
# TRANSIT SIGNAL PRIORITY

## Opportunities for improvement in Toronto

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- Worked in both **Toronto** and the **Netherlands** designing Transit Signal Priority operations and software

- Masters Thesis on **Transit Signal Priority** efficiency at TU Delft in the Netherlands

# OUTLINE

1. What TSP is (and isn't)
2. What TSP can do
3. Limitations to TSP in Toronto
4. Opportunities to improve TSP in Toronto

# WHAT IS "TRANSIT SIGNAL PRIORITY" (TSP)?

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*Traffic signal priority is simply the idea of giving **special treatment** to transit vehicles at signalized intersections.*

- US Federal Transit Administration

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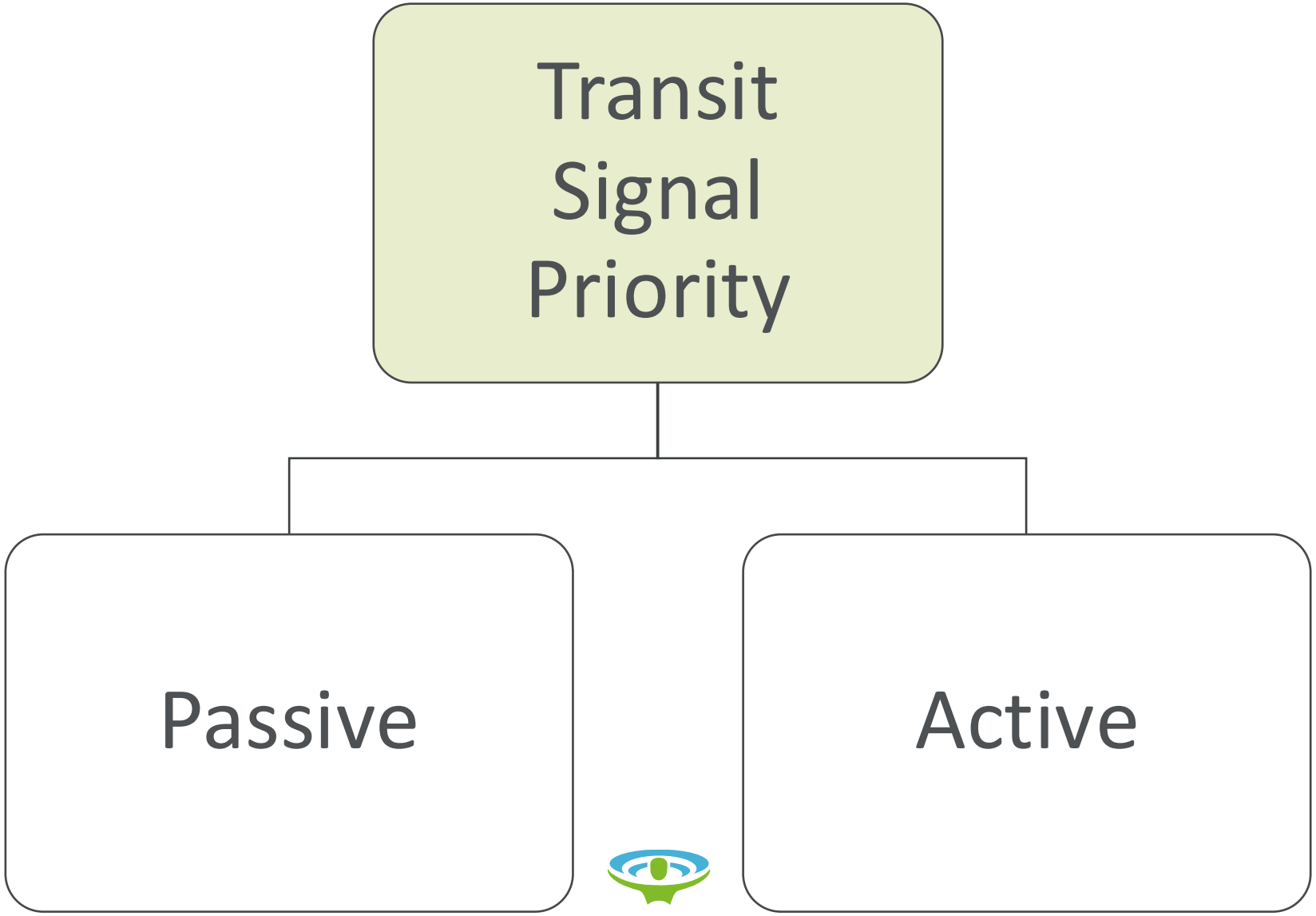
- US Federal Transit Administration

Note: Different than public's definition!

# WHAT TRANSIT SIGNAL PRIORITY (TSP) IS



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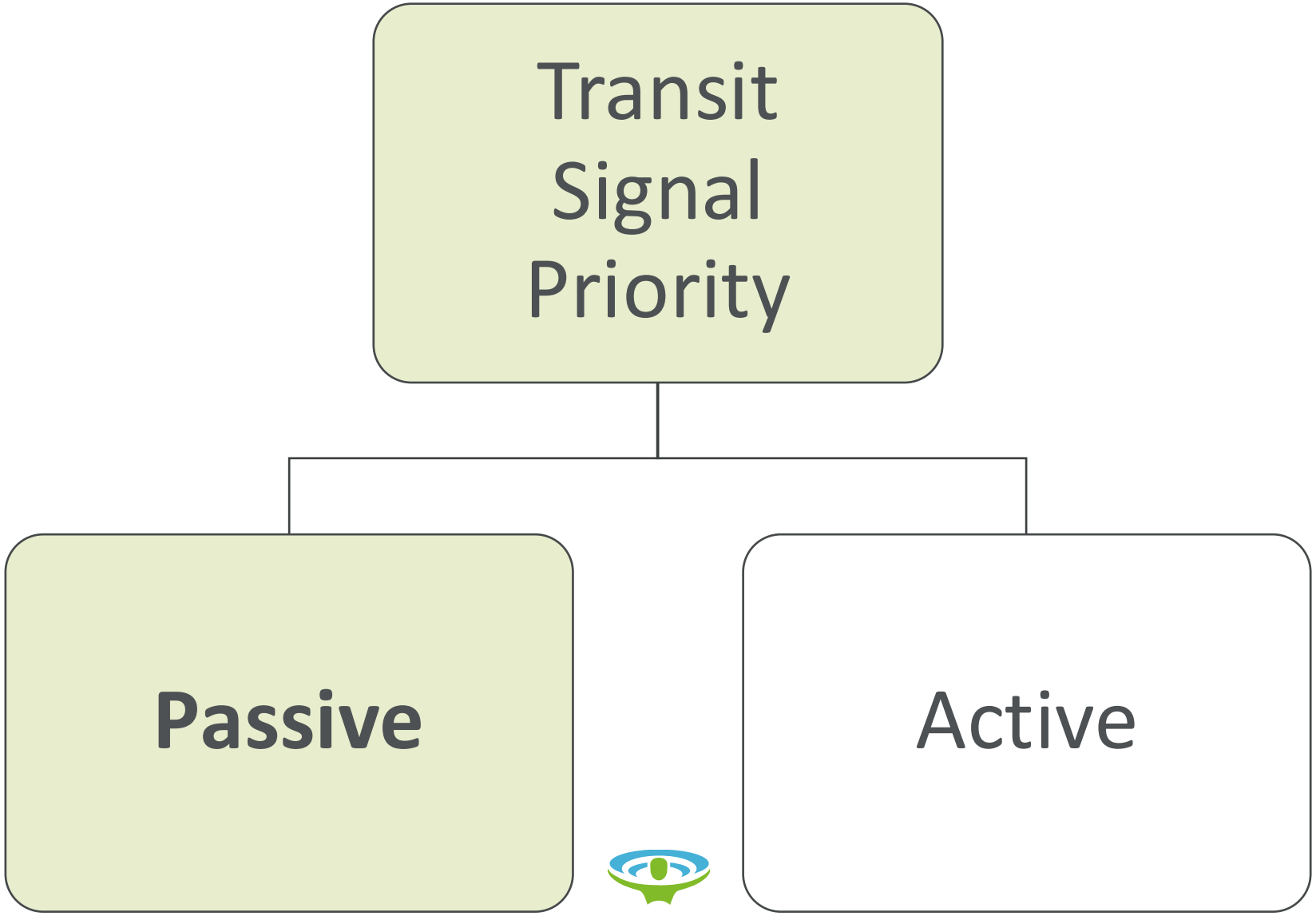

