McGill University
Civil Engineering & Applied Mechanics

CARSP•ACPSER

Canadian Association of Road Safety Professional Conference 2017

EVALUATION OF LEVEL-OF-SERVICE AND SAFETY INDICATOR OF BICYCLE TRAFFIC LIGHT TREATMENTS AT SIGNALIZED INTERSECTIONS

Elaborated by: Bismarck Ledezma-Navarro*, Joshua Stipancic and Anthony Andreoli

Supervised by: Prof. Luis Fernando Miranda-Moreno

INTRODUCTION

- In Montreal, the utilization of cycling infrastructure has increased significantly over the last 10 years.
  - Faster commuting option in urban areas
  - Avoid congestion
  - Reduction in emissions and noise pollution
  - Cheaper infrastructure
  - Public health improvement
- However, road safety for cyclists is still a major concern
  - Increase in bicycle ridership results in an increase in the number of dangerous interactions and collisions between motor vehicles and non-motorized modes

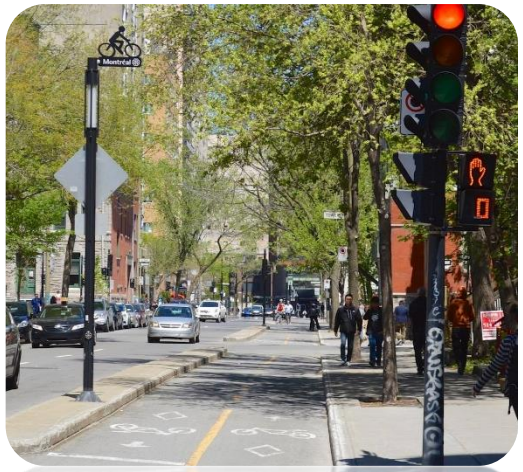
INTRODUCTION

Bicycle facilities

Bike boxes

City treatments

Bike traffic signals



+ Reduction of vehicle-bike conflicts, red violations, and collisions

+ Increase in level of service by reducing bicycle delays.

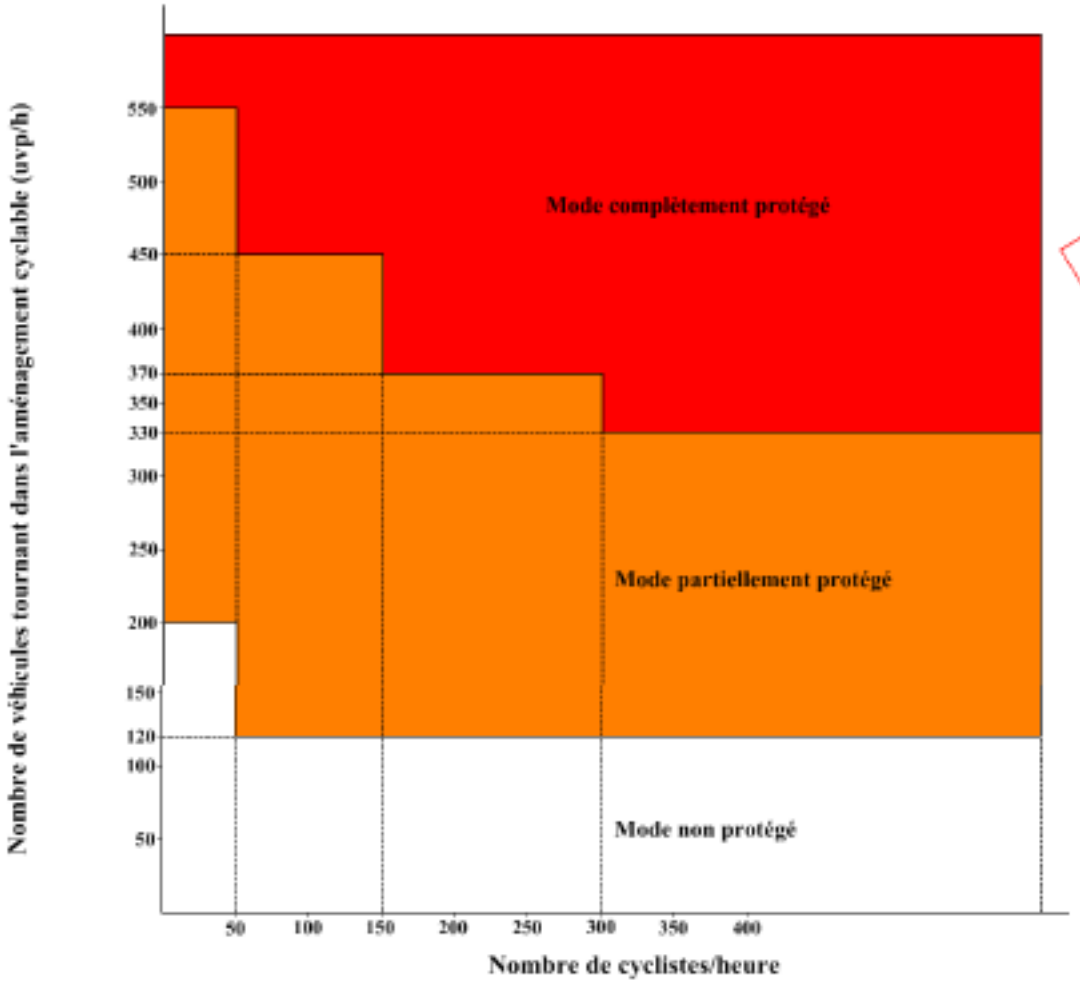
- Increasing delays for motorized road users

INTRODUCTION

- Several key questions regarding the installation of bicycle signals must be addressed.
  - Criteria to identify the intersections that would benefit from treatment
  - Potential impacts of introducing bike signals and how can the impacts be measured?
- In an attempt to address the questions surrounding the implementation of bicycling signals, the Dep Transportation of the City of Montréal has un important step in the development of a bicyc guide

CRITERIA - PROPOSED METHODOLOGY

Figure 2: Mode de fonctionnement recommandé en fonction du nombre de conflits véhicules/cyclistes

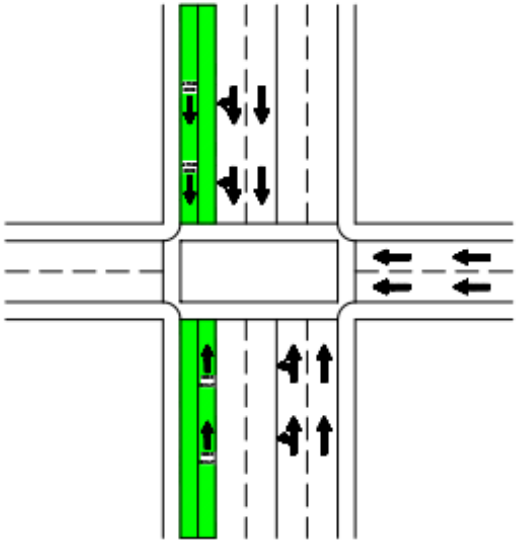


Préliminaire

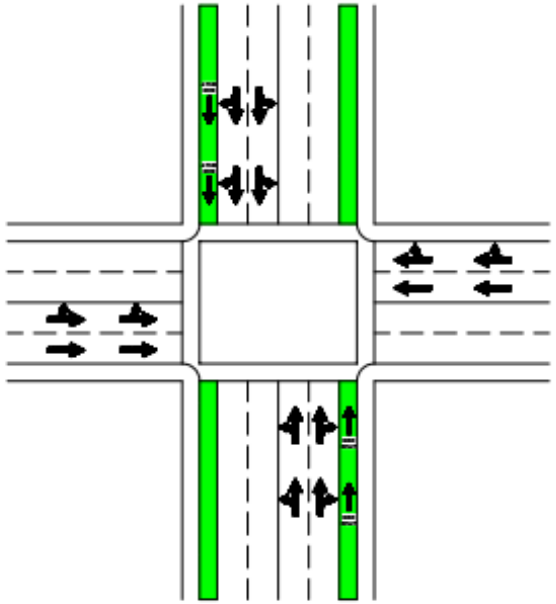
STUDY OBJECTIVES

- Help evaluating the proposed guidelines for Montreal "Guide de conception des feux en présence d'aménagements cyclables »
- Investigate the impact of different signals strategies in terms of congestion and safety:
  - Non protected or Base case - BC
  - Partially protected - PP
  - Completely protected – CP
  - "Completely protected with protected turn" - CPT

