

**SYNCHRO VERSUS HCM:
A COMPARISON OF THE MOST POPULAR METHODS FOR
SIGNALIZED INTERSECTION CAPACITY ANALYSIS**

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INTRODUCTION

The Highway Capacity Manual has been adopted by many agencies as the standard tool for the analysis of signalized intersection capacity. Another popular traffic analysis tool, the Synchro traffic signal timing program, is often used as a surrogate for the Highway Capacity Manual. Since the Synchro program uses similar inputs and outputs as the Highway Capacity Manual and because it is widely accepted for use in signal timing, it can be argued that Synchro provides signalized intersection capacity analysis that is equally accurate (or more accurate) than analysis based on the Highway Capacity Manual. However, the results of Synchro and the Highway Capacity Manual vary and there is no conclusive evidence that has shown that one is more accurate than the other.

The situation described above presents a dilemma for traffic engineers in agencies where the Highway Capacity Manual has been adopted as the standard. If a signalized intersection analysis is conducted using Synchro, should it be rejected as not meeting the HCM standard or accepted as an equivalent traffic analysis tool? This paper presents a study conducted by the author to answer this question for the City of Perris, California, where the author has worked as a consulting traffic engineer reviewing traffic impact studies and providing comments on their accuracy.

Some research has been done to compare the results of the HCM and Synchro. As an example, a 2002 study published in the ITE Journal (1), found that differences in the delay estimates of the two programs occurred because of differences in assumptions regarding signal progression and right-turn-on-red movements, as well as a different method of delay calculation used by Synchro (Percentile Delay). This study included a summary of differences between the programs, but did not include a conclusion on whether Synchro could be used as a surrogate for HCM analyses.

SAMPLE PROBLEMS

In order to provide further analysis of this issue presented above, the study described in this paper analyzed five isolated signal sample problems from the Highway Capacity Manual and nine sample intersections from a coordinated signal system in the City of Perris, using both the HCM and Synchro with equivalent inputs (to the extent possible). The coordinated signal system in the City of Perris is shown in Exhibit 1. This system was analyzed using 2030 future traffic conditions. A summary of assumptions used in selecting key parameters for the analysis is shown in Exhibit 2. It should be noted that this analysis was conducted using Synchro 6 and McTrans HCS version 4.1E. Changes in software have occurred since this analysis was done, but the changes are not considered to be significant in terms of the overall results of this study.

RESULTS FOR ISOLATED SIGNALS

The results of the analysis for the five HCM sample problems are shown in Exhibit 3. Based on these examples, Synchro provided a slightly more conservative result than the HCM.

RESULTS FOR COORDINATED SIGNAL SYSTEMS

The results of the analysis for the sample coordinated signal system in the City of Perris are shown in Exhibits 4 through 6 and can be described as follows:

- ◆ Exhibit 4 shows the results assuming the order of phasing is fixed in the Synchro program and HCM Arrival Type 4 is used. Under these conditions, Synchro averaged 7.7 seconds less delay for the study area intersections than the HCM.

- ◆ Exhibit 5 shows the results assuming the order of phasing is fixed in the Synchro program and HCM Arrival Type 5 is used. Under these conditions, the results varied for individual intersections, but the overall average delays for Synchro and the HCM were nearly identical.

- ◆ Exhibit 6 shows the results assuming the order of phasing in the Synchro program can be varied to optimize traffic operations and HCM Arrival Type 4 is used. Under these conditions, Synchro averaged 10.0 seconds less delay for the study area intersections than the HCM.

CONCLUSIONS/RECOMMENDATIONS

On an overall basis, the results of this study indicate that there is variation in the results of signalized intersection analysis conducted using Synchro and the HCM and that the variation in the results can be significant, in certain cases. However, it is also clear that the results can vary based on input parameters that are highly judgmental, such as HCM Arrival Type and whether the order of phasing can be varied to allow for phasing that Synchro considers to be optimal.