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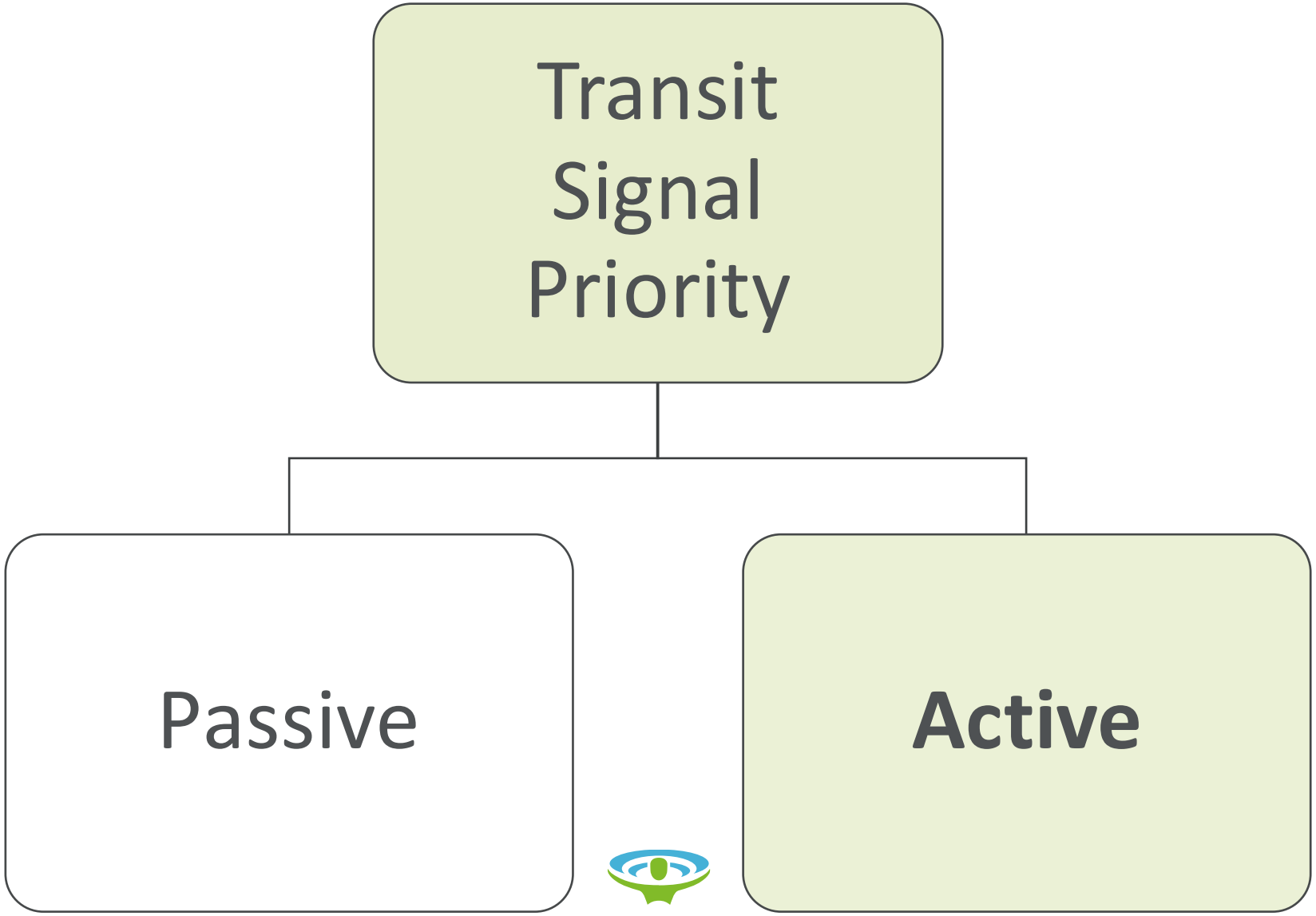

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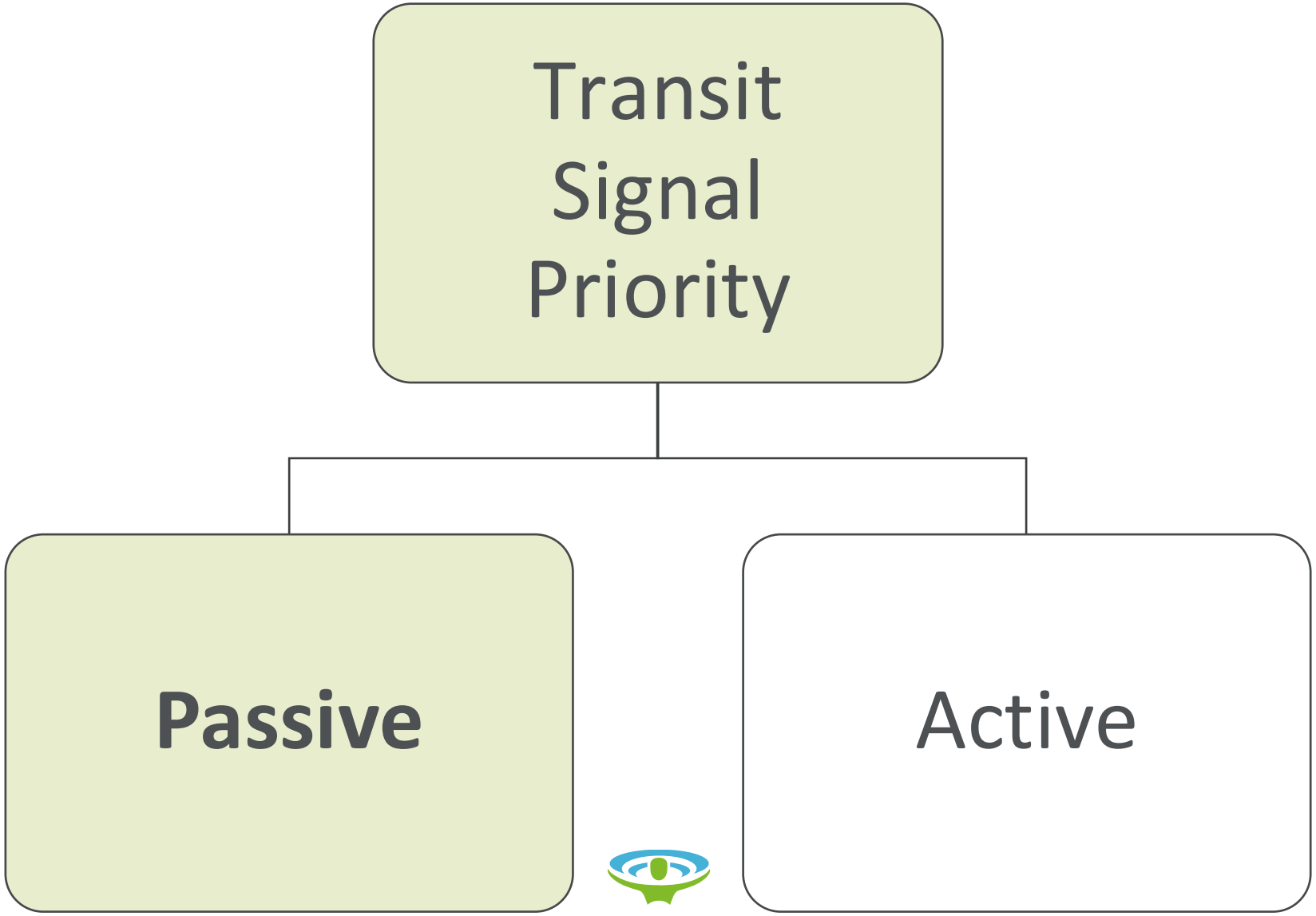
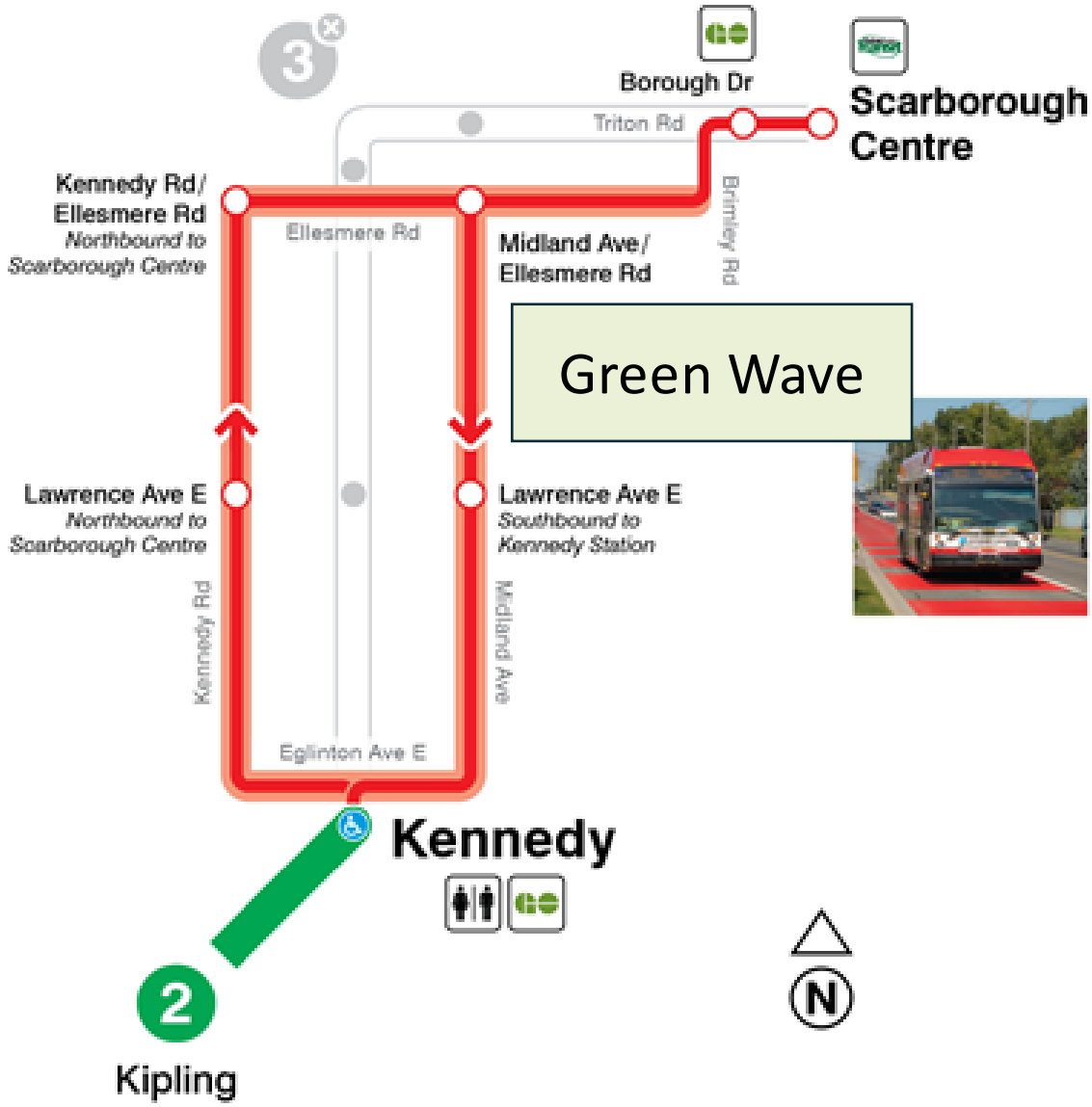
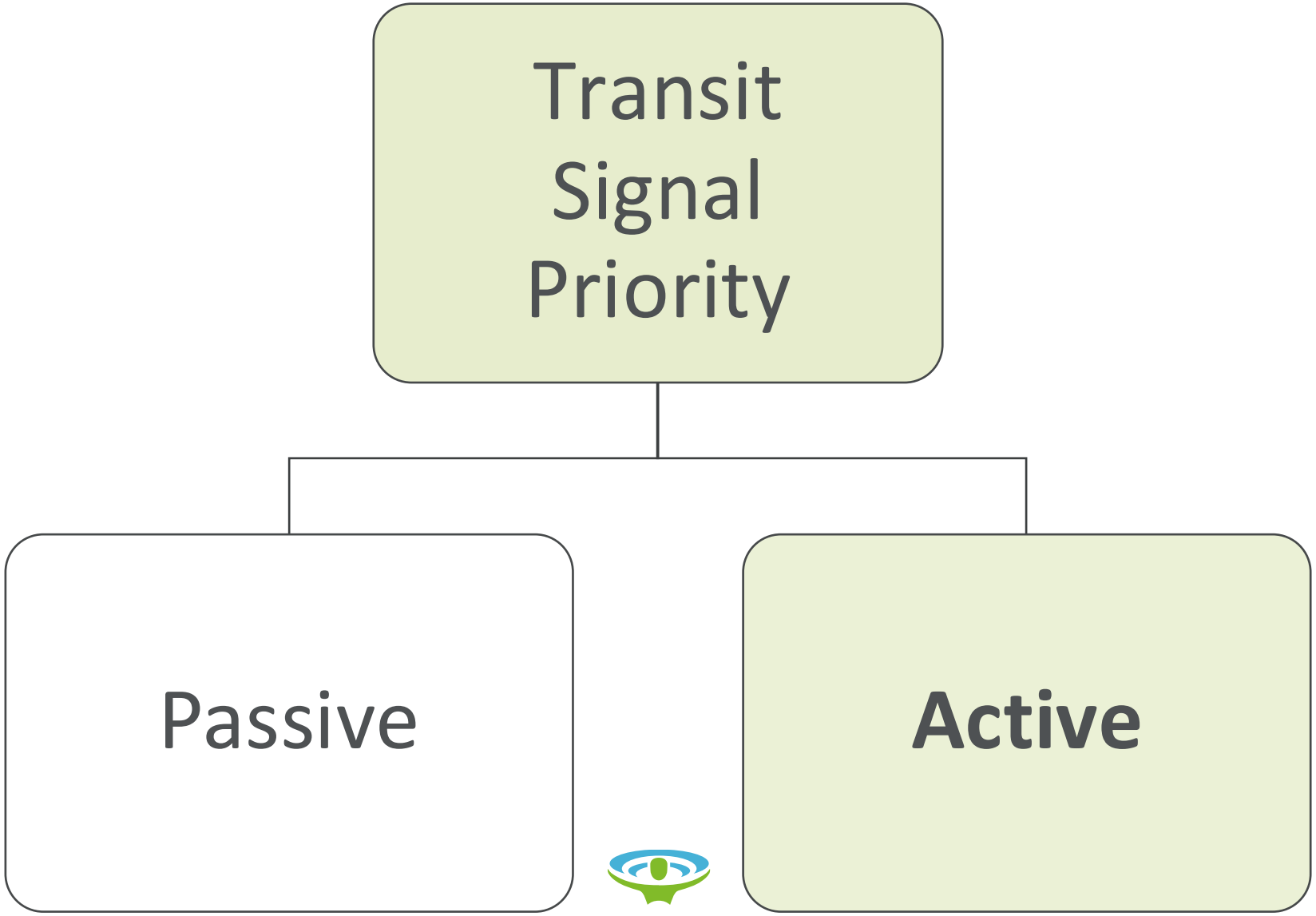


