Should I Use CORSIM or SimTraffic?

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Background

The main objective of this paper is to compare the results of CORSIM and SimTraffic on an arterial with low to moderate traffic volumes. HDR has been involved in a project in the cities of Waterloo and Cedar Falls, Iowa entitled Blackhawk Signal Optimization Study. The main intent of the project was to develop signal-timing plans for ten signal sub systems that would decrease delay and air emissions. One of HDRs strategies was to use CORSIM as a tool to determine if the optimized timing plans were "functioning" like we hoped they would in the field. The existing CORSIM models were calibrated using travel time runs along the systems included within our scope. When the project first originated, CORSIM was really the only choice for traffic simulation that HDR was familiar/comfortable with. Since then, the developers of Synchro have developed a new traffic simulation program entitled SimTraffic. SimTraffic is somewhat similar to CORSIM and thus HDR staff was interested in knowing if there would be any major differences between the simulation results obtained by CORSIM and those obtained by SimTraffic.

Systems Chosen for Comparison Analysis

HDR staff compared two subsystems that were included in the Blackhawk Signal project. The *existing* AM peak hour signal timing of the Hudson Road and Kimball Avenue subsystems were selected for comparison. The Hudson system consists of nine signalized intersections. The existing roadway geometry along Hudson Road consists of two northbound and southbound through lanes with left turn bays at each intersection. In general, all existing signals were running as fully actuated uncoordinated signals. The side street traffic was generally light for the analysis period. In general, the CORSIM and SimTraffic results were similar. The results were considered to be within reasonable ranges of each other and thus a more detailed comparison of the two simulation programs was completed.

Due to the "*typical*" roadway and signal timing of the Hudson system, we chose to concentrate more on comparing the results of an "*untypical"* system. The Kimball system consists of four signalized and one unsignalized intersection. The Kimball system also consists of *"untypical"* roadway geometry and signal phasing/timing. Kimball Avenue consists of two northbound and southbound through lanes, but does not contain left turn lanes. Due to the relatively high left turn movements along Kimball Avenue, fully actuated uncoordinated split phasing exists in some form at each of the signalized intersections. Two of the four intersections have all four approaches split phased. The traffic volumes of the two systems are shown below and compare with each other rather favorably.

<u>*Hudson Road*</u>

- Morning thru-volume 450-950, predominant flow southbound
- Mid-day thru-volume 300-750, predominant flow northbound
- Evening thru-volume 550-1200, flow balanced

Kimball Avenue

- Morning thru-volume 250-700, flow balanced
- Mid-day thru-volume 450-1100, flow balanced
- Evening thru-volume 450-1100, flow balanced

The main difference is that the volumes along Kimball Avenue are generally balanced throughout the day. This makes the signal timing of this particular system rather complicated. The existing split phasing along Kimball Avenue forces all traffic to stop on each approach and thus two-way progression can not be accomplished very easily.

General Discussion of Results

Ten minutes of seeding and sixty minutes of simulation time were used for both the networks while comparing the results of the two models. The average of three model runs was also used in comparing the results of the two models. In general, the SimTraffic delays and vehicle speeds were similar to those of CORSIM. There were however some discrepancies with the queue lengths between the two simulation models. A more detailed discussion on queue lengths will be covered in the next section. The simulation results for speed, volume, delay and the number of stops are depicted in Table 1.

The following are some general observations between the CORSIM and SimTraffic simulation results listed in Table 1.

- **Speed:** The speed variation was observed to be less than five miles per hour.
- **Volume:** The total volume entering/exiting each intersection along the arterial was generally less than 100 vehicles.
- **Delay/LOS:** The delay variation was generally less than 10 seconds. The LOS was within the same category.
- **Stops:** The SimTraffic number of stops ranged from 5% to 22% higher or lower than that of the CORSIM stops.

Overall, the two simulation models compare favorably close for each of the categories listed above.

Definition of a "Queued" Vehicle

To adequately compare the queue lengths between the two models, a general description of when each model considers a vehicle to be "queued" should be described. The following is a brief description of each models definition of when a vehicle is considered to be queued.

CORSIM: A vehicle is considered queued when having an acceleration rate of less than 2 ft/sec^2. When a vehicle has an acceleration rate of less than 2 ft/sec^2 and a speed of less than 3 ft/sec (2 mph), it is considered queued every second. If a vehicle has an acceleration rate of less than 2 ft/sec^2 and a speed more than 3 ft/sec but less than 9 ft/sec (6 mph) it is considered queued every other second.

SimTraffic: A vehicle is considered queued when traveling less than 10 ft/sec (7 mph). A vehicle is considered queued when it is either at the stop bar or behind another queued vehicle.

