OPTIMAL DYNAMIC GREEN TIME FOR DISTRIBUTED SIGNAL CONTROL

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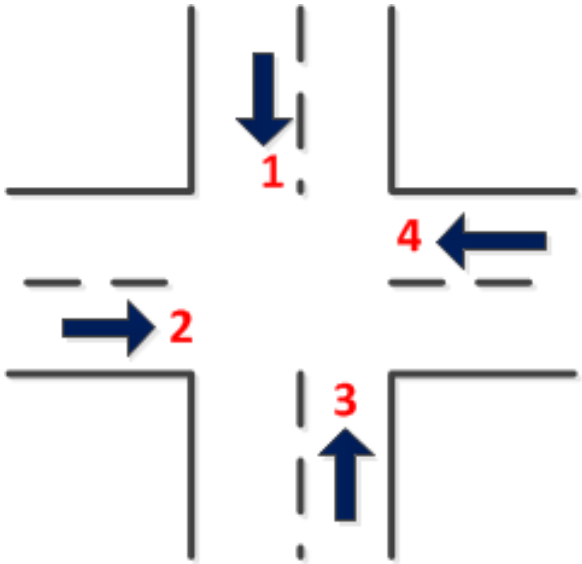
Introduction

- A variety of traffic signal control strategies for urban intersection exit;
  - Isolated strategy
  - Coordinated strategy

Distributed control

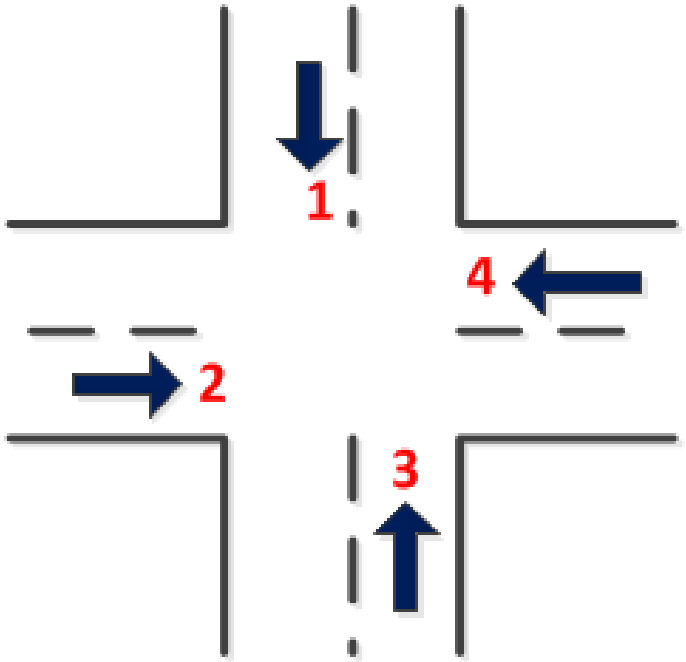
- Backpressure



Every slot time, the intersection controller determines which phase to be activated, according to the local traffic situation

Distributed control

- Backpressure (s)