# PASSIVE TRANSIT SIGNAL PRIORITY

**Signal coordination**
optimized for transit



# WHAT TSP IS



# ACTIVE TRANSIT SIGNAL PRIORITY

**Detects transit vehicles** in real time and adjusts timings

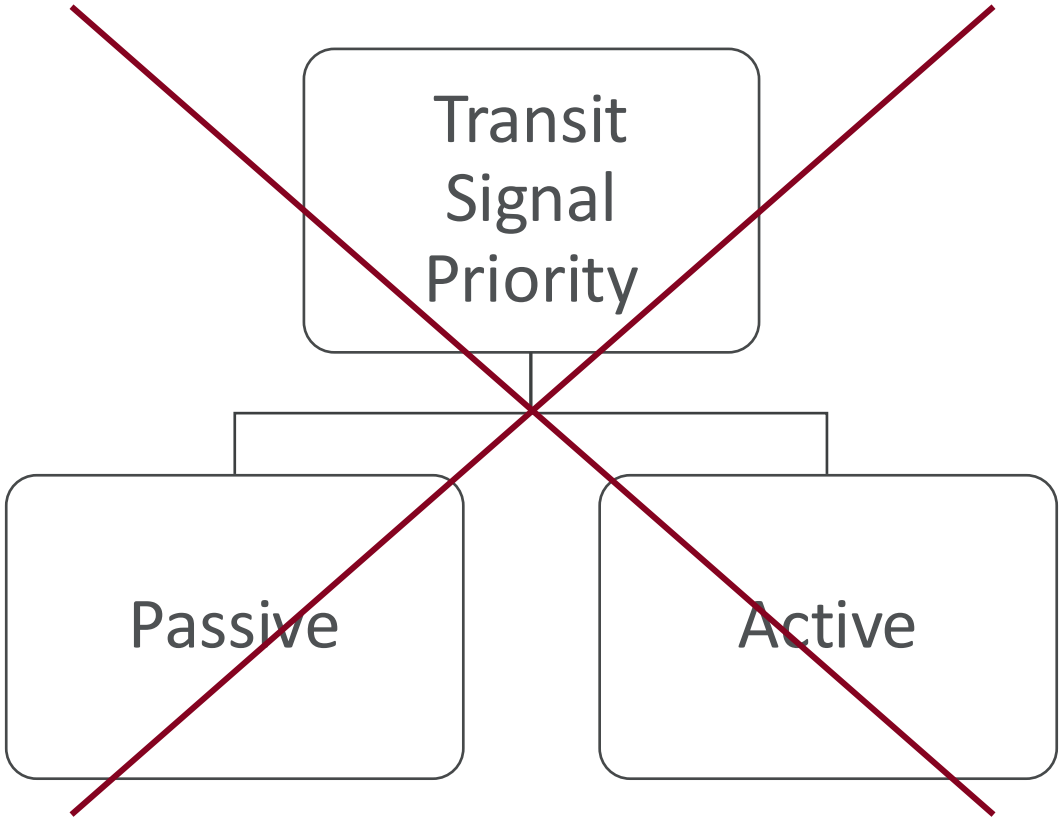
Does “something” to help individual transit vehicles




Image sources (clockwise from top): Sky’s Trains; Booledozer; Brackish Stowaway | via Wikimedia.org

# ACTIVE TSP DOES NOT GUARANTEE A GREEN LIGHT

# HOW TO GUARANTEE A GREEN LIGHT




**Signal Pre-emption**

# SIGNAL PREEMPTION

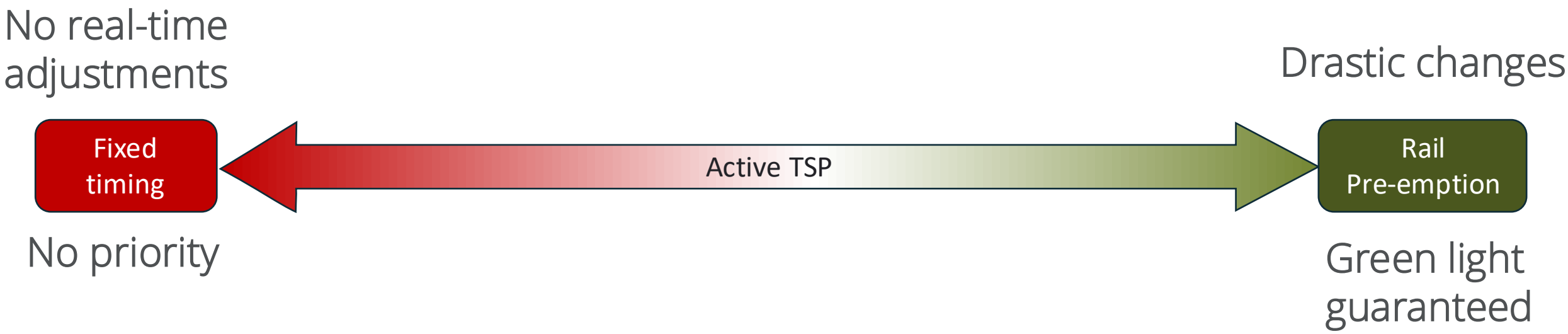
Makes **virtually unlimited** changes, to provide green at all costs.

