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CIVE 3700 – Highway Engineering

Term Project

Introduction

The purpose of this term project is to introduce students to the Aimsun software to understand how to use the Webster and HCM methods to determine geometric and traffic characteristics. These methods create signal phasing systems and phase lengths for different intersections, creating a detailed layout. By using a four way intersection with two lane highways, this project was able to be modeled in software with verifying calculations completed in Excel.

Method

The first method used in this project is the Webster method. In this method, a phasing scheme is assumed to determine a sum of critical ratios. Using four different phases, E-W Left, E-W Through, N-S Left, and N-S Through, a sum of critical ratios is determined. After, lost time per cycle and cycle length are calculated, allowing for allocated green times to be determined. No pedestrian movement is assumed in the Webster Method. The HCM method is then used in a similar fashion to the Webster method. In this method, a critical v/c ratio is assumed as 0.9 and cycle length is determined. After, phase lengths is also calculated. Following HCM, pedestrian movement is also neglected. Both the Webster and HCM methods are calculated using Excel to verify calculations. These calculations are listed in the Appendix of this report.

After, an Aimsun pre-timed tutorial is followed to create the new project. Following this tutorial, sections are drawn, and nodes are edited allowing for a signalized intersection to be created. Two control plan and master plans are created, and traffic is assigned. The dynamic scenario is created to experiment with the different simulations.

Results & Discussion

After completing 50 replications for each control plan to calculate the average, Aimsun produced a variety of output results. The HCM and Webster results are attached in the appendix below. Different figures were also produced. Figure 1.0 shows a plot of delay vs time. Figure 1.1 shows a plot of travel time vs time. Figure 1.2 shows a plot of CO2 emission vs time. Figure 1.3 shows a plot of number of stops vs time. In all of these plots, both the Webster and HCM methods are displayed.

Figure 1.0 Plot of Delay Time vs Time

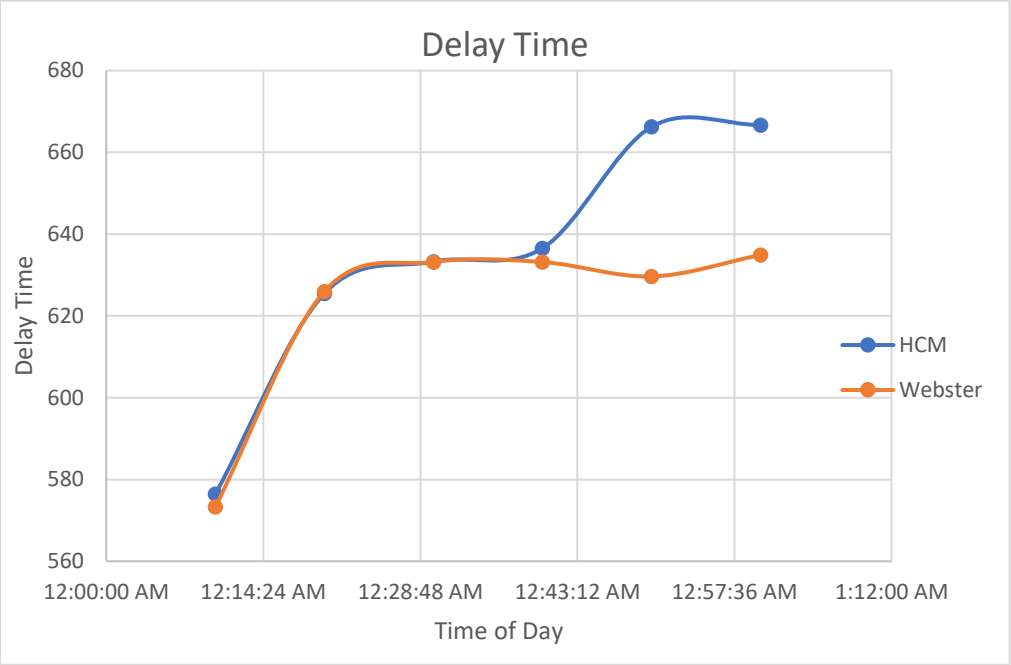


Figure 1.1 Plot of Travel Time vs Time

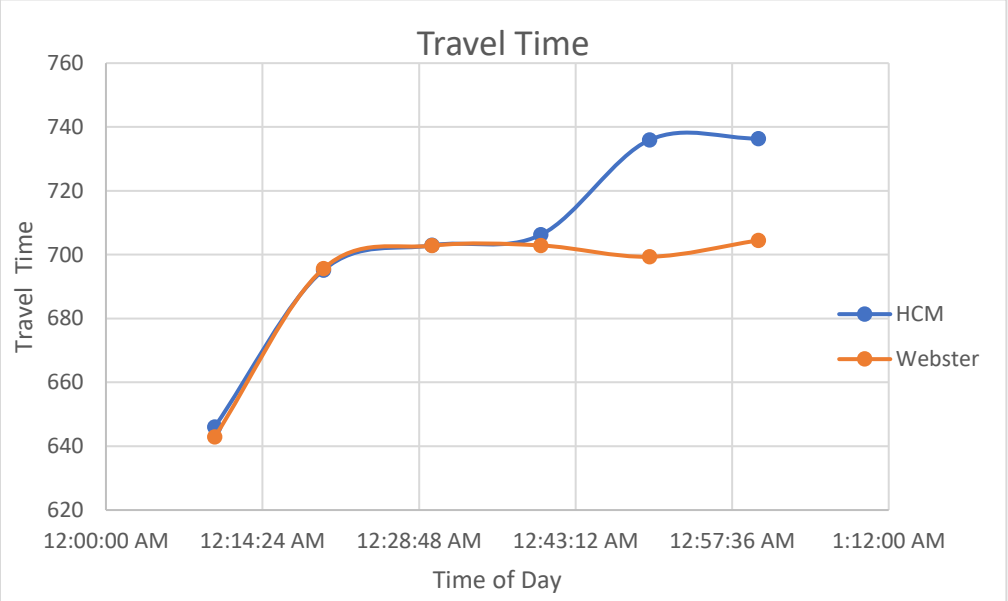


Figure 1.2 Plot of CO2 Emissions vs Time

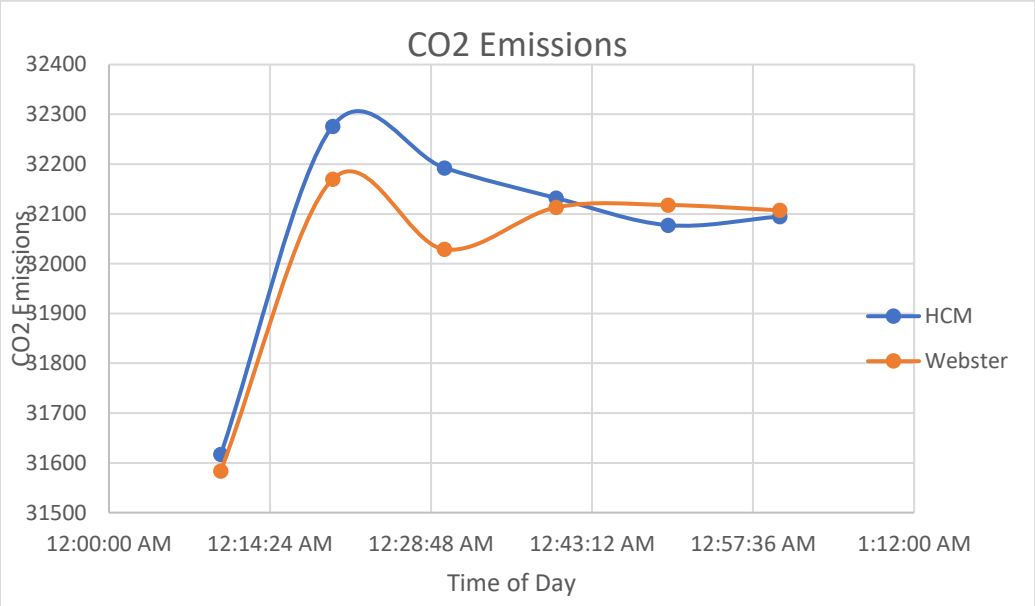
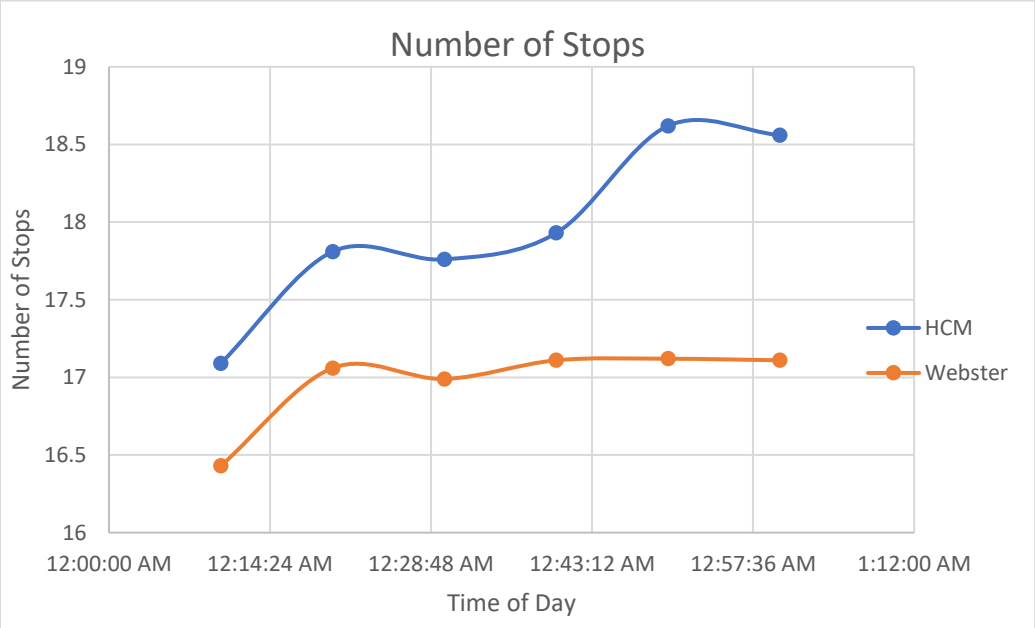


