PERFORMANCE ANALYSIS OF PARALLEL FLOW INTERSECTION AND DISPLACED LEFT TURN INTERSECTION DESIGNS

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ABSTRACT

The displaced left turn (DLT) (also known as the continuous flow intersection (CFI)) design has proven to be a superior alternative to the conventional intersection in terms of handling heavy volumes during peak periods. In locations where the availability of additional right of way and driveway access is not a major concern, the DLT design is a cost effective and time saving option compared to the expensive option of grade separated interchanges. Recently, a new non-traditional intersection design called the parallel flow intersection (PFI) has been proposed. The PFI is also an at-grade design and operates with the same number of signal phases as a DLT. This research compares the operational performance of DLT and PFI designs based on the maximum through and left turn movement throughputs for three different high volume scenarios using traffic simulation.

The results indicate that maximum throughput values of through movement in PFI were very close to the values obtained for DLT. The designs produced similar results mainly because both operate as two-phase signals (at the main intersection) with equal green times for through movements. The left turn movement throughputs in PFI were found to be lower than those at DLT. In particular, for two study cases, the DLT was able to process 180 and 80 more vehicles per hour per lane than the PFI. This can be attributed to the fact that, on average, the left turning vehicles experience greater number of stops in a PFI than they would in a DLT.

INTRODUCTION

Long delays and deteriorating levels of service at signalized intersections are usually remedied by adding lanes, increasing the cycle lengths, coordination, and synchronization of signals. Adding lanes on existing roadways in urban areas is a challenge due to the high costs of acquiring right of way. Adjustments to cycle lengths and signal coordination can only provide marginal improvements at saturated intersections. These challenges have forced traffic engineers and planners to look for alternative solutions.

Unconventional intersection designs are creative solutions to address the congestion problem at signalized intersections. In the last few decades many novel designs have been implemented in the United States. Few examples include, median u-turn, jughandle, quadrant roadway design, superstreet, among others. Several of these designs have not only proven to improve the traffic performance but also safety. These designs accomplish superior performance mainly by reducing the number of signal phases at the intersection, typically by moving left turn movements to upstream or downstream locations outside the main intersection.

In this paper, we evaluate an innovative intersection design called the Parallel Flow Intersection (PFI) (*1*) and compare it with a similar unconventional design, the displaced left turn intersection (DLT). The PFI design was invented and patented by Gregory Parsons (*1*). The main focus of this study is to determine the maximum throughputs of through and left turn movements for both designs using different design layouts and traffic volume combinations. The throughput values obtained for each of the combinations are dependent on the traffic volume assumptions made for the other movements. The maximum throughput values are indicative of the maximum volumes that can be processed by these designs and should therefore serve as a selection guide while considering these design alternatives.

The paper is organized as follows. The second section reviews the literature on the two unconventional designs. In the third section, details of the analyzed designs and the signal phasing schemes are presented. The fourth section describes the analysis methodology including the volume cases and signal timing plans. The performance measures are reported in the results section. The results of both designs are compared and conclusions drawn in the final section.

LITERATURE REVIEW

Since the PFI is a relatively new design, not much research has yet been done compared to the DLT design. The main findings of existing studies are summarized here.

Jagannathan and Bared *(2)* modeled three different cases of DLT and compared them with their conventional counterparts. The three cases are a full DLT with displaced left on all four approaches, a partial DLT on two opposing approaches only of four-legged designs, and the third is a T-intersection. They found that the DLT outperformed the conventional design for all cases, including the case with a separate pedestrian signal phase. They concluded that the DLT could be an effective solution for congested intersections.

Reid and Hummer *(3)* compared seven unconventional intersection designs (the quadrant roadway intersection, median U-turn, superstreet median, bowtie, jughandle, split intersection, and displaced left turn intersection) with their conventional equivalents. The results of average travel times, vehicle miles, and the number of trips showed that one or more unconventional designs had lower travel times than the conventional design for every site. Based on the moving-to-total time ratio, they found that the DLT design consistently proved to be the most efficient design.

Cheong et al *(4)* evaluated and compared operational performance of displaced left turn intersection, PFI, and upstream signalized crossover (USC) echoing findings similar to above research. The results showed that the DLT design outperformed the other two designs for most traffic conditions. At low traffic volume levels, the average delays of through traffic were found to be lower for PFI than the DLT and USC. It was also found that the average delays of left turn movements at high volumes are similar for PFI and DLT designs. The study did not perform a throughput analysis for any of these intersections.

El Esawey and Sayed *(5)* examined the impact of changes in spacing between primary and secondary intersections on performance of DLT and upstream signalized crossover intersections (USC). Results obtained were consistent for both designs indicating an increase in capacity with an increase in the spacing between intersections. It was also shown that the DLT outperformed the USC for all study scenarios, especially for high volume scenarios.

DESCRIPTION OF DESIGNS

Displaced left turn Intersection (DLT)

DLT with Displaced Left Turn on all four approaches (or Full DLT design)

Displaced left turn intersection, also known as the Crossover Displaced Left turn (XDL) is a re-organized at-grade intersection design. The DLT relocates left turns to the left of opposing through movement lanes (see Figure 1). This arrangement allows concurrent movement of through traffic and the corresponding left turns operating under a two phase signal setting. This design favors heavy and balanced opposing traffic flows.

Left turning traffic is directed into left turn bays and stopped at the crossover intersection with the opposing through traffic. The left turning vehicles cross the opposing through lanes once the phase turns green, travel through the displaced left turn lane until they reach the signal at the main intersection. Three signal controllers are used for this design. The main intersection signal is denoted as SC1, the signals at the crossover intersections for east and west approaches are controlled by SC2, and the north and south crossover intersections are controlled by SC3. A single signal phasing diagram is shown in Figure 2(a) for all three controllers. During phase 1 at the main intersection east bound (EB) and west bound (WB) through traffic proceeds simultaneously with the corresponding left turn movements. During the same time through traffic at the east and west crossover intersections (SC2) and the left turns at north and south crossover intersections (SC3) get the green. All the remaining movements proceed during the next phase.

The geometric configuration for this design has two through lanes, one left turn, and one right turn lane on each of the four approaches. The left turning bays are 350ft long, displaced left turn lanes before the main intersection are 325ft long and right turn lanes are 250ft long (see Figure 1).

DLT with displaced left turn on two approaches (or Partial DLT design)

A second DLT design consisting of a partial DLT with crossovers only on the northbound and southbound approaches was also studied (see Figure 3). This design operates under three phases as shown in Figure 2(b). The additional, third, phase is dedicated to left turning traffic on the eastbound and westbound approaches. At the main intersection, during phase 1 the northbound and southbound through traffic move simultaneously with left turning vehicles from both directions. The eastbound and westbound through movements occur in phase 2 and left turn movements occur in phase 3. The geometrics of turn lanes and crossover locations are comparable to the full DLT design previously described.

