management</td>
<td>Moderate</td>
<td>193</td>
<td>208</td>
<td>188</td>
<td>175</td>
</tr>
<tr>
<td>Poor access management</td>
<td>Moderate</td>
<td>227</td>
<td>204</td>
<td>260</td>
<td>225</td>
</tr>
<tr>
<td>Good access management</td>
<td>Moderate</td>
<td>554</td>
<td>464</td>
<td>410</td>
<td>600</td>
</tr>
<tr>
<td>Good access management</td>
<td>High</td>
<td>1692</td>
<td>508</td>
<td>506</td>
<td>2000</td>
</tr>
<tr>
<td>Good access management</td>
<td>High</td>
<td>969</td>
<td>536</td>
<td>489</td>
<td>1200</td>
</tr>
</tbody>
</table>
Ease of use

SimTraffic hands down easiest to code and debug.

CORSIM more difficult, particularly with respect to debugging.

AIMSUN requires longest coding time, but does provide more flexibility. Error checking as-you-go eliminates most debugging.
Visualization similar for all 3 models in basic mode

AIMSUN and SimTraffic offer greater flexibility with background images (e.g., aerial photos, site plans)

AIMSUN offers 3-D
Before and after access management analyzed with SimTraffic, CORSIM, and AIMSUN

- Before: several closely-spaced intersections serving commercial developments
- After: access to all developments reduced to one intersection
1. Existing 12 pump gas station
2. 150,000 ft.² Wal-Mart;
3. 12 pump gas station; 274 room Hotel; 27,000 ft.² grocery store; 5,000 ft.² video store; 14,000 ft.² pharmacy; 5,000 ft.² walk-in bank; 4,000 ft.² fast-food restaurant;
4. 383,000 ft.² Shopping Center
5. 400 unit Apartment Complex
WITHOUT ACCESS MANAGEMENT

1590
1498
92
59
41
355
1690
538
373
355
1507
212
100
175
189
1196
375
55
1705
1760
55
1236
454
100
313
229
803
463
509
1122
Brief Example

WITH ACCESS MANAGEMENT
Maximum Queue Length for WB Thru Movement
(without Access Management)

- SimTraffic: 2500 ft
- CORSIM: 500 ft
- AIMSUN: 300 ft

Max Queue Length (ft)
Maximum Queue Length for WB Thru Movement (with Access Management)

- SimTraffic: 1200 ft
- CORSIM: 600 ft
- AIMSUN: 400 ft
Comparison of Before and After System Delays

- SimTraffic
- CORSIM
- AIMSUN

Total Vehicle Delay (hrs)

- Before Access Management
- After Access Management
Comparison of Before and After Number of Stops

- SimTraffic
- CORSIM
- AIMSUN

Before Access Management:
- SimTraffic: 16,000
- CORSIM: 6,000
- AIMSUN: 12,000

After Access Management:
- SimTraffic: 0
- CORSIM: 4,000
- AIMSUN: 14,000

Legend:
- Blue: Before Access Management
- Red: After Access Management
Maximum Queue on Stop Controlled Side Street Approach (ft)

<table>
<thead>
<tr>
<th>SimTraffic</th>
<th>CORSIM</th>
<th>AIMSUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Queue Length (ft)</td>
<td>600</td>
<td>100</td>
</tr>
</tbody>
</table>
Comparison of Estimated Delay Reductions Resulting from Access Management

Reduction in Vehicle Delay (hrs)

- SimTraffic
- CORSIM
- AIMSUN

Main Street Delay (hrs) | Side Street Delay (hrs)
Recommendations

- Short links vs. time steps. Coding every single driveway does not necessarily make your simulation “more realistic” because of potential problems introduced by short links.

- Choke points, if not modeled correctly, can reduce traffic flow to the rest of your network.

- SimTraffic generates MOE’s by approach, CORSIM and AIMSUN by segment. Make sure you sum MOE’s from all segments influenced by intersection.
Recommendations

Calibration not realistic
- What do you usually use to calibrate for each model?
- Can you predict these parameters for future conditions?
- Often you are “sketch planning” for AM

Make sure you compare apples to apples when comparing access management alternatives. Many times, networks lengths vary from one scenario to next.
Questions

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