

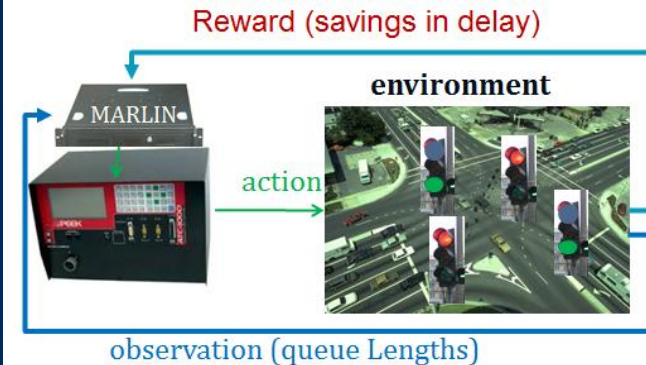
Multi-Agent Reinforcement Learning For Integrated Network (MARLIN) of Adaptive Traffic Signal Controllers

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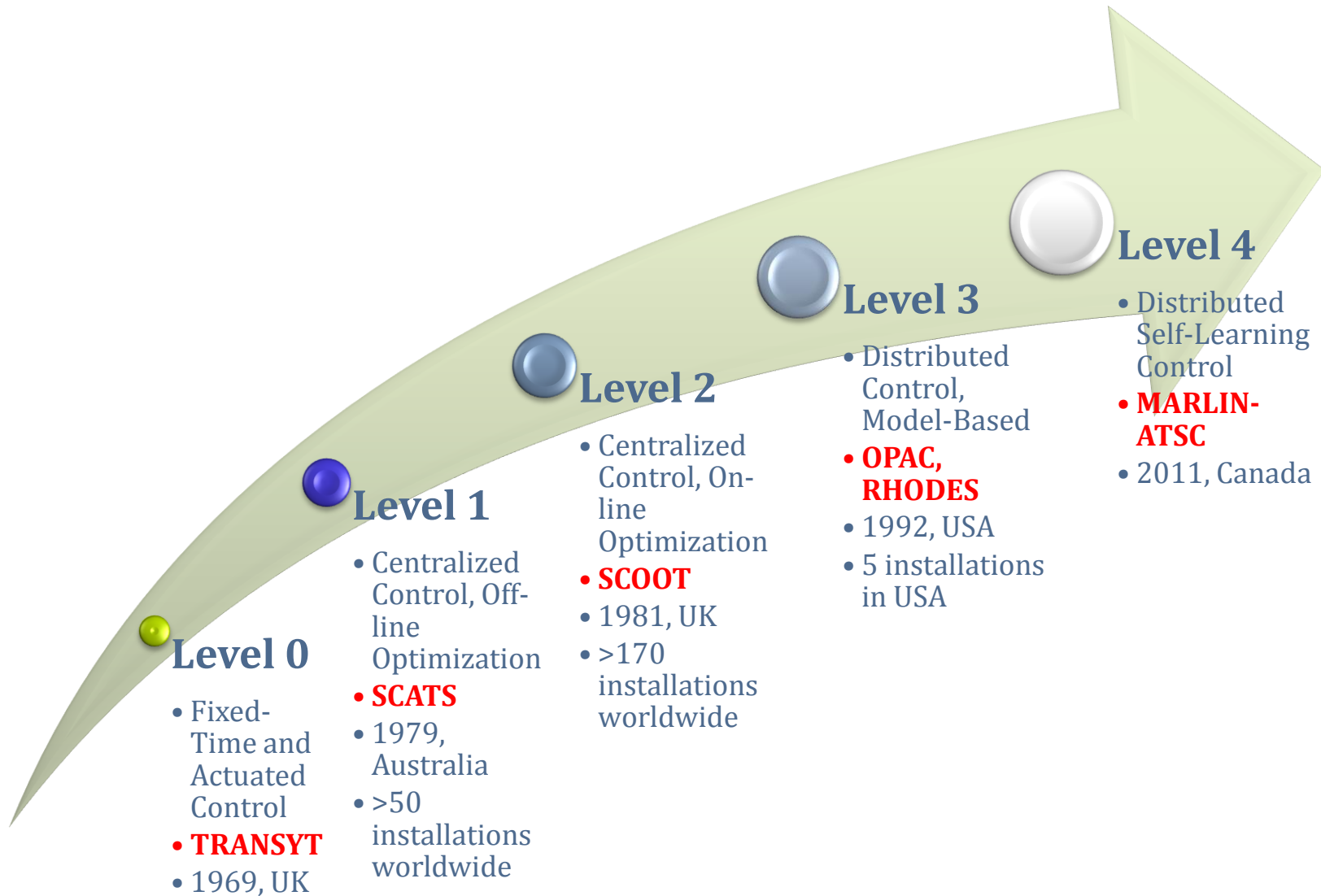
Traffic Lights

- Intended as source of safety and efficiency
- Become source of delay under heavy demand
- How to make them smart, agile and demand responsive?