Detect trains far in advance

Hold light green indefinitely

Danforth & Midland

# LEVELS OF TRANSIT PRIORITY



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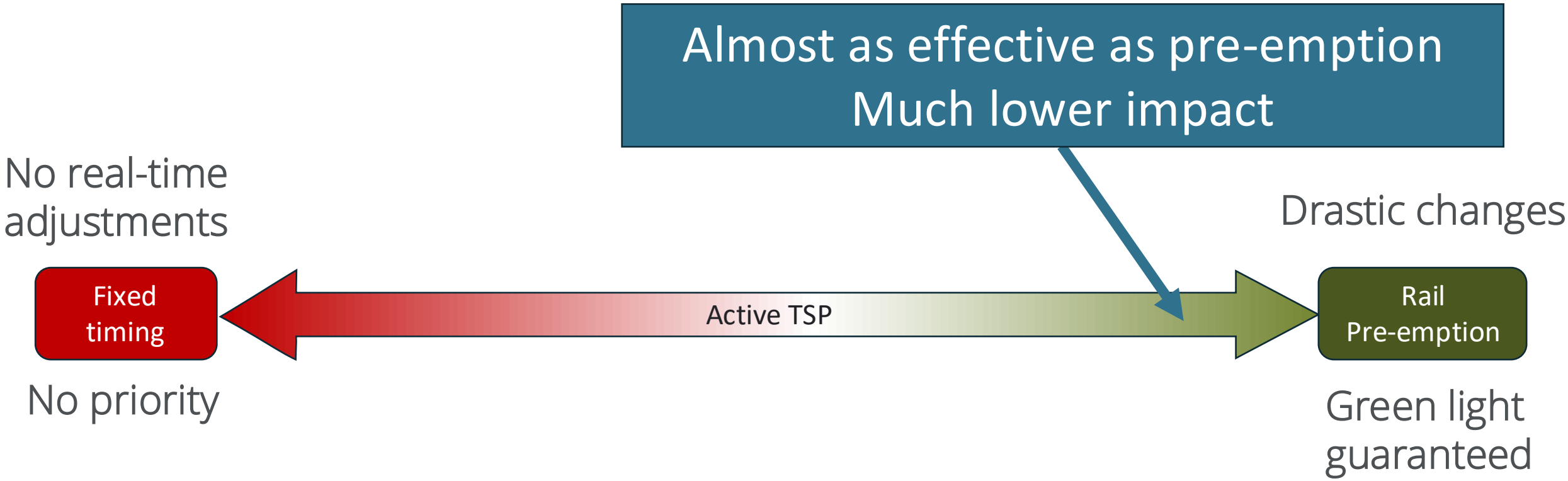


# TSP ACTIONS

How can we adjust signal timing to give a streetcar a green light?

## Spadina & Nassau


What if streetcar arrives here?

# RED TRUNCATION

# RED TRUNCATION ON SPADINA?

Green duration is already the minimum pedestrian duration

Truncation is impossible.

Spadina & Nassau

# MULTI-STAGE PEDESTRIAN CROSSINGS

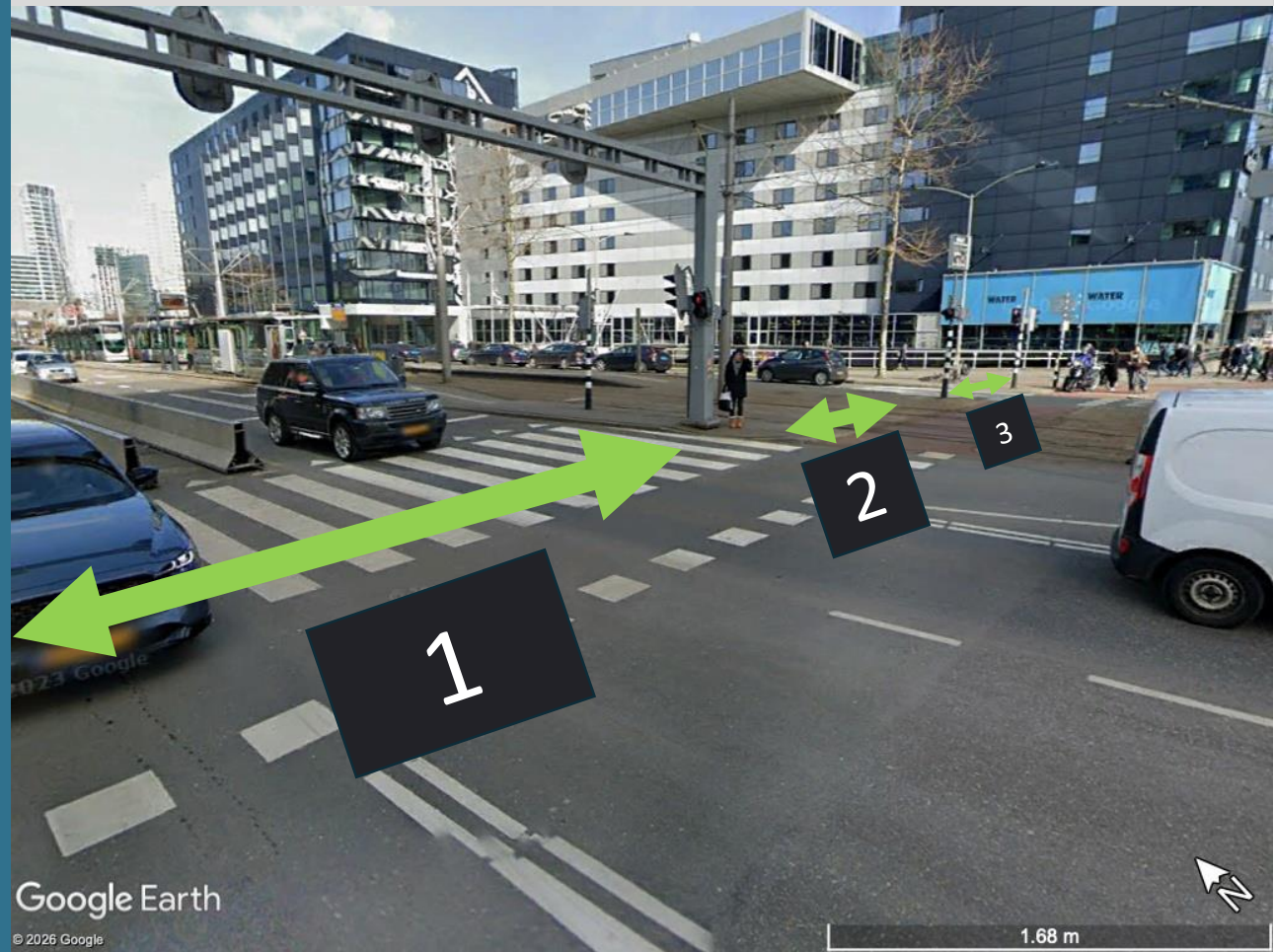
In the Netherlands, they divide pedestrian crossing into short segments:

- Clear pedestrians off tracks in 10 seconds

When there isn't a late tram approaching:

- Pedestrians can cross without getting stopped in the median
- Pedestrian green wave in both directions

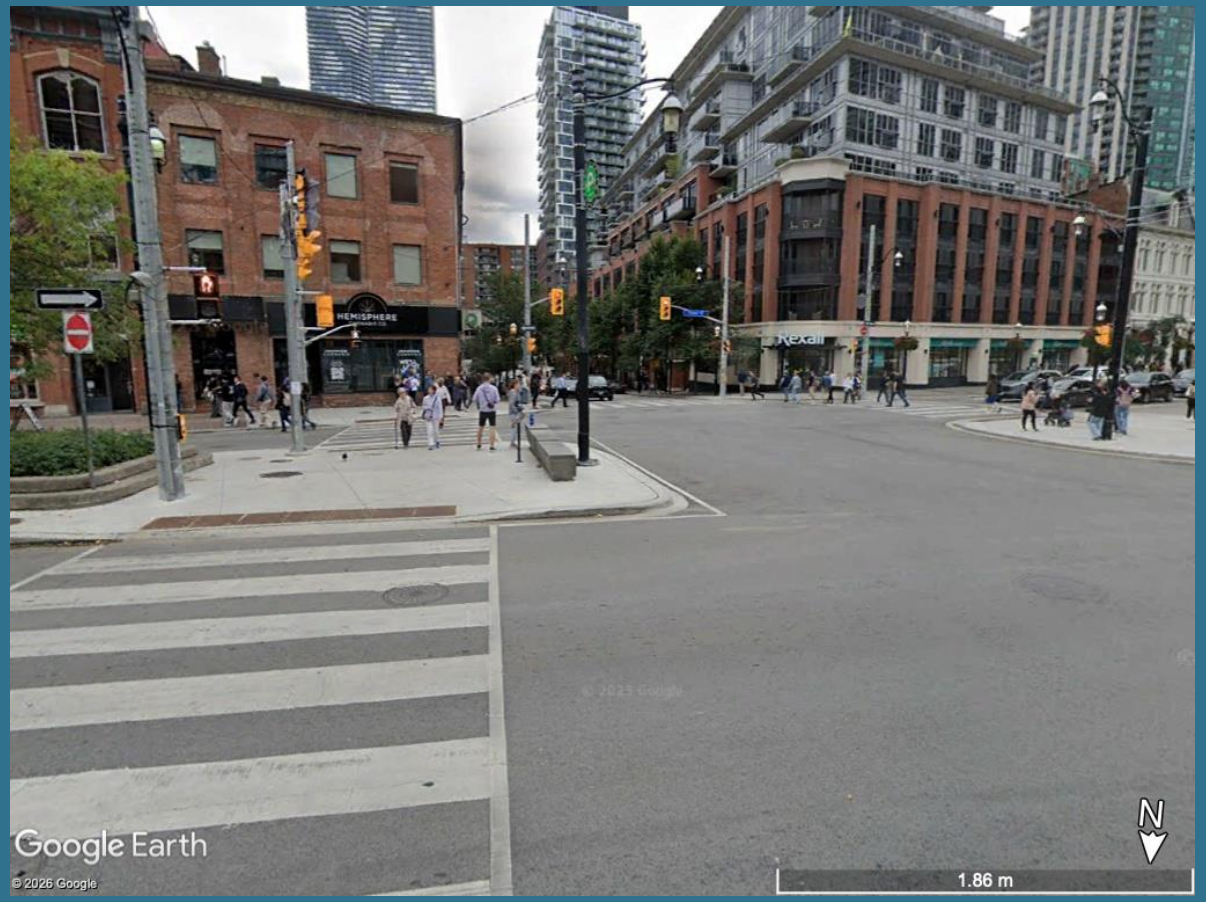
3-stage crossing
in Rotterdam, Netherlands