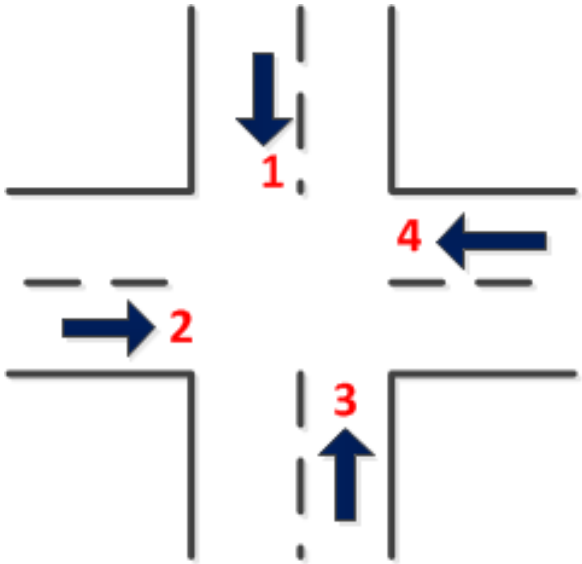


$$S\ (t)\square \qquad W_{ab}\ (t)\xi_i$$

$$W_{ab}\ (t)\square\ Q_a\ (t)-Q_b\ (t)$$

Distributed control

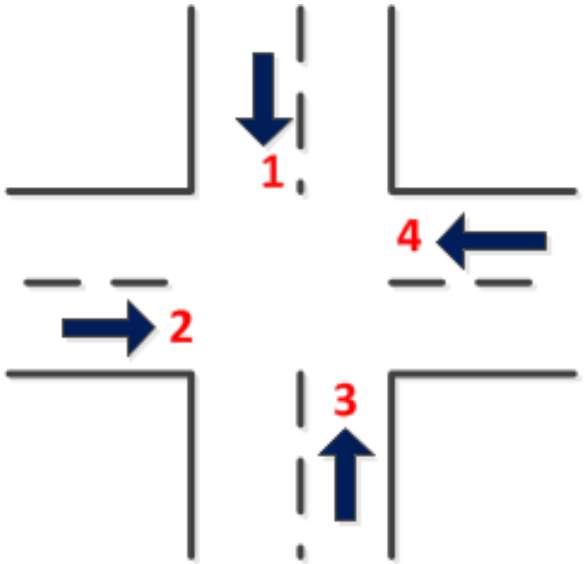
- Backpressure



Every slot time, the phase with the highest the backpressure will be activated, e.g. given the right of the way.

Distributed control

- Backpressure

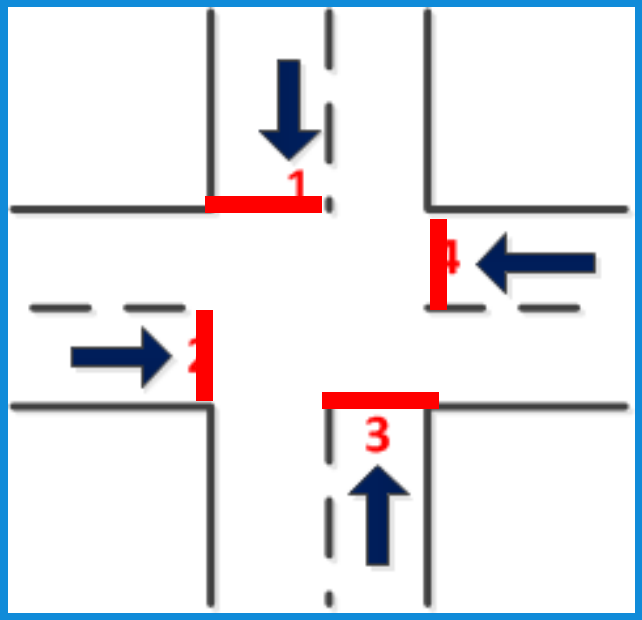


Slot time is the control step, and the green time length equals to (several) slot time length(es).

Wongpiromsarn, T., T. Uthaicharoenpong, W. Yu, E. Frazzoli, and W. Danwei. Distributed traffic signal control for maximum network throughput. In ITSC, 2012 15TH IEEE Conference. 2012

Problem:

1. “All red time” is not taken into consideration;



Problem:

2. **Low robustness: possible large effect of a failing detector**

Therefore,

an optimal dynamic slot time approach is presented.

KEY CONCEPTS:

{ periodic
aperiodic } control

{ static
dynamic } slot time

{ global
local } slot time

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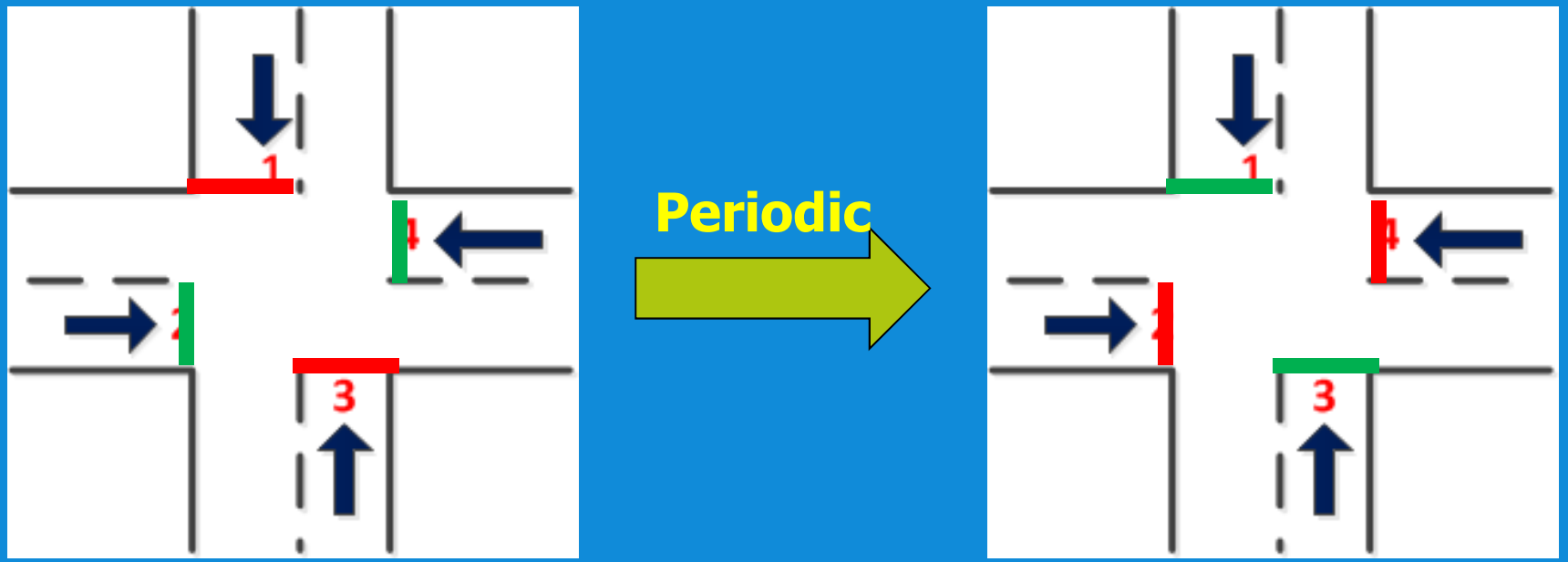
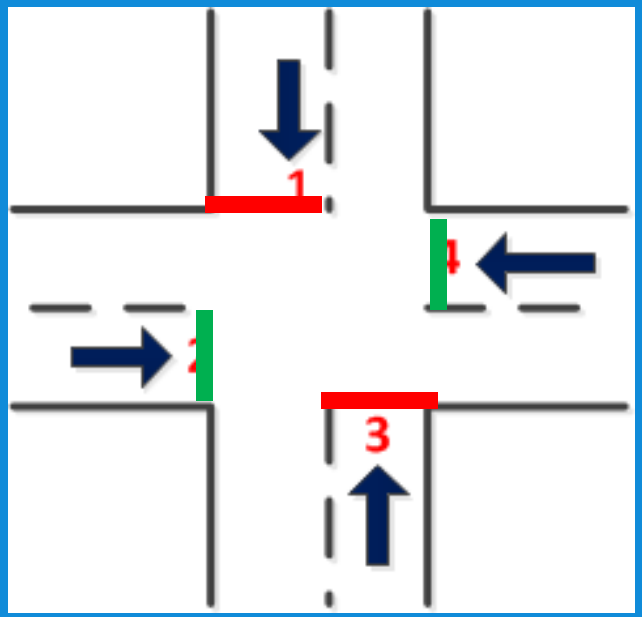
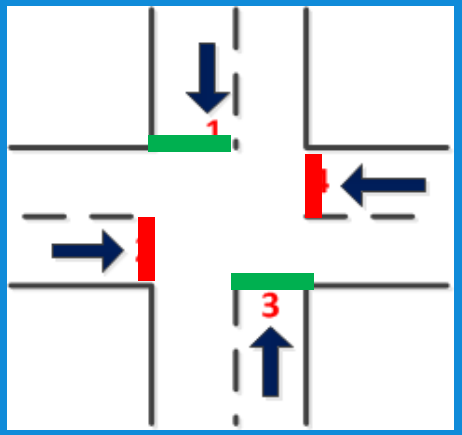