Parallel Flow Intersection (PFI)

Four legged parallel flow intersection (or Full PFI design)

The PFI is a recently developed (in 2006) two phase intersection design patented by Gregory Parsons (U.S. Patent No. 7,135,989) (*1*). Simultaneous movement of left turns with cross-street through movements makes it work as a two phase signal design. PFI accomplishes this operation with bypass turn lane placed parallel to cross-street lanes. Bypass turn lanes are located to the left of the opposing through lanes (see Figure 4).

The PFI design exploits the combination of a bypass intersection and the main intersection to accomplish the desired left turn maneuver. Left turning traffic first stop at the bypass intersection signal along with through movements, and then continue into the center left turn lane provided between the bypass and main intersections (see Figure 4). At the main intersection, they cross the opposing lanes and turn into the bypass roadway parallel to the cross-street. They then go through the bypass intersection on the cross-street to complete the left turn maneuver. The main intersection operates as a two phase cycle (SC1); during the first phase the through traffic from eastbound and westbound directions get green along with the left turn traffic from the northbound and southbound directions. Meanwhile, at the eastbound and westbound bypass intersections (SC2), the through movement gets green while lefts are stopped and at the northbound and southbound bypass intersections (SC3) left turns are allowed to proceed. This phasing setup is shown in Figure 5. This design configuration has two through lanes, one centre left turn lane, one bypass lane, and one right turn lane on every approach. The bypass lane, the center left turn lane, and the right turn lane are all 325ft in length.

Two legged parallel flow intersection (or Partial PFI design)

The second design was proposed for an intersection of a major road (north-south) and a minor road (east-west). The PFI was applied only on two legs of the intersection (see Figure 6). Unlike the partial DLT design presented earlier, the bypass lanes in a partial PFI being parallel to the cross-street result in bypass intersections on the eastbound and westbound directions. This is a marked difference in the design aspect of a partial PFI as compared to a partial DLT which also means different right of way requirements for each approach. This design operates with three phases as shown in Figure 5(b). In phase 1, the northbound and southbound through traffic get the green at the main intersection and the left turning traffic gets green at the eastbound and westbound bypass intersections. The eastbound and westbound through movements at the main intersection proceed in the second phase. And, the eastbound and westbound left turn movements proceed in the third phase. The geometrics of turn lanes and crossover locations are similar to the full PFI design previously described.

ANALYSIS METHODOLOGY

Traffic performance of the described DLT and PFI designs was evaluated using traffic simulation. The VISSIM (version 5.10) traffic simulation tool was chosen due to its flexibility in modeling innovative designs. As mentioned before, the performance analysis was focused on determining the maximum lane throughput for each design for three different volume cases.

In this paper, 'throughput' is defined as the maximum traffic flow that can be serviced by a lane. Two criteria were used to determine the throughput conditions for any movement – 1) the model output volume (simulation output) for the movement under consideration was 150 vehicles lower than the input entering volume (demand) for the movement, or 2) the travel delay for any movement at the intersection reaches 80 seconds per vehicle.

The first step towards obtaining throughput involved determining optimal signal timing plans. This was accomplished by varying the cycle length between 55 seconds and 80 seconds. The range for cycle length variation was determined from the authors' previous research on unconventional designs including the DLT (*2 and 6*). It was found that a 60 second cycle length was optimal for all cases for both DLT and PFI designs. However, the phasing and timing plans were different from one case to another owing to the fact that each case was separately optimized to produce throughput conditions.

Signal heads were also placed on right turn lanes to accommodate pedestrian movements. The duration of each simulation run was one hour and the traffic arrivals are Poisson with exponentially distributed headways. To account for the randomness of traffic simulation, each design case was simulated for 30 different random seeds (i.e., 30 different simulation runs) and the mean values were computed. A statistical t-test was then used to compare and verify if the estimated throughputs for the DLT and PFI designs were statistically different for each case.

Three different traffic volume cases were modeled: 1) Balanced flows, 2) Different splits, and 3) Partial design. For the first two cases, the full DLT and full PFI designs are compared and for the third case the partial designs are compared. A cycle length of 60 seconds produced throughput values for both DLT and PFI designs. In addition, for every phase the all-red interval was set to 2 seconds and the amber interval was set to 3 seconds. All signal controllers used in the analysis were fixed time controllers. The traffic composition consisted of 98% passenger cars and 2% heavy vehicles. The desired speed on all approaches was defined as a uniform distribution between 30 mph to 36 mph.

Case 1: Balanced Flows

In this case, all four approaches are similar to each other and experience the same amount of traffic volumes. Two sets of input traffic volumes are defined: 1) for estimating the throughput for through movement (called through scenario), and 2) for estimating the throughput for left turn movement (called left turn scenario). Table 1 shows the volumes for all movements.

For through scenario, the demand for through movements was started at 1800 vehicles per hour (900 per lane) and then raised by an increment of 100 until throughput conditions were met. While determining throughput for the through movement the volumes for all other movements were kept fixed. Similarly, the demand data shown in the left turn scenario column corresponds to the iterative determination of left turn throughput. Identical input volumes are used for both DLT and PFI designs. It was also found that the signal timing plans producing the throughput conditions were the same for both designs. The signal timing plans for the DLT and PFI designs for case 1 are shown in Table 2 and Table 3, respectively.

Case 2: Different Splits

The intersection designs were similar to case 1 (full DLT and full PFI), except that the northbound and southbound movements are treated as major road movements and the eastbound and westbound movements are treated as minor road movements. For this case, the throughputs were obtained for the major road movements while the volumes on the minor road approaches were held fixed. The input volumes for determining through and left turn throughput volumes can be found in Table 1 in the case 2 columns. The timing plans are shown in Tables 2 and 3 for DLT and PFI designs, respectively.

Case 3: Partial design

In this case, the partial designs of DLT (see Figure 3) and PFI (see Figure 6) are analyzed. The northbound and southbound approaches are treated as major road movements and the eastbound and westbound approaches are treated as minor road movements. Unlike the previous two cases, this case operates in three phases at the main intersection. The additional phase serves the left turns on the minor road. As in case 2, throughputs were obtained for major road movements keeping the volumes on minor roads fixed. Again, the input volumes for determining through and left turn throughputs for case 3 can be found in Table 1. The three phase timing plans are shown in Tables 2 and 3 (case 3) for DLT and PFI designs, respectively.

RESULTS

The mean throughput values obtained from multiple simulations (30 runs each) for both DLT and PFI cases are shown in Table 4. In addition to the throughput values, the results of average intersection delay are also reported.

The throughput values shown in Table 4 reveal that both DLT and PFI designs have similar throughputs and average intersection delays for through movements, with the exception of case 2 for which the PFI was able to serve 30 more vehicles per hour per lane than the DLT. The results of left turn movement indicate that the DLT outperformed PFI for all three cases. In particular, the DLT was able to serve 50, 180, and 80 more vehicles per hour per lane than the PFI for cases 1, 2, and 3, respectively. The delay values for left turns were also higher at the PFI for all three cases. A statistical t-test was performed to test the difference between the mean throughput values for DLT and PFI for all cases. The test results of each case confirmed that the DLT and PFI throughputs were statistically different at the 5% significance level. The mean throughputs, standard deviations, and 95% confidence intervals (*mean ± 1.96*standard deviation*) of through and left turn movements for both DLT and PFI cases are shown in Figures 7 and 8.