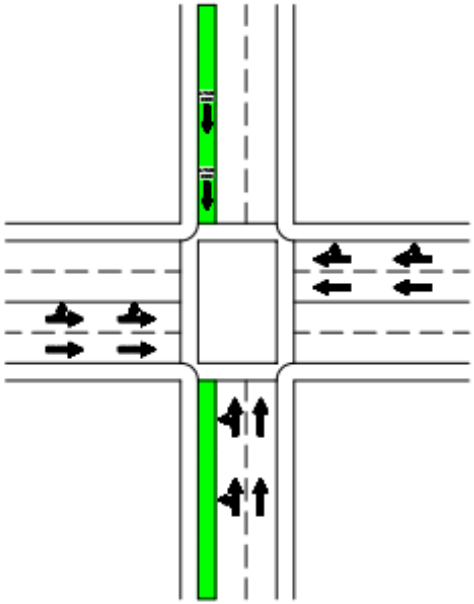
MODEL INTERSECTIONS



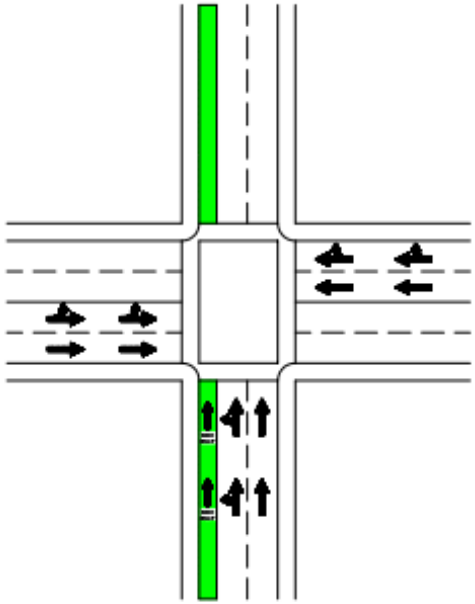
A. Left bike lanes



B. Bike lanes at both sides

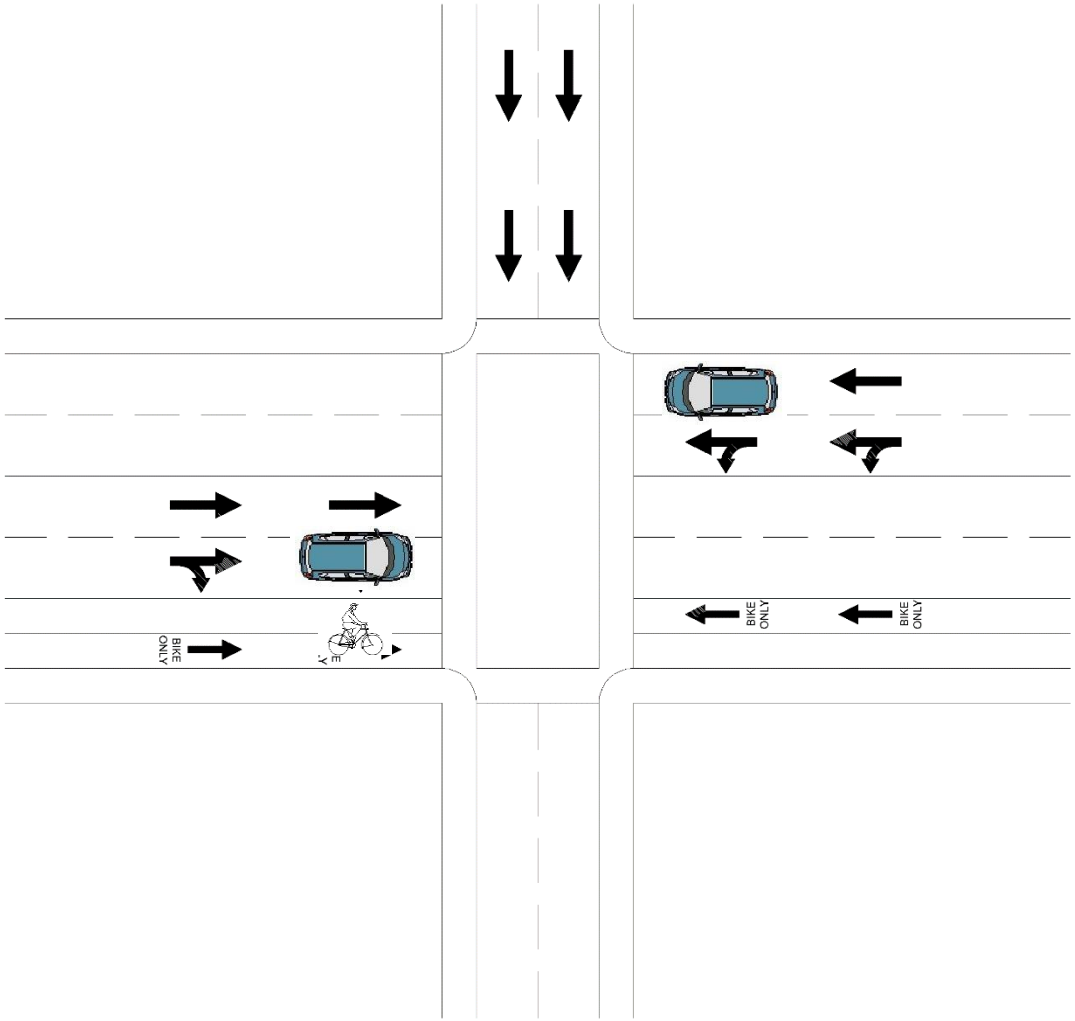


C. Contraflow bike lane

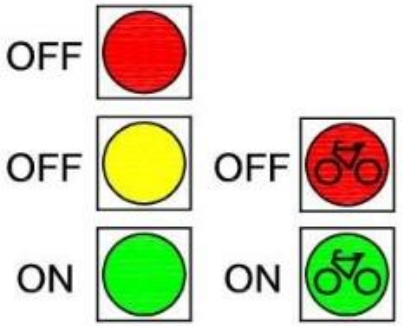


D. Left bike lane

TRAFFIC PHASES, BASE CASE (BC)

