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

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6th Access Management Conference
August 31st 2004

Effects (Benefits) of Access Management

- Chapter 2 of the Access Management Manual:
  - Safety
  - Operational
  - Economic
  - Land Use and Environmental

Operational Effects of AM

- 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)

Purpose

- Examine the implications of using traffic simulation packages to analyze *effects* access management
  - Promoting access management
  - Sketch planning
  - Operational/design analyses

Simulation Models

- 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)

Facility	SimTraffic	CORSIM	AIMSUN
Surface Street	●	●	●
Freeways	●	●	●
Two-way left-turn lanes			

● = full capability, ○ = full capability, [blank] = no capability

Capabilities (control)

Control	SimTraffic	CORSIM	AIMSUN
Unsignalized intersection	●	●	●
Actuated signals	●	●	●
Coordination	●	●	●
All-way stop control	●	●	●
Roundabouts	●	○	●
Medians	○	○	○

Capabilities (operations)

Operations	SimTraffic	CORSIM	AIMSUN
Weaving sections	●	●	●
U-turns	●		
Transit operations	●	○	●
Pedestrians	●	○	●
Parking		●	●

Algorithms & default parameters

- 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)

Car Following & AM

- 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

- 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.

Gap Acceptance & AM

- 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.

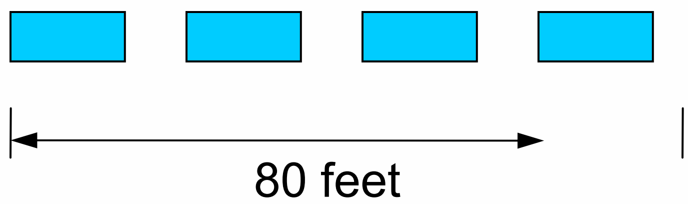
Performance measures

- 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

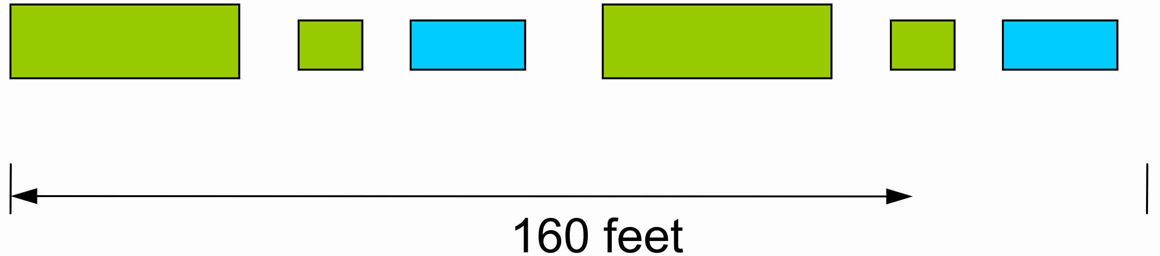
Performance measures

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

Does 4 vehicles mean this?



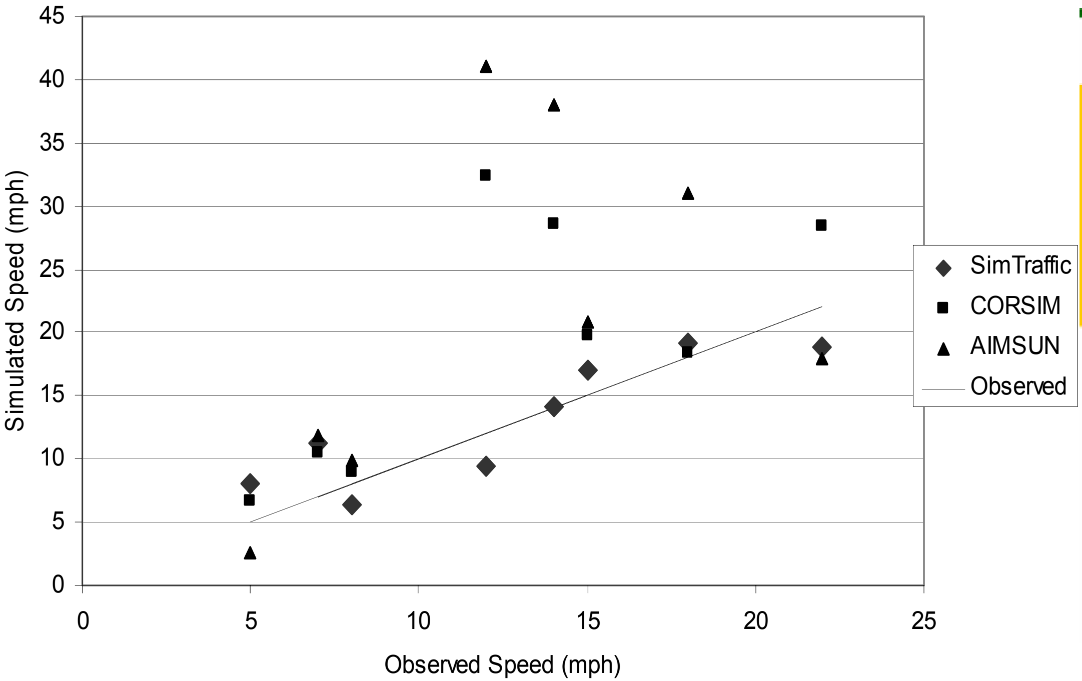
Or this?