Figure 1.3 Plot of Number of Stops vs Time



Conclusion

Based on the results discovered, it can be noted that both the Webster and HCM methods are useful in determining traffic characteristics. Aimsun was effective in modeling and displaying traffic flow and patterns, based on a variety of carefully selected inputs. The different plots provided show how the Webster method tends to be more efficient, with lower travel and delay times, stops, and CO2 emissions. As a result, it can be concluded that the Webster method is more efficient in terms of environmental and economical factors. This is indeed possible because the Webster Method uses a cycle time of 150 seconds

while the HCM method uses a cycle time of 155 seconds. A lower cycle time means less waiting, smoother traffic flows and a lower number of stops, producing a more efficient flow.

Appendix

Method Calculations

Webster Method

	Phase 1: E-W	***Phase 2: E-W***	***Phase 3: N-S***	***Phase 4: N-S***		
	Left Turn	**Through**	**Left**	**Through**		
qij	350	950	360	400		
Sij	1750	3400	1750	3400		
	0.2	0.279411765	0.205714286	0.117647059	Total Yi	0.802773
Total Lost Time Per Cycle (s)	4	4	4	4	Total Time	16

Cycle Length	147.0387729
Value Used	**150**

Allocate Green Times	
Total Effective Green Time (Gte)	**134**

Phase Lengths	Time (s)
(G+Y)1	36.88427719
(G+Y)2	50.13979902
(G+Y)3	37.83811368
(G+Y)4	23.13781011

HCM Method

	Phase 1: E-W	***Phase 2: E-W***	***Phase 3: N-S***	***Phase 4: N-S***		
	Left Turn	**Through**	**Left**	**Through**		
qij	350	950	360	400		
Sij	1750	3400	1750	3400		
	0.2	0.279411765	0.205714286	0.117647059	Total Yi	0.802773
Total Lost Time Per Cycle (s)	4	4	4	4	Total Time	16

Cycle Length	0.9 = 0.80277 (C/(C-16))
	1.12 C - 17.938 = C
	0.12 C = 17.938
	C = 149.48
Value Used (s)	**155**

Phase Lengths	

Total Effective Green Time, Gte	**139**

Phase Length	Time (s)
(G+Y)1	38.12995918
(G+Y)2	51.88009002
(G+Y)3	39.11938658
(G+Y)4	23.87056422

Summary Outputs

HCM Method

Time Series	Value	Standard Deviation		Units
Delay Time - Car	634.03		6.39	sec/km
Density - Car	53.95		0.13	veh/km
Flow - Car	3113.16		25.89	veh/h
Fuel Consumption - Car	0		0	l
Harmonic Speed - Car	5.12		0	km/h
IEM Emission - Car - CO2	192389.83	N/A		g
IEM Emission - Car - NOx	290.33	N/A		g
IEM Emission - Car - PM	58.73	N/A		g
IEM Emission - Car - VOC	407.9	N/A		g
IEM Emission - Interurban - Car - CO2	596248.38	N/A		g/km
IEM Emission - Interurban - Car - NOx	899.78	N/A		g/km
IEM Emission - Interurban - Car - PM	182	N/A		g/km
IEM Emission - Interurban - Car - VOC	1264.15	N/A		g/km
Input Count - Car	3146.82	N/A		veh
Input Flow - Car	3146.82		26.18	veh/h
Max. Virtual Queue - Car	17419.76		153.45	veh
Mean Queue - Car	28.92		0.09	veh
Mean Virtual Queue - Car	8690.26		87.89	veh
Missed Turns - Car	0		0	
Number of Lane Changes - Car	600.84		33.05	#/km
Number of Stops - Car	17.96		0.2	#/veh/km
Speed - Car	15.88		0.24	km/h
Stop Time - Car	602.55		5.99	sec/km
Total Number of Lane Changes - Car	388.64		21.38	
Total Number of Stops - Car	36165.85		519.24	
Total Travel Time - Car	34.47		0.09	h
Total Travel Time (Vehicles Inside) - All	0.47		0.08	h
Total Travel Time (Vehicles Inside) - Car	0.47		0.08	h
Total Travel Time (Waiting Out) - All	2620.1		24.01	h

Total Travel Time (Waiting Out) - Car	2620.1	24.01	h
Total Travelled Distance - Car	174	1.59	km
Total Travelled Distance (Vehicles Inside) - All	0.58	0.05	km
Total Travelled Distance (Vehicles Inside) - Car	0.58	0.05	km
Travel Time - Car	703.68	6.39	sec/km
Vehicles Inside - Car	33.66	1.06	veh
Vehicles Lost Inside - Car	0	0	veh
Vehicles Lost Outside - Car	0	0	veh
Vehicles Outside - Car	3113.16	25.89	veh
Vehicles Waiting to Enter - Car	17419.74	153.49	veh
Waiting Time Virtual Queue - Car	1351.54	9.88	sec