Evolution of “Adaptive” Traffic Signal Control

MARLIN-ATSC: Level 4



Issues with Leading ATSC Technologies?

Centralized

- Expensive
- Not scalable
- Not robust

Model-Based

- Relying on an accurate traffic modelling framework
- the accuracy of which is questionable

Curse of Dimensionality

- Increasing the complexity of the system exponentially with the increase in the number of intersections/controllers

Human Intervention Requirements

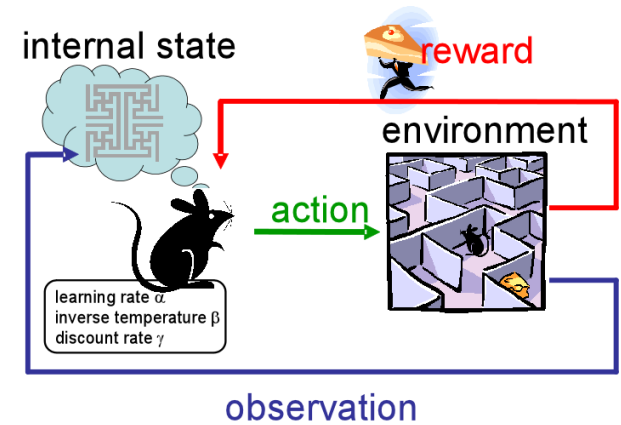
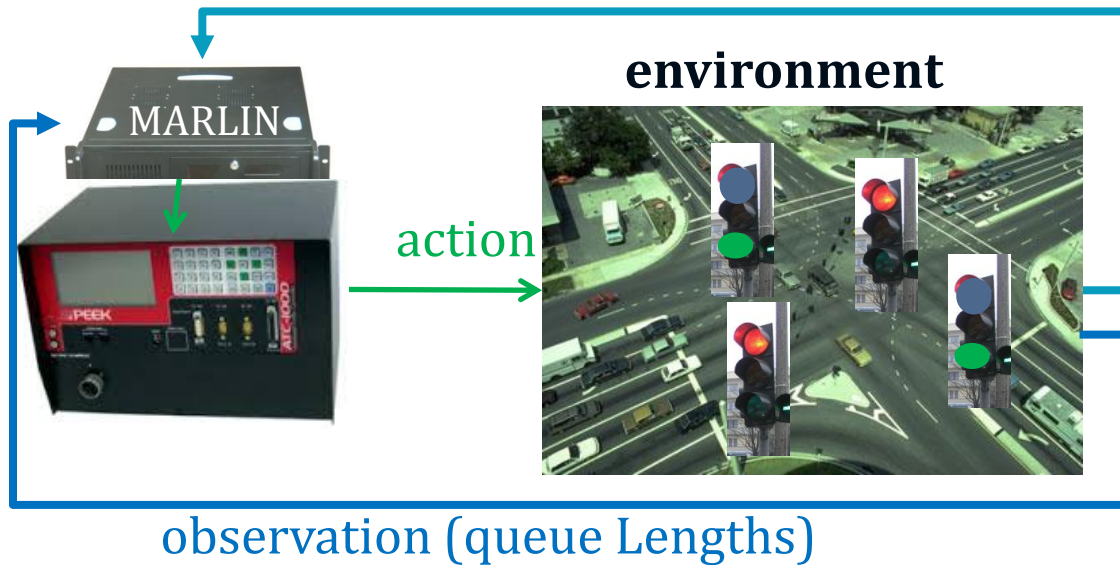
- Requiring highly skilled labour to operate due to their complexity.



MARLIN: The Technology Solution

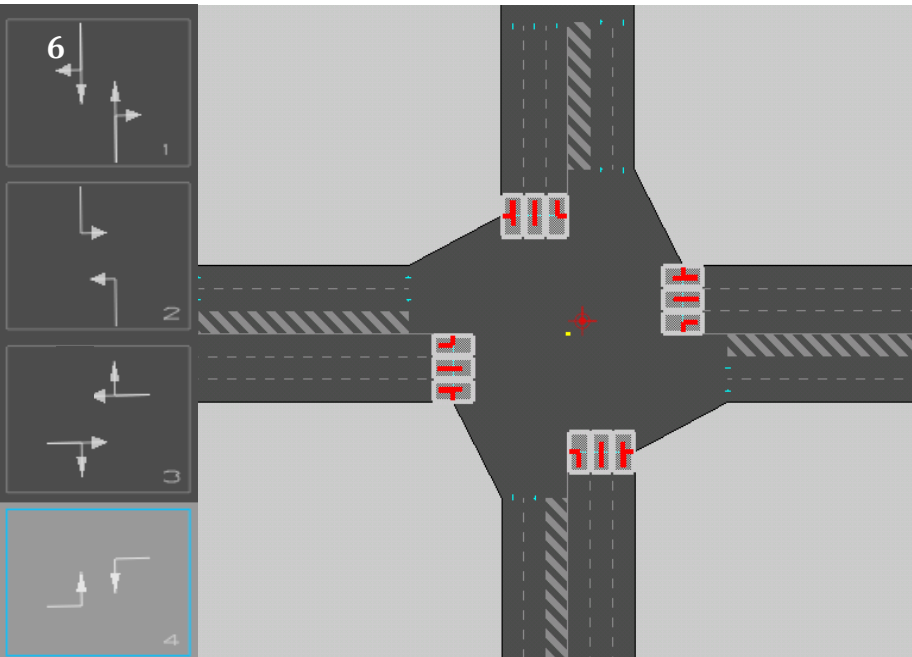
Reinforcement Learning

Reward (savings in delay)