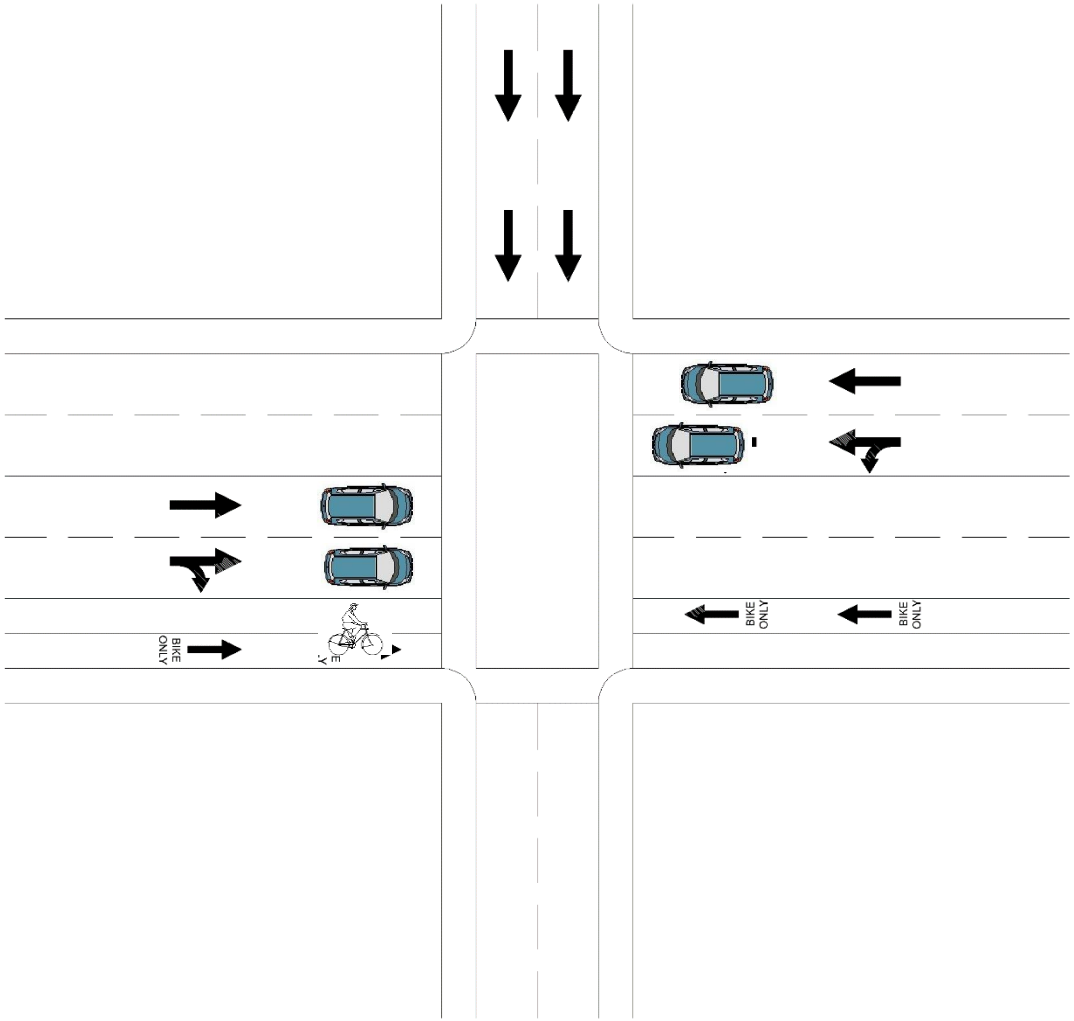


A, Base Case (BC). This is the traditional traffic light treatment where all users move simultaneously in the same phase

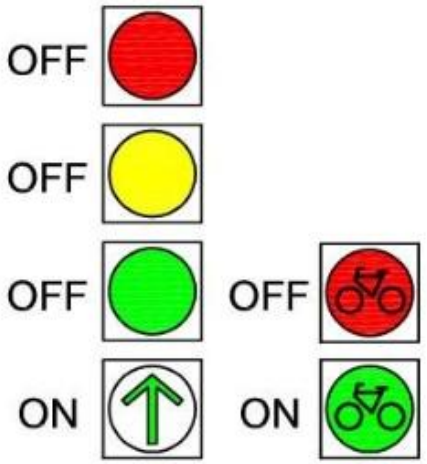


A. Non protected

TRAFFIC PHASES, PARTIALLY PROTECTED (PP)

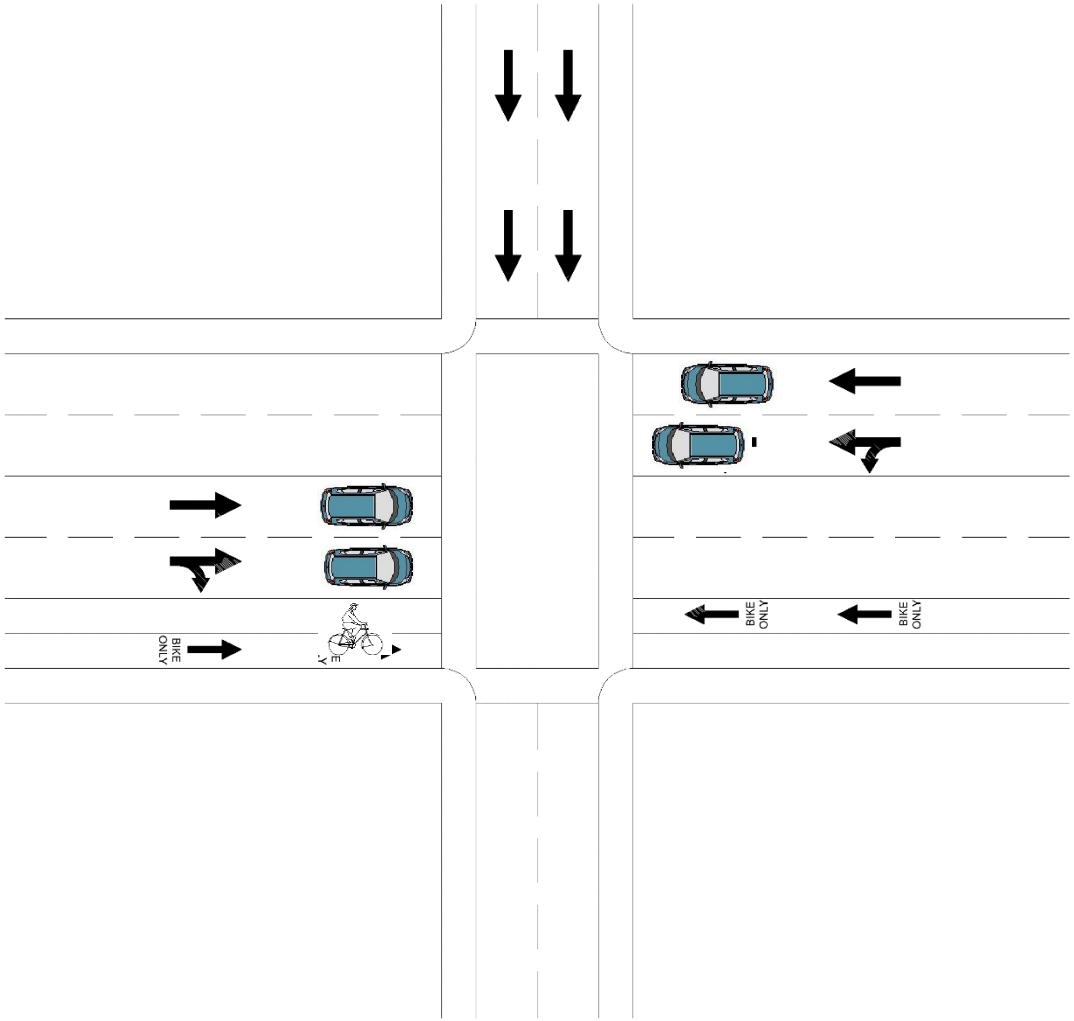


B, Partially Protected (PP). Cyclists or/and pedestrians have a leading green while through movements are allowed for vehicles.