Accuracy

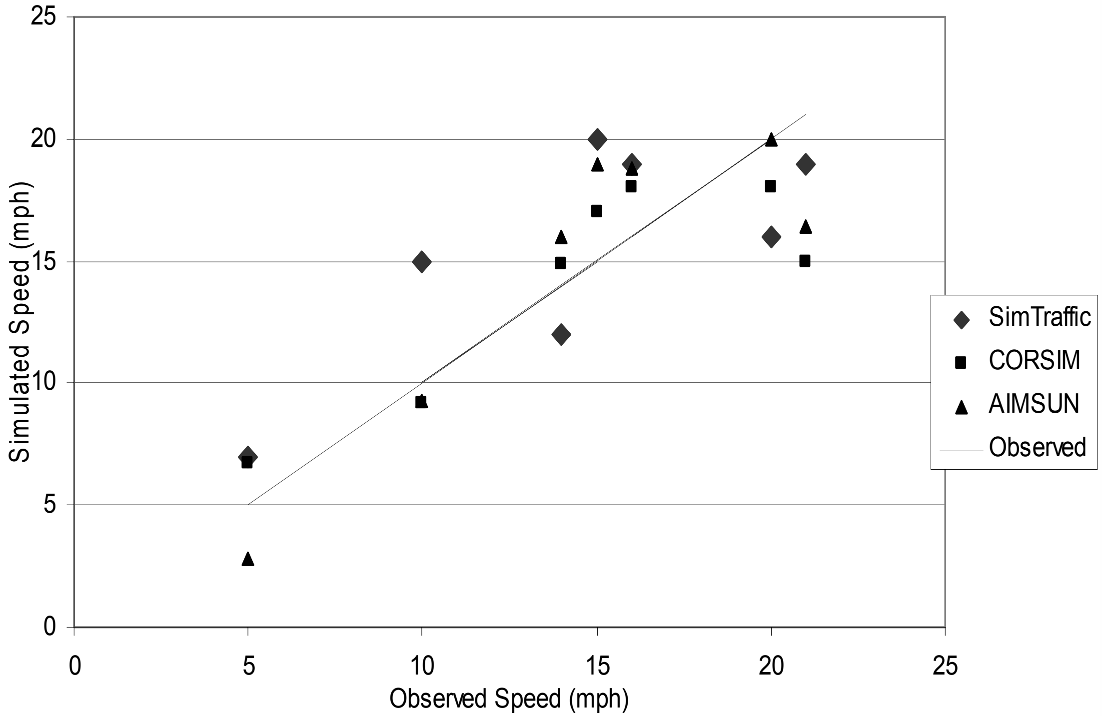
- All models must be carefully calibrated and validated to provide meaningful results, but the reality is that modelers often don't have good data upon which to base this. The result is that un-calibrated networks are often used.
- All models do a pretty good job under light to moderate traffic conditions. 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.