Simulated Testbed

Bay and Front (Downtown Toronto)



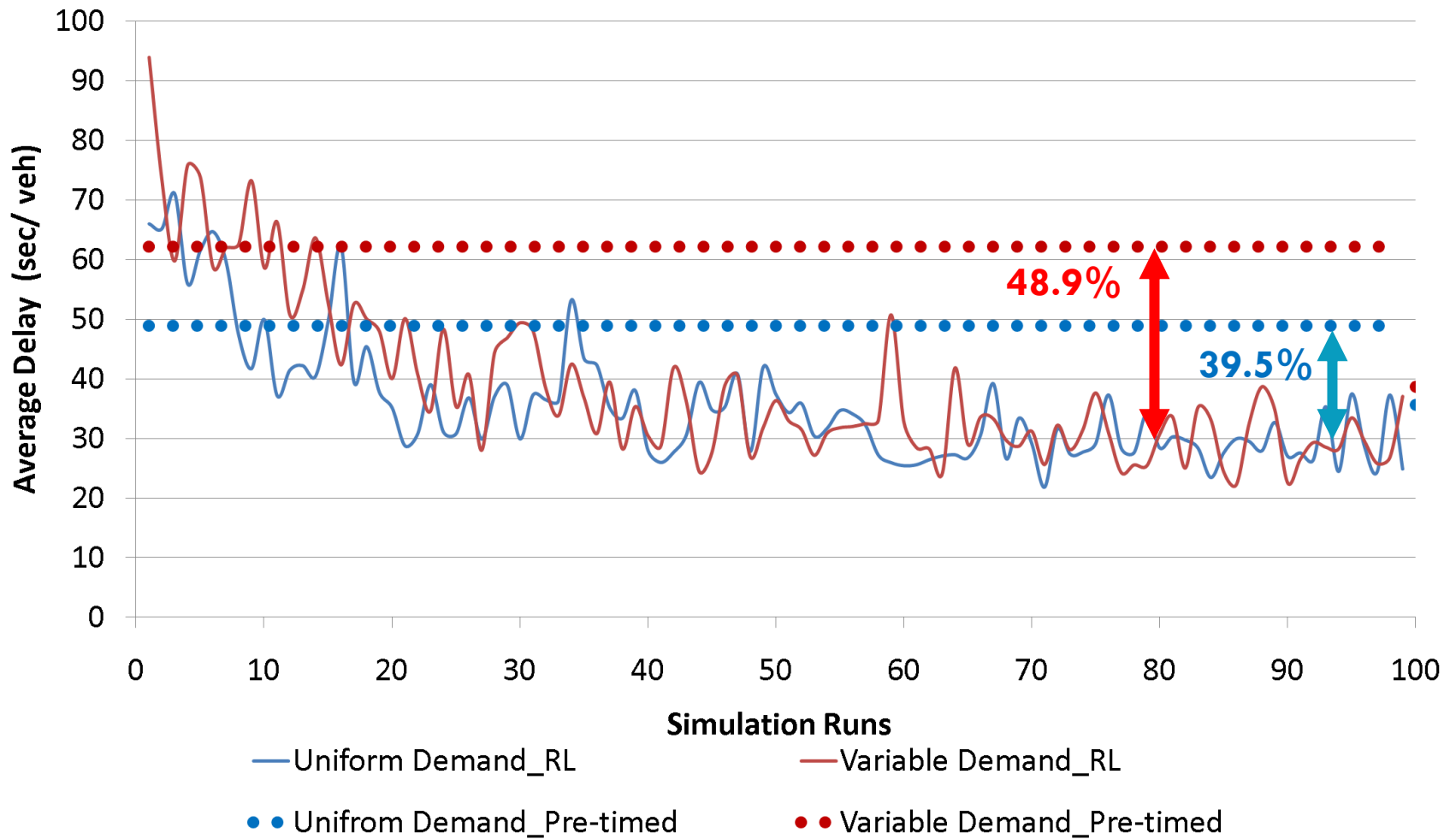
Paramic Model

Traffic Volumes (OD Matrix)