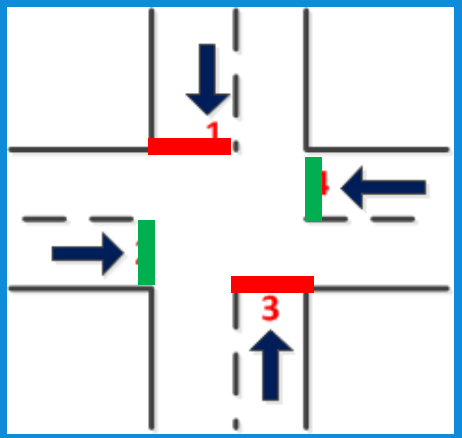
KEY CONCEPTS:

periodic
aperiodic
} control



Aperiodic





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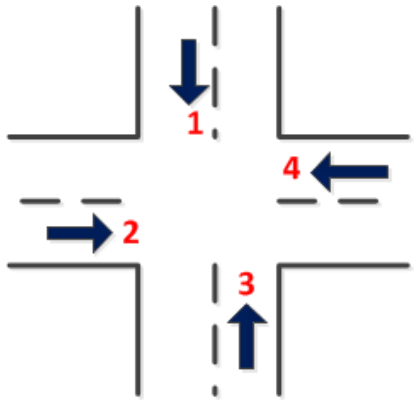
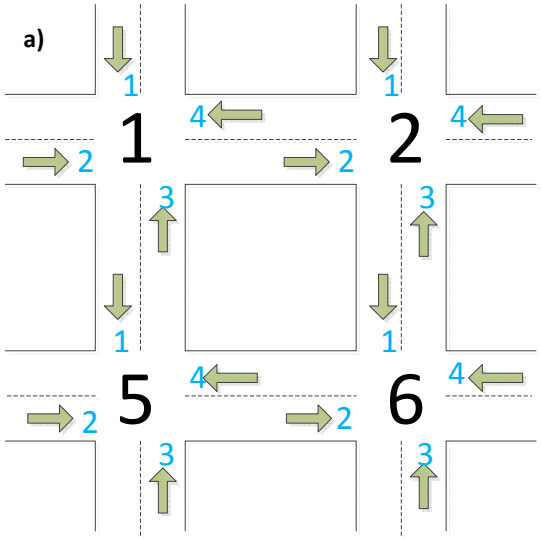
{ **global**
local } **slot time**

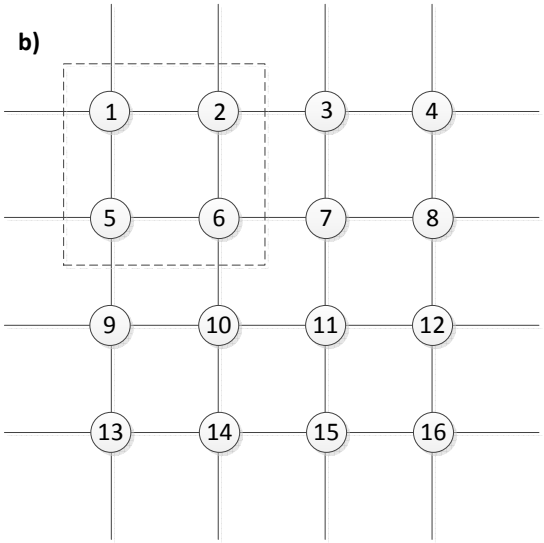
Critical junction: highest back-pressure
or back-pressure difference