The average numbers of stops were also recorded during the simulations. The values for left turn and through movements are shown in Table 5 and Table 6 for DLT and PFI, respectively. The average number of stops by left turning vehicles are averaged on all four approaches for balanced flows (case 1), while for cases 2 and 3, the average of major road movements (northbound and southbound) and minor road movements (eastbound and westbound) are computed separately. The average stops for through movements were also computed in a similar fashion.

A comparison of the values in Tables 5 and 6 reveal that the average numbers of stops for both through and left turn movements in almost all cases were fewer in the DLT than the PFI. For left turn throughput scenarios, left turning vehicles stopped more than three times in PFI for cases 1 and 2 compared to two times in DLT. For the left turn scenario in case 3 (partial designs), the average number of stops for minor road through movements was higher for PFI (2.5 stops) than for DLT (1.4 stops). This can be attributed to the fact that the through movements on minor road in partial DLT encounter only one traffic signal whereas in partial PFI they encounter three signals. For the through scenario in case 3, the major road left turn movements go with the major road through movements in DLT, however in PFI they go with the minor road through movements. This difference in the phase plans result in fewer stops for the major road left turns in DLT as compared to PFI.

The throughput values obtained for case 3 designs were the highest for left turns and second highest for the through movement compared to the other two cases. This may seem unexpected given that case 3 has one extra signal phase compared to the other cases. The reasons for this finding were further explored. A review of the signal timing plans (see Tables 2 and 3) for the through scenario reveals that the through movement received 25, 35, and 30 seconds for cases 1, 2, and 3, respectively. This directly translates to throughput values in the same order. For left turn scenarios, the left turn movements in partial designs (of DLT and PFI) go through one less traffic signal as compared to the full designs in cases 1 and 2. The impact of this on the number of stops can be found in Tables 5 and 6 that clearly show that the left turn movements stop fewer times in case 3 as compared to case 1 and case 2. Therefore, the left turn throughput values for case 3 are greater than the values for case 1 and case 2.

The performance of comparable conventional intersection designs was also obtained using simulation for all cases. For through scenarios, the throughput values were found to be 635, 740, and 890 vehicles per hour per lane for case 1, case 2, and case 3, respectively. The values for cases 1 and 2 are significantly lower than the PFI and DLT values reported in Table 4 earlier. For left turn scenarios, the estimated throughput value for case 1 was 240 vehicles per hour per lane, nearly half of the throughput obtained for DLT. The high volumes on non-left turn movements in cases 2 and 3 did not allow for performing a throughput analysis for the left turn scenarios.

CONCLUSIONS

This paper compared the operational performance of DLT and PFI designs based on through and left turn movement throughputs for three different high volume scenarios using traffic simulation. The results indicated that the throughput values of through movement at PFI were very close to the values obtained at DLT, with the exception of Case 2 for which the PFI offers slightly higher throughput (30 more vehicles per hour per lane) than the DLT. The designs produced similar results mainly because both operate as two-phase signals at the main intersection.

The left turn movement throughputs at PFI were found to be lower than those at DLT. The DLT was able to serve 50, 180, and 80 more vehicles per hour per lane than the PFI for cases 1, 2, and 3, respectively. This can be attributed to the fact that, on average, the left turning vehicles had to stop more often in a PFI than in a DLT. The difference in throughput values of DLT and PFI for every case was found to be statistically significant at the 95% confidence level. The marked difference in the left turn movement throughput values between DLT and PFI shows that the DLT should be preferred over the PFI in situations with heavy left turn volumes on one or more approaches.

The geometric configurations of the partial DLT and PFI designs are noticeably different from each other. For the DLT design, the additional storage for major road left turn movements (the displaced left turn) and the crossover are located on the major road whereas for the PFI the corresponding bypass lane and the crossover are located on the minor road. Another difference in the two designs is the number of traffic signals the minor road through movements encounter; one signal in the DLT versus three signals in the PFI. This means that while replacing an existing conventional intersection design the DLT is more suitable at locations where additional right of way is available in the major road direction, whereas the PFI is better suited for locations where additional right of way is available on the minor road (cross-street).

The total footprint of a PFI can be smaller than a DLT for both full and partial designs depending on the right turn volumes. The right turning movements in a PFI can merge into the cross-street at the main signal unlike in a DLT where they need an additional acceleration lane on the cross-street to merge. However, when the right turn volumes are high the PFI will need an additional right turn lane upstream of the bypass signal. With the additional right turn lane the footprint becomes similar to the footprint of the DLT.

In future research, the traffic and safety performances of the two designs will be further analyzed. Specifically, the impact of spacing of the crossover (or bypass) signals on the overall operations of the two designs will be explored. The safety of both designs will be assessed using the surrogate safety assessment tool. The impact of addition of pedestrian phases to the signals on the overall operations of the designs will also be studied.