# 2-STAGE PEDESTRIAN CROSSINGS IN TORONTO

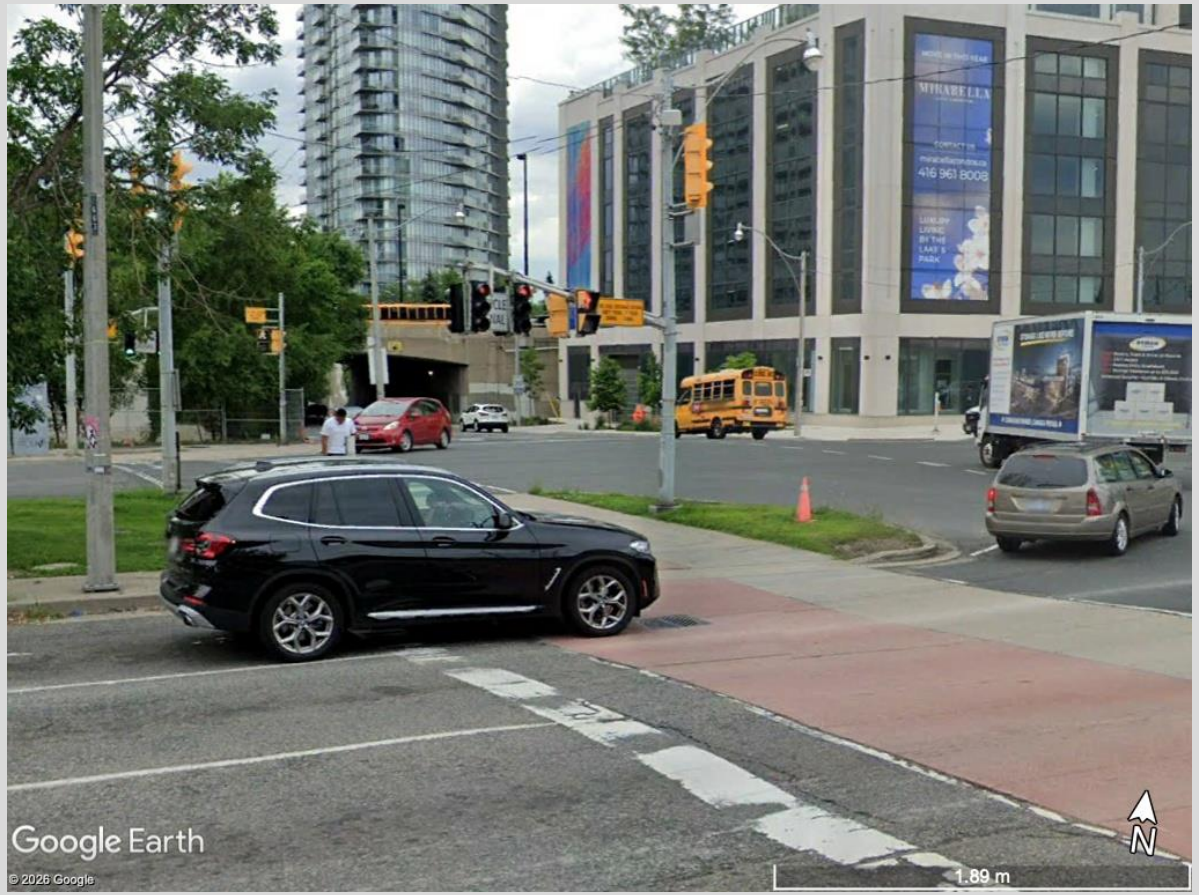
## Church & Front

Pedestrian green wave northbound only




## Lake Shore & Windermere

Pedestrian green wave southbound only



# SIGNALS CANNOT IMMEDIATELY SUMMON A GREEN LIGHT

What if streetcar arrives here?

# GREEN EXTENSION


What if streetcar arrives here?

# GREEN EXTENSION

To extend
or not to extend?

# GREEN EXTENSION

Maximum Green Extension

# GREEN EXTENSION

Higher maximum extension
= lower transit delay

Maximum Green Extension

# GREEN EXTENSION

Maximum in Montreal:
5 seconds

Maximum Green Extension
(5 seconds)

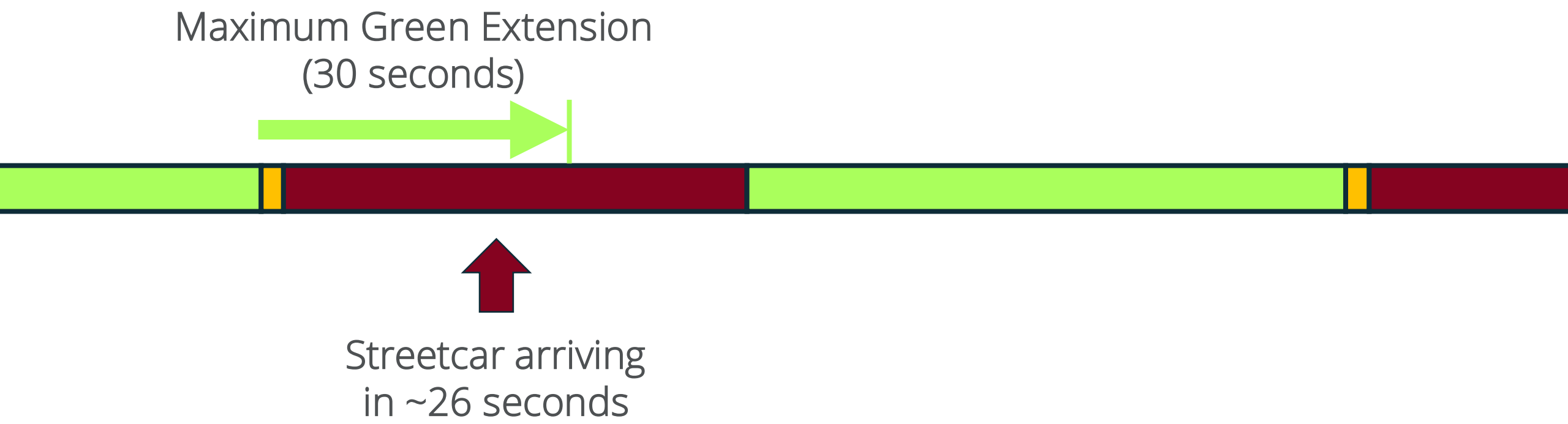
# GREEN EXTENSION

Maximum in Rotterdam:
20 seconds

# GREEN EXTENSION

Maximum in Toronto:
30 seconds

# GREEN EXTENSION



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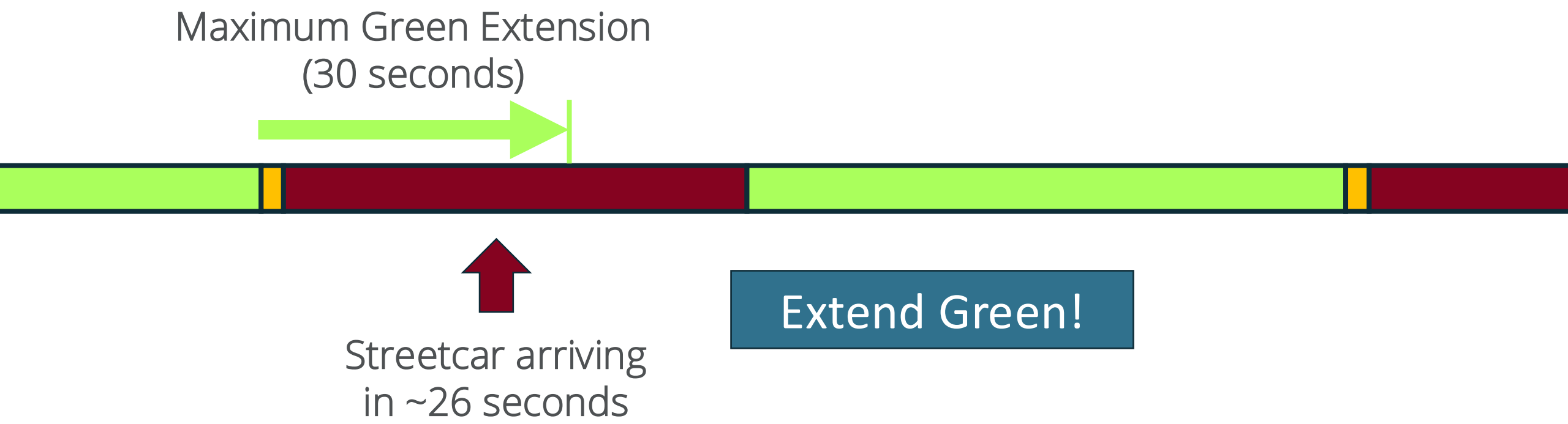

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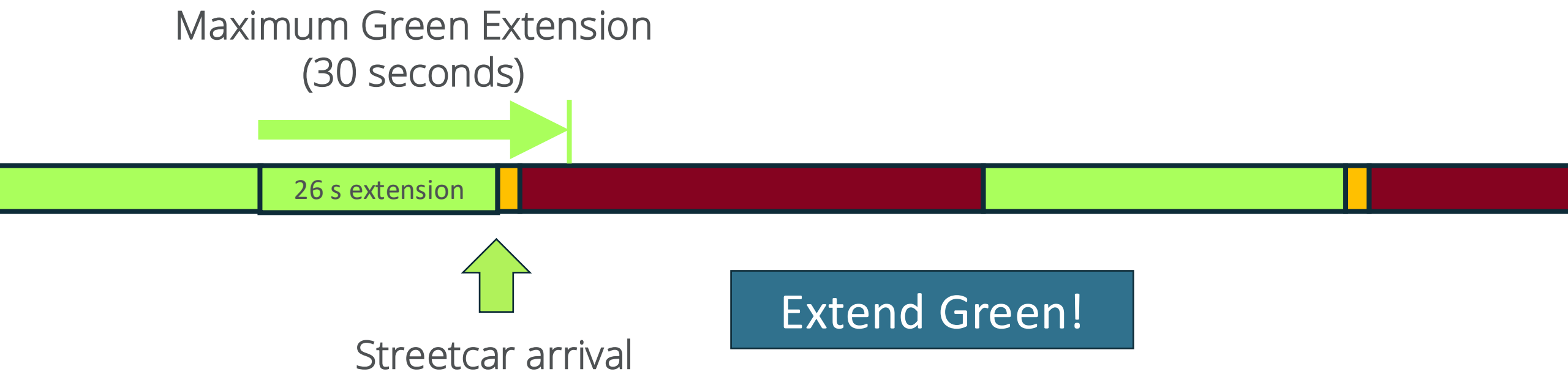