Speeds



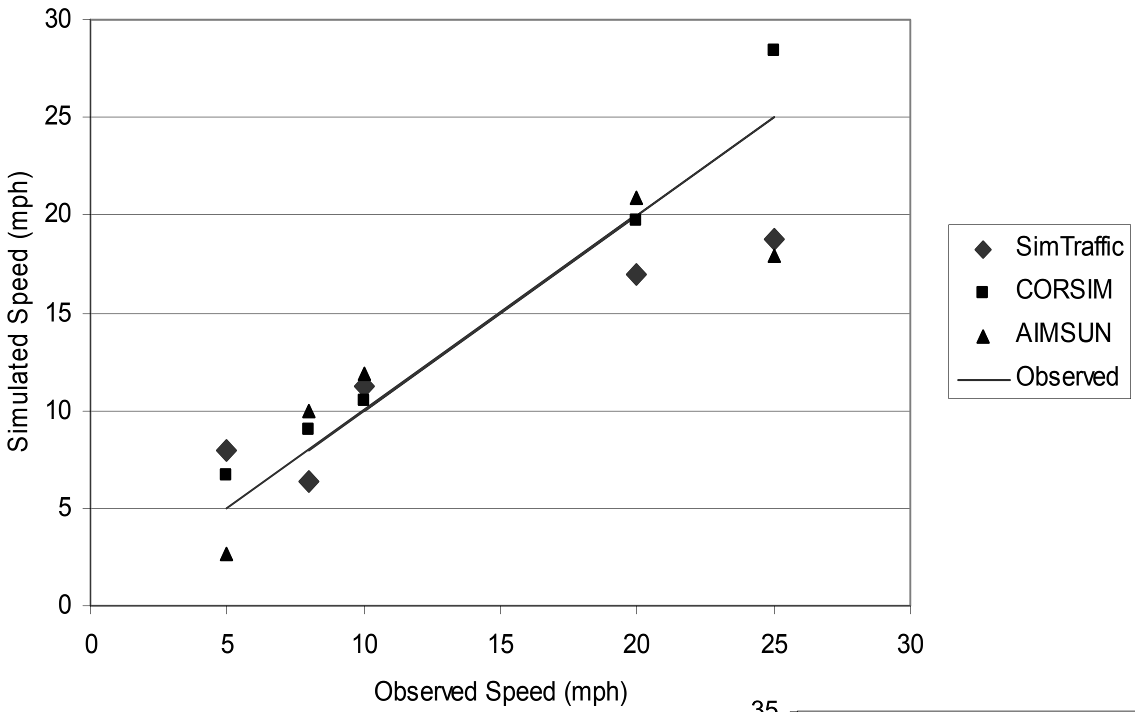
Un-calibrated

Calibrated



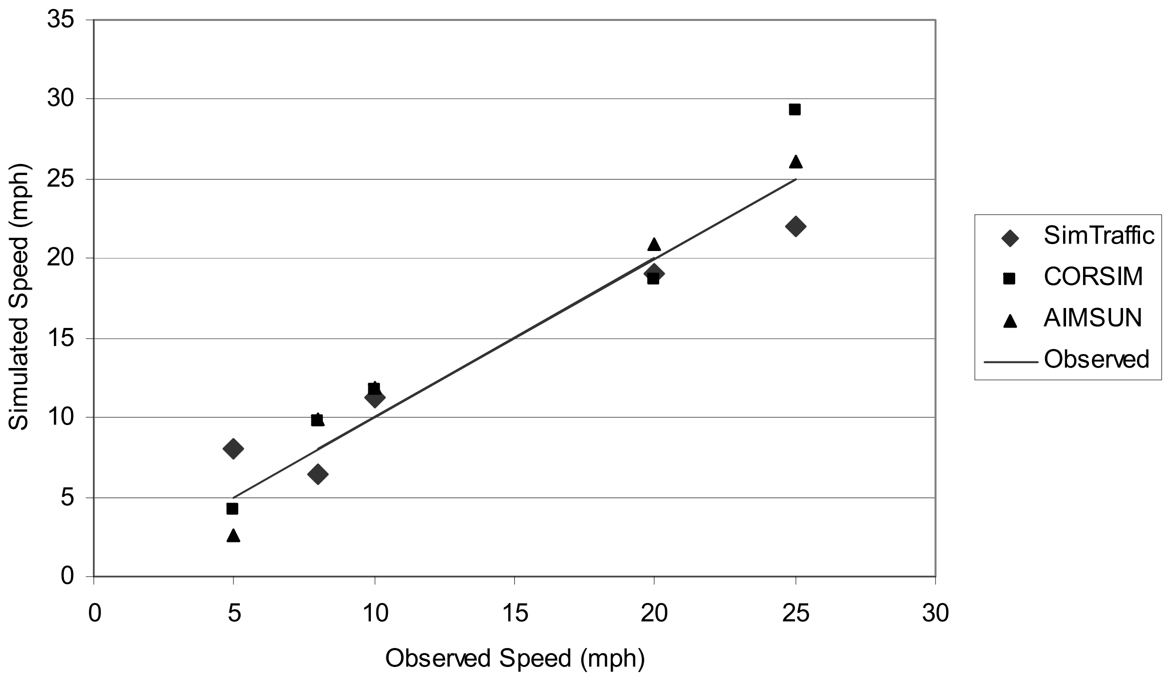
Highly congested arterial w/ relatively controlled access

Speeds



Un-calibrated

Calibrated



Less congested arterial w/ poorly controlled access

Estimating Queues (un-calibrated)

Segment	Traffic	SimTraffic	CORSIM	AIMSUN	Observed
Poor access management	Light	105	96	88	100
Poor access management	Moderate	193	208	188	175
Poor access management	Moderate	227	204	260	225
Good access management	Moderate	554	464	410	600
Good access management	High	1692	508	506	2000
Good access management	High	969	536	489	1200