Optimal green time approach

Dynamic slot time







Dynamic slot time

$$T_{slot}(t) = \tau + \max\left(0, \min\left(50, \tau_A(t)\right)\right)$$

Minimal green time for each phase

Dynamic factor

$$T_{slot}(t) = \tau + \max\left(0, \min\left(50, \tau_A(t)\right)\right)$$

Dynamic factor

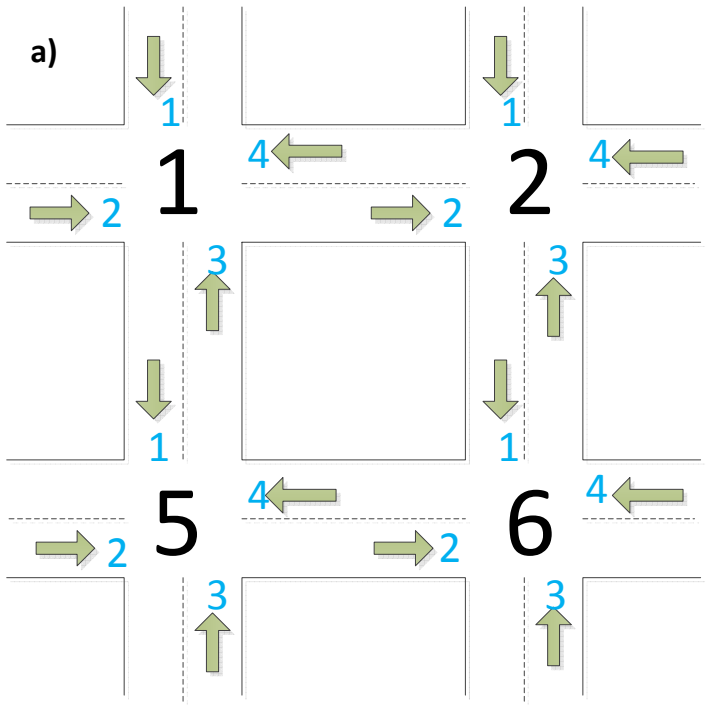
$$\tau_A(t) = \alpha\left(\mathrm{B}_{act}(t) - \mathrm{B}_{non}(t)\right)Q_{up}^{\max *}(t)$$