Actual Network

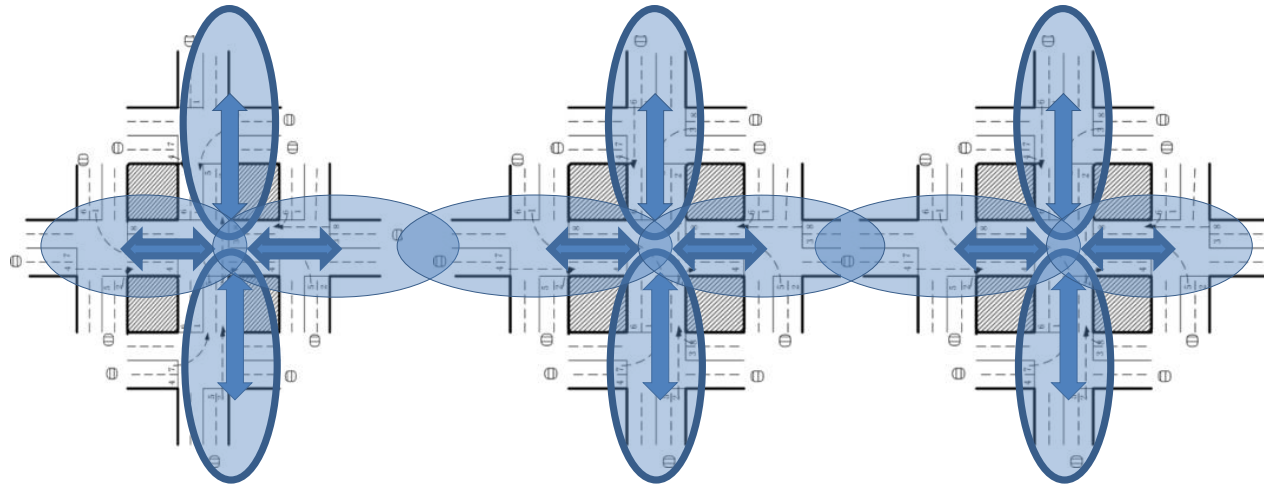
	E	S	N	W	Total
E	0	278	86	844	1208
S	88	0	721	71	880
N	188	806	0	100	1094
W	1223	121	134	0	1478
Total	1499	1205	941	1015	4660