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LIST OF FIGURES AND TABLES

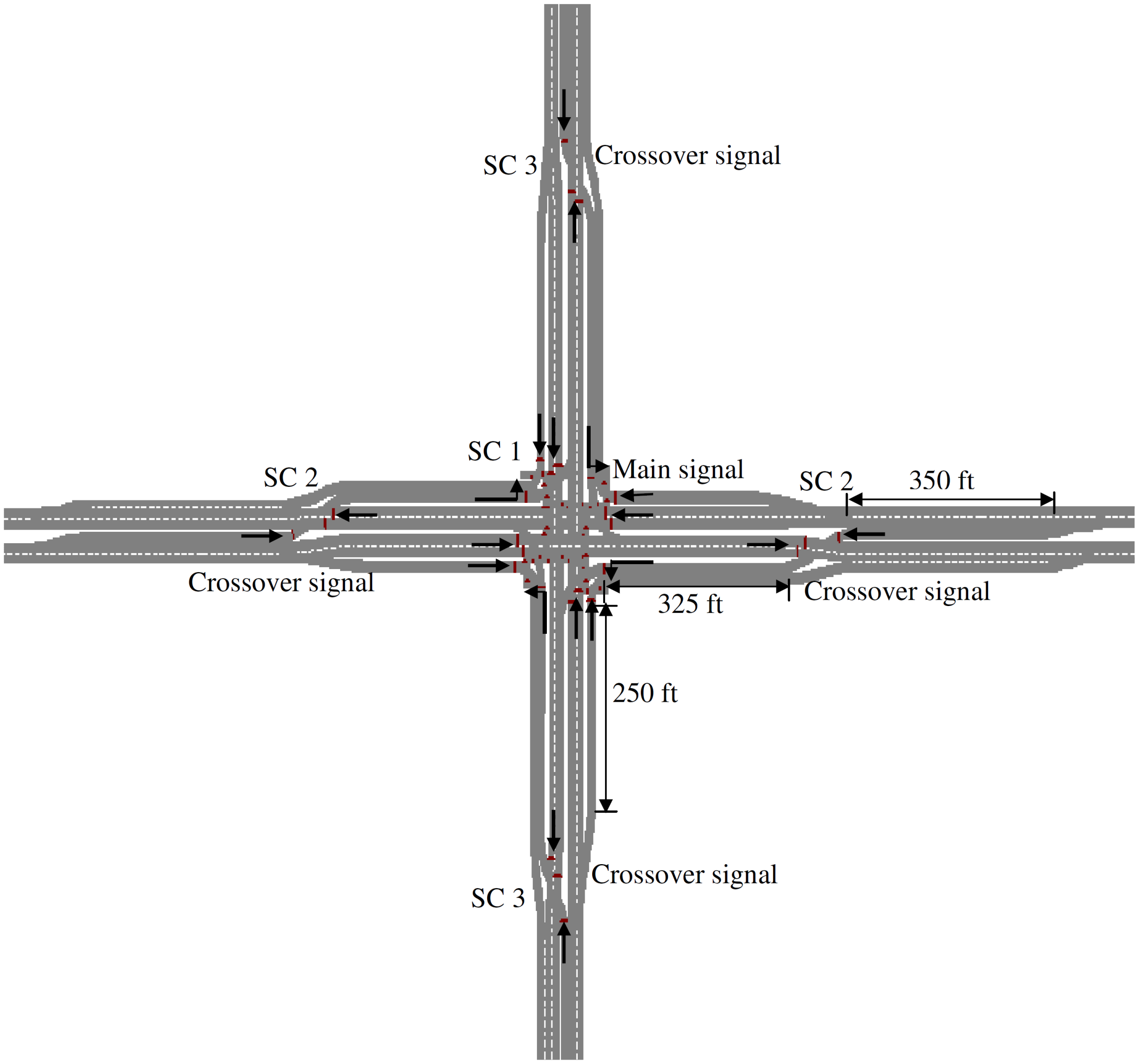


FIGURE 1 Layout of a displaced left turn intersection

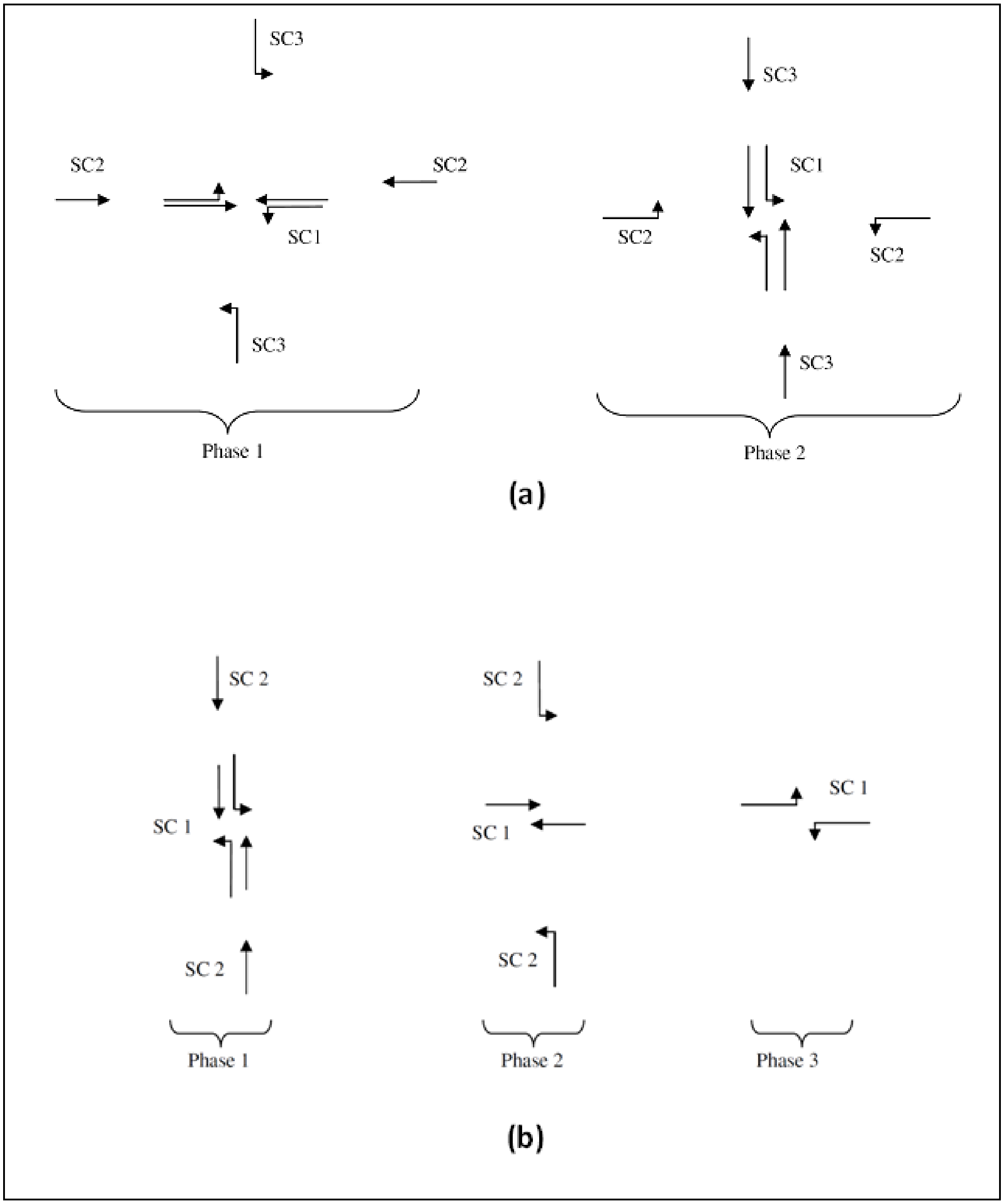


FIGURE 2 Phasing diagram for DLT – (a) full design and (b) partial design

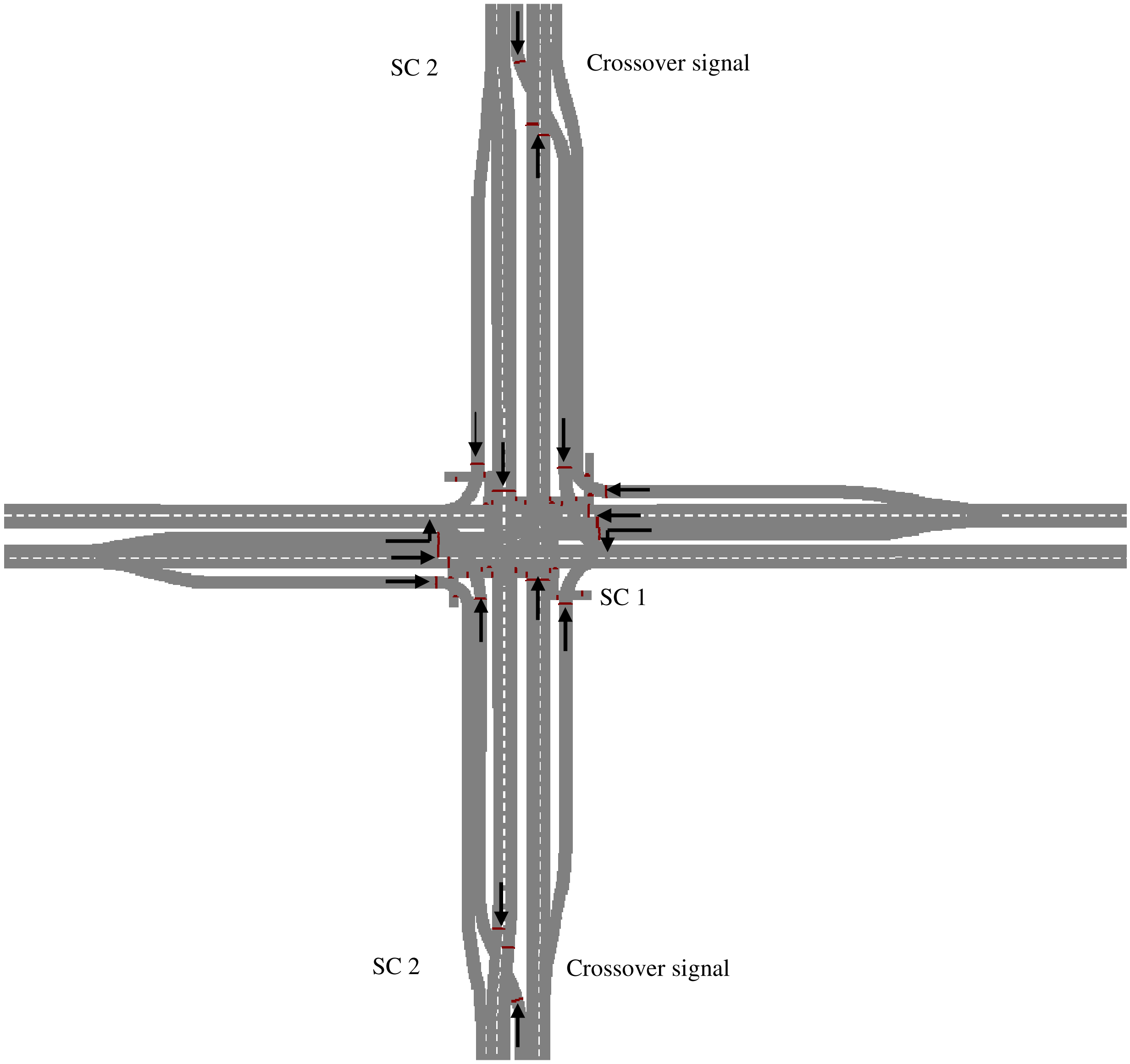


FIGURE 3 Partial DLT intersection design