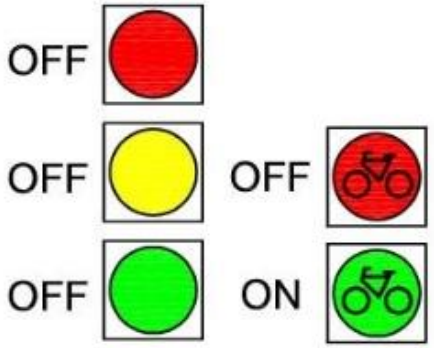


B. Partially protected

TRAFFIC PHASES, COMPLETED PROTECTED (CP1)

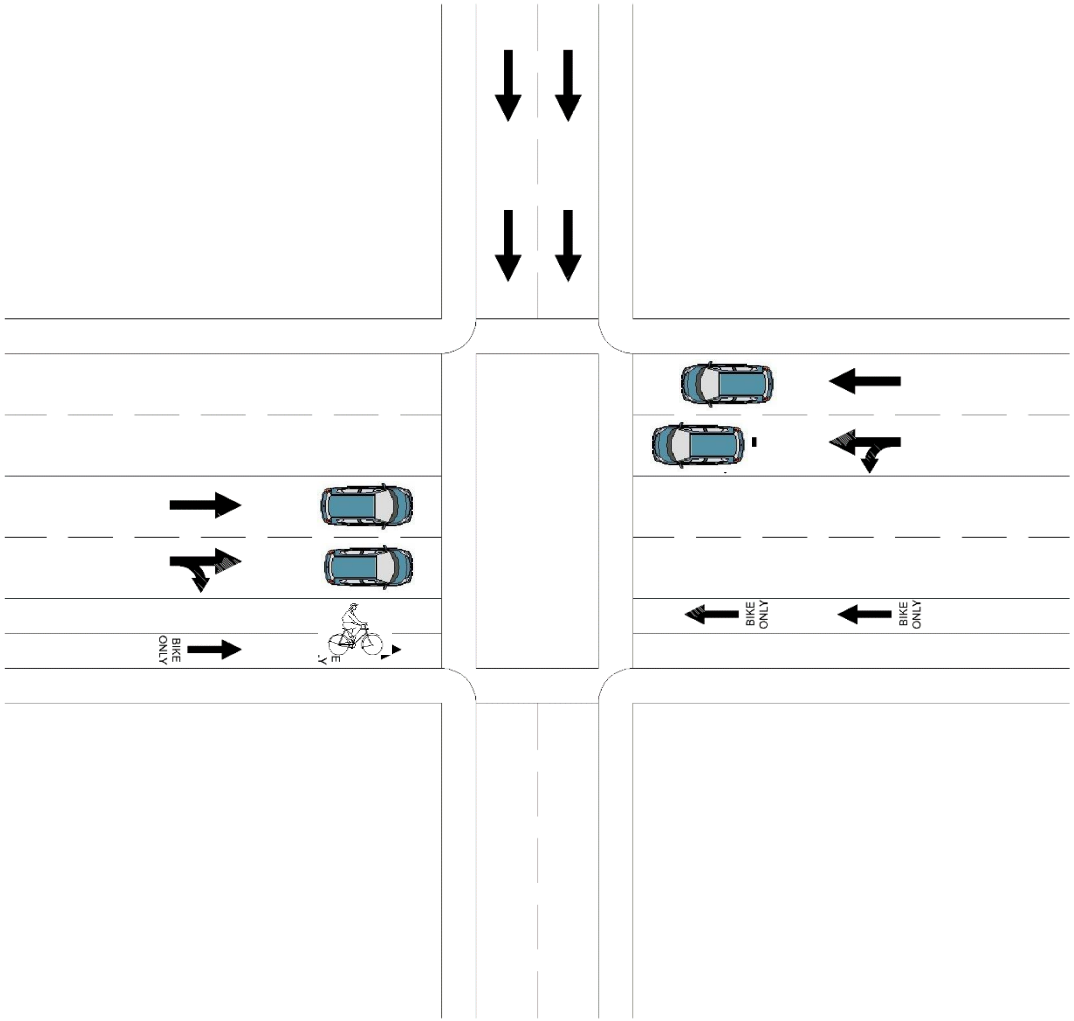


C, Completed Protected (CP1). This design gives the cyclists or/and pedestrians a leading green while all vehicle movement is restricted

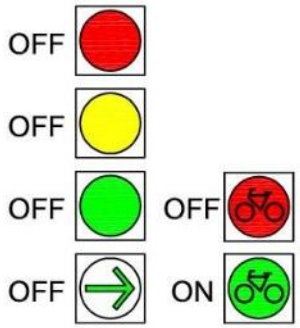


C. Completed protected

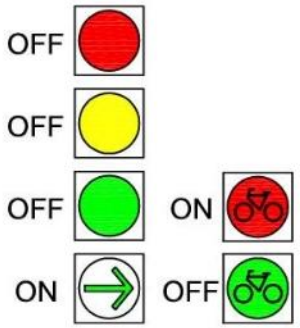
TRAFFIC PHASES, COMPLETED PROTECTED 2 (CP2)



D, Completed Protected 2 (CP2), This mode is similar to C, but at the end of the green phase it stop cyclist and vehicles going through for some seconds allowing turning vehicles to do so without major conflicts.



D1. Completed protected with turn, stage one



D2. Completed protected with turn, stage two

SIGNAL PHASES CYCLES (84S)

Direction	Intersection 1 and 2						
	Base Case						
Main (All)	47		3	2	30		2
Secondary (All)	50			2	27	3	2
	Partially Protected						
Main - Through (Veh)	10	37	3	2	30		2
Main - Turning (Veh)	10	37	3	2	30		2
Main (Bike)	10	37	3	2	30		2
Secondary (All)	50			2	27	3	2