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

- 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

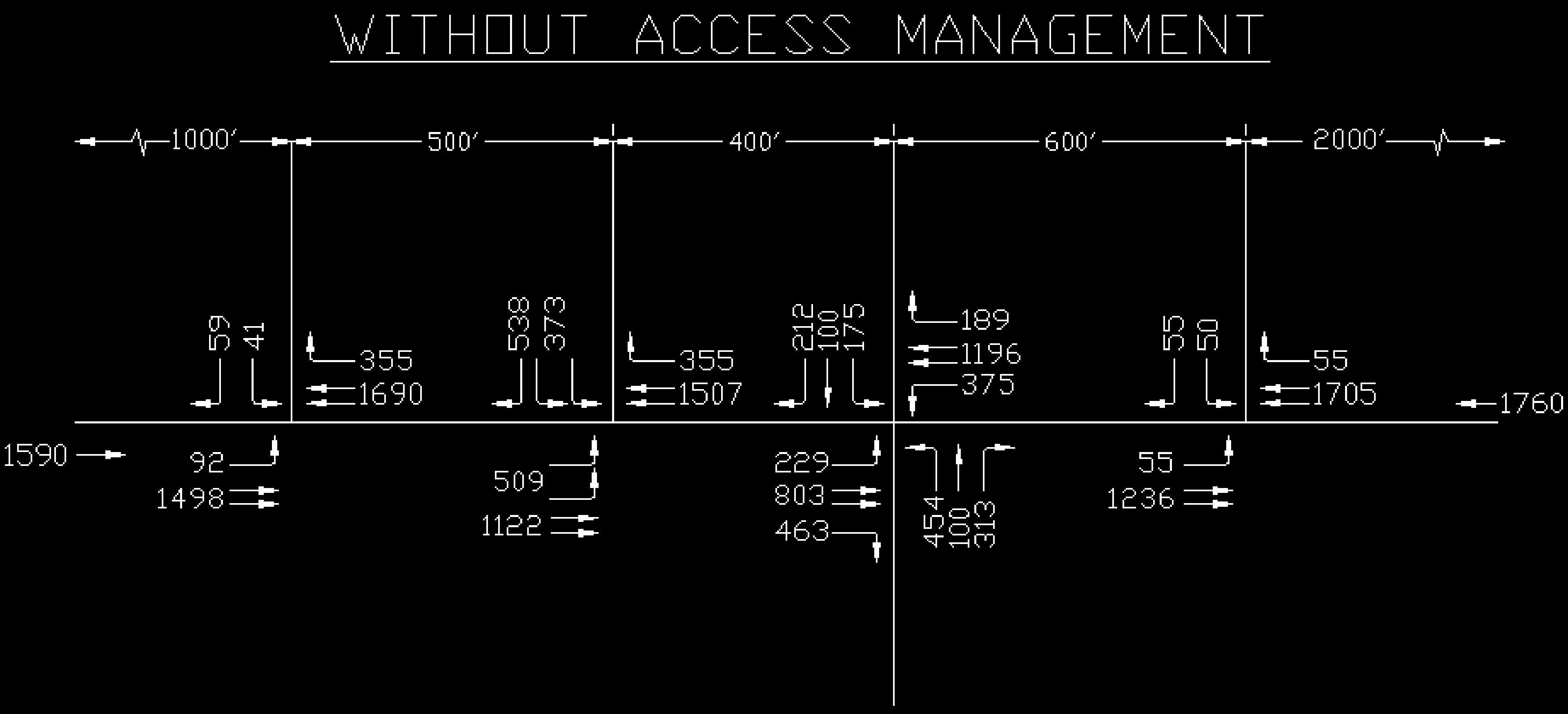
Brief Example

- 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

Land Use Assumed for Example

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

Brief Example



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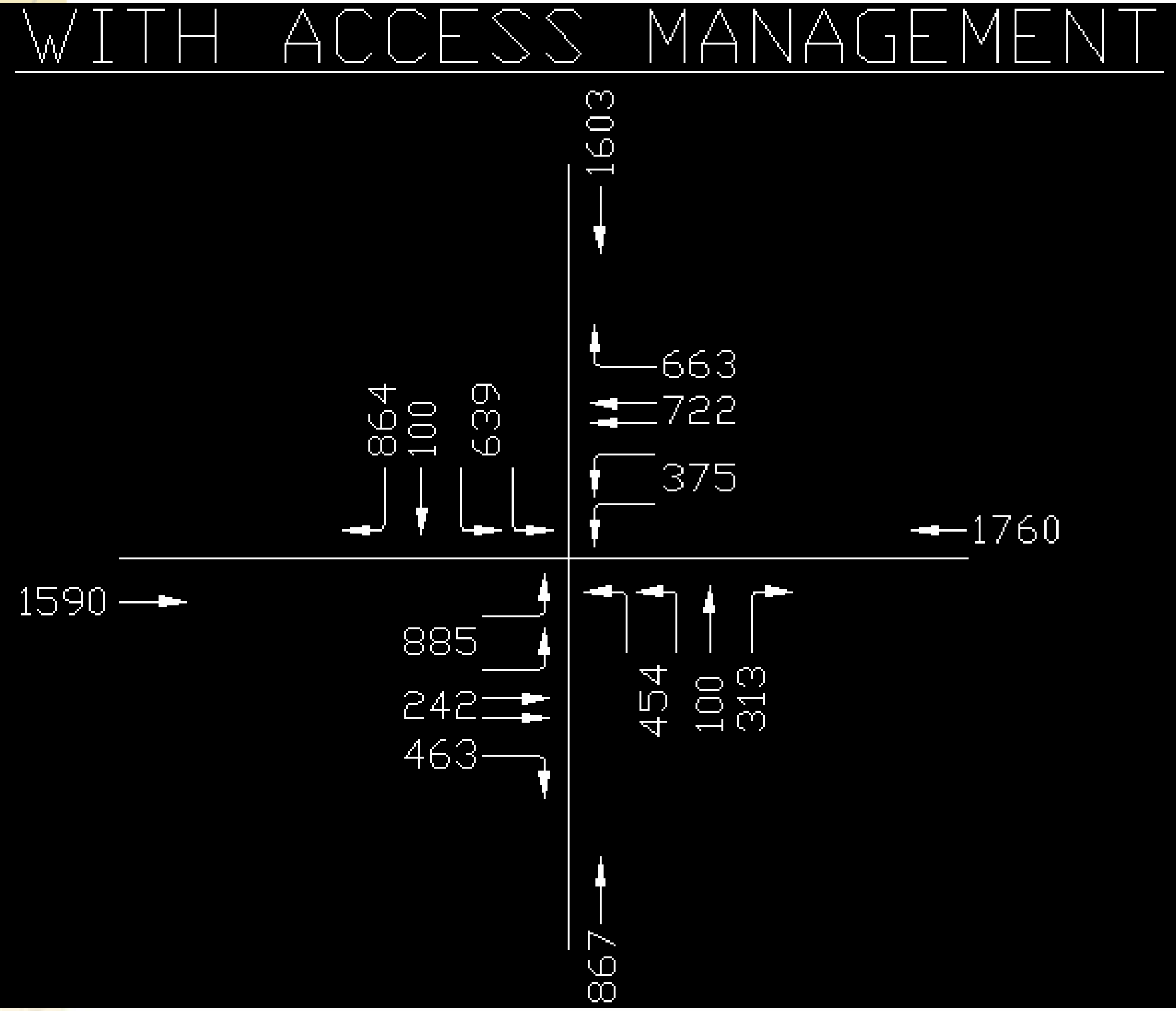