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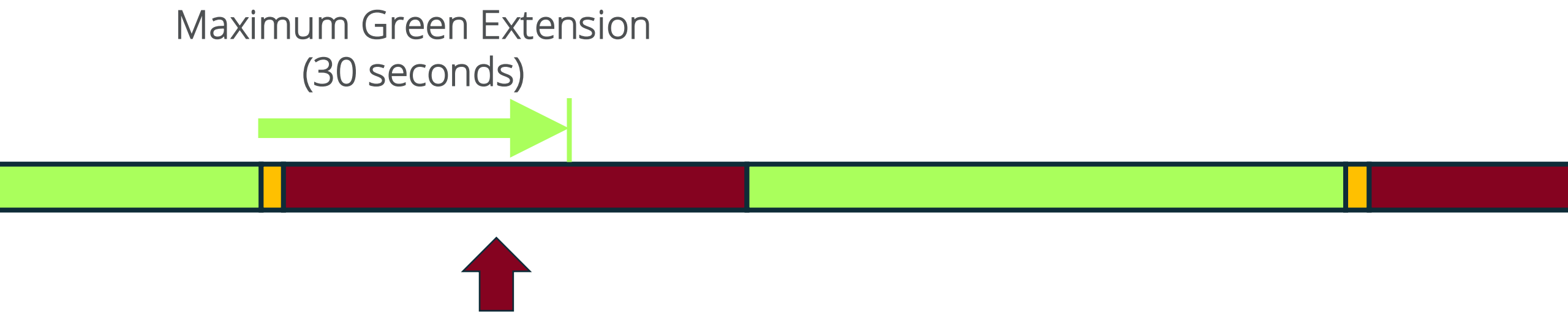
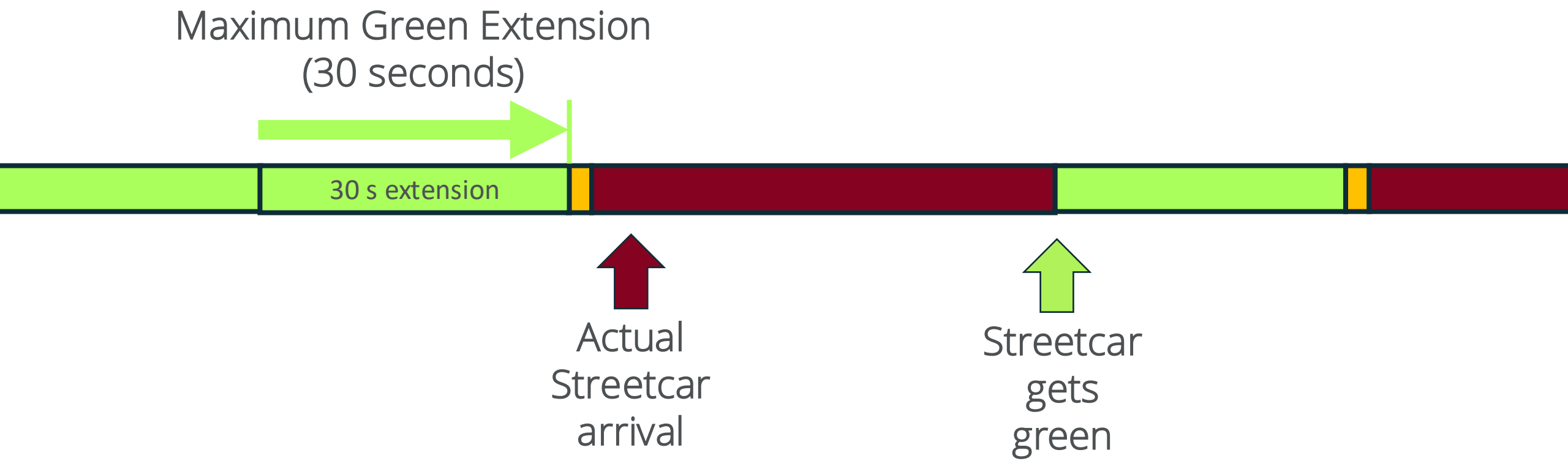



What if this streetcar arrival estimate is wrong?

# GREEN EXTENSION

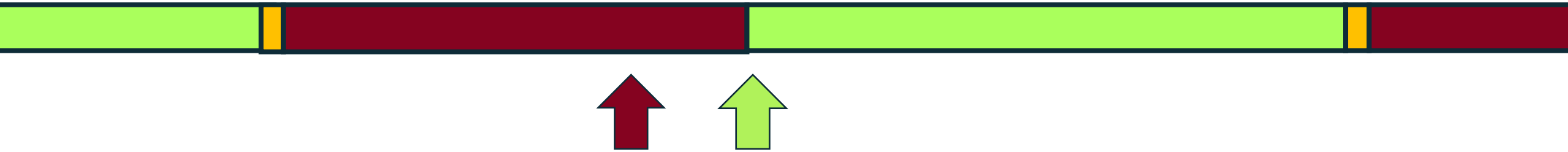

Extend Green!

# GREEN EXTENSION



# GREEN EXTENSION

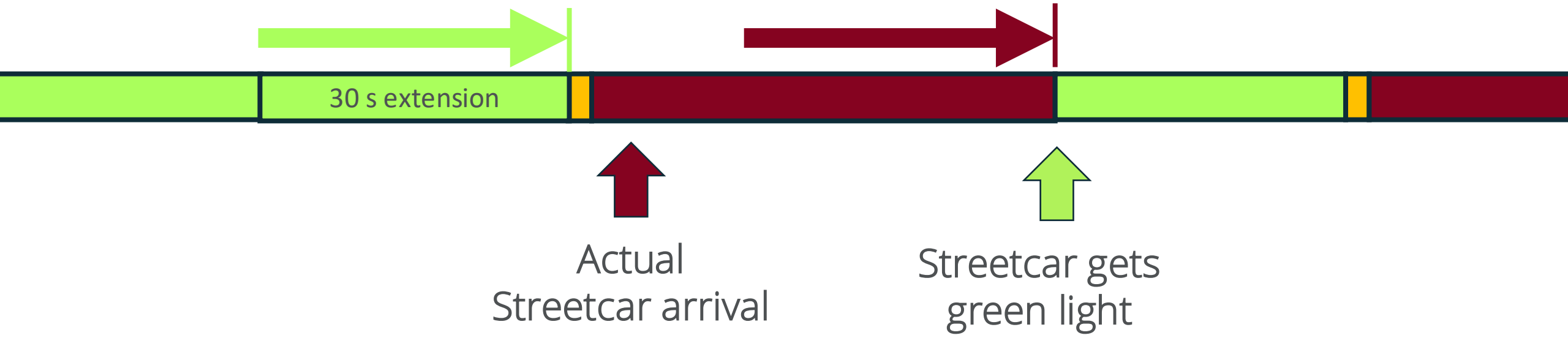
If the signal hadn’t extended the green:



Streetcar gets green

# GREEN EXTENSION

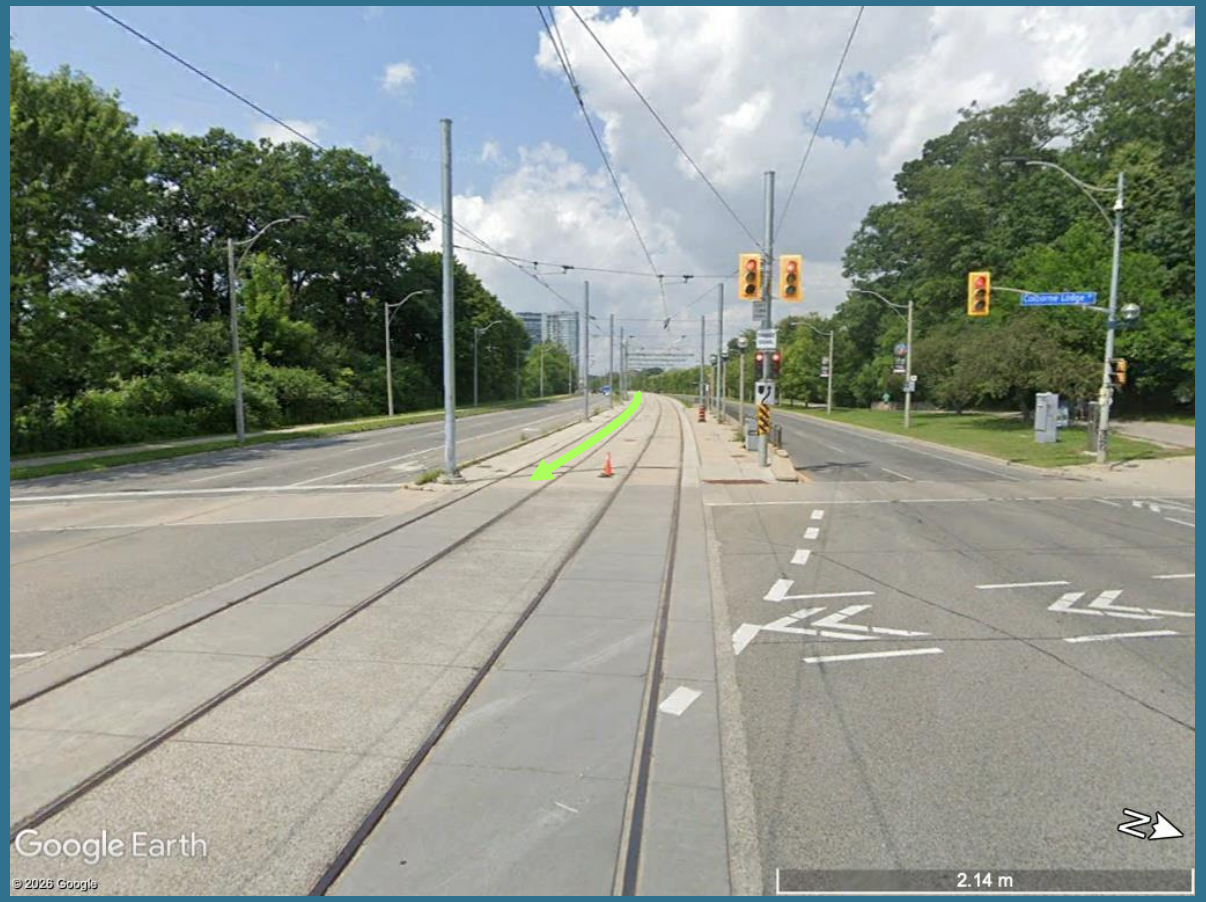
Due to inaccurate estimate
TSP **increased** delay by 30 seconds!