Performance: Average Delay Reduction

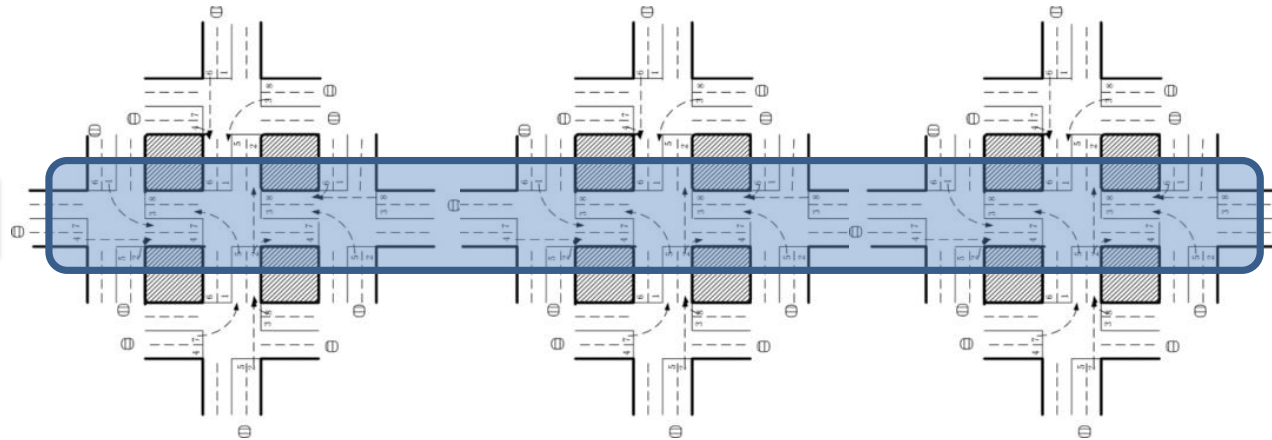


MARLIN- ATSC: Game Theory and Network-Wide Coordination

Collaboration with each adjacent intersection in the neighborhood



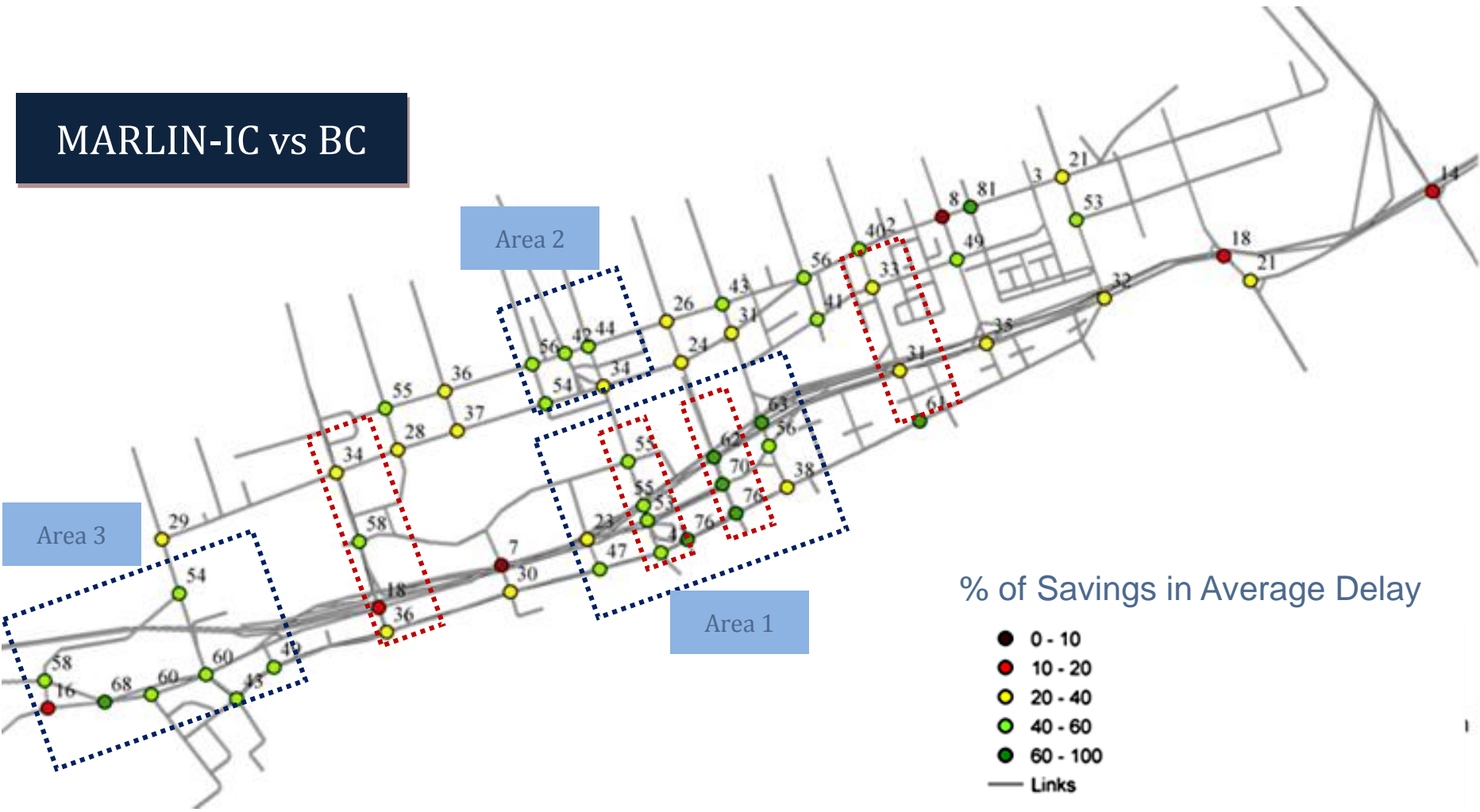
Corridor Synchronization



Large-scale Simulated Testbed

Downtown Toronto

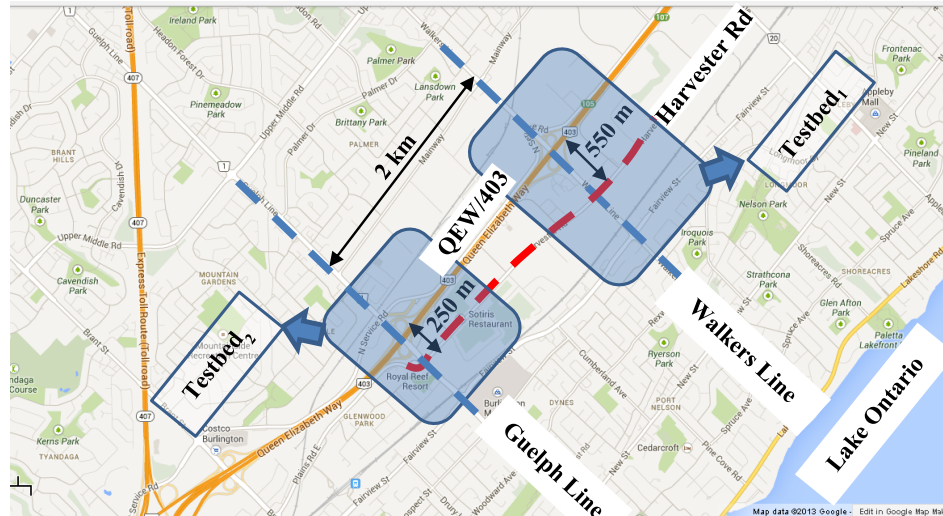
MARLIN-IC vs BC