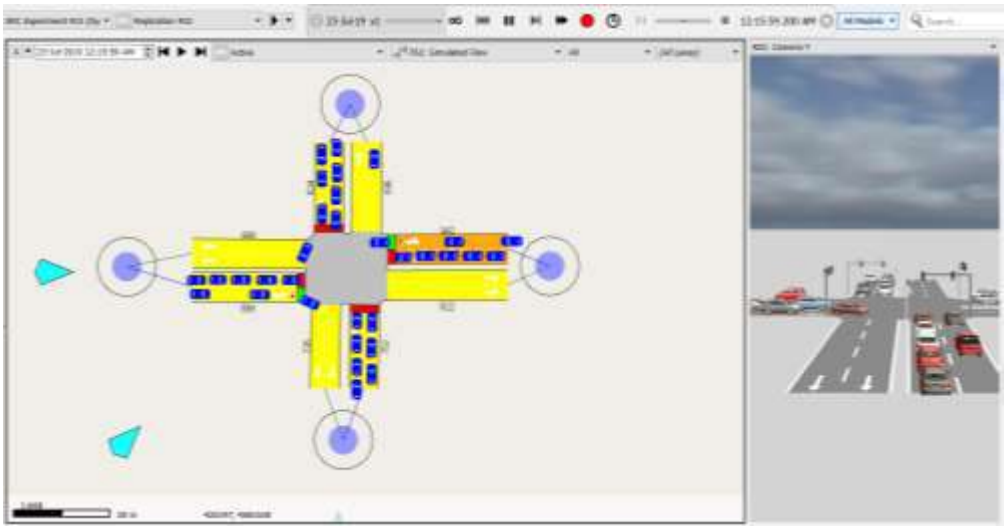
Webster

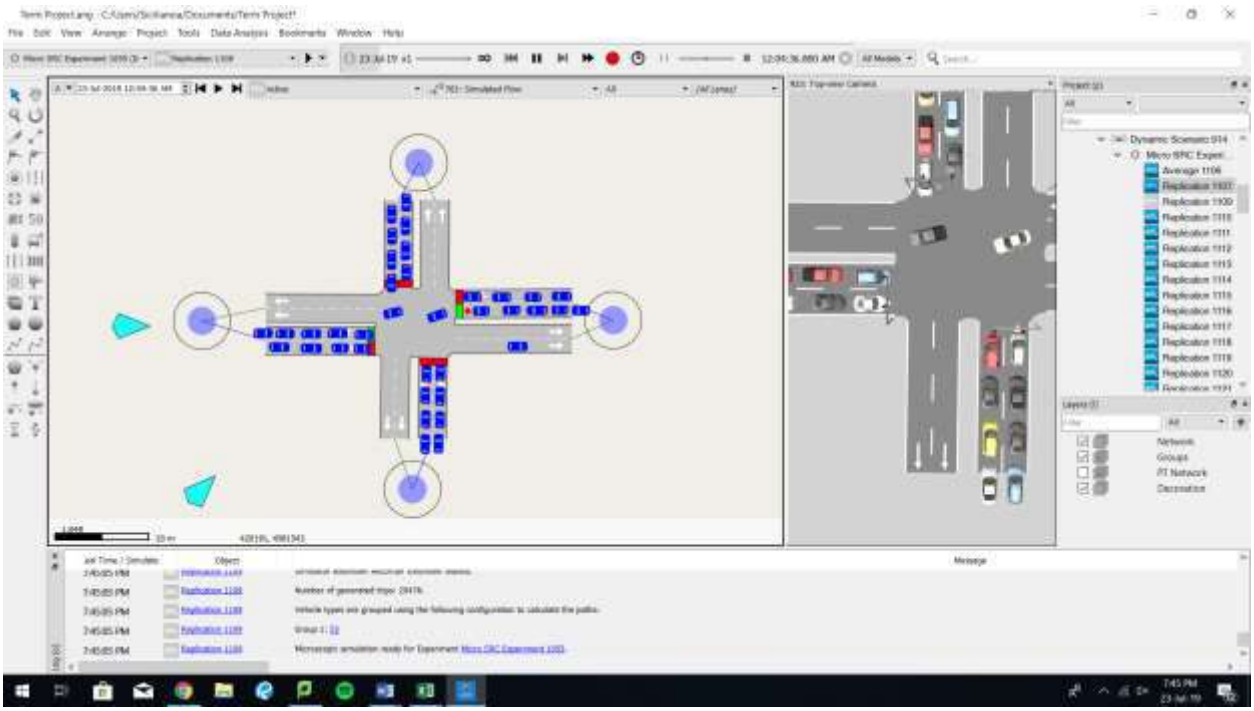
Time Series	Value	Standard Deviation		Units
Delay Time - Car	621.78		6.27	sec/km
Density - Car	53.94		0.21	veh/km
Flow - Car	3167.66		22.76	veh/h
Fuel Consumption - Car	0		0	l
Harmonic Speed - Car	5.21		0	km/h
IEM Emission - Car - CO2	192120.57	N/A		g
IEM Emission - Car - NOx	291.8	N/A		g
IEM Emission - Car - PM	58.77	N/A		g
IEM Emission - Car - VOC	407.38	N/A		g
IEM Emission - Interurban - Car - CO2	595413.91	N/A		g/km
IEM Emission - Interurban - Car - NOx	904.33	N/A		g/km
IEM Emission - Interurban - Car - PM	182.13	N/A		g/km
IEM Emission - Interurban - Car - VOC	1262.53	N/A		g/km
Input Count - Car	3203.66	N/A		veh
Input Flow - Car	3203.66		22.32	veh/h
Max. Virtual Queue - Car	17389.22		130.2	veh
Mean Queue - Car	28.84		0.14	veh
Mean Virtual Queue - Car	8674.58		74.18	veh
Missed Turns - Car	0		0	
Number of Lane Changes - Car	622.54		24.84	#/km
Number of Stops - Car	16.97		0.19	#/veh/km
Speed - Car	16.9		0.23	km/h
Stop Time - Car	588.46		5.98	sec/km
Total Number of Lane Changes - Car	402.68		16.07	
Total Number of Stops - Car	34771.11		450.8	

Total Travel Time - Car	34.45	0.16	h
Total Travel Time (Vehicles Inside) - All	0.81	0.19	h
Total Travel Time (Vehicles Inside) - Car	0.81	0.19	h
Total Travel Time (Waiting Out) - All	2615.52	19.99	h
Total Travel Time (Waiting Out) - Car	2615.52	19.99	h
Total Travelled Distance - Car	176.31	1.4	km
Total Travelled Distance (Vehicles Inside) - All	0.54	0.05	km
Total Travelled Distance (Vehicles Inside) - Car	0.54	0.05	km
Travel Time - Car	691.4	6.28	sec/km
Vehicles Inside - Car	36	1.12	veh
Vehicles Lost Inside - Car	0	0	veh
Vehicles Lost Outside - Car	0	0	veh
Vehicles Outside - Car	3167.66	22.76	veh
Vehicles Waiting to Enter - Car	17389.2	130.22	veh
Waiting Time Virtual Queue - Car	1336.24	11.46	sec