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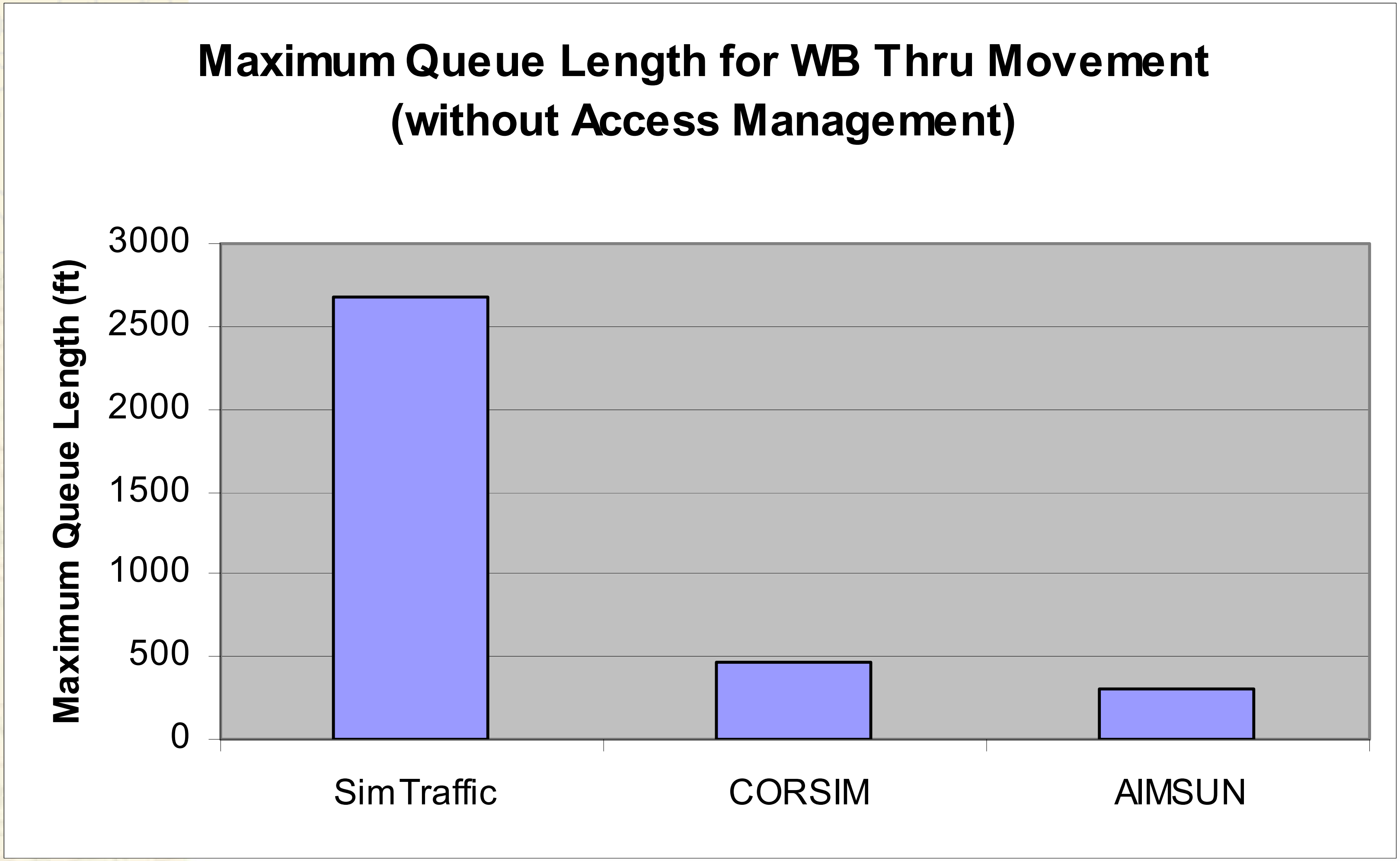

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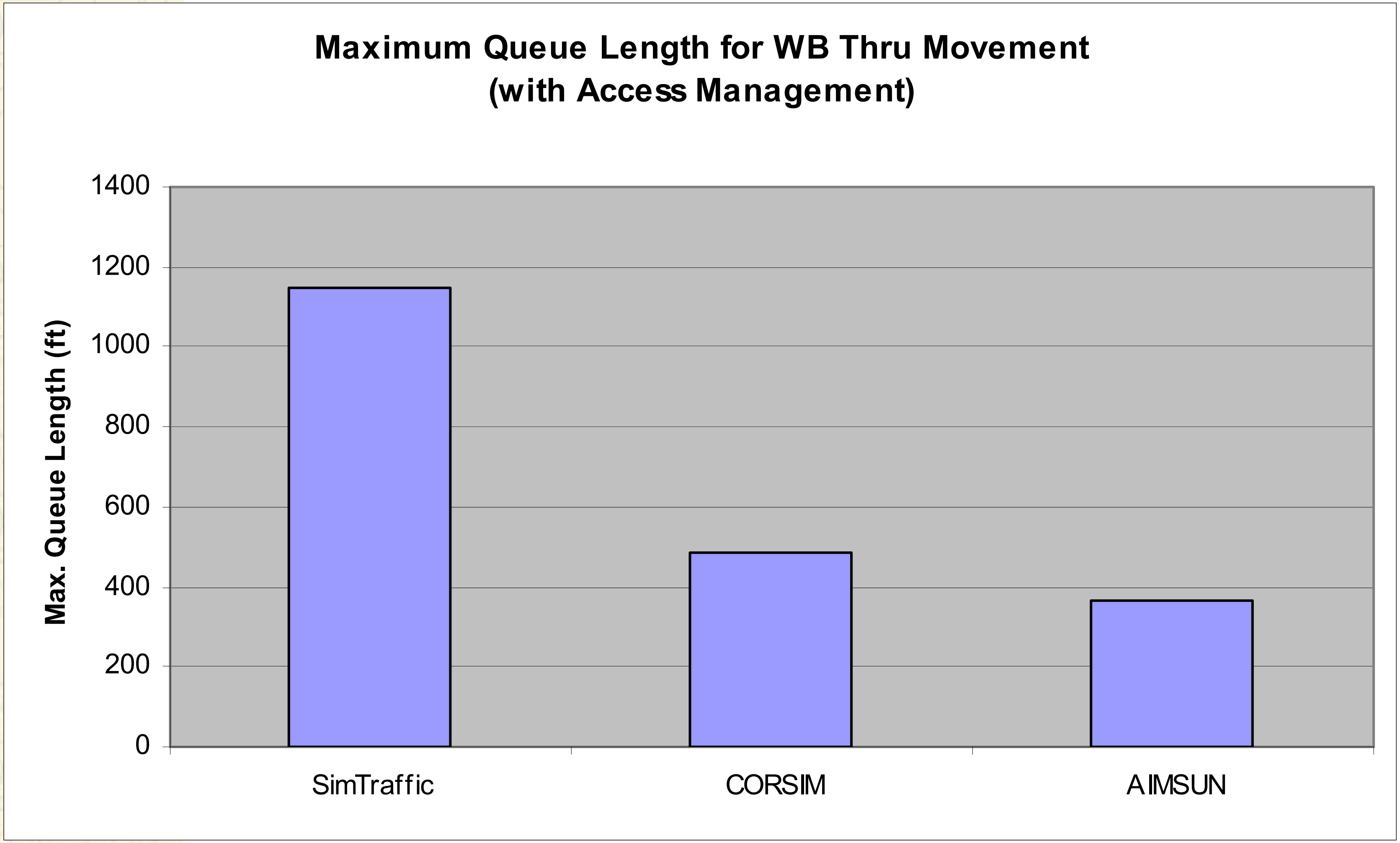