% of Savings in Average Delay

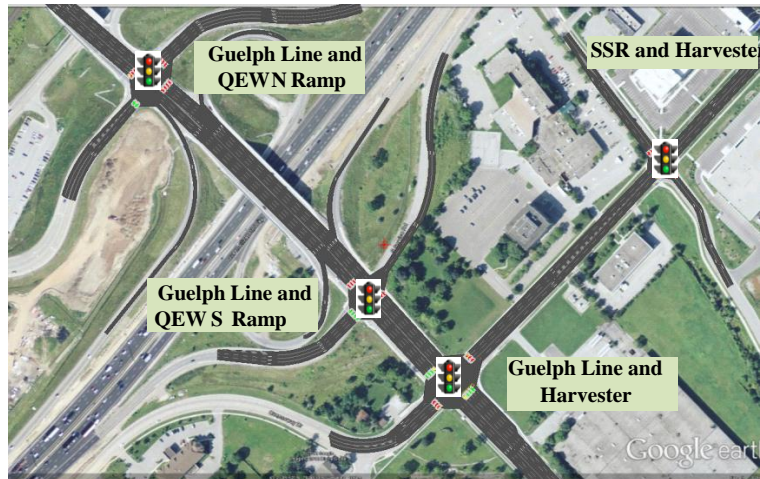
- 0 - 10
- 10 - 20
- 20 - 40
- 40 - 60
- 60 - 100
- Links

Simulation Testing on City of Burlington



Testbed 2

Testbed 1



Guelph Line & Harvester Rd.



Walkers Line & Harvester Rd.

Effect of of MARLIN vs Existing Conditions

Guelph Line

6,578 vehicles

- MARLIN-C vs Base Case
 - Speed Savings: 11-25%