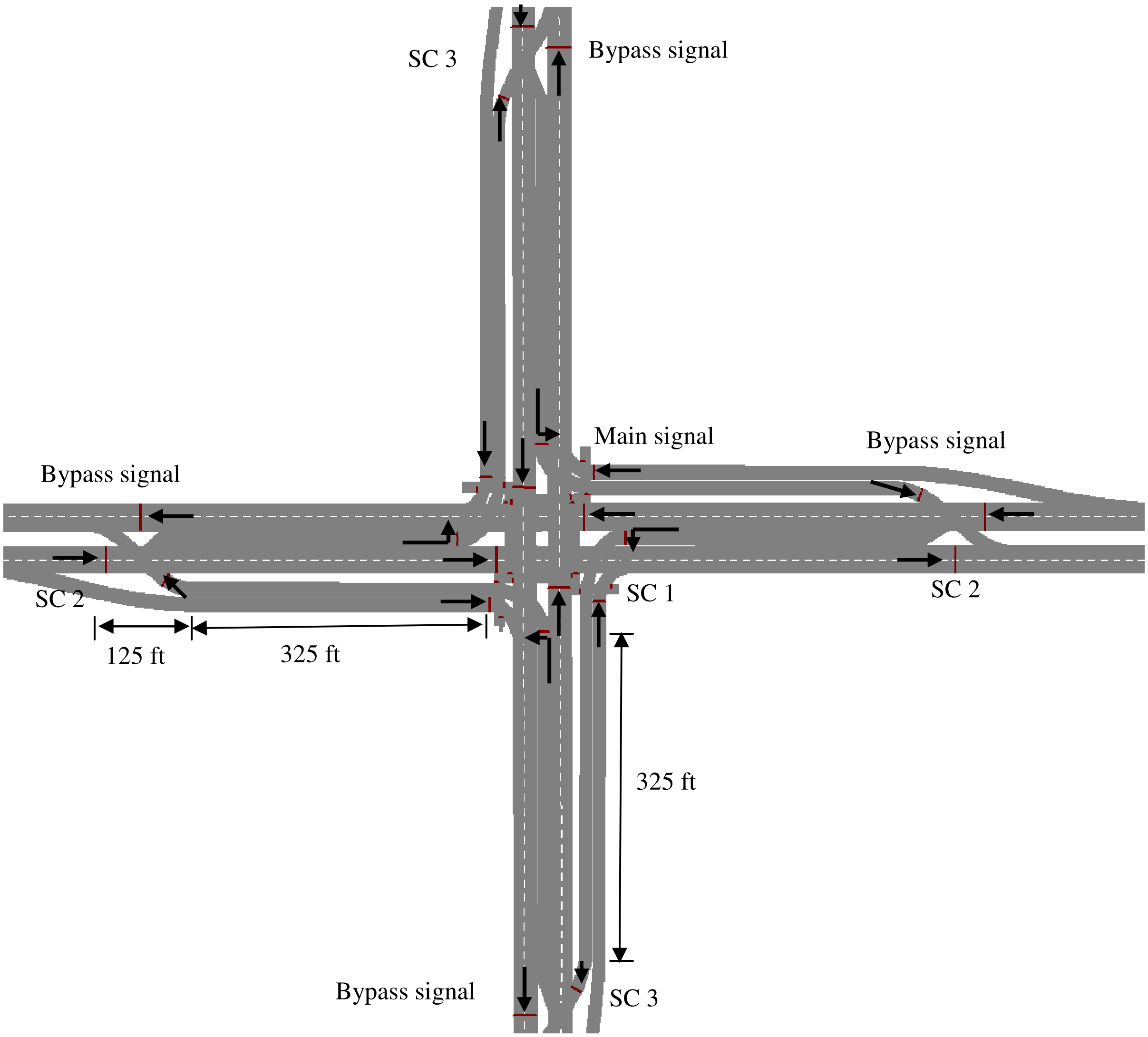


FIGURE 4 Layout of Parallel Flow Intersection

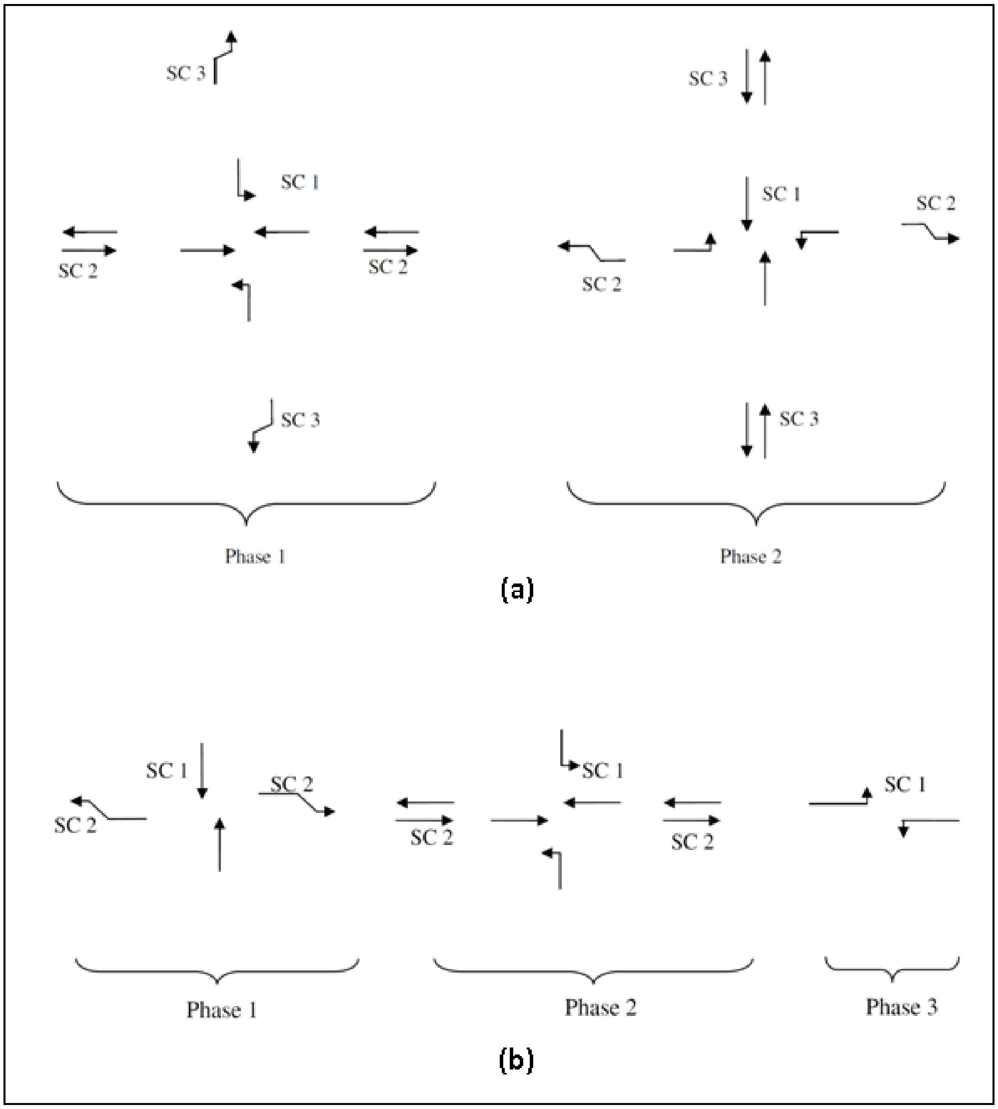


FIGURE 5 Phasing diagram for the PFI – (a) full design and (b) partial design

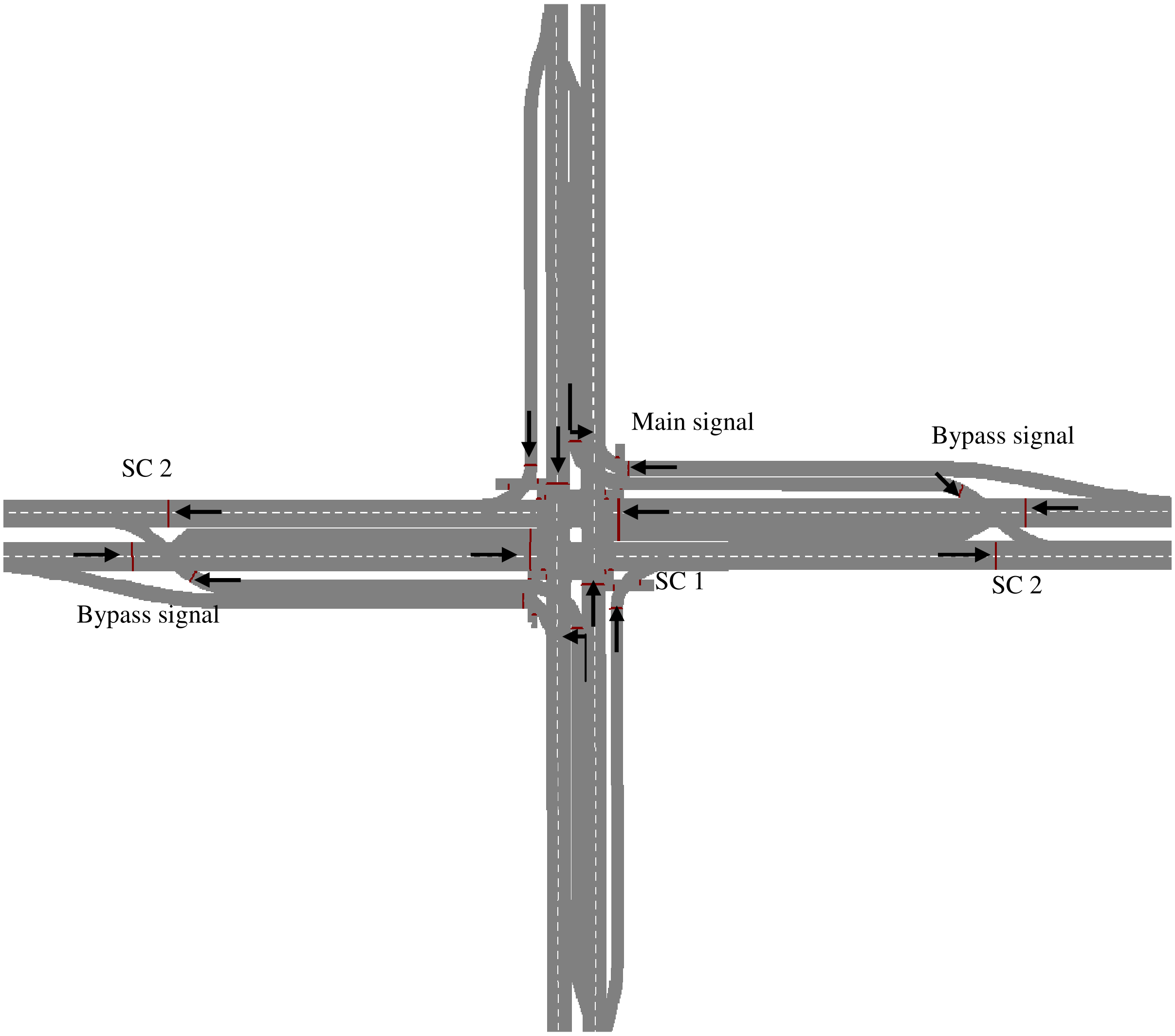


FIGURE 6 The Partial PFI Design

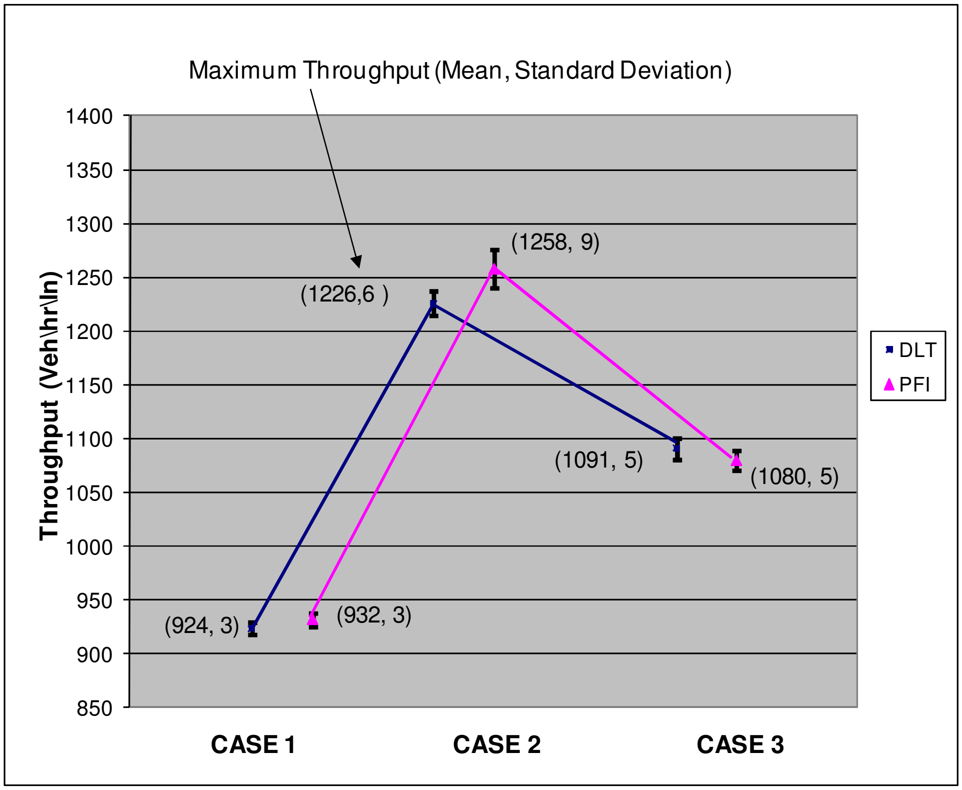


FIGURE 7 Maximum throughput for the through movement and the 95 % confidence interval