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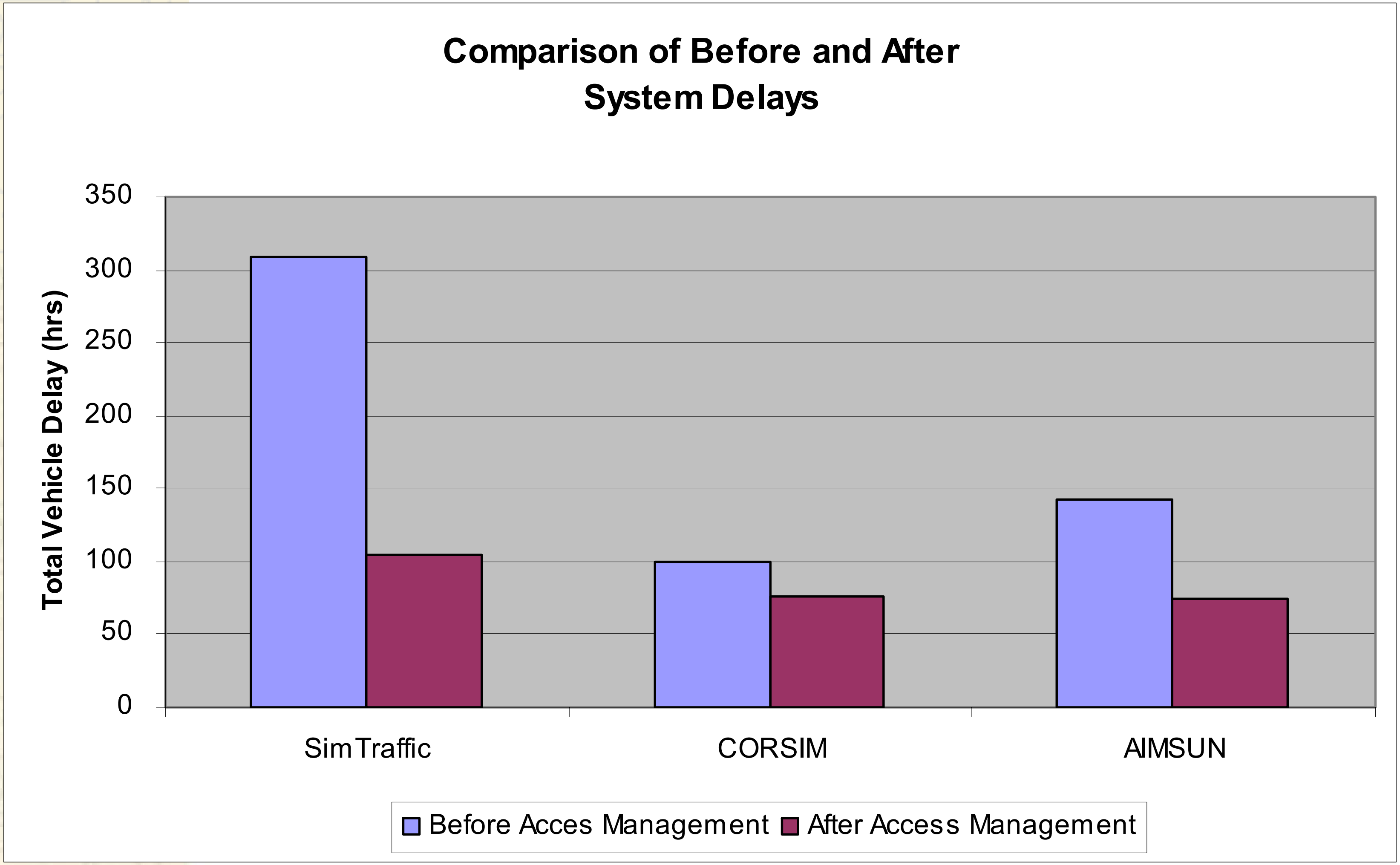