Prior to conducting this study, general experience had led the author to believe that the Synchro program resulted in results approximately one level of service better than the HCM with similar inputs. After numerous comparisons between the two traffic analysis tools, it is apparent that the differences between the two are relatively minor compared to differences in results based on selection of key input parameters. There is some indication that Synchro provides slightly worse results at isolated intersections and slightly better results in coordinated signal systems, in comparison to the HCM. However, this result is based on the unique assumptions and judgments made in this

study. An analyst using a different set of input assumptions could easily come up with a different conclusion. This speaks to the need for appropriate checking of the input and results, regardless of which program is used. In addition, agencies that desire consistency in the results between different studies would be advised to use only one traffic analysis tool (Synchro or the HCM) and to develop a consistent set of input assumptions.

In the case of the City of Perris, the author has concluded that Synchro can provide an acceptable surrogate for HCM signalized intersection capacity analysis. This approach is applicable in a City where the need for engineering judgment is understood and there is not a need to have exact agreement of results among various studies that analyze the same intersection.

REFERENCES

(1) Washburn, Scott S. and Larson, Nate, Signalized Intersection Delay Estimation: Case Study Comparison of TRANSYT-7F, Synchro, and HCS, ITE Journal, March 2002

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Exhibit 1

Perris, California

Sample Coordinated Signal System

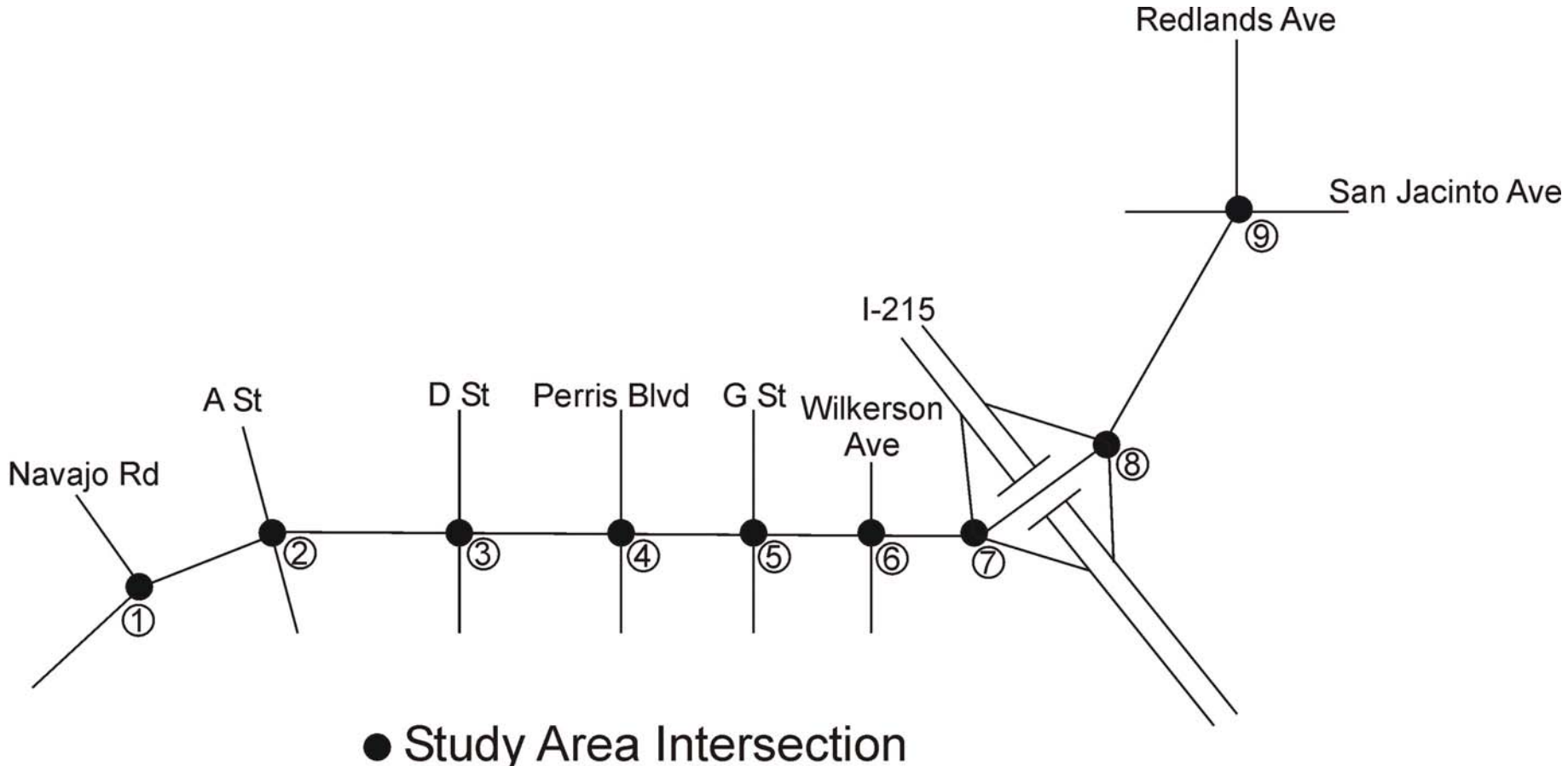