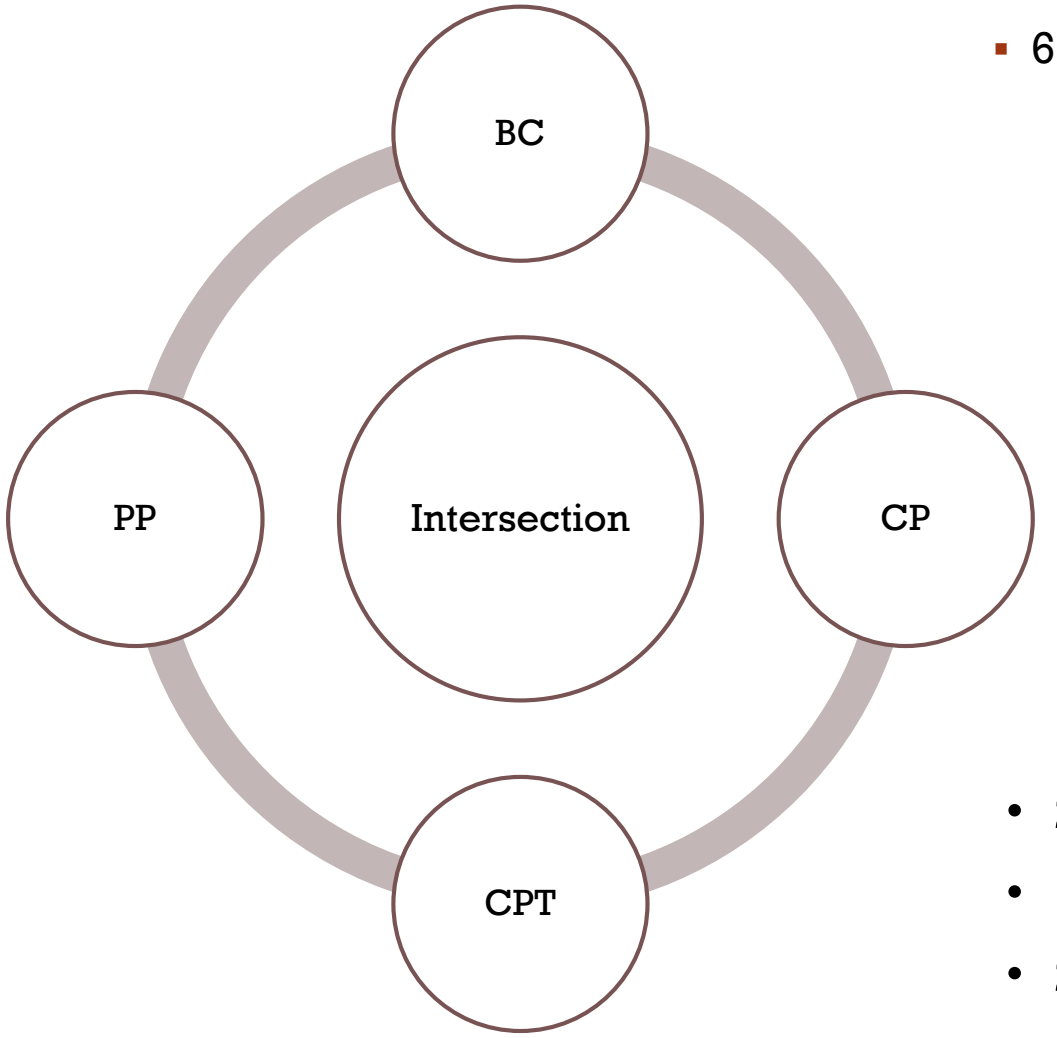
TRAFFIC INPUTS

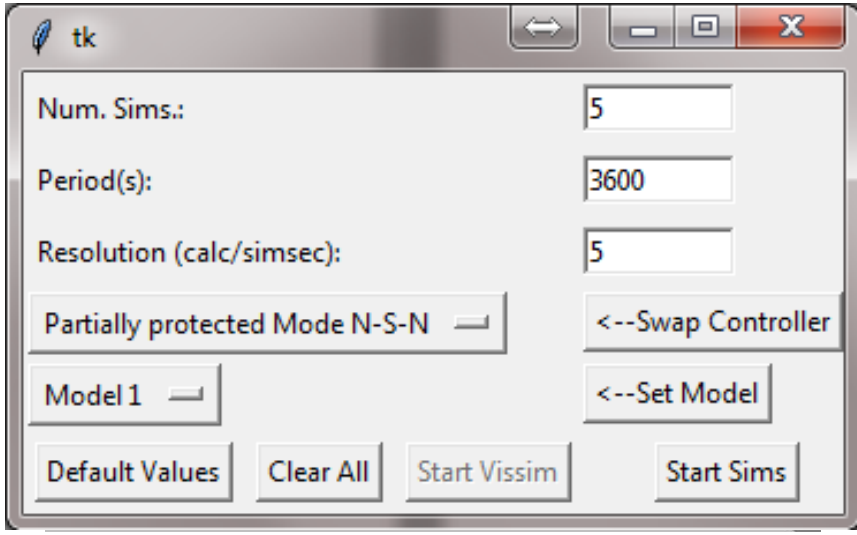
Vehicles	Cyclist												
	1	50	100	150	200	250	300	350	400	450	500	550	600
50													
100													
150													
200													
250													
300													
350													
400													
450													
500													
550													
600													

- Vehicles speed, 50 km/h.
- Cyclists speed, 80% at 15 km/h, and 20% at 20 km/h.

SIMULATION, VISSIM V5.4

- 4 different intersections
- 156 different traffic flow combinations
- 624 simulation sets per intersection

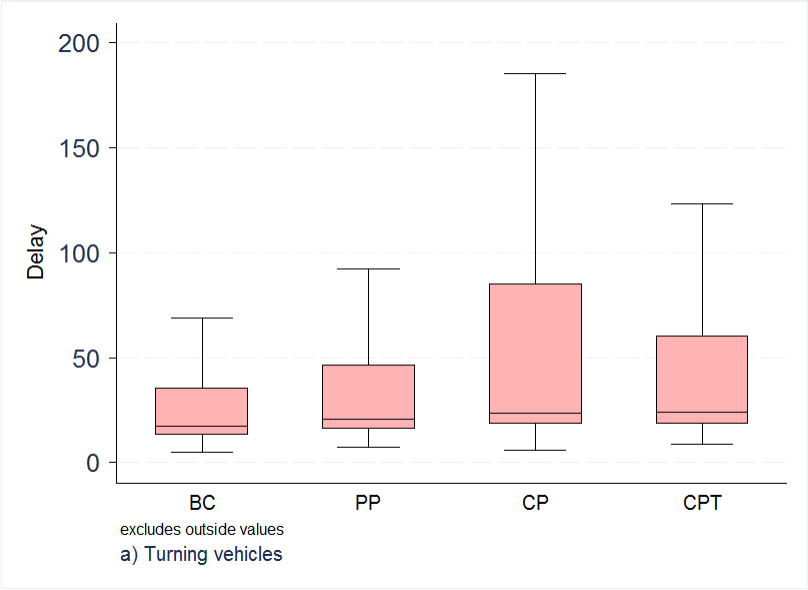




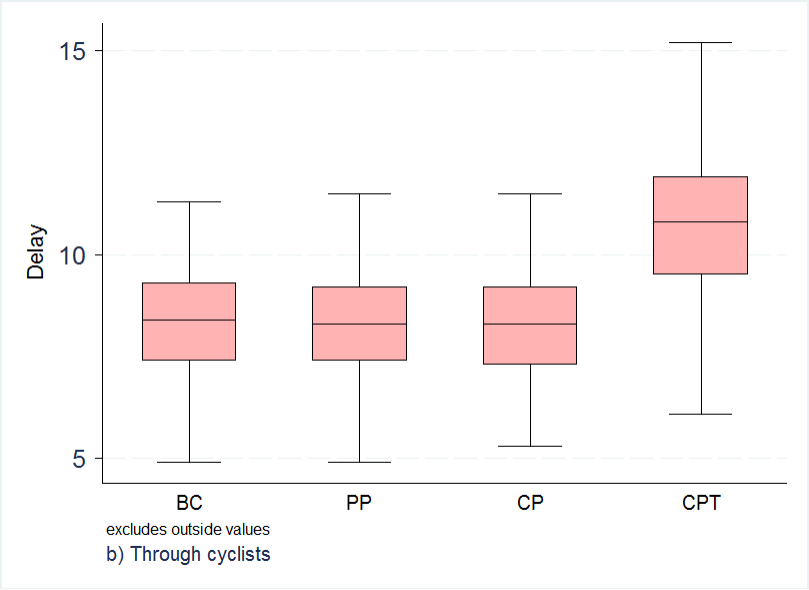
- 2,496 simulations sets
- 10 unique simulations per set
- 24,960 total simulations

RESULTS, INTERSECTION 1 SUMMARY

Variable	Light phase			
	BC	PP	CP	CPT
Through vehicles median (s)	10.6	10.8	16.7	20.0
Through vehicles IQR (s)	3.6	4.8	8.45	9.75
Turning vehicles median (s)	17.5	20.6	23.6	23.9
Turning vehicles IQR (s)	22.35	30.5	66.95	41.95
Through cyclists median (s)	8.4	8.3	8.3	10.8
Through cyclists IQR (s)	1.9	1.8	1.9	2.4
Crossing conflicts	678	390	293	402