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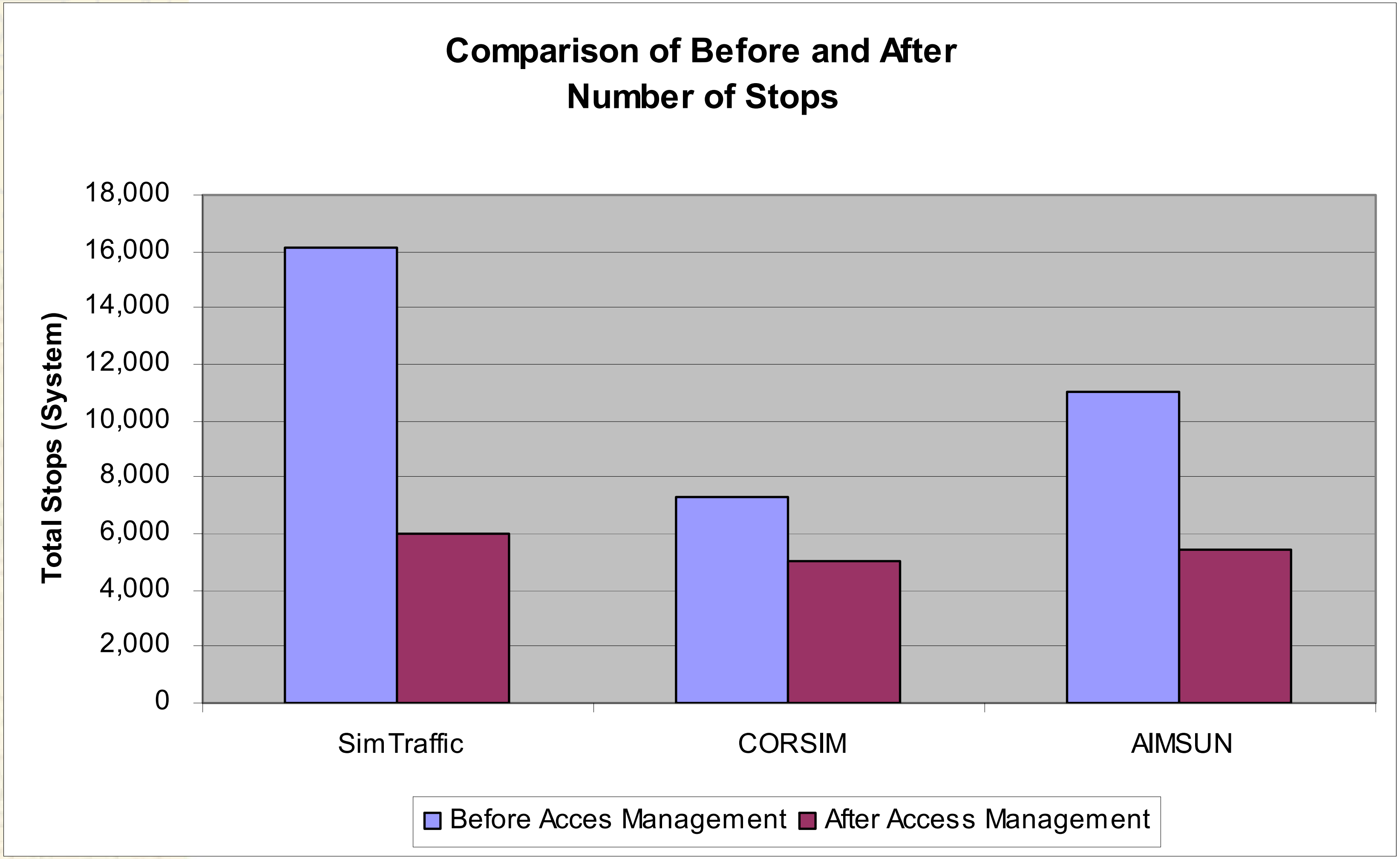

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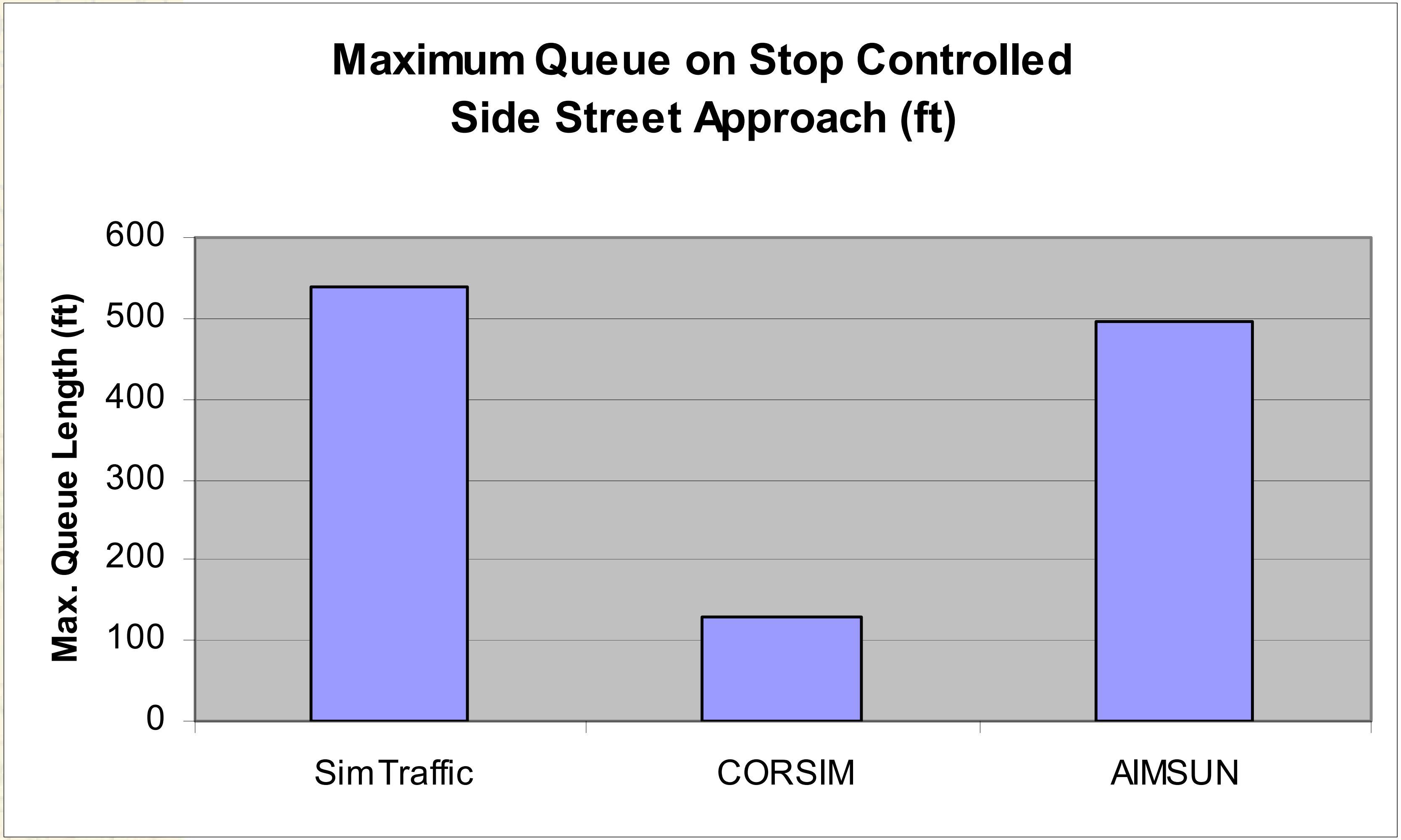