Exhibit 2

Key Assumptions

- ◆ **Cycle Length = 100 (HCM Example Problems)**
- ◆ **PHF = 0.92**
- ◆ **Lost Time = 4.0 sec**
- ◆ **Unit Extension = 3.0 sec**
- ◆ **Base Saturation Flow = 1900 veh/hour**
- ◆ **Lane Width = 12 ft**
- ◆ **Heavy Vehicles = 2%**
- ◆ **No Pedestrians/Bicycles/Parking/Buses**
- ◆ **Upstream Filtering (I Value) = 0.5 (HCM)**
- ◆ **Right Turn on Red = 25% (HCM)**

Exhibit 3
Results: HCM Example Problems

Problem	LOS/Average Delay (sec)		Difference in Delay (sec)
	HCM	Synchro	
1	C/30.5	C/33.6	+ 3.1
2	B/16.9	C/20.9	+ 4.0
3	E/NA	F/NA	NA
4	E/67.8	E/69.6	+ 1.8
5	D/NA	E/59.5	NA
		Average	+ 3.0

NA = Results not comparable due to extremely high delay results for one or more traffic movements.

Exhibit 4
Results: Perris, California
(Coordinated System)
Synchro Phasing Fixed – HCM Arrival Type 4

Intersection	LOS/Average Delay (sec)		Difference in Delay (sec)
	HCM	Synchro	
1	C/30.9	C/20.4	-10.5
2	F/NA	F/NA	NA
3	F/NA	F/NA	NA
4	E/70.8	E/55.2	-15.6
5	F/NA	F/NA	NA
6	C/22.2	B/17.3	-4.9
7	C/30.3	B/13.9	-16.4
8	C/34.5	D/39.9	+5.4
9	D/42.7	D/38.6	-4.1
		Average	-7.7

Exhibit 5
Results: Perris, California
(Coordinated System)
Synchro Phasing Fixed – HCM Arrival Type 5

Intersection	LOS/Average Delay (sec)		Difference in Delay (sec)
	HCM	Synchro	
1	B/15.6	C/20.4	+4.8
2	F/NA	F/NA	NA
3	F/NA	F/NA	NA
4	E/64.6	E/55.2	-9.4
5	F/NA	F/NA	NA
6	B/12.5	B/17.3	+4.8
7	C/23.8	B/13.9	-9.9
8	C/28.8	D/39.9	+11.1
9	D/41.3	D/38.6	-2.7
	Average		-0.2

Exhibit 6
Results: Perris, California
(Coordinated System)
Synchro Phasing Optimized – HCM Arrival Type 4

Intersection	LOS/Average Delay (sec)		Difference in Delay (sec)
	HCM	Synchro	
1	C/30.9	C/20.4	-10.5
2	F/NA	F/NA	NA
3	F/NA	F/NA	NA
4	E/70.8	D/51.3	-19.5
5	F/NA	F/NA	NA
6	C/22.2	B/12.6	-9.6
7	C/30.3	B/12.5	-17.8
8	C/34.5	D/35.6	+1.1
9	D/42.7	D/38.7	-4.0
		Average	-10.0