 - Travel Time Savings: 8-21%
- Savings in CO2 Emission Factors
 - MARLIN vs Base Case : - 32%

MARLIN-C >> MARLIN-I

Coordination is Necessary



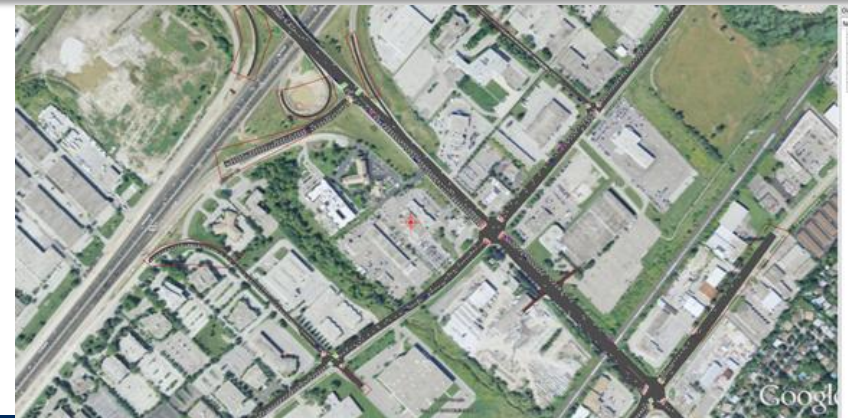
Walkers Line

9,134 vehicles

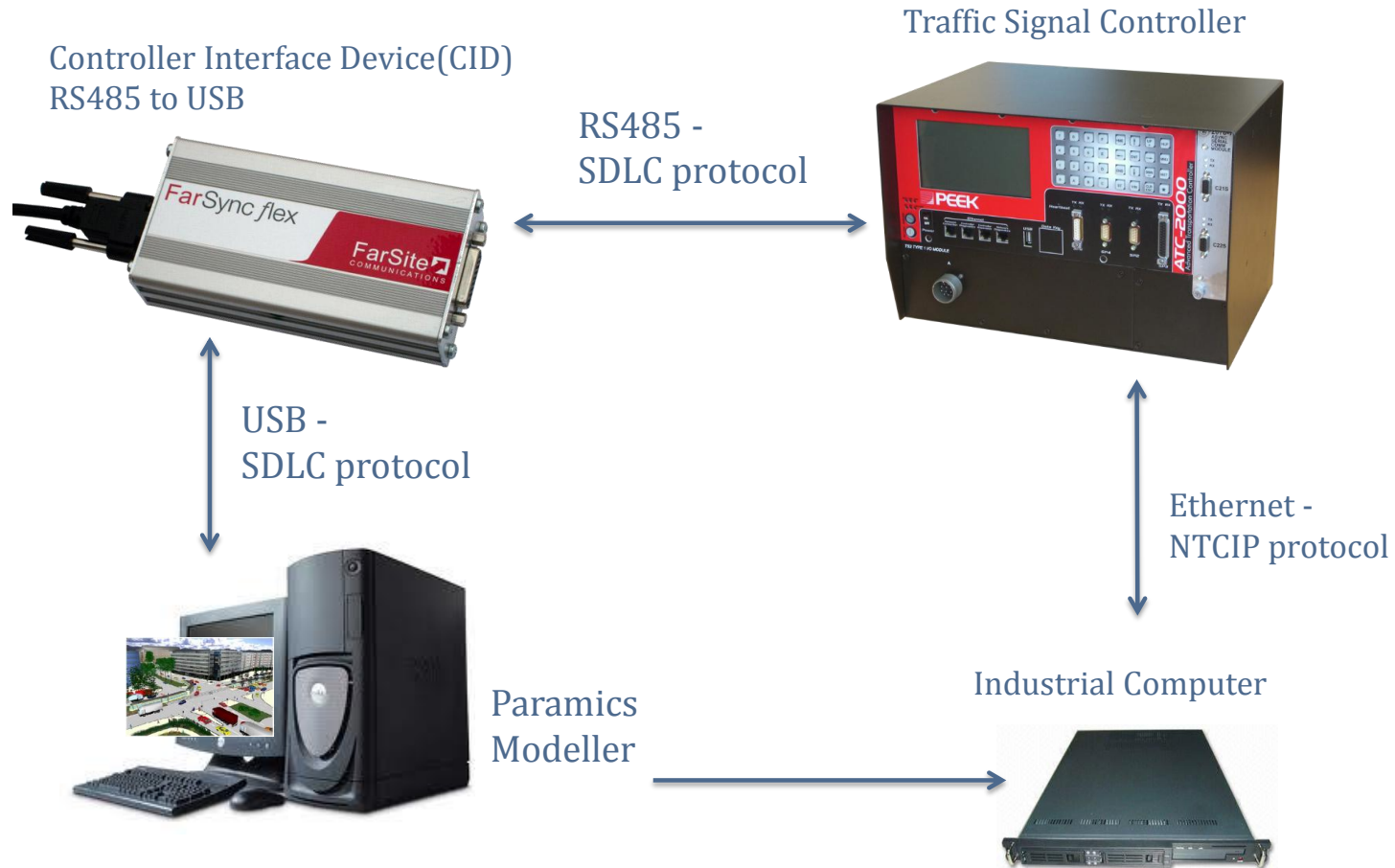
- MARLIN vs Base Case
 - Speed Savings: 13-32%
 - Travel Time Savings: 11-25%
- Savings in CO2 Emission Factors
 - MARLIN vs Base Case : - 13%