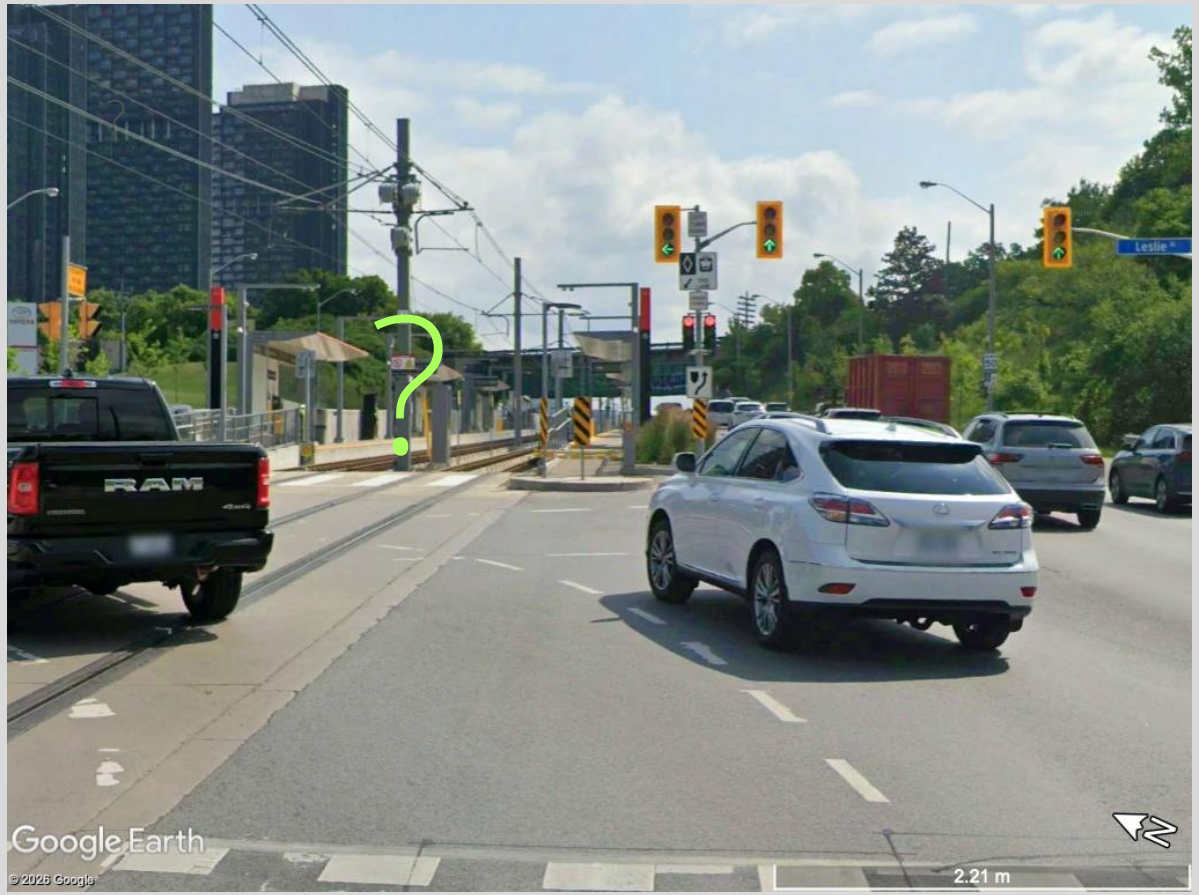
# ACCURATE TRAVEL TIME ESTIMATES ARE ESSENTIAL FOR EFFICIENT TSP

# TSP ACCURACY DEPENDS ON ENVIRONMENT

## No stop in detection zone: Consistent travel time



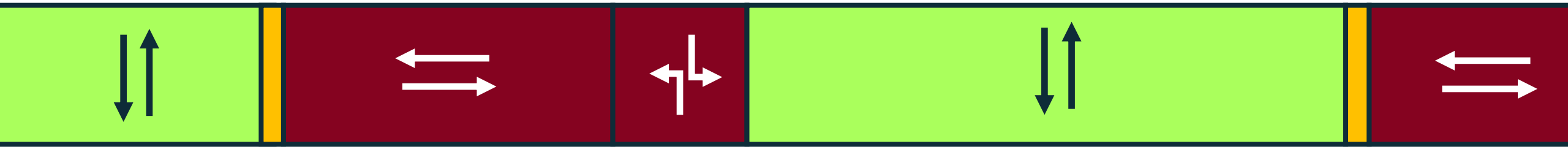

## Near side stop: Inconsistent dwell time



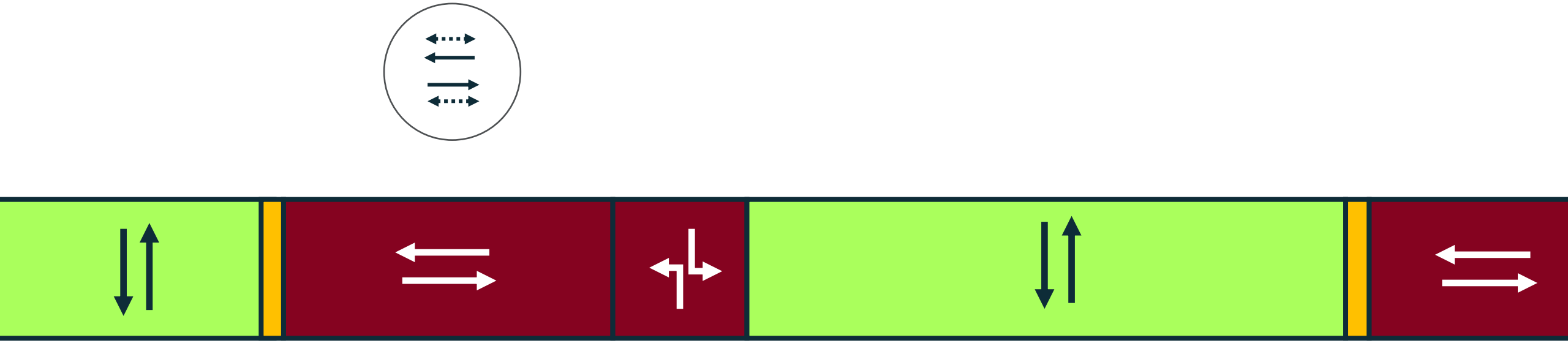
# STOP BEFORE INTERSECTION

# =

# LESS EFFICIENT TSP

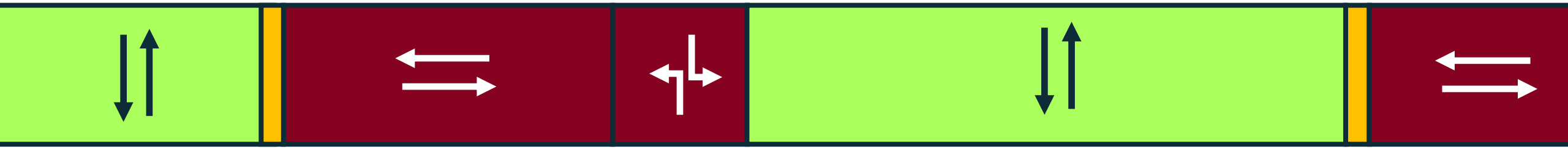


Side street



Side street

Left turns



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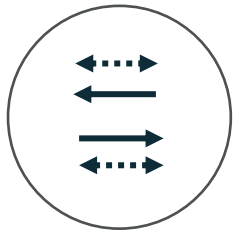