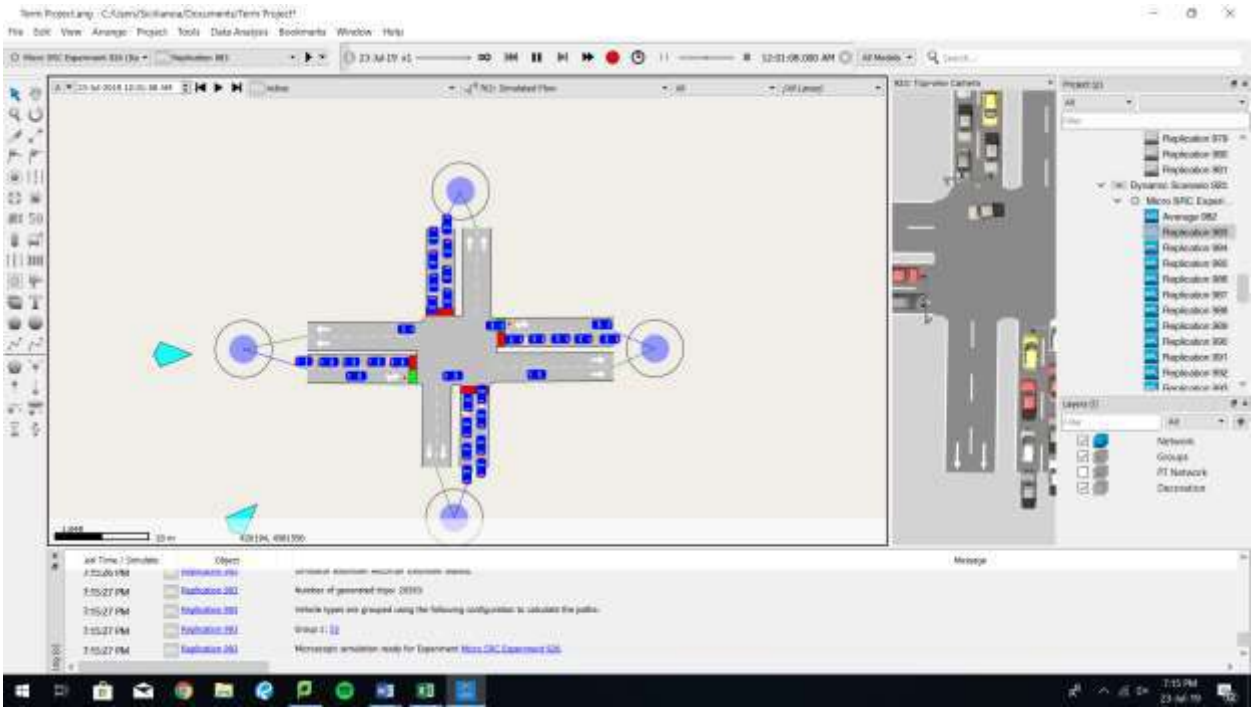
Print Screens

Webster Method

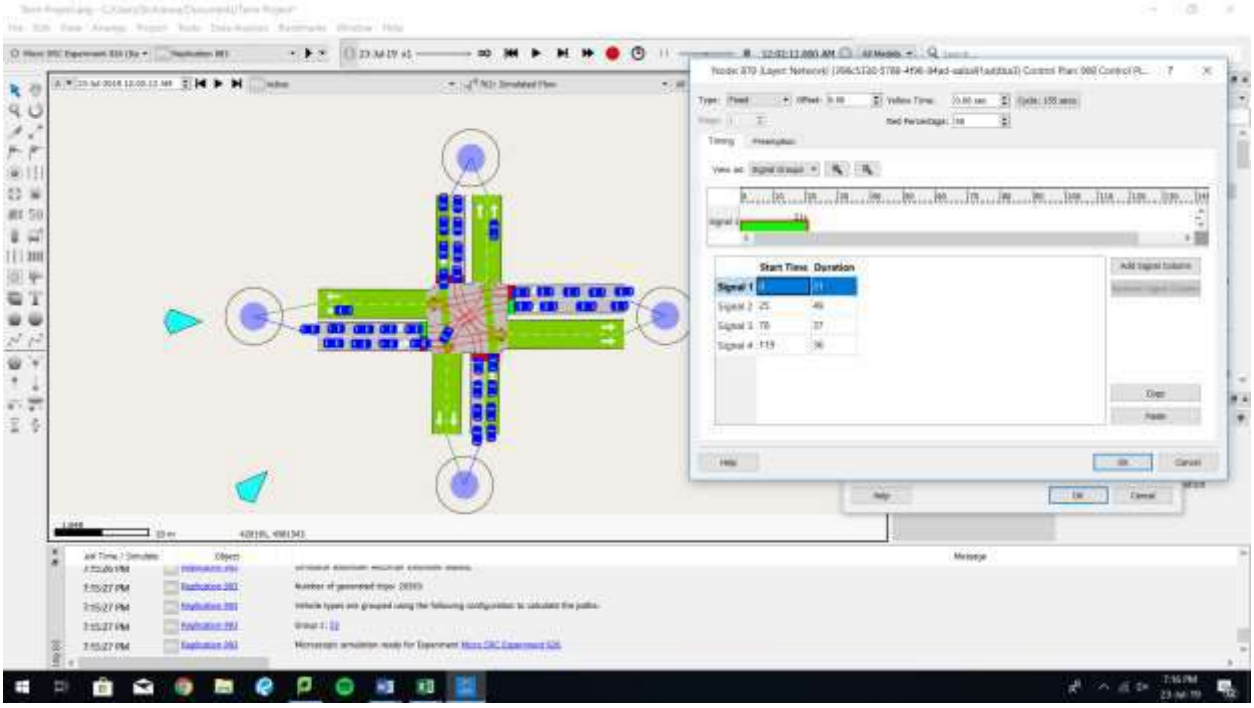


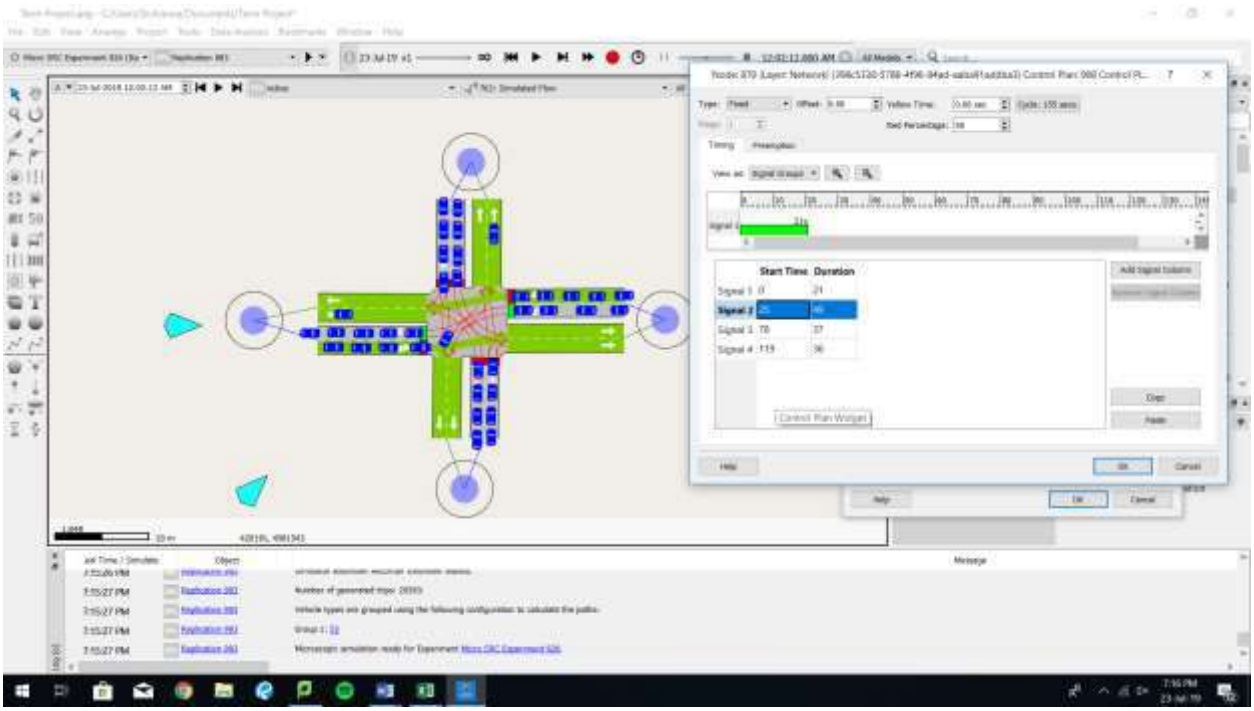