MARLIN-I ~ MARLIN-C

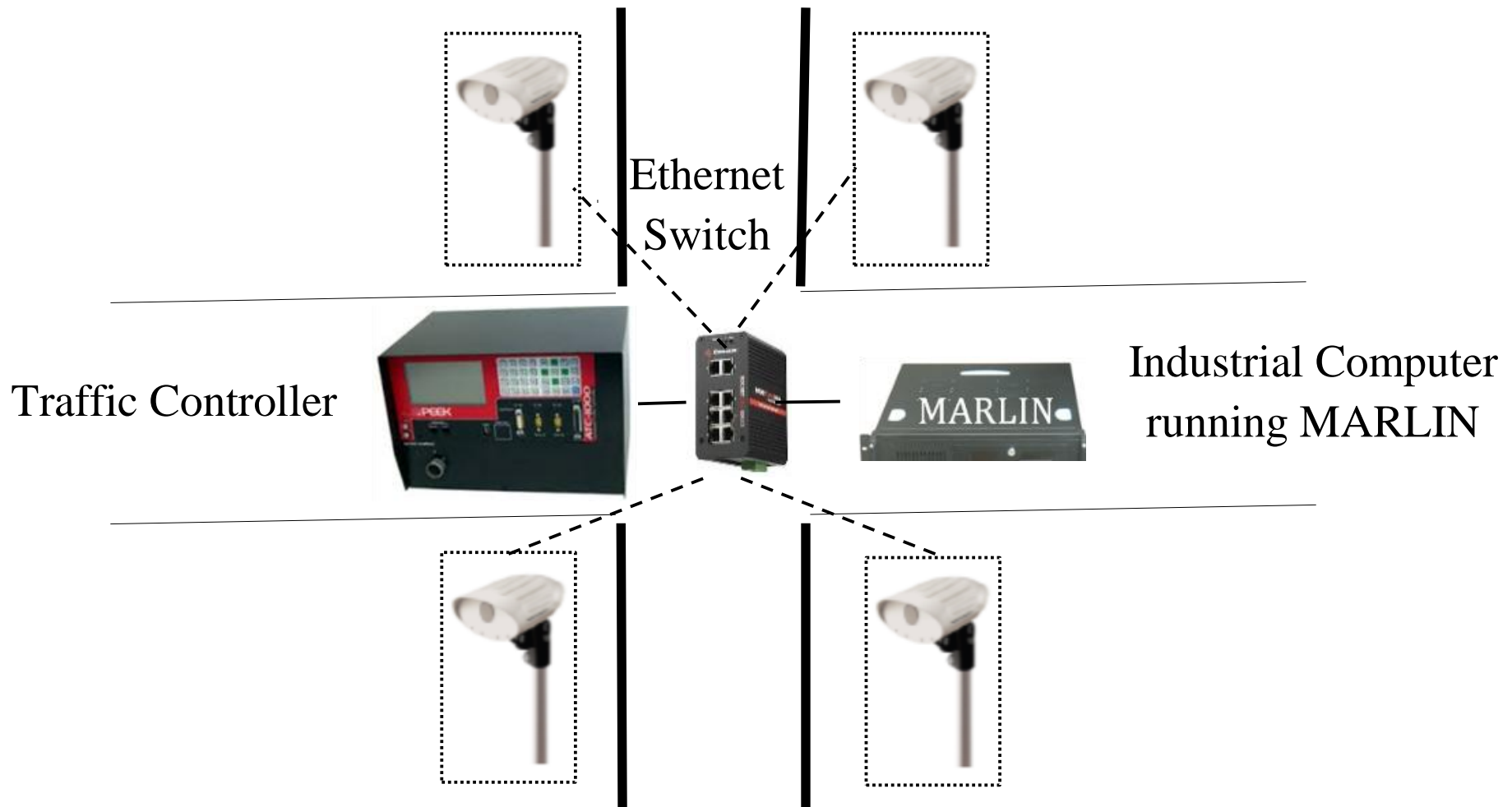
Independent is Enough



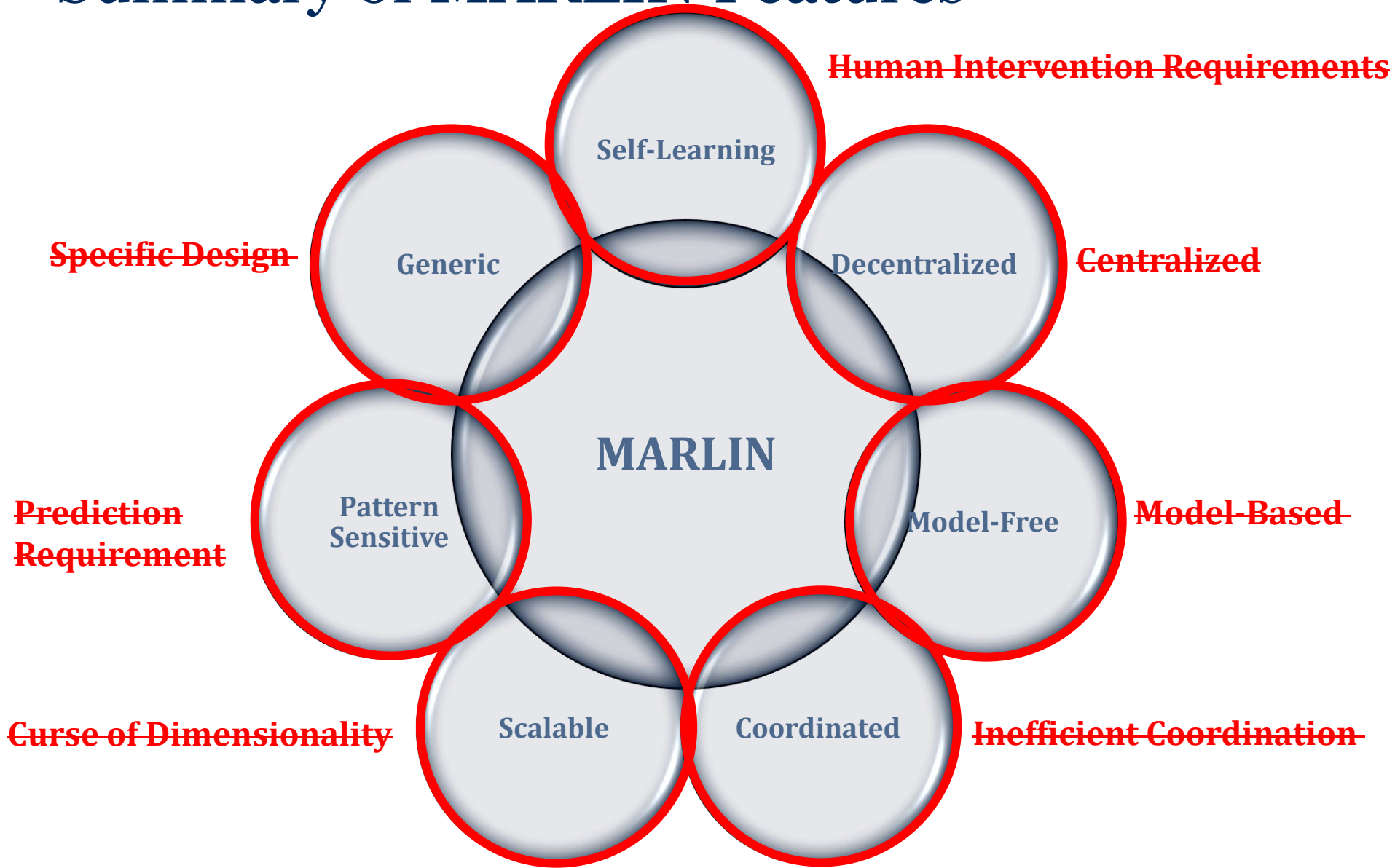
MARLIN-Hardware In The Loop Simulations (HILS) Architecture



MARLIN Field Components



Summary of MARLIN Features



Status

Field
Operations
Testing
(City of Burlington)

*R & D
Partnership with
PEEK*

Research and Lab
Testing



Thank You!

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