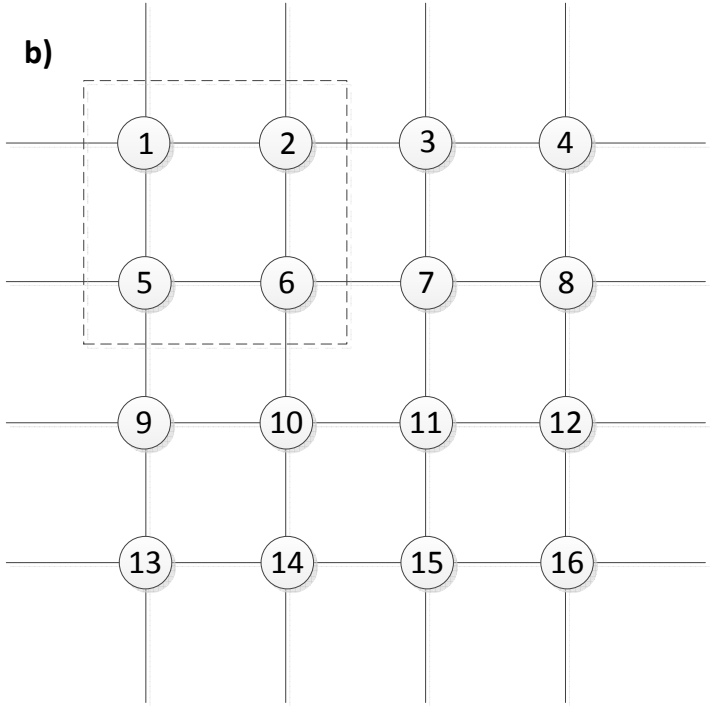
Backpressure of the to be active phase

Backpressure of the next non-active phase

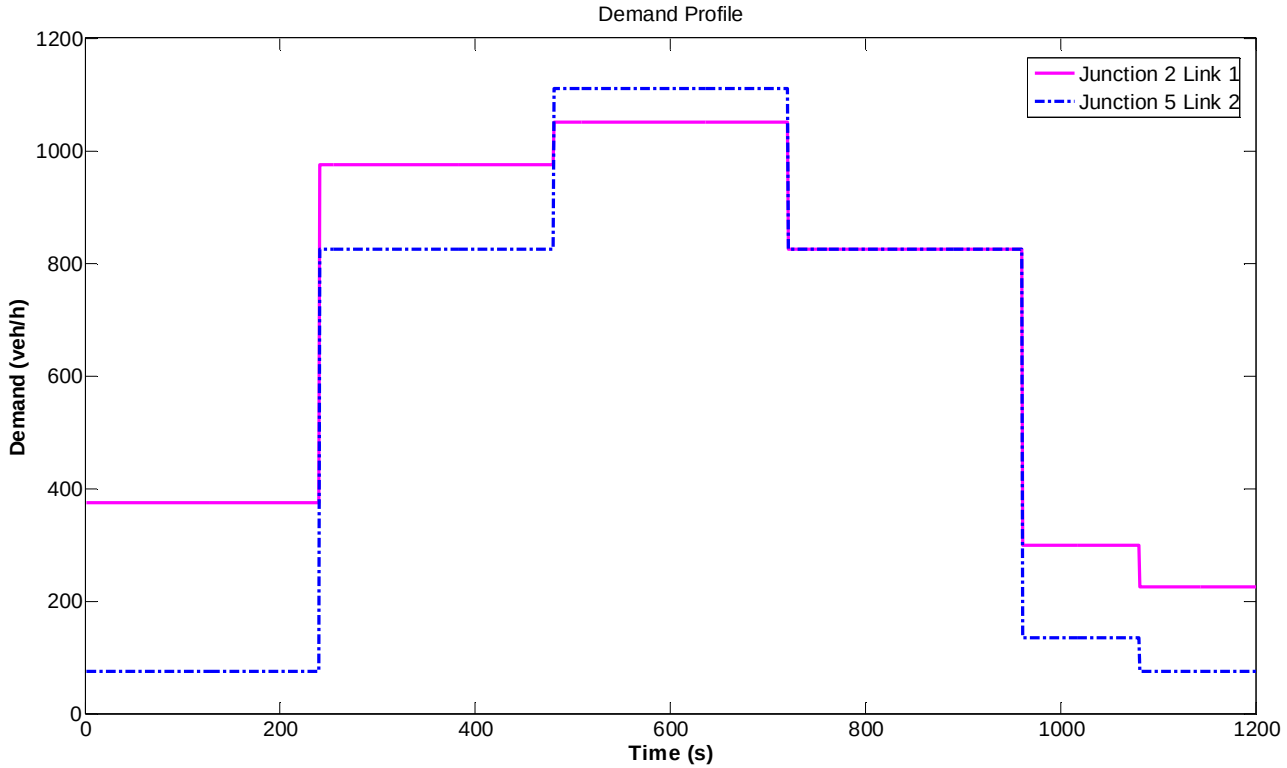
Simulations

Network





Demand


Demand Profile
Junction 2 Link 1
Junction 5 Link 2
Demand (veh/h)
Time (s)
0
200
400
600
800
1000
1200

Static

Simulation scenarios	*TTS*	*Max queue length*
Aperiodic	2.9×105	21.07
periodic	1.2×105	21.02

Dynamic

Simulation scenarios		Criticality parameter	*TTS*
			Dynamic
Aperiodic	Global	Back-pressure	5.5551×10^5
		Back-pressure difference	5.5551×10^5
	Local		1.1066×10^6
Periodic	Global	Back-pressure	1.1217×10^5
		Back-pressure difference	1.1217×10^5
	Local		9.5729×10^5

Conclusion

We conclude a slot time calculation approach to extend the basic back-pressure signal control strategy. This approach takes the all red time into consideration and overcomes the low robustness of the basic one.

Thank you !

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