EMPIRICAL EVALUATION OF BUS AND CAR DELAYS AT PRE-SIGNALS

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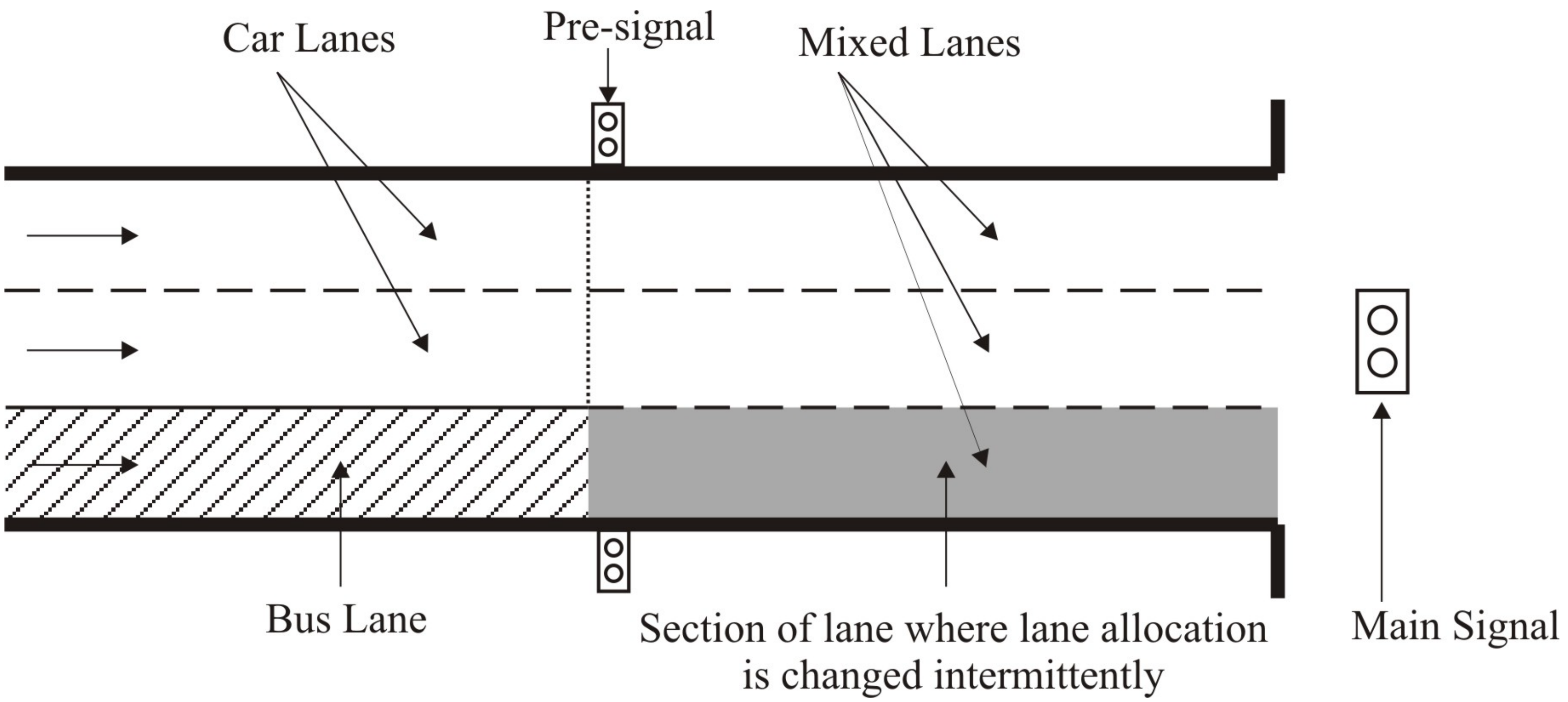
Motivation

- In urban environments, where buses and cars operate in mixed fashion, bus delays can be exacerbated at signalized intersections due to the interactions with cars.
- Dedicated bus lanes can be used to give priority to buses
  - In urban setting this is typically done by converting an existing regular (i.e., car) lane to bus use only
  - However this is not always feasible
- Bus delays at signalized intersections can still be reduced without taking a lane fully away from cars, especially when bus flows are low.