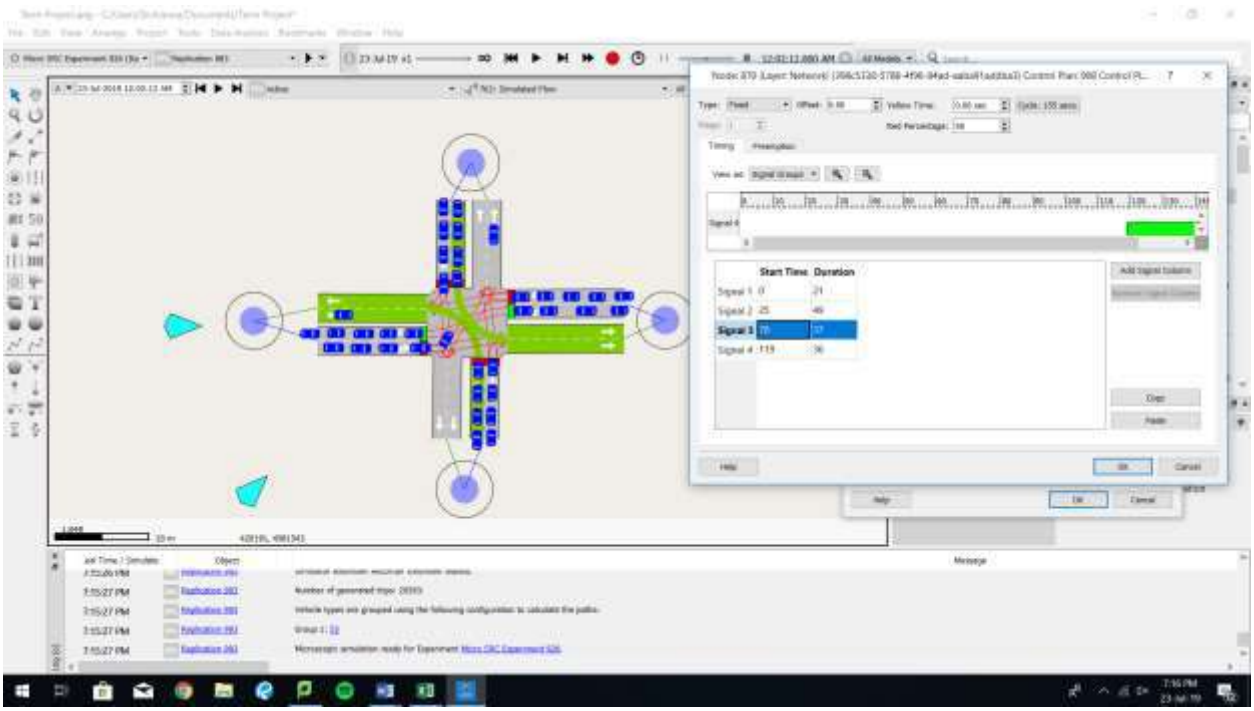
HCM Method

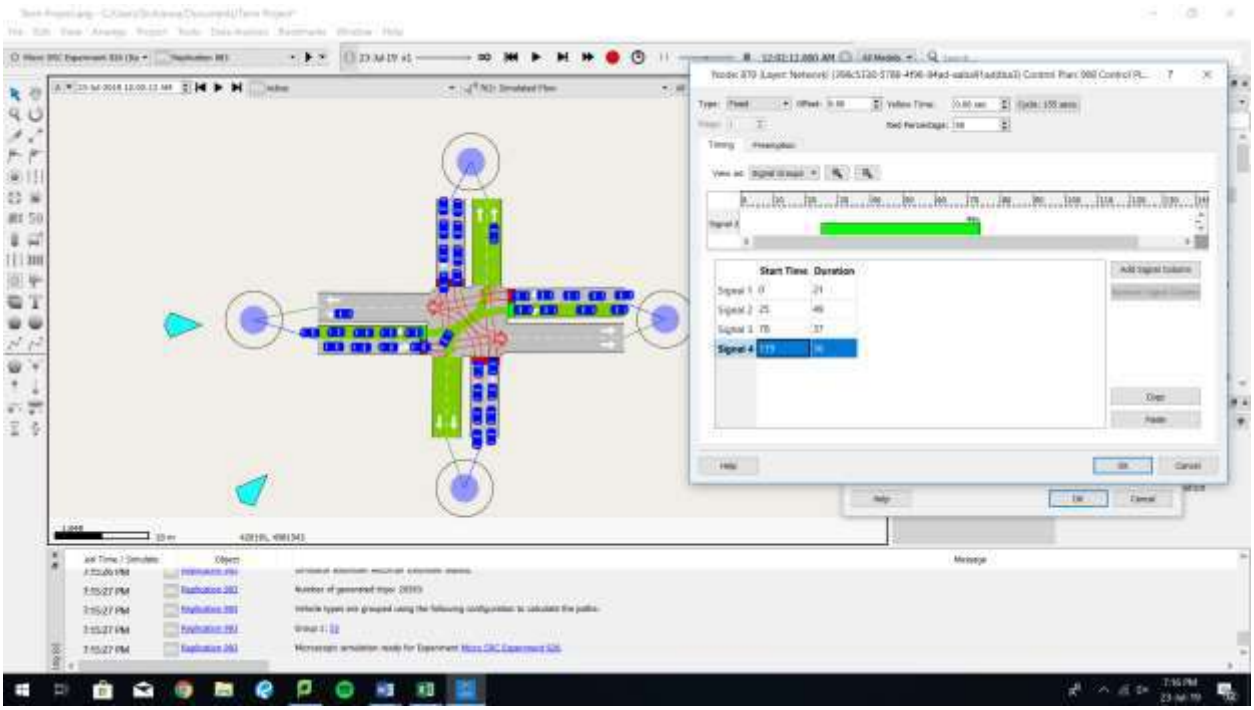


Active Node

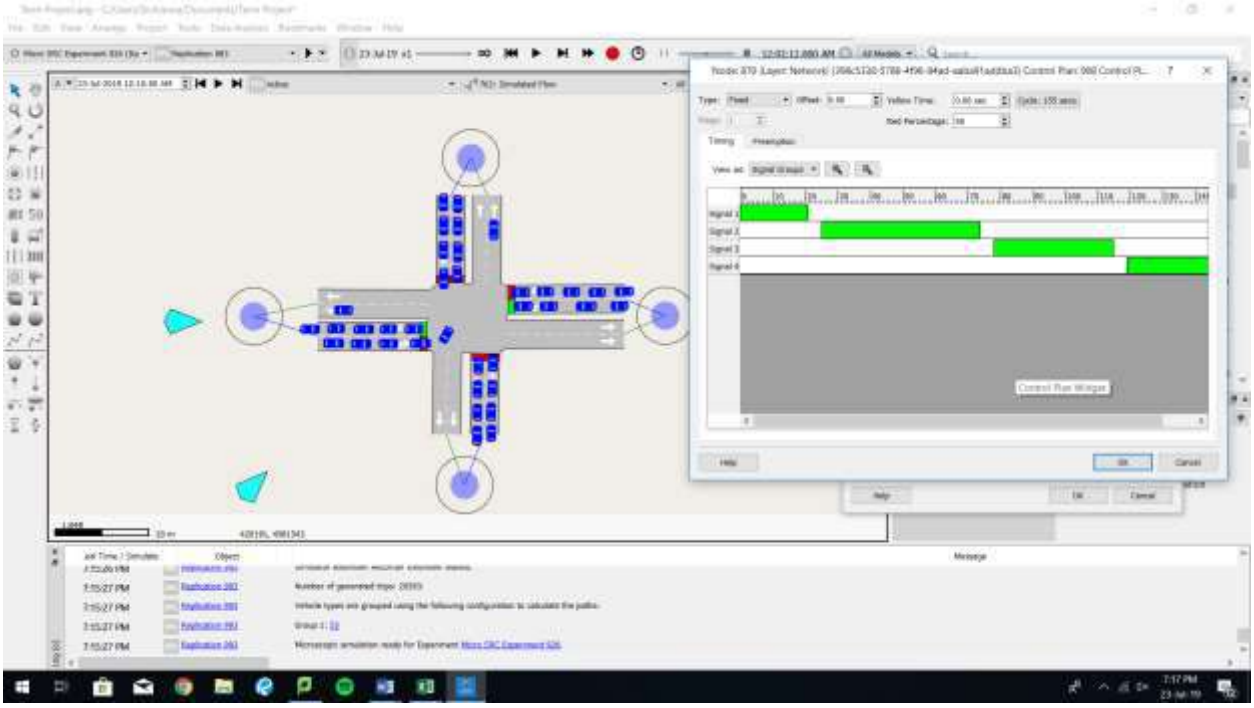




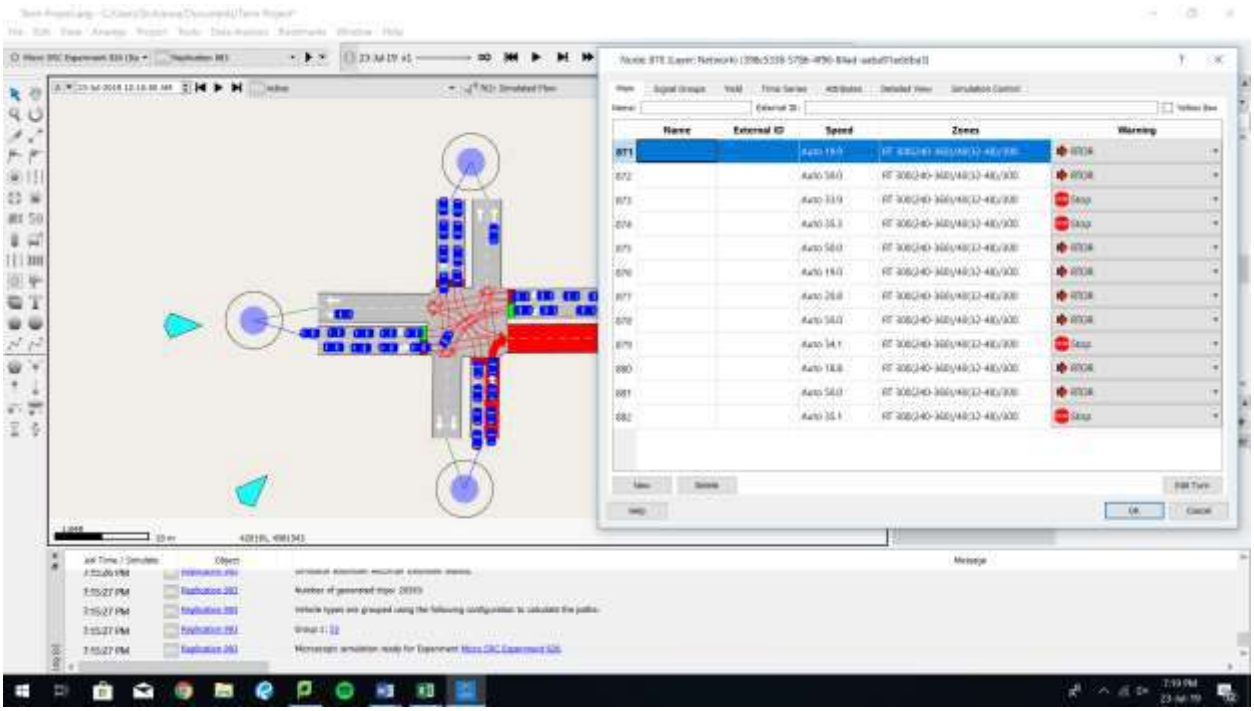