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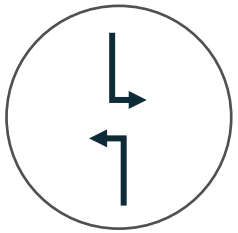
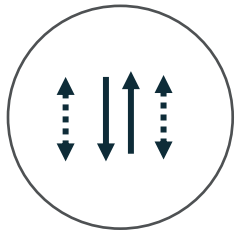
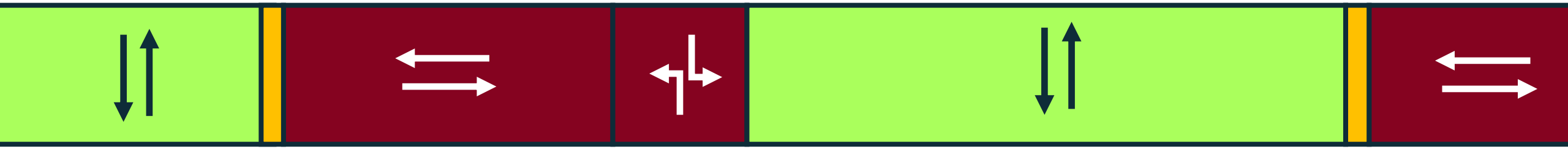
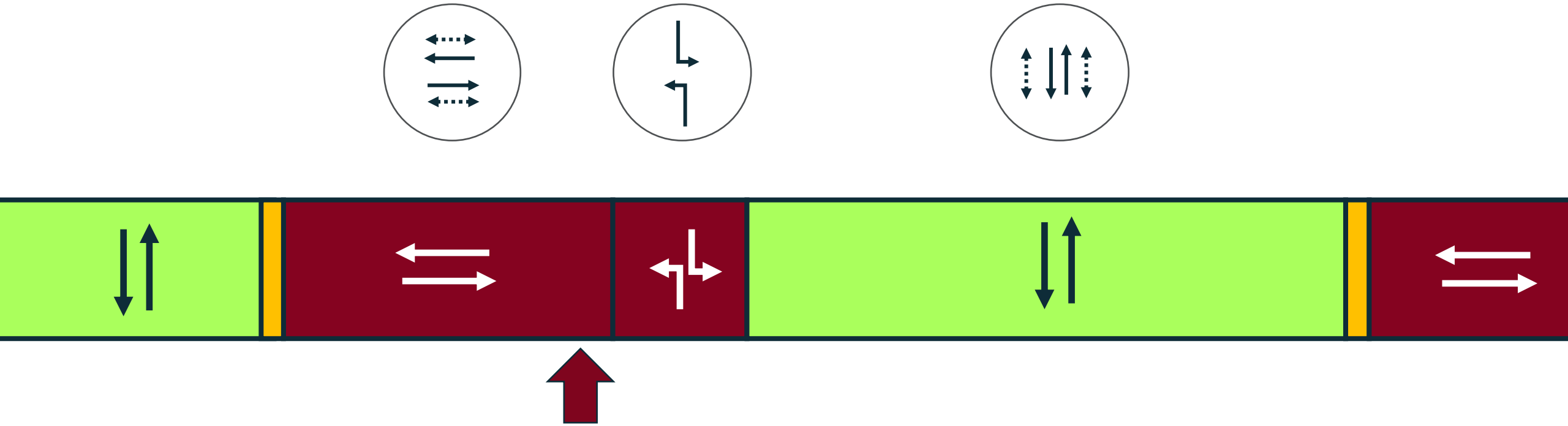


Spadina Ave

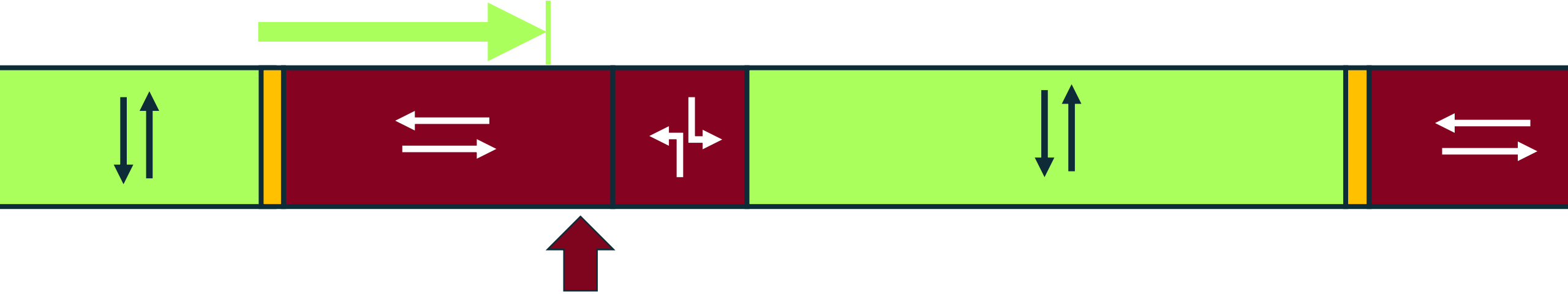






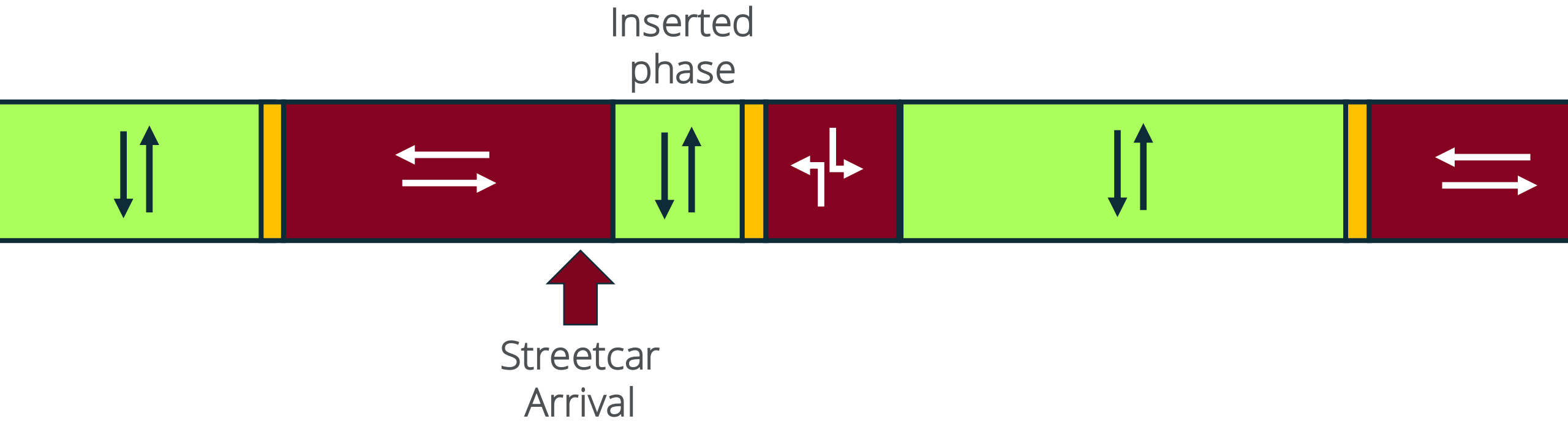
What if streetcar arrives here?

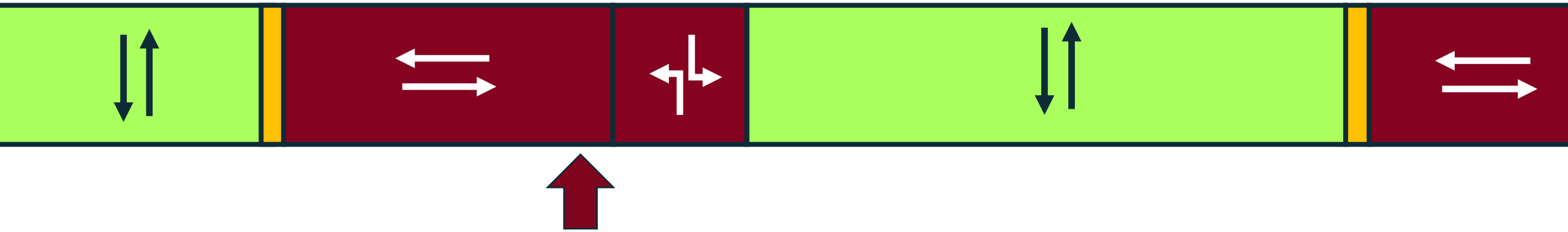
Maximum Green Extension



What if streetcar arrives here?

# PHASE INSERTION





What if streetcar arrives here?

# PHASE ROTATION

What if streetcar arrives here?

# HOW TO MINIMISE IMPACTS ON OTHER TRAFFIC

# REDUCE IMPACTS WITHOUT SLOWING DOWN TRANSIT

- Green time compensation
- Conditional TSP

# GREEN COMPENSATION

After streetcar leaves, provide extra green time to the impacted movement.

City's TSP equipment can do this, but the feature is rarely used.

Green extension with typical method


Green extension with green compensation

# CONDITIONAL PRIORITY

Vary the level of priority depending on the streetcar's headway or schedule adherence

- Early streetcars need to slow down, regardless of red lights
- Late streetcars need to catch up
- Schedule is based on above-average travel time.
  - Speeding up early streetcars makes no difference to schedule

# CONDITIONAL PRIORITY

To achieve best average speed, threshold for “lateness” needs to be under 60 seconds

Typical setup in the Netherlands:

| | Green Extension | Phase Insertion | Red Truncation |
|---|---|---|---|
| **Early** (>20 seconds) | ☑ | | |
| **On time** (+/- 20 seconds) | ☑ | ☑ | |
| **Late** (>20 seconds) | ☑ | ☑ | ☑ |

# TAKEAWAYS

- Toronto has a strong TSP system, but it is constrained by policy and intersection layouts.
- Tips to improve TSP:
  - Trial pedestrian-friendly multi-stage crossing timings
  - Explore opportunities to eliminate near-side stops
  - Introduce phase rotation and/or insertion (already underway)
  - Use green compensation as standard practice
  - Continue rollout of conditional TSP – make sure thresholds are aggressive.

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# SOURCES FOR TORONTO EXAMPLES

Max green extension = 30 s
https://www.toronto.ca/legdocs/mmis/2020/ie/bgrd/backgroundfile-157804.pdf

Transit signal coordination on Kennedy & Midland:
https://www.toronto.ca/legdocs/mmis/2023/ex/bgrd/backgroundfile-236178.pdf

ATC-1000 Signal controllers at TSP locations ("PE_TP"):
https://www.toronto.ca/wp-content/uploads/2017/12/8b7b-Traffic-Signals-2017-08-04_TCS_List_a.pdf

TTC/City installing conditional priority on bus network ("ATSP"):
https://www.toronto.ca/news/city-of-toronto-expands-traffic-agents-program-to-increase-road-safety-and-keep-traffic-moving/

City installing conditional priority on LRT network; 420 TSP locations (April 2025)
https://www.toronto.ca/legdocs/mmis/2025/cc/bgrd/backgroundfile-254795.pdf

Signal timing for TCS0278 Spadina & Nassau, Nov 2024
*Obtained via Information Request: https://www.toronto.ca/services-payments/streets-parking-transportation/traffic-management/traffic-signals-street-signs/request-signal-timing-information/*