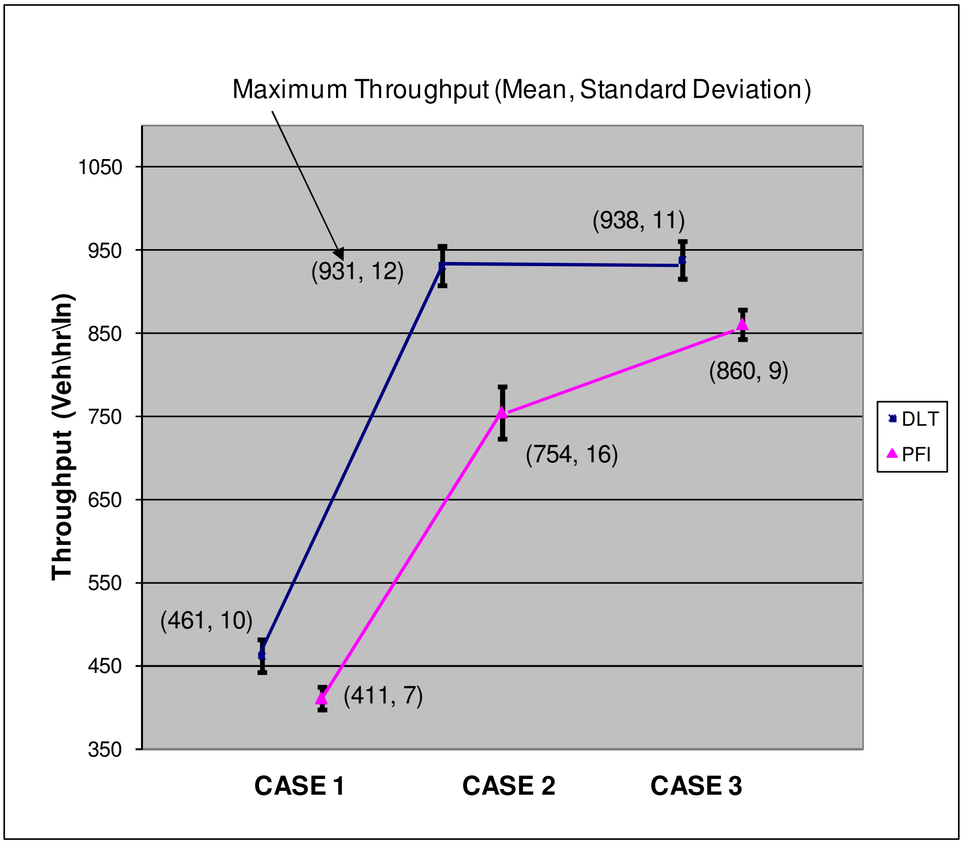


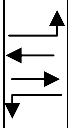
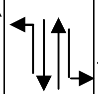
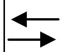
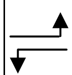
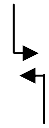
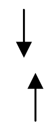
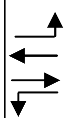
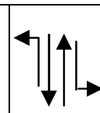
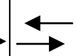
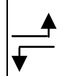
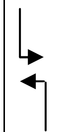
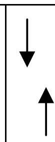
FIGURE 8 Maximum throughput for the left turn movement and the 95 % confidence interval

TABLE 1 Input volumes for estimating throughput for through and left turn movement scenarios