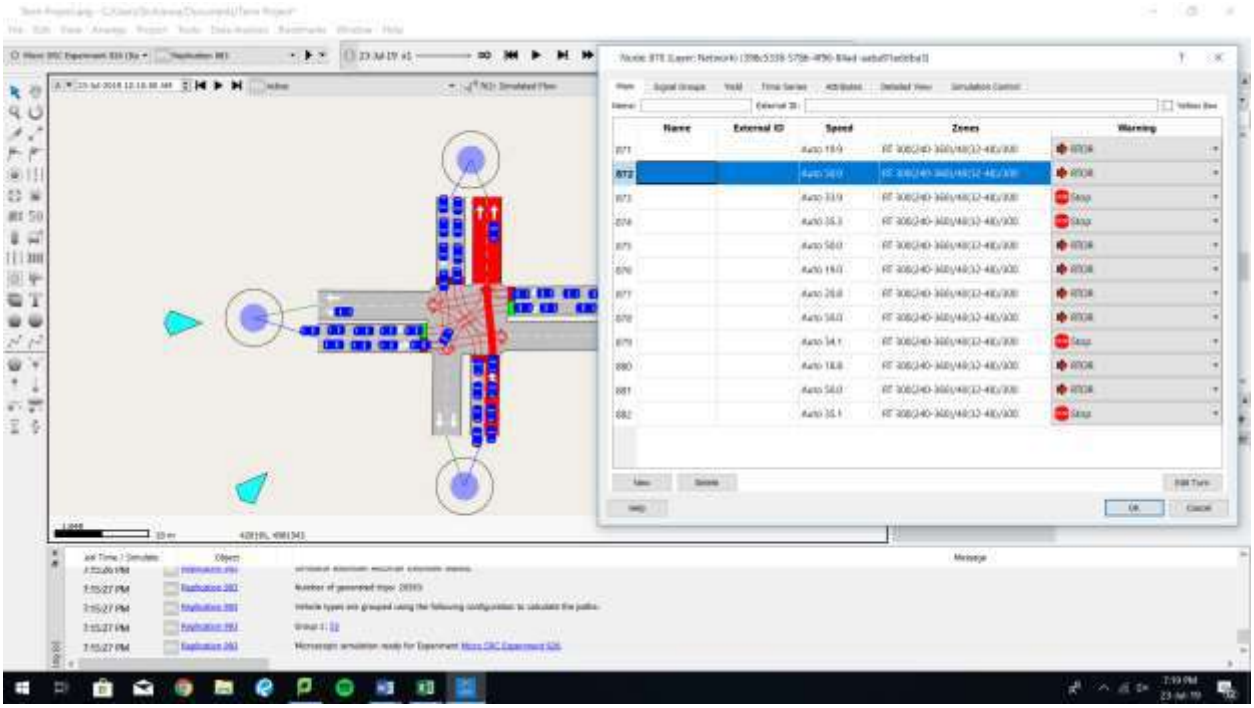


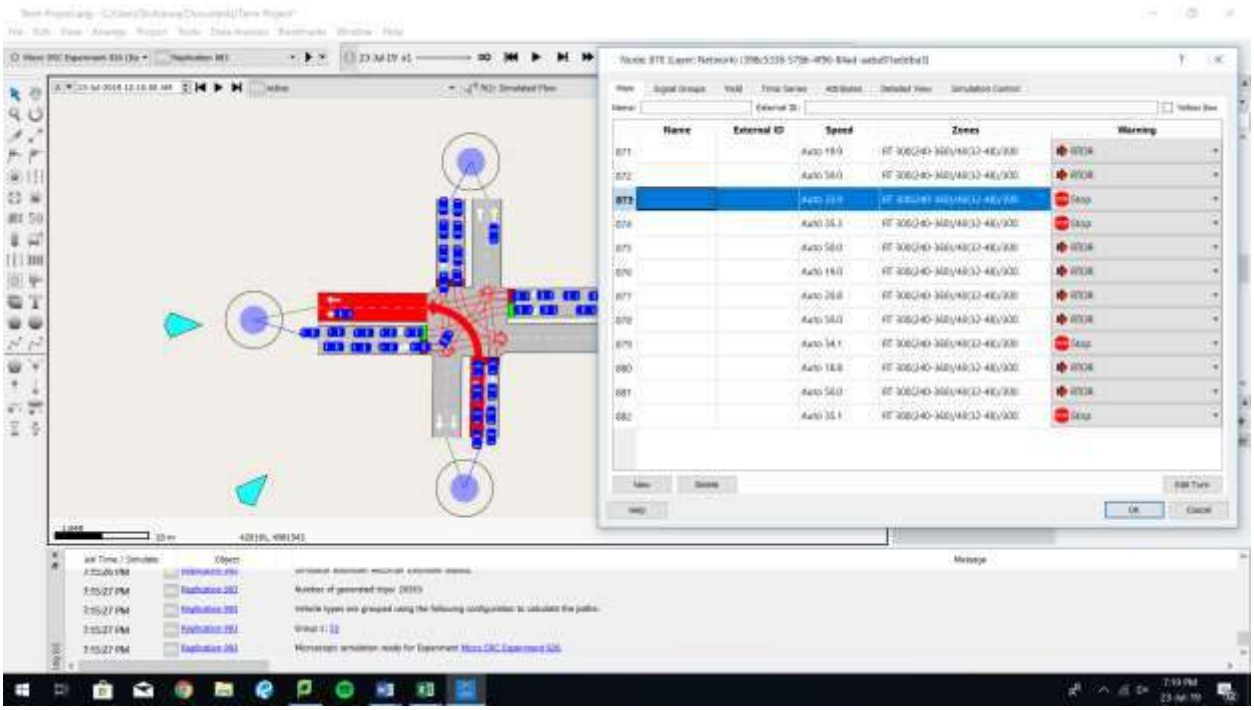
Entire Control Plan

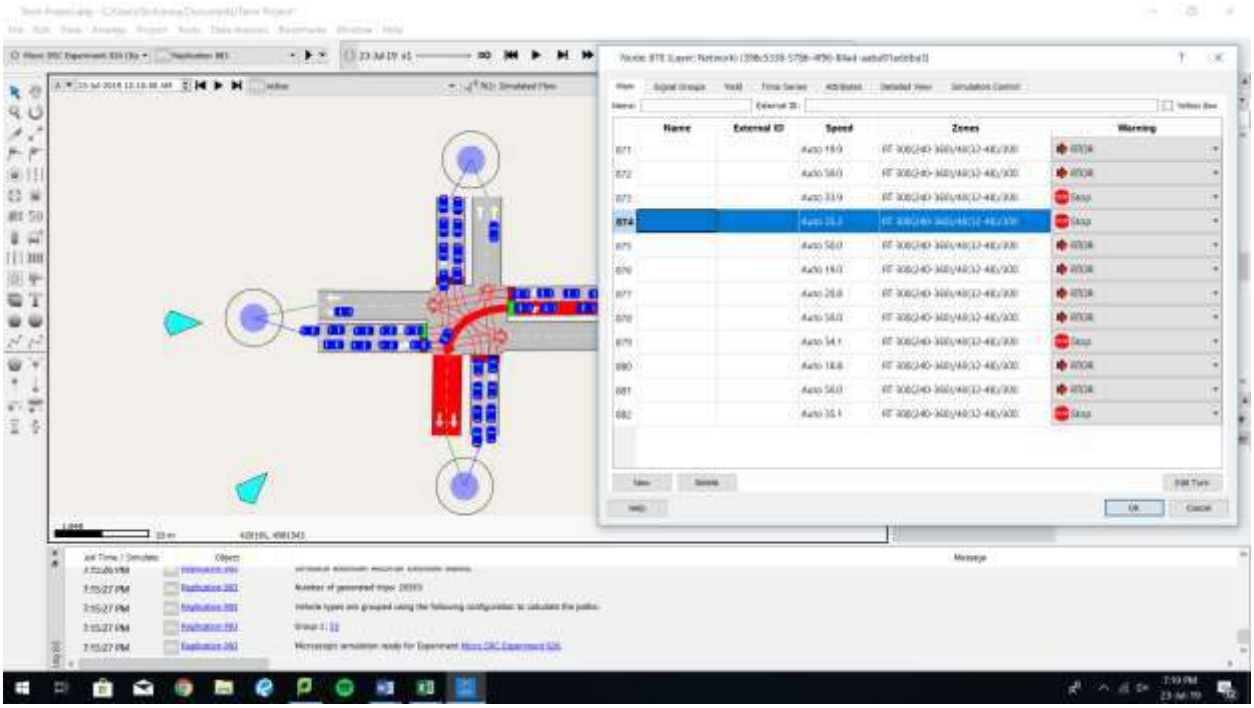


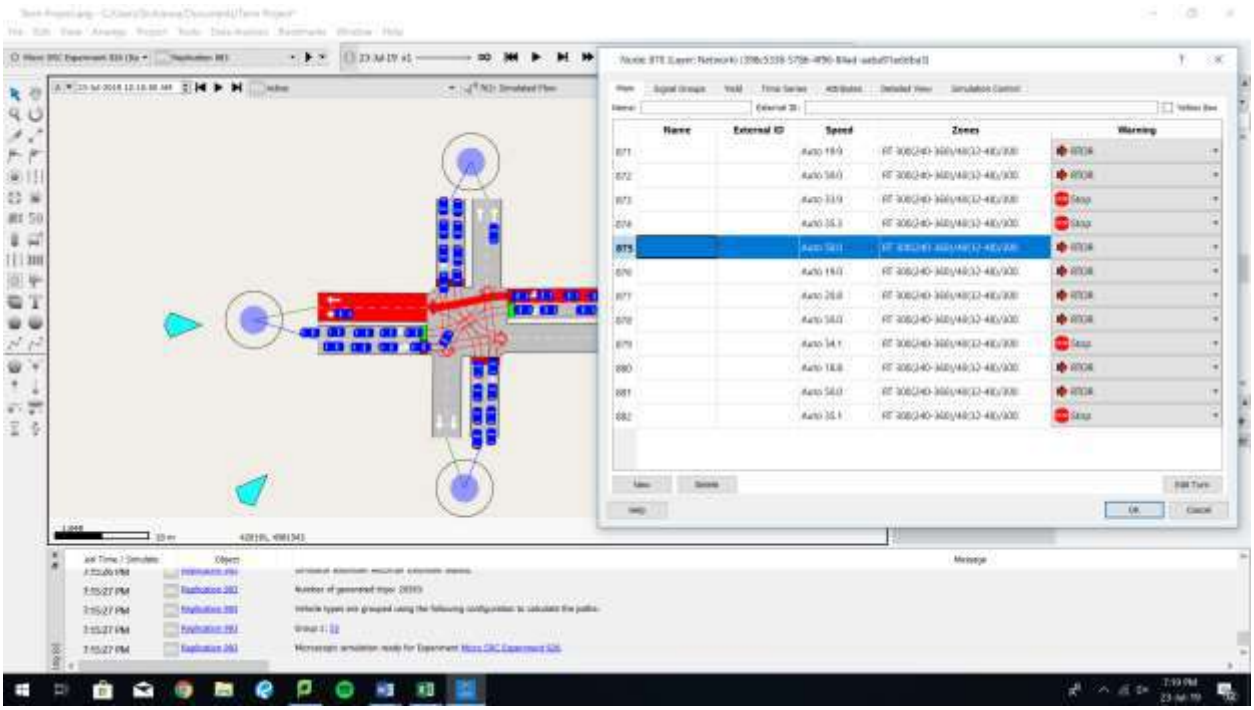