Goal

- Investigating the use of additional signals to provide priority to buses at signalized intersections.
  - i.e, a pre-signal upstream of the main signal to allow buses to jump the car queues.
- Cars can still use all lanes at the main intersection to fully utilize the capacity of the signal when buses are not present

Pre-signal


Car Lanes
Pre-signal
Mixed Lanes
Bus Lane
Section of lane where lane allocation is changed intermittently
Main Signal

Background

- Shared lane strategies targeted at links:
  - For signalized arterials:
    - Intermittent bus lanes (IBL) (Viegas and Lu, 2001; 2004)
    - Bus lanes with intermittent priority (BLIP) (Eichler and Daganzo, 2008)
  - Field tests:
    - Lisbon, Portugal → Increase bus speeds by 15-20 % (Viegas et al., 2007)
    - Melbourne, Australia → Increase in bus speeds not as significant as in Lisbon (Currie and Lai, 2008)
- Shared lane strategies targeted at nodes:
  - Pre-signals (Wu and Hounsell 1998)
  - Implementations found in London, U.K. and Zurich, Switzerland

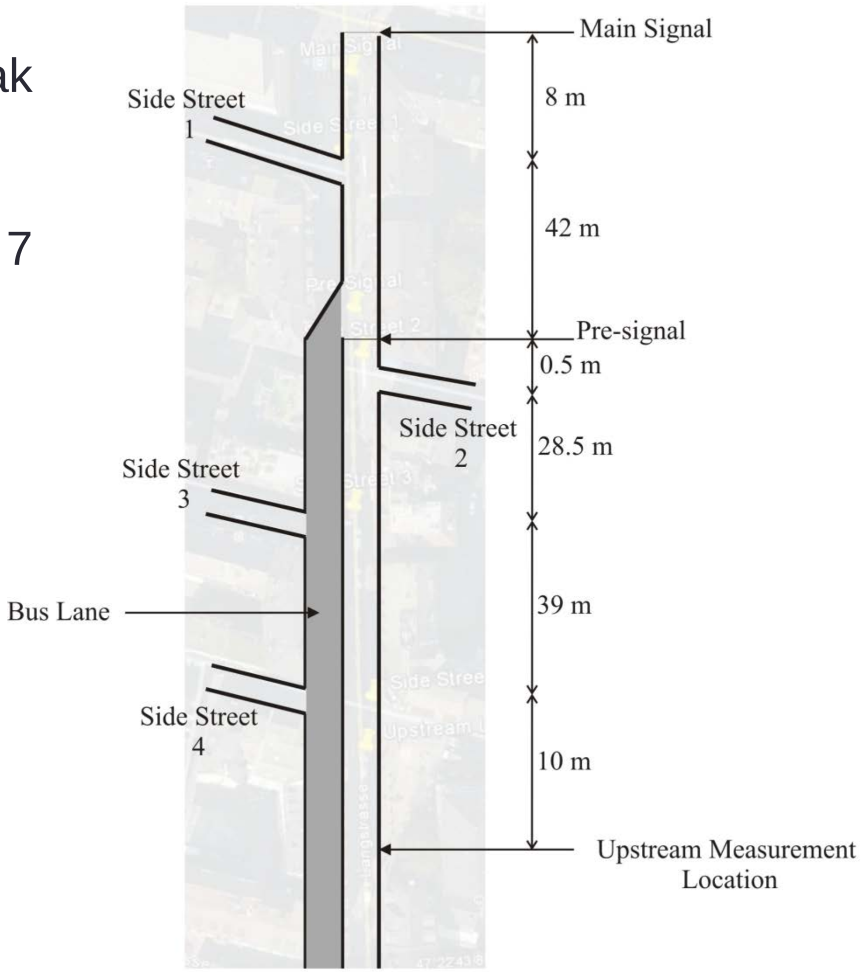
Pre-signal site in Zurich

- Pre-signal at langstrasse

Operation of pre-signal

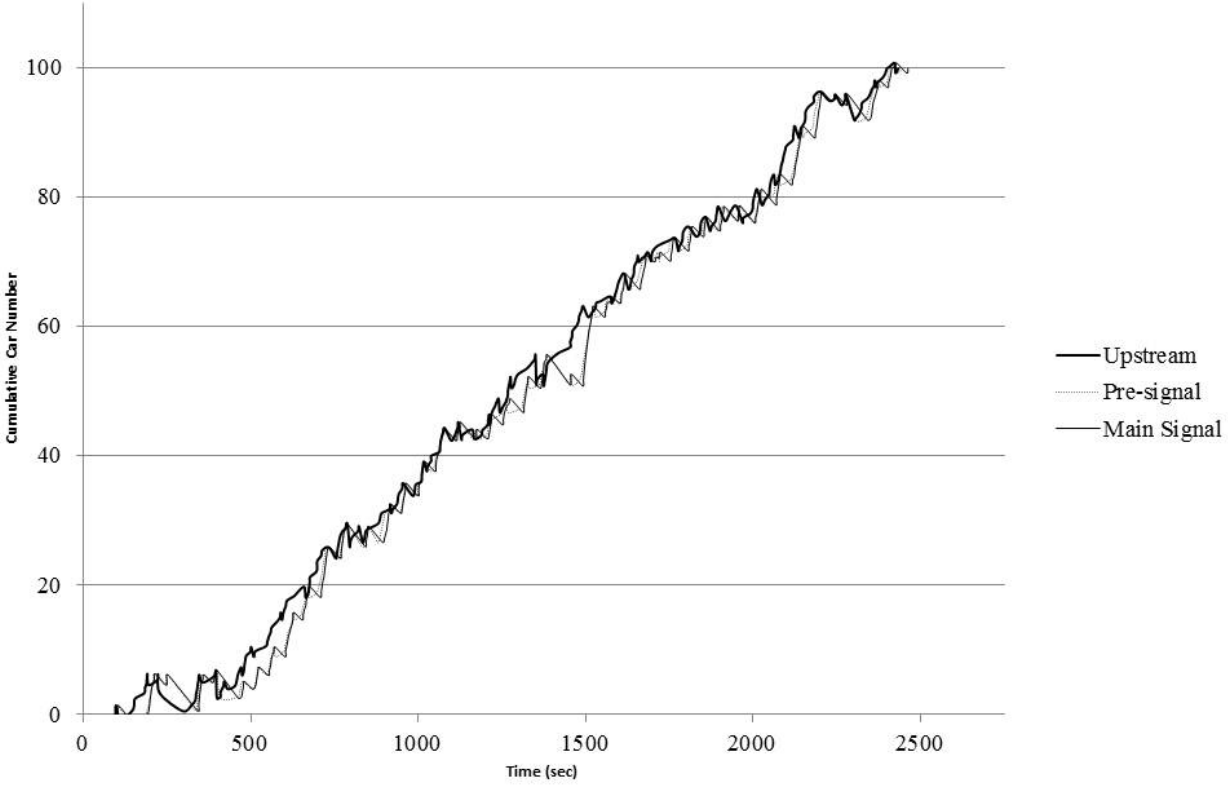
Data collection

- Data collected during morning peak (7:30 am to 8:30 am)
- Cumulative car counts collected at 7 locations along bus route
- Travel times of buses collected



Results of data collection

- Transformed cumulative curves of car arrivals to:
  - Upstream location,
  - Pre-signal, and
  - Main signal



Results of data collection – car delays

Average car delay per cycle (sec)	# of cycles	Upstream of pre-signal	Between pre-signal and main signal	Total
Bus not present	22	13.5	5.9	19.4
Bus present	5	16.1	8.0	28.3

- Car delays upstream of the pre-signal > car delay between pre-signal and main signal.