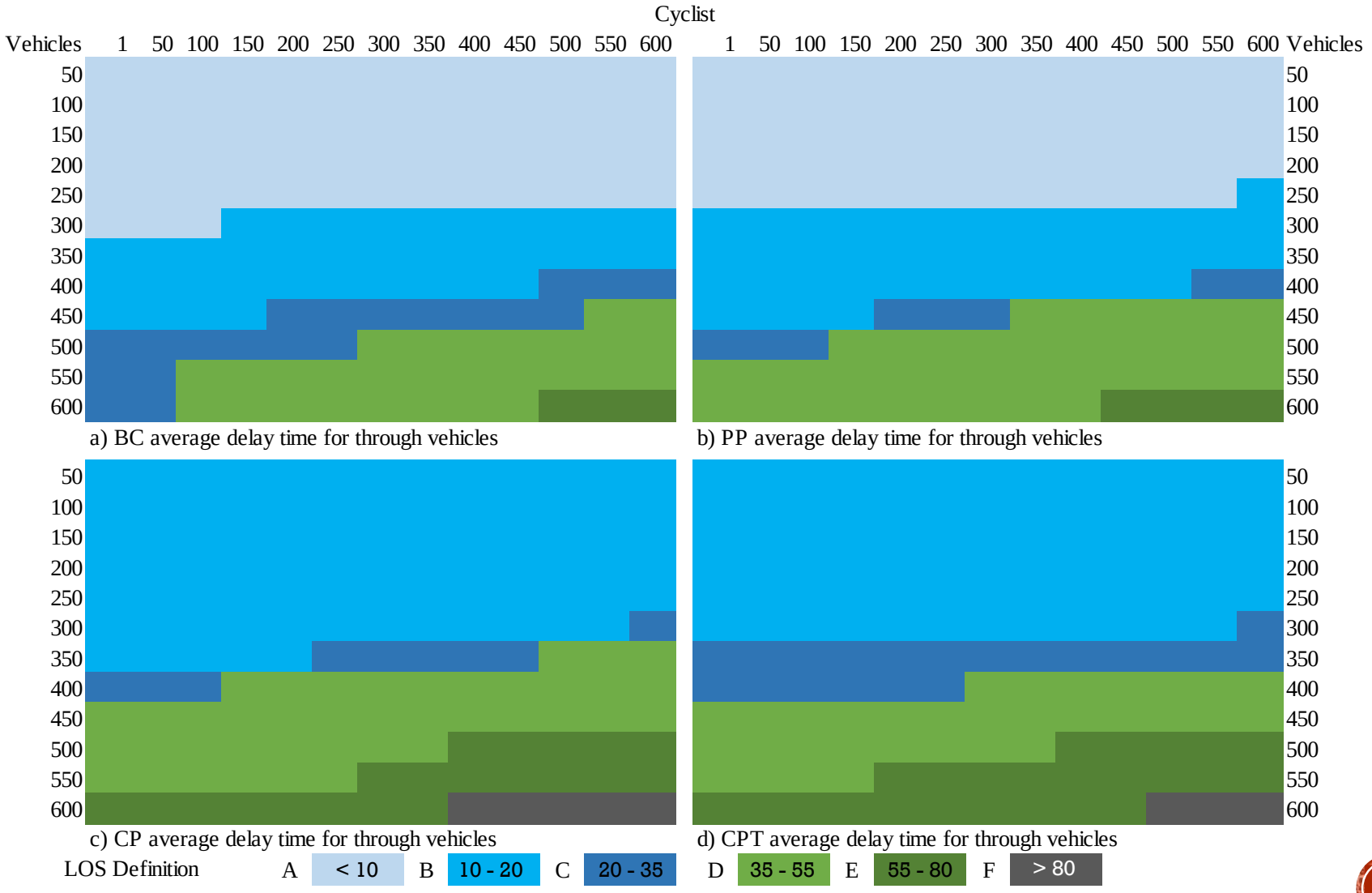


a) Turning vehicles

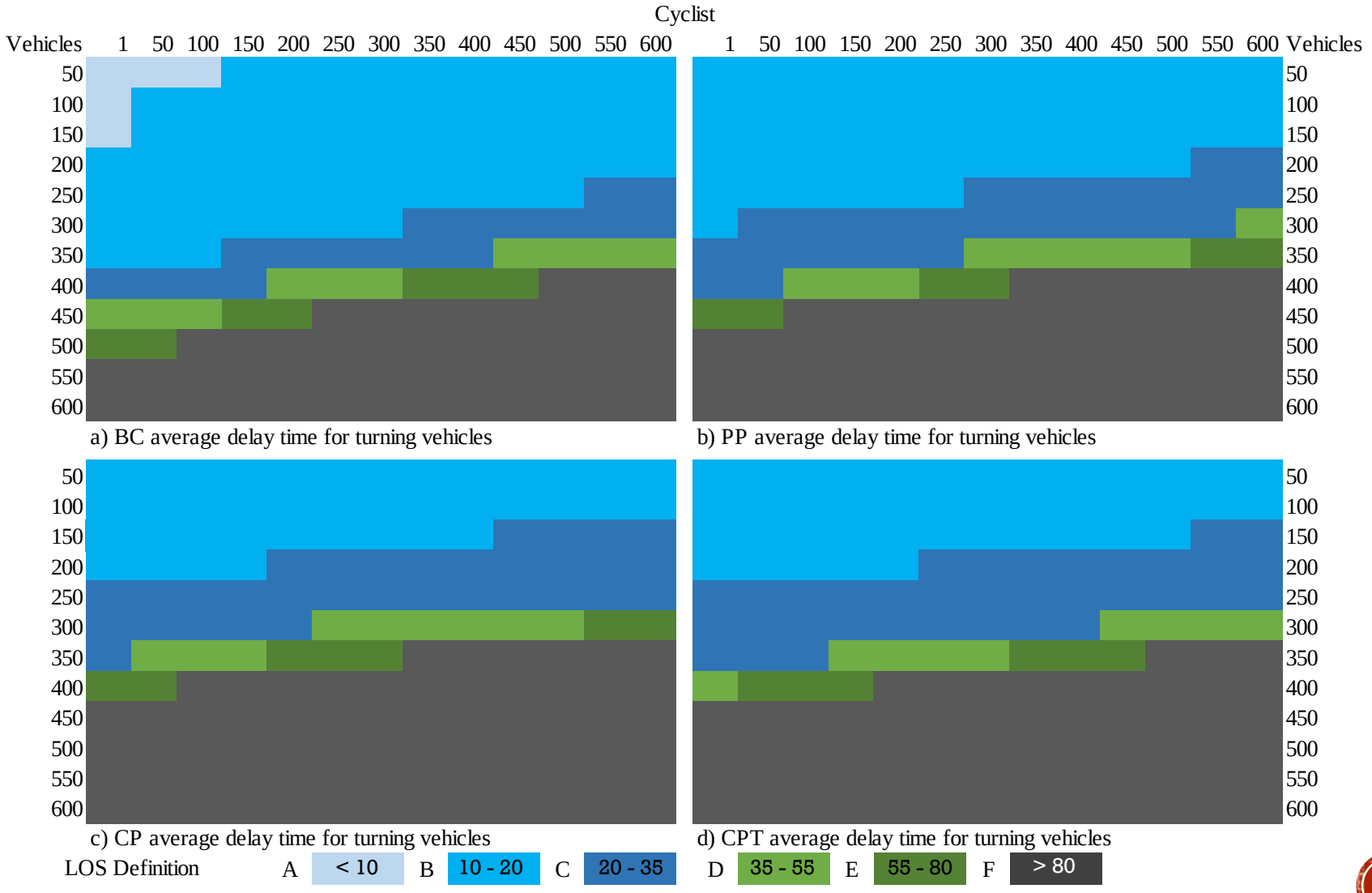


b) Through cyclists

INTERSECTION 1, LOS THROUGH VEHICLES



INTERSECTION 1, LOS TURNING VEHICLES



CONCLUSIONS

- The effectiveness of the CP design is clear, with the lowest number of crossing conflicts between vehicles and cyclists.
- The second safest scenario is the PP, followed by the CPT and BC, the most dangerous of the four cases.
- Although the CP is the phase with the lower number of conflicts, it is also the phase with longest and most variable delay.
- From these results, the PP signal design is able to improve cyclist safety without greatly affecting LOS for vehicles and cyclists.