Signal Groups

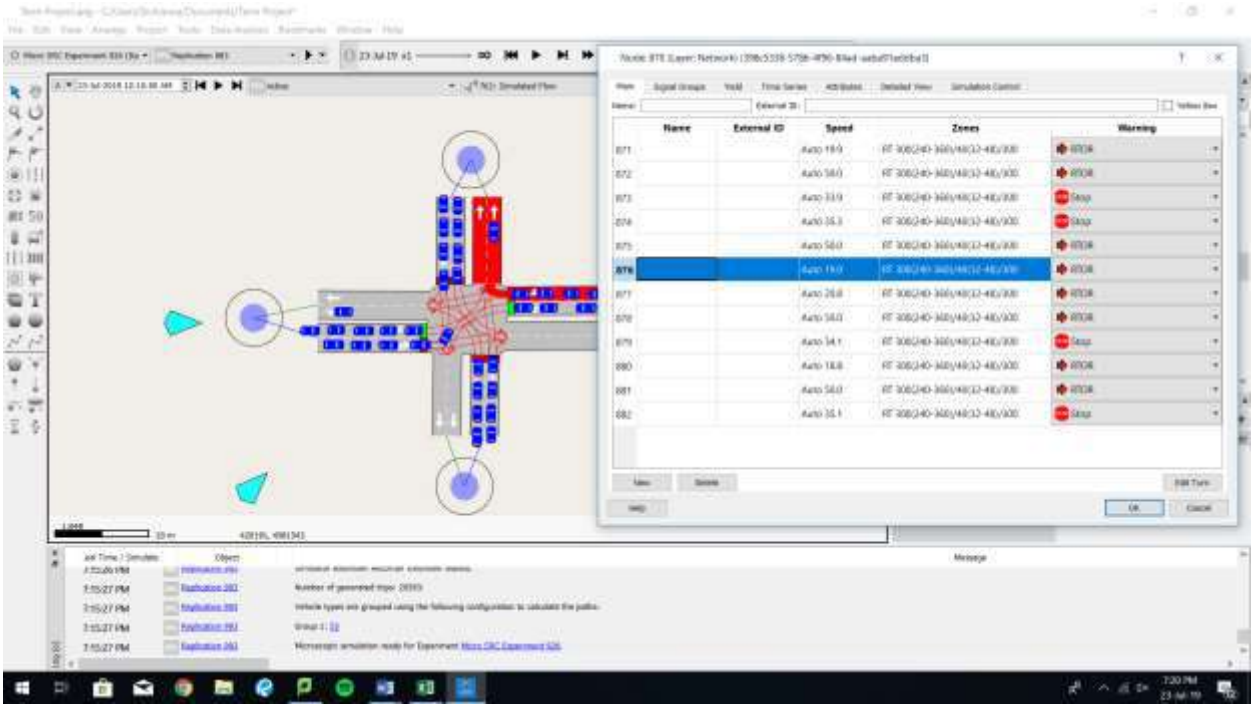


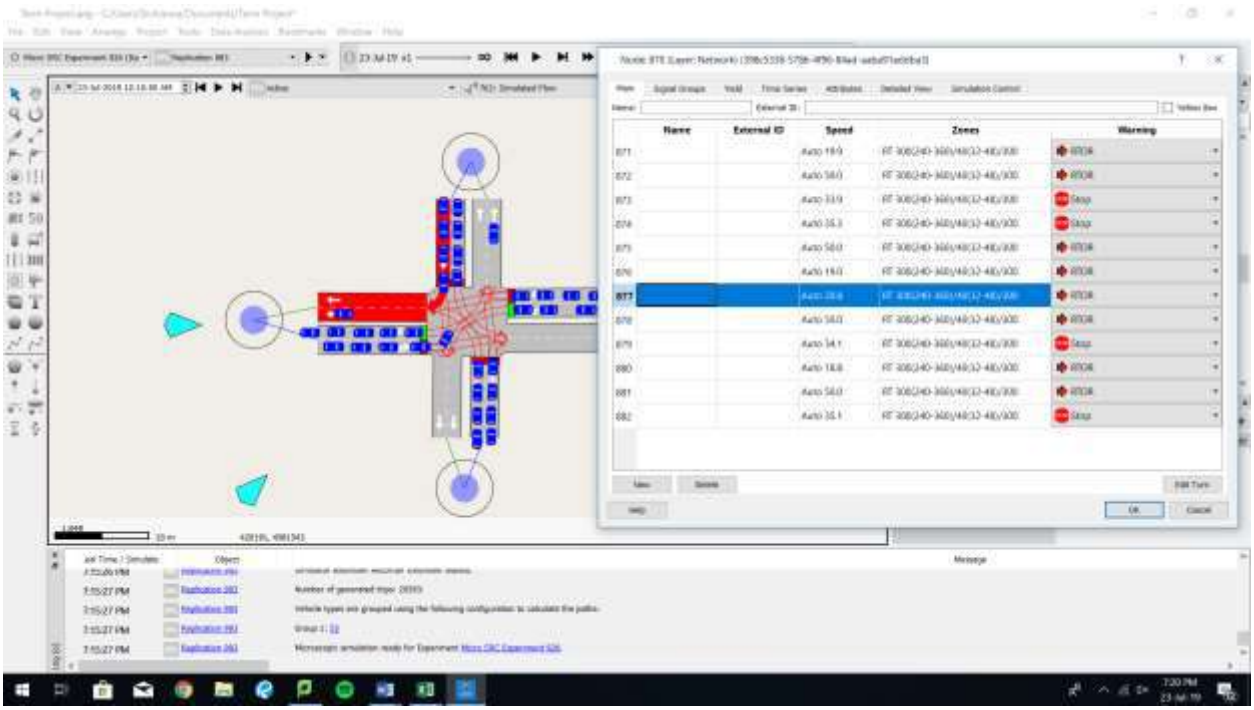


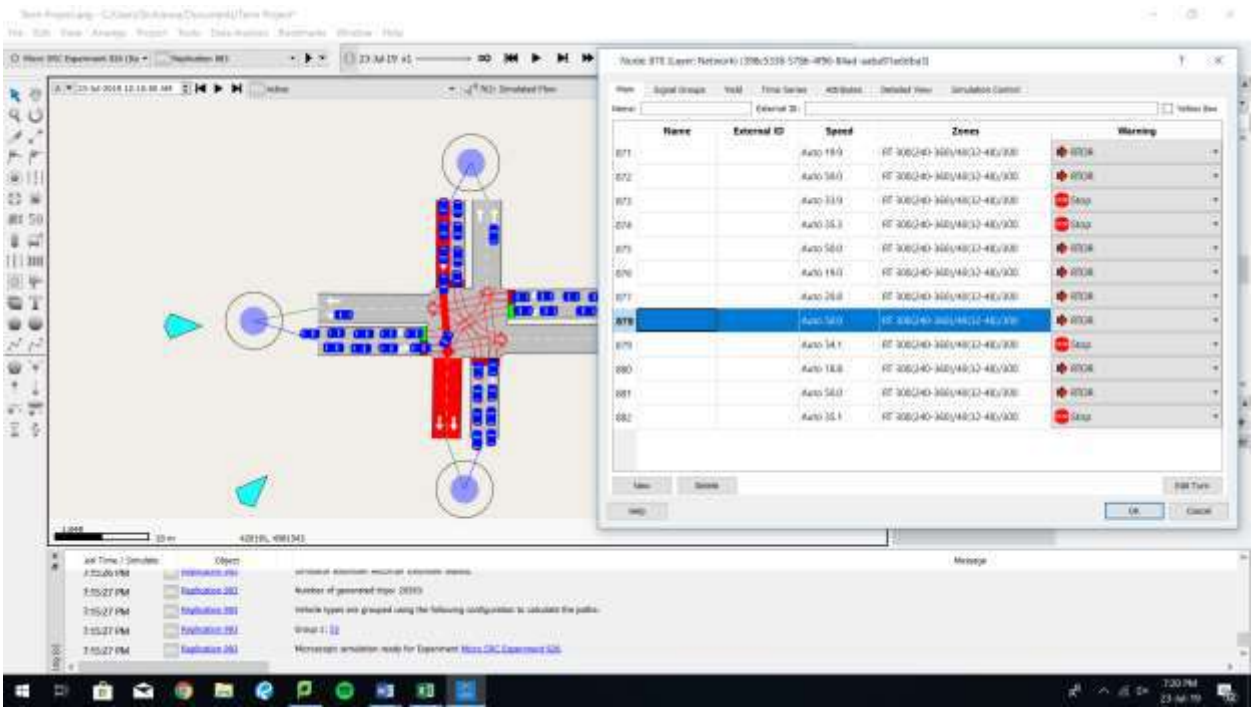