Each model also reports more than one type of queue length from a simulation run. There are differences in what each model reports and whether or not the queue was actually observed during the simulation run or not. The following is brief description of each models reported queue lengths. It should be noted that

SimTraffic sometimes counts vehicles that are stopped making mandatory lane changes as vehicles that are queued. It should be noted that if your model is generally stable, the maximum queue generally is close to the actual average queue.

CORSIM:

- *Maximum Queue:* This is the longest queue length observed during the simulation.
- *Average Queue:* This value consists of the average observed queue over time during the simulation. The average is computed during the entire simulation and thus includes queue values of zero in its calculation. Because of this, HDR does not report this value.

SimTraffic:

- *Maximum Queue:* This is the longest queue length observed during the simulation.
- *Average Queue:* Every two-minute time period a maximum queue length is recorded. The *average queue* is the average of the 2-minute queue.
- *95%tile Queue:* Consists of the average queue plus 1.65 standard deviations for all of the 2-minute time periods. This queue length might not be observed during an actual simulation.

Another important piece of information to be considered when comparing queue results is how the two models actually report the queue lengths. CORSIM reports queue in terms of vehicles and not in terms of measured differences. SimTraffic on the other hand actually reports the queue length based on the distance that the model run observes. This can make a big difference if there are a lot of heavy trucks in the simulation run. For example, in CORSIM four heavy trucks would be listed as four vehicles and in SimTraffic a queue length of 300 feet could be listed for the same four vehicles. It is up to the user to decide what an acceptable vehicle length would be for the particular mix of traffic that is being modeled when determining a queue length in CORSIM.

Comparison of Queue Results

This section will briefly cover the comparison of Queue results between the two simulation models. The comparison between the two simulation models is for this particular set of existing data as noted above. Some of this discussion could apply to other sets of data, while some of the discussion might not pertain. The overall concept of understanding the particular simulation model that you chose to use however can not be overstated. As we begin to compare the results, the importance of understanding the following two terms can not be overstated:

- *Calibration:* Each model should be calibrated to existing field conditions in order to be valid. There are several items that can be used to calibrate the simulation models. A few of these are travel speed, travel time, queue lengths, or volume served. Each model has different parameters that should be checked during calibration runs to be sure that the results are matching existing field conditions.
- *The definition of "Queue":* Understanding how each simulation model determines whether a car is considered to be queued or not is also very important. This can affect the interpretation of the results as well as the calibration process noted above. This is also true when the results of two models are being compared with each other. The results should be different, but a viable explanation should accompany the differences.

Included with this discussion of queue lengths are three tables that list the results of each simulation model. The tables list queue length for each lane along the approach to the five intersections. For purposes of this paper, each of the SimTraffic queues (described above) are only compared with the Maximum Queue reported by CORSIM. The following paragraphs briefly describe the results listed in the tables.

Table 2 depicts the Maximum queue of the two simulation models. In general, the SimTraffic maximum queues are consistently higher than those of CORSIM. The SimTraffic queues range from 25% higher to over 200% higher than those of CORSIM. The largest difference occurs at the intersection of Kimball & Brookridge where SimTraffic is five times larger than that of CORSIM.

Table 3 depicts the 95% queue of SimTraffic to the Maximum Queue in CORSIM. In general, the SimTraffic maximum queues were also consistently higher than those of CORSIM. The SimTraffic 95% queues were lower than the maximum queues reported in SimTraffic, but still were as much as three times those of CORSIM. The 95% queue lengths compare more reasonably than those of the maximum queue lengths. This tends to lead to the fact that one should be careful when reporting Maximum queue lengths. The simulation runs should be observed to be sure that something out of the ordinary caused the Maximum Queue length to be larger than that of the 95% Queue.

Table 4 depicts the Average Queue of SimTraffic to the Maximum Queue of CORSIM. The average queue in SimTraffic appears to be very comparable to the Maximum Queue reported by CORSIM. The Average Queue of SimTraffic for an hour simulation is an average of 30 2-minute queues. The CORSIM Maximum Queue that is generally observed, if the model has been successfully calibrated, usually represents more of an "average" queue over an hour simulation run. The exception to this can be if a simulation is being conducted during a peak 15-minute time period. If the hour simulation model is generally stable, the simulation generally depicts queues similar to those in the field. The close relationship between these queues can be attributed to SimTraffics' averaging of 30 2-minutes periods. This generally tends to even out a spike in a one time observed queue.