McGill University
Civil Engineering & Applied Mechanics

Canadian Association of Road Safety Professional Conference 2017

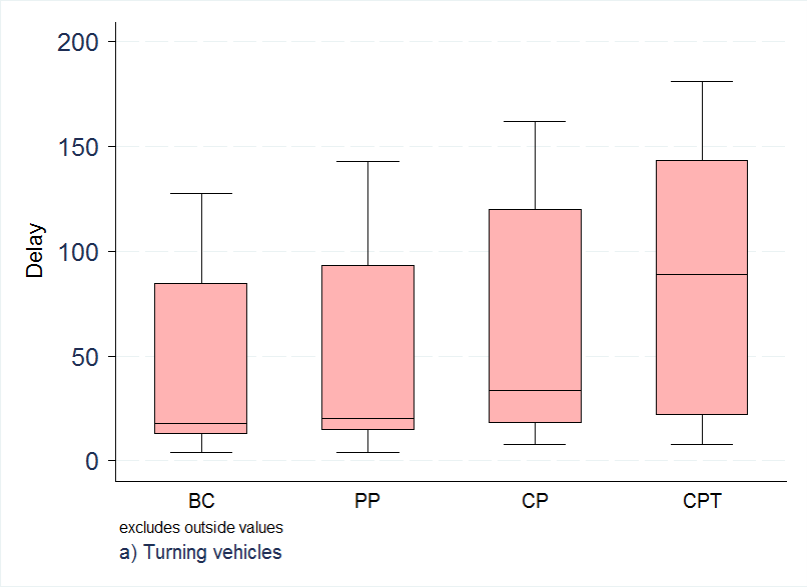
Thank you for your attention

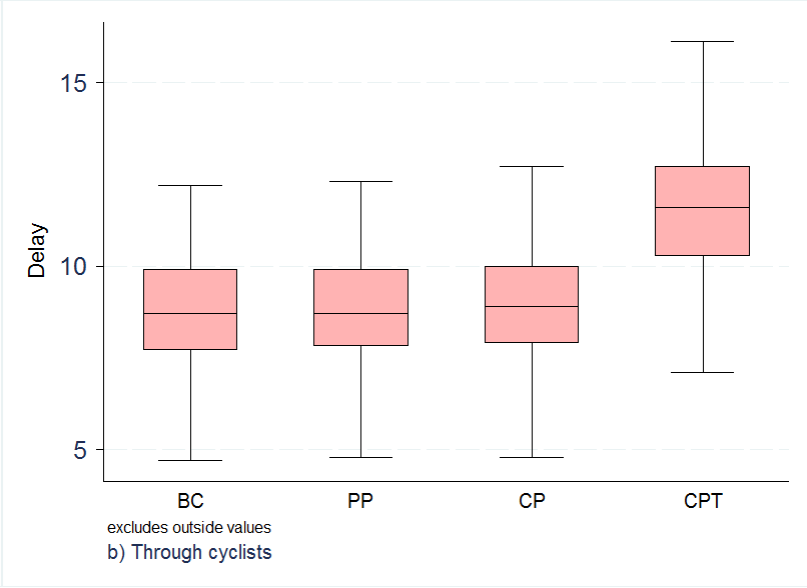
McGill

June , 2017. Toronto, Ontario

RESULTS, INTERSECTION 2 SUMMARY

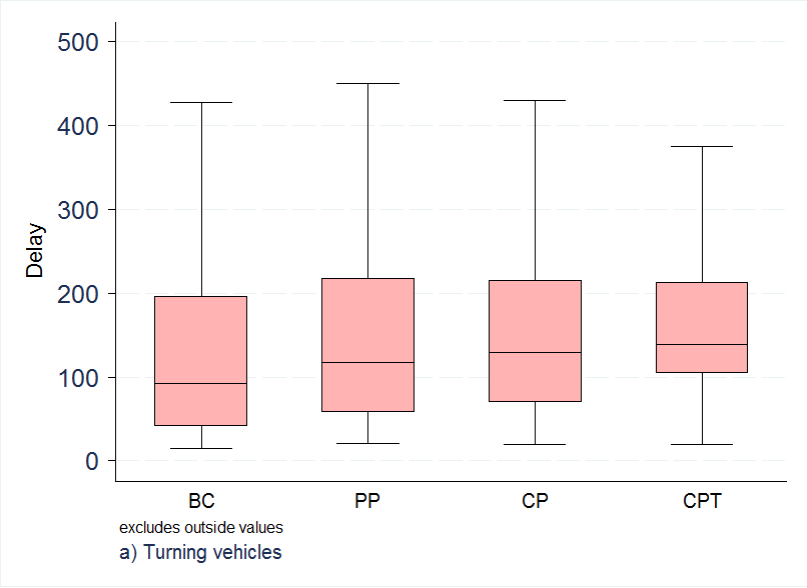
Variable	Light phase			
	BC	PP	CP	CPT
Through vehicles median (s)	18.6	19.9	35.1	90.3
Through vehicles IQR (s)	73	80.8	101.2	120.9
Turning vehicles median (s)	18	20.35	33.7	88.95
Turning vehicles IQR (s)	71.8	78.5	101.9	121.4
Through cyclists median (s)	8.7	8.7	8.9	11.6
Through cyclists IQR (s)	2.2	2.1	2.1	2.45
Crossing conflicts	416	330	182	247



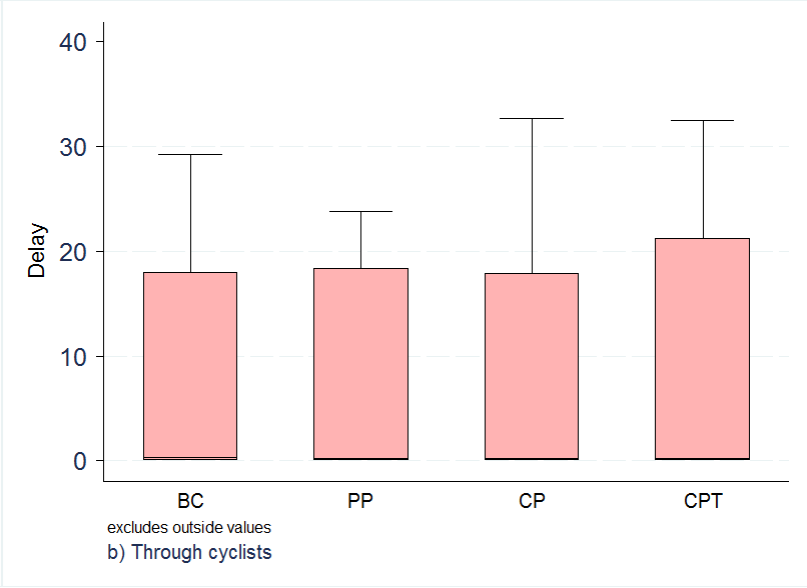


RESULTS, INTERSECTION 3 SUMMARY

Variable (%)	Light phase, turning direction			
	BC	PP	CP	CPT
Through vehicles median	10.6	10.8	16.7	20.0
Through vehicles IQR	3.6	4.8	8.45	9.75
Turning vehicles median	17.5	20.6	23.6	23.9
Turning vehicles IQR	22.35	30.5	66.95	41.95
Through cyclists median	8.4	8.3	8.3	10.8
Through cyclists IQR	1.9	1.8	1.9	2.4
Crossing conflicts	4051	2681	2642	2894