Movement		CASE 1		CASE 2		CASE 3	
		Through Scenario	**Left turn Scenario**	**Through Scenario**	**Left turn Scenario**	**Through Scenario**	**Left turn Scenario**
		Volume (veh/hr)	Volume (veh/hr)	Volume (veh/hr)	Volume (veh/hr)	Volume (veh/hr)	Volume (veh/hr)
EBL	West to North	200	(300 to 500)*	200	200	100	100
EBR	West to South	50	50	50	50	50	50
EBT	West to East	(1800 to 2050)*	1200	1000	1000	700	700
WBL	East to South	200	(300 to 500)*	200	200	100	100
WBR	East to North	50	50	50	50	50	50
WBT	East to West	(1800 to 2050)*	1200	1100	1100	800	800
NBL	South to West	200	(300 to 500)*	200	(700 to 1150)*	200	(750 to 1150)*
NBR	South to East	50	50	50	50	50	50
NBT	South to North	(1800 to 2050)*	1200	(2400 to 2900)*	1200	(2000 to 2450)*	1200
SBL	North to East	200	(300 to 500)*	100	650	100	600
SBR	North to West	50	50	50	50	50	50
SBT	North to South	(1800 to 2050)*	1200	1550	650	1300	650
Total Intersection Volume		**8,200 to 9,200**	**6,200 to 7,000**	**6,950 to 7,450**	**5,900 to 6,350**	**5,500 to 5,950**	**5,100 to 5,500**

** indicates the range of input volumes for the movement for which throughput is being maximized*

TABLE 2 Signal timing plans for DLT

	Through Scenario						Left turn Scenario					
	SC 1		SC 2		SC 3		SC 1		SC 2		SC 3	
												
CASE 1	Φ1	Φ2	Φ1	Φ2	Φ1	Φ2	Φ1	Φ2	Φ1	Φ2	Φ1	Φ2
Green (seconds)	25	25	35	15	15	35	25	25	25	25	25	25
Yellow (seconds)	3	3	3	3	3	3	3	3	3	3	3	3
All-Red (seconds)	2	2	2	2	2	2	2	2	2	2	2	2
CASE 2												
Green (seconds)	15	35	35	15	10	40	15	35	30	20	30	20
Yellow (seconds)	3	3	3	3	3	3	3	3	3	3	3	3
All-Red (seconds)	2	2	2	2	2	2	2	2	2	2	2	2

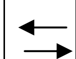
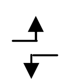
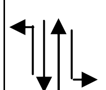
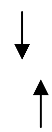
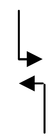
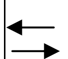
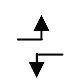
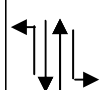
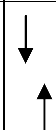
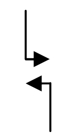
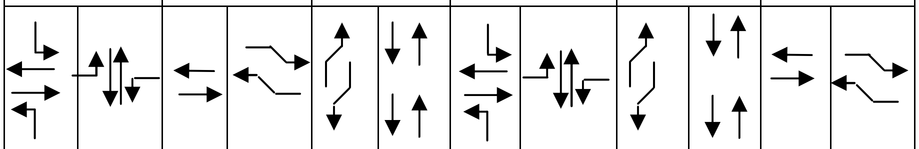
	Through Scenario					Left turn Scenario				
	SC 1			SC 2		SC 1			SC 2	
										
CASE 3	Φ1	Φ2	Φ3	Φ1	Φ2	Φ1	Φ2	Φ3	Φ1	Φ2
Green (seconds)	11	4	30	40	10	11	4	30	20	30
Yellow (seconds)	3	3	3	3	3	3	3	3	3	3
All-Red (seconds)	2	2	2	2	2	2	2	2	2	2

TABLE 3 Signal timing plans for PFI

	Through Scenario						Left turn Scenario					
	SC 1		SC 2		SC 3		SC 1		SC 2		SC 3	
												
CASE 1	Φ1	Φ2	Φ1	Φ2	Φ1	Φ2	Φ1	Φ2	Φ1	Φ2	Φ1	Φ2
Green (seconds)	25	25	35	15	15	35	25	25	25	25	25	25
Yellow (seconds)	3	3	3	3	3	3	3	3	3	3	3	3
All-Red (seconds)	2	2	2	2	2	2	2	2	2	2	2	2
CASE 2												
Green (seconds)	16	34	30	20	10	40	25	25	15	35	25	25
Yellow (seconds)	3	3	3	3	3	3	3	3	3	3	3	3
All-Red (seconds)	2	2	2	2	2	2	2	2	2	2	2	2

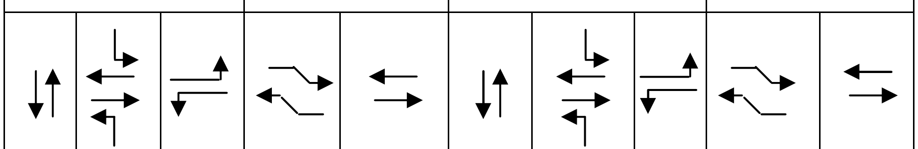
	Through Scenario					Left turn Scenario				
	SC 1			SC 2		SC 1			SC 2	
										
CASE 3	Φ1	Φ2	Φ3	Φ1	Φ2	Φ1	Φ2	Φ3	Φ1	Φ2
Green (seconds)	30	11	4	20	30	16	24	5	35	15
Yellow (seconds)	3	3	3	3	3	3	3	3	3	3
All-Red (seconds)	2	2	2	2	2	2	2	2	2	2

TABLE 4 Performance measures for through and left turn movements

Case	Through movement				Left turn movement			
	Capacity (vphpl)		Average Delay (sec/veh)		Capacity (vphpl)		Average Delay (sec/veh)	
	DLT	PFI	DLT	PFI	DLT	PFI	DLT	PFI
Balanced flows	924	932	71	68	461	411	47	66
Different splits	1226	1258	32	35	931	754	39	48
Partial designs	1091	1080	38	39	938	860	44	55

TABLE 5 Number of stops for DLT cases

Movement		CASE 1		CASE 2		CASE 3	
		Through Capacity	**Left turn Capacity**	**Through Capacity**	**Left turn Capacity**	**Through Capacity**	**Left turn Capacity**
		Stops/Veh	Stops/Veh	Stops/Veh	Stops/Veh	Stops/Veh	Stops/Veh
Major Road	Left turns	2.5	2.4	2.1	2.1	1.2	1.6
	Throughs	2.0	1.6	1.2	1.6	1.4	1.8
Minor Road	Left turns	2.5	2.4	1.5	1.5	2.0	1.4
	Throughs	2.0	1.6	1.2	1.0	1.3	1.4

TABLE 6 Number of stops for PFI cases

Movement		CASE 1		CASE 2		CASE 3	
		Through Capacity	**Left turn Capacity**	**Through Capacity**	**Left turn Capacity**	**Through Capacity**	**Left turn Capacity**
		Stops/Veh	Stops/Veh	Stops/Veh	Stops/Veh	Stops/Veh	Stops/Veh
Major Road	Left turns	2.9	3.2	2.3	3.3	1.9	1.6
	Throughs	2.1	2.1	1.3	2.1	1.2	1.5
Minor Road	Left turns	2.9	3.2	2.2	2.4	1.4	1.8
	Throughs	2.1	2.1	1.4	1.2	1.2	2.5