Summary of Results

The intent of this memo was to compare the outputs of two calibrated traffic simulation models. In the process of writing this memo, it became very apparent that not only do the results of the models need to be compared, but that understanding the models themselves are crucial to interpreting the results. Overall, the results between the two simulation models were very close to each other. All MOEs compared very well with each other in the sense that the same LOS category and "general" queue length were observed. The importance in understanding the results from the model you select to run can not be over stated. On the surface, the simulation models seem to report rather different results, but once the correct results are compared with each other, both simulation models seem to produce very similar outcomes. Hopefully this paper has provided some valuable insight to the question: ***Should I use CORSIM or SimTraffic?***

References:

1. CORSIM 4.32 User Guide (On-Line), Developed by ITT Industries for FHWA Office of Operations Research, Development and Technology.
2. Synchro 4.0 User Guide (On-Line), Developed by Trafficware Corporation, 1009B Solano Ave., Albany, CA.

CORSIM vs. SimTraffic
Blackhawk Signal Optimization Study: Kimball System

Table 1: Measure of Effectiveness Comparison

Intersection	SimTraffic				CORSIM			
	Speed	Volume	Delay/LOS	Stops	Speed	Volume	Delay/LOS	Stops
Kimball & Ridgeway	9.7	1923	47.6/D	1593.7	12.0	1936	37.9/D	1663.3
Kimball & Park	15.0	1366	28.8/C	997.7	17.4	1311	23.1/C	913.0
Kimball & Rachel	26.3	1046	5.2/A	178.0	29.0	986	4.4/A	158.3
Kimball & Brookridge	15.0	1071	18.1/B	713.7	17.6	1030	14.8/B	583.3
Kimball & San Marnan	12.0	1657	27.5/C	1205.0	14.2	1647	27.7/C	1076.0
Total Network	16.0	3298	61.4	4690.0	18.7	3263	73.4	4328.3

Table 2: Maximum Queue Length Comparison

Intersection	SimTraffic (Maximum)				CORSIM (Maximum)			
	EB	WB	NB	SB	EB	WB	NB	SB
Kimball & Ridgeway	242/253	227/263	288/921	242/239	173/140	147/133	260/253	147/140
Kimball & Park	272.7	198.3	226/218	198/1715	93.3	100.0	173/160	193/173
Kimball & Rachel	105.3	26.0	66/57	22/27	53.3	20.0	30/30	27/33
Kimball & Brookridge	87.0	47.0	597/604	170/165	53.3	20.0	147/120	113/113
Kimball & San Marnan	64/483/298/148	119/97/344/117	99/113	450/305	20/87/80/120	67/60/60/100	73/80	253/160

Table 3: 95% Queue Length Comparison

Intersection	SimTraffic (95%)				CORSIM (Maximum)			
	EB	WB	NB	SB	EB	WB	NB	SB
Kimball & Ridgeway	226/238	199/226	255/437	208/215	173/140	147/133	260/253	147/140
Kimball & Park	173.7	159.0	186/187	176/304	93.3	100.0	173/160	193/173
Kimball & Rachel	78.3	15.0	29/28	10/9	53.3	20.0	30/30	27/33
Kimball & Brookridge	70.3	45.3	313/321	147/128	53.3	20.0	147/120	113/113
Kimball & San Marnan	70/238/152/129	75/79/162/98	88/102	296/184	20/87/80/120	67/60/60/100	73/80	253/160

Table 4: Average Queue Length Comparison

Intersection	SimTraffic (Average)				CORSIM (Maximum)			
	EB	WB	NB	SB	EB	WB	NB	SB
Kimball & Ridgeway	149/161	130/152	166/183	137/142	173/140	147/133	260/253	147/140
Kimball & Park	87.0	86.0	115/111	102/129	93.3	100.0	173/160	193/173
Kimball & Rachel	46.0	3.0	2/13	1/1	53.3	20.0	30/30	27/33
Kimball & Brookridge	42.0	21.0	115/121	83/69	53.3	20.0	147/120	113/113
Kimball & San Marnan	40/74/65/75	41/39/60/55	47/60	158/91	20/87/80/120	67/60/60/100	73/80	253/160

Notes:

1. SimTraffic 4.0 and CORSIM 4.32 were used for this analysis.
2. If there is more than one lane, the lanes start from the right curb and move to the left.
3. All lane groups are shared except at San Marnan. The lanes are RTTL for EB &WB.
4. The 1997 HCM tables were applied to determine the Level of Service.
5. During one or more of the SimTraffic runs at the intersections of Kimball Ave with Park & Ridgeway, the Max, queues were very large and thus the average of the three runs become skewed.
6. SimTraffic reports the queue length as simulated, while CORSIM reports the number of vehicles in a queue. For CORSIM calcualted queue lengths, a length of 25 feet per vehicle was assumed.

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