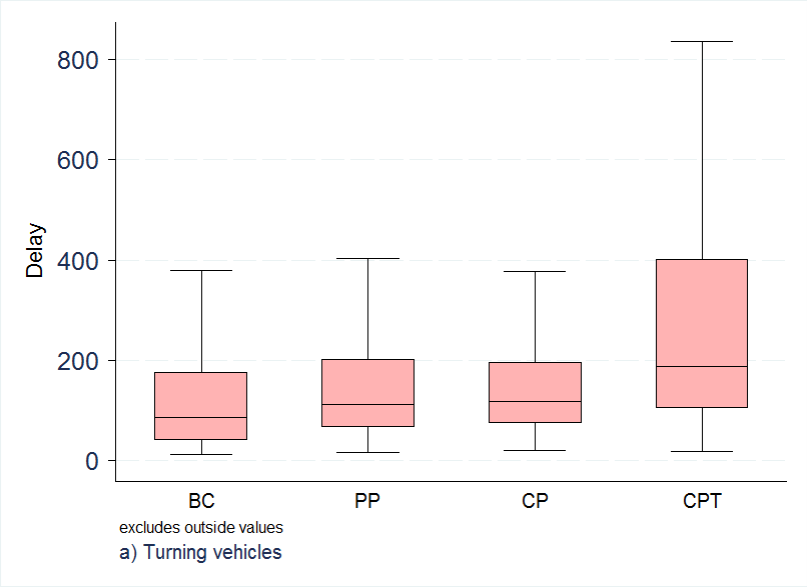
a) Turning vehicles



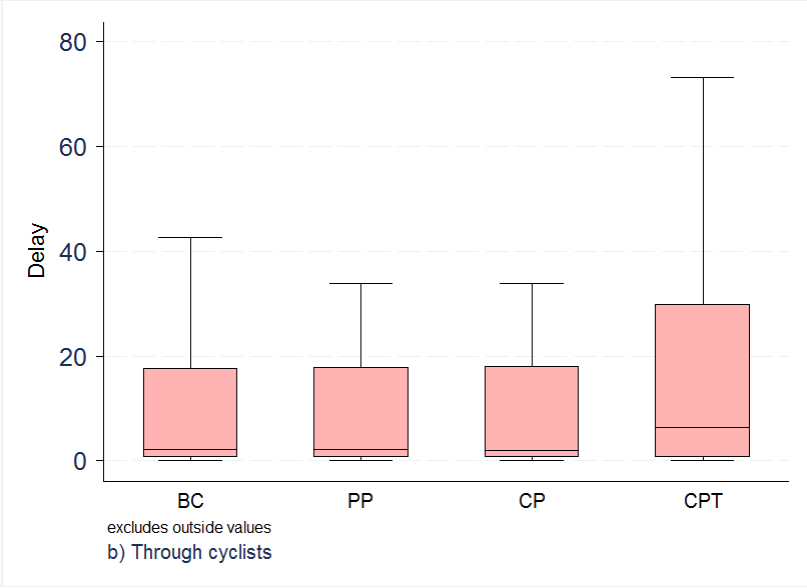
b) Through cyclists

RESULTS, INTERSECTION 4 SUMMARY

Variable (%)	Light phase, turning direction			
	BC	PP	CP	CPT
Through vehicles median	10.6	10.8	16.7	20.0
Through vehicles IQR	3.6	4.8	8.45	9.75
Turning vehicles median	17.5	20.6	23.6	23.9
Turning vehicles IQR	22.35	30.5	66.95	41.95
Through cyclists median	8.4	8.3	8.3	10.8
Through cyclists IQR	1.9	1.8	1.9	2.4
Crossing conflicts	38	16	29	23

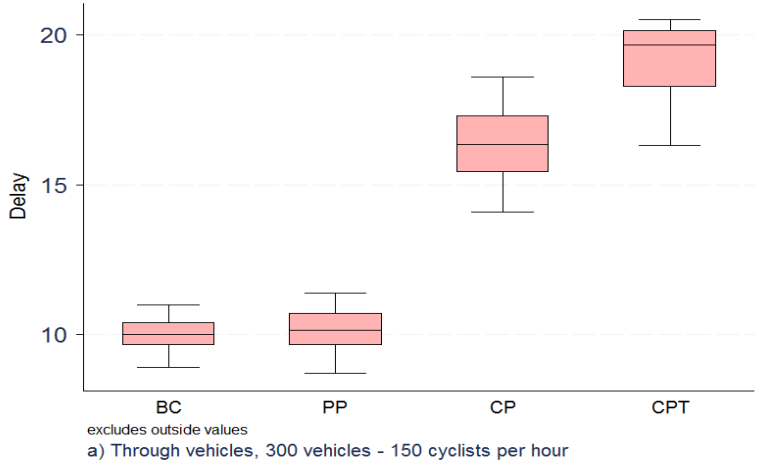


a) Turning vehicles

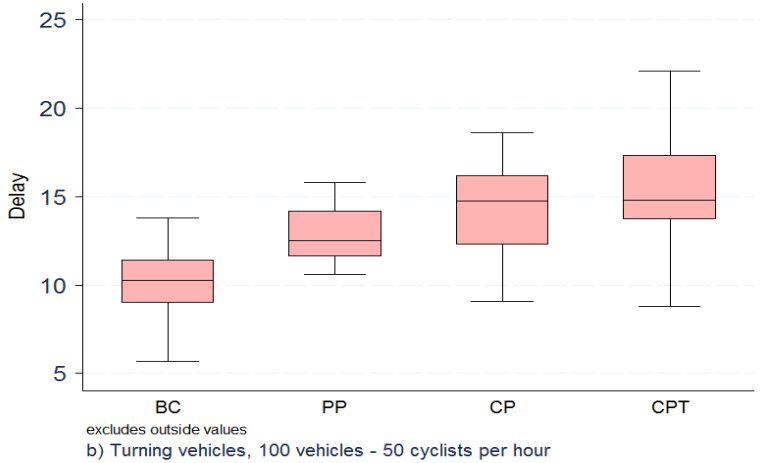


b) Through cyclists

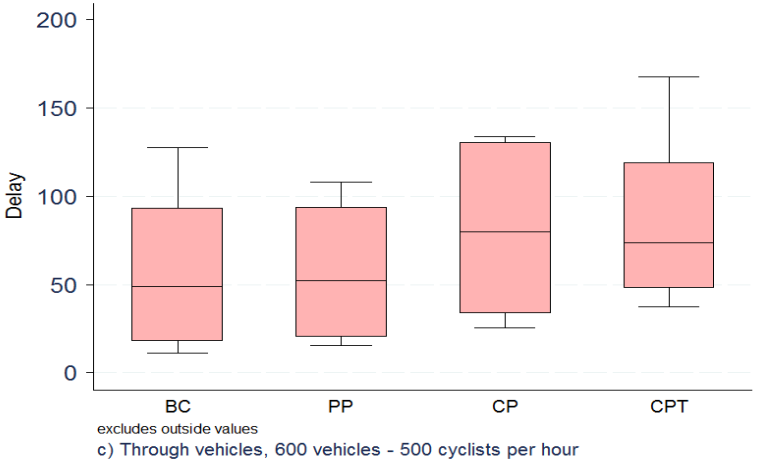
VEHICLES DELAY



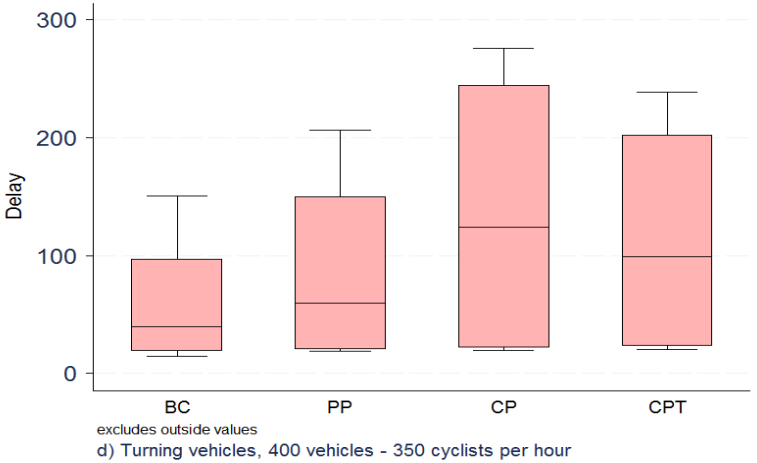
a) Through vehicles, 300 vehicles - 150 cyclists per hour



b) Turning vehicles, 100 vehicles - 50 cyclists per hour



c) Through vehicles, 600 vehicles - 500 cyclists per hour



d) Turning vehicles, 400 vehicles - 350 cyclists per hour