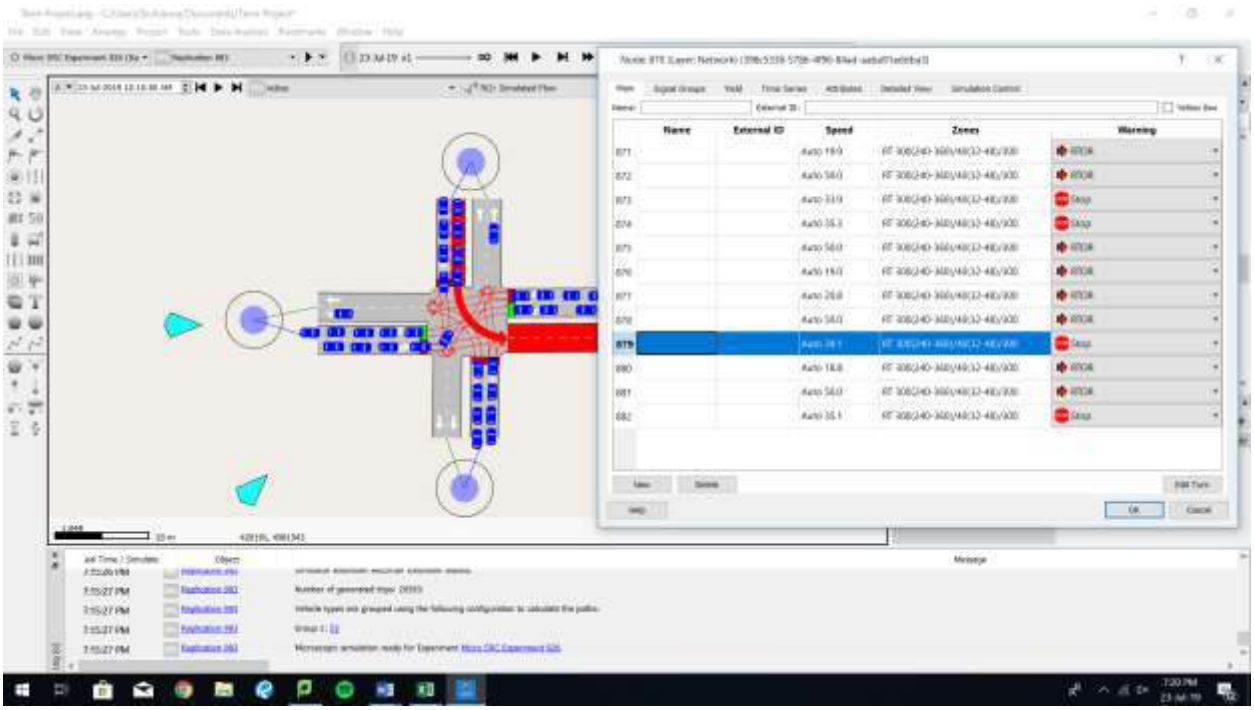


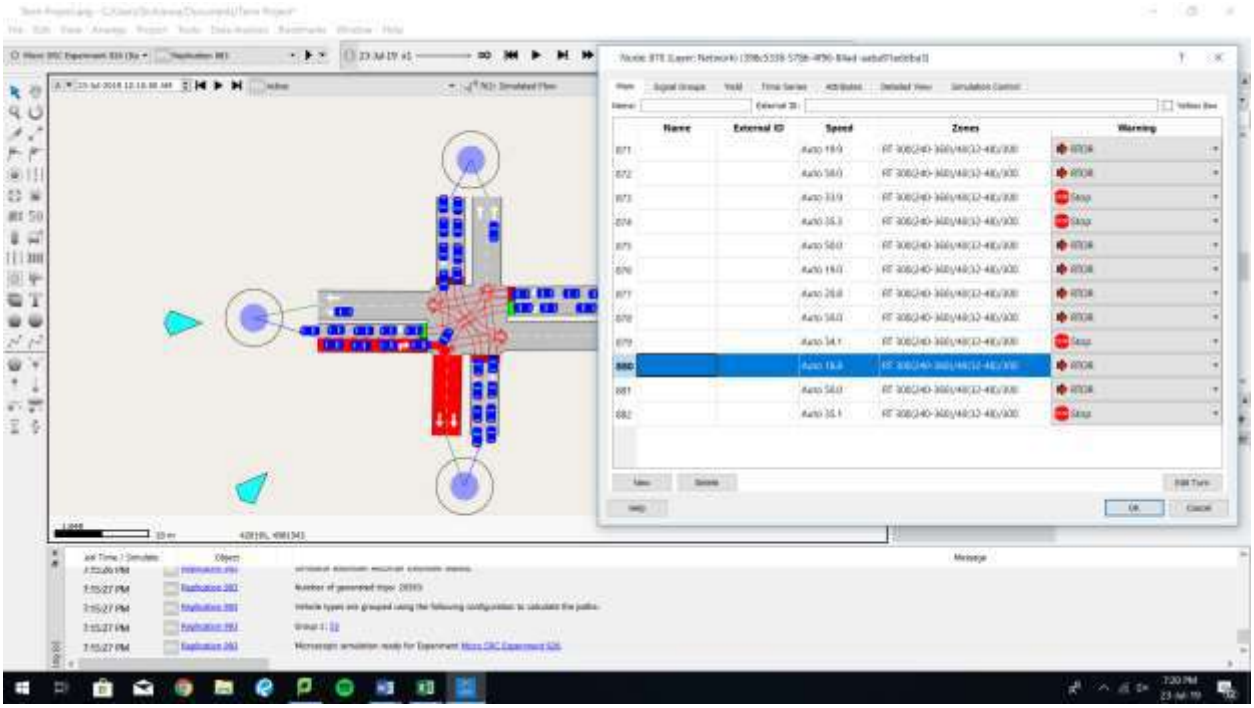


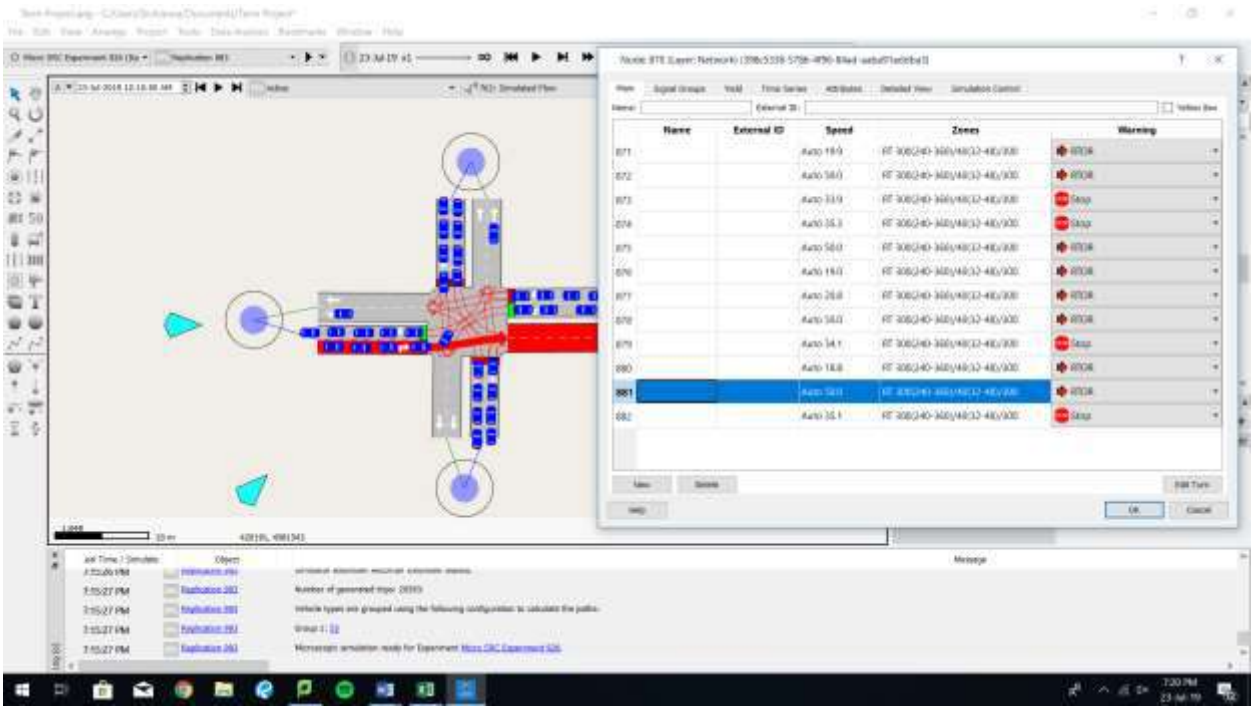


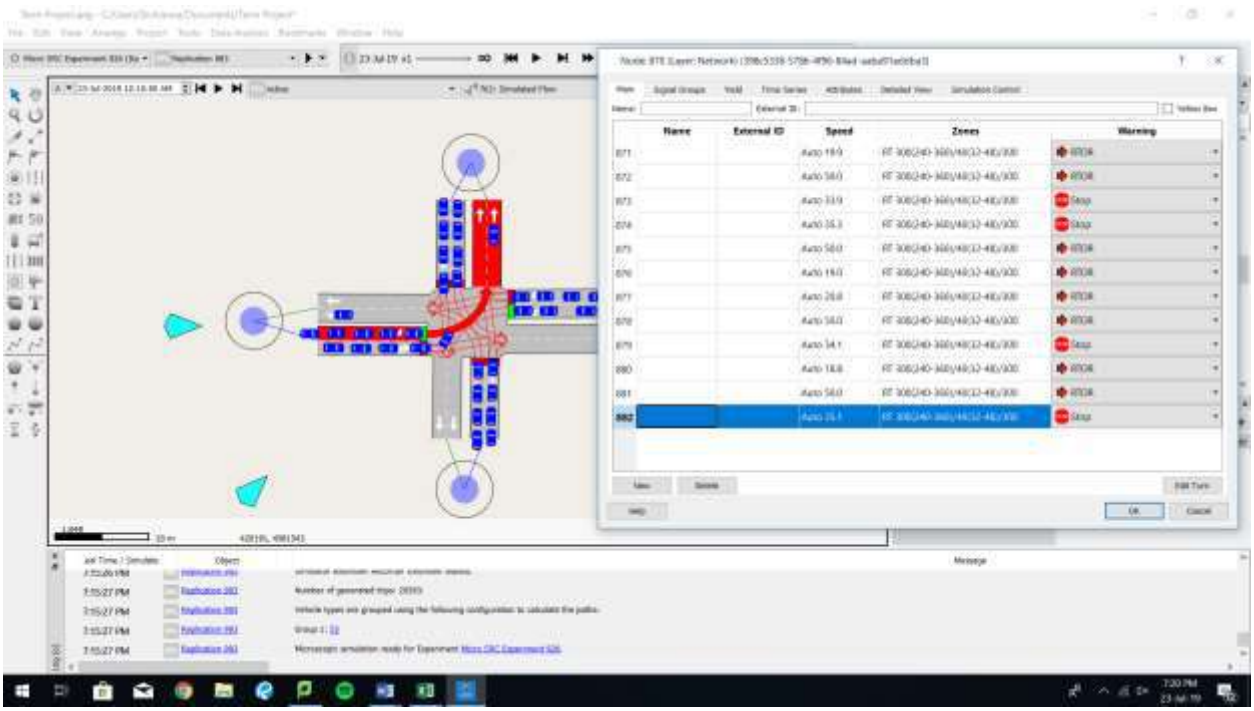












Dynamic Scenario