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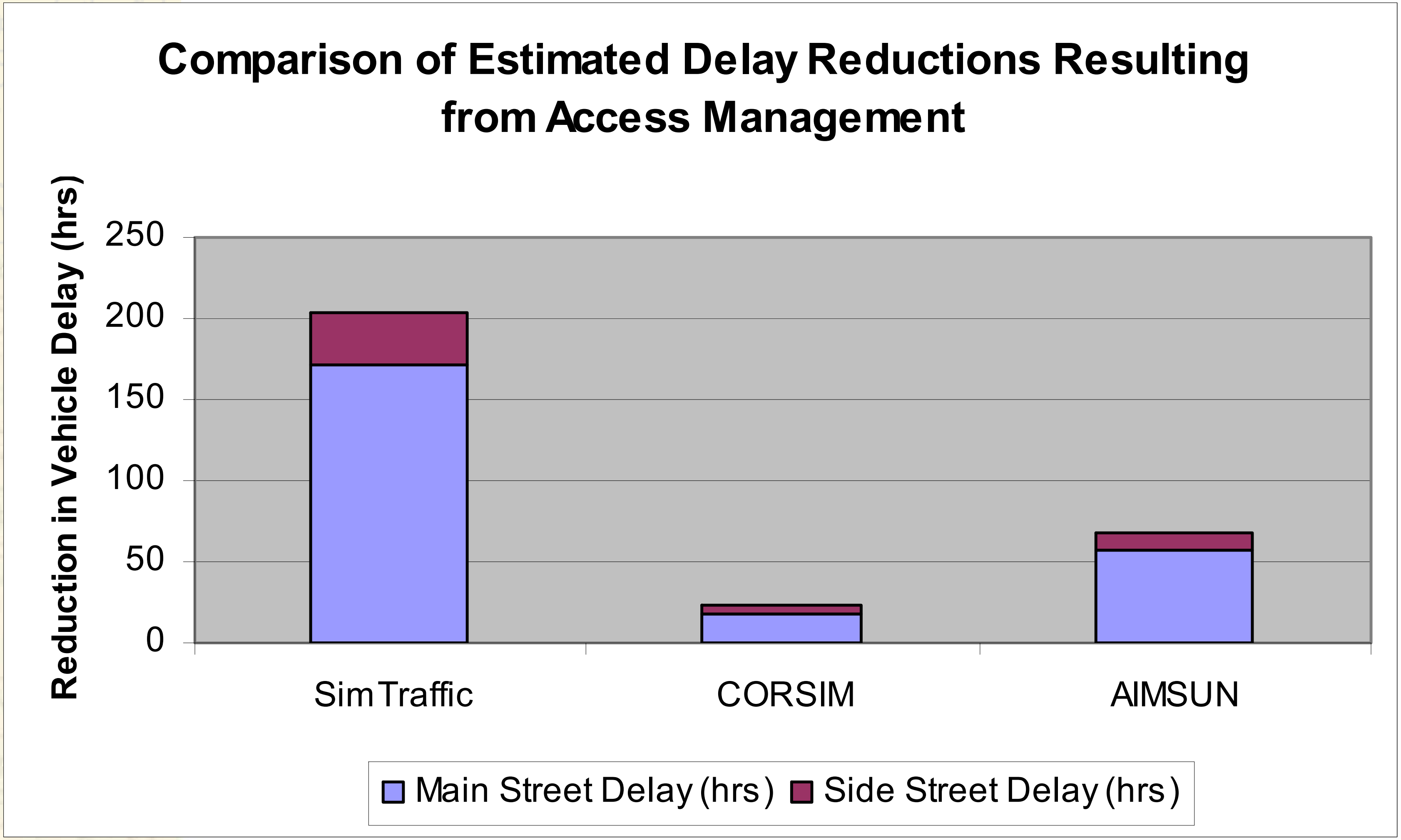

Recommendations

- 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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