- Also note that, car delays upstream of pre-signal are significantly higher during cycles which buses are present as compared to cycles during which buses are not present.
- The presence of a bus during a cycle also increases the car delay observed between the pre-signal and the main signal.

Results of data collection – bus delays

Bus #	Delay (sec)	Percentage of wasted green time
1	6	0
2	16	0
3	28	0
4	6	0
5	0	30
6	18	0
7	1	36
8	12	0

Duration of green time wasted → the duration during which cars would have normally discharged from the main signal but could not because of a red pre-signal.

Interpretation of results

- Evidence for reduced discharge flows in cycles which buses are present seen in disaggregate data.
  - Discharge flows when buses are present: 780 veh/hour
  - Discharge flows when buses are not present: 1166 veh/hour
- The cycles during which green time is wasted are not necessarily the ones with the lowest discharge rates
  - Low discharge rates can be observed even if pre-signal does not starve the main signal of flow.
- Bus delay (10.9 sec) < Car delay (19.4 sec when bus not present, 28.3 sec when bus present)

Conclusions

- Average car delays at the intersection increase when a bus is present.
- The presence of a bus reduces the discharge flow from the main intersection.
- Bus delays were found to be significantly lower than average car delays
  - The effects of existing transit signal priority?
  - Even without transit signal priority expect that pre-signals would reduce bus delays.
    - A pre-signal allows buses to move in front of car queues which otherwise could not be cleared with the use of transit signal priority.

Thank you for your attention

Questions?

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