Negotiable Collaborative Public Transport Signal Priority

Master's Thesis of Philipp Nicolas Stüger

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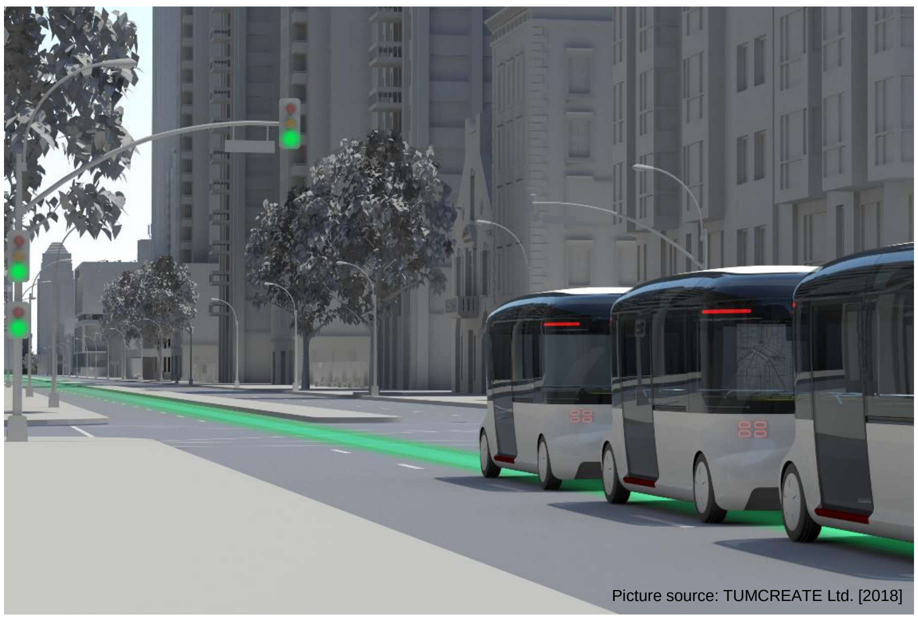
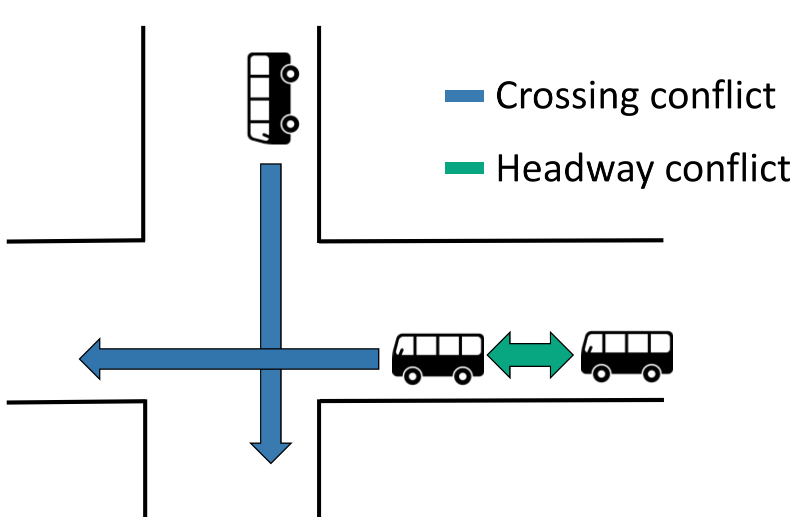


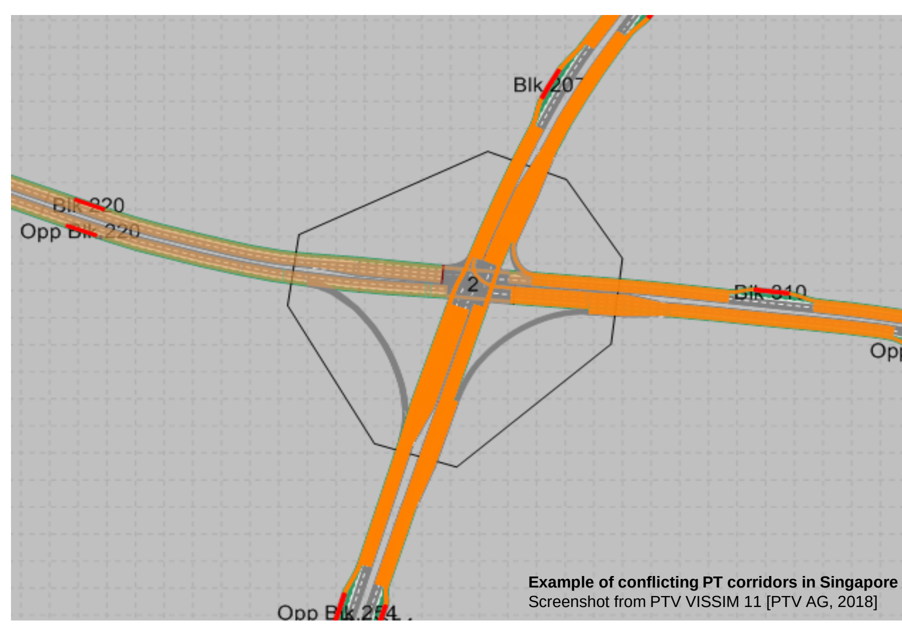
Picture source: TUMCREATE Ltd. [2018]

This thesis presents a novel approach to solve conflicting public transport priority requests especially in a dense urban network characterised by a high arrival frequency of public transport (PT) vehicles. Usually, two types of conflicts exist. Vehicles can either request a crossing direction at the same time or have an unfortunate headway (see figure below). The developed method therefore utilises a bidding approach to justify the implementation of prioritisation measures. Every vehicle gets an individual score assigned which is determined in three steps. First, cancellation conditions (e.g. if a vehicle is earlier than one cycle time) reduce the overall number of considered vehicles. Second, eight variables are used to determine the bidding score of each vehicle: Examples are a possible delay, the service hierarchy (e.g. tram before bus), the probability to get prioritised again at a close downstream traffic signal or the historical delay on the remaining route. A flexible weighting architecture allows an adoption to local conditions and policies.



according to [Wahlstedt, 2014]
Bus icon source: Bus icon made by Freepik from www.flaticon.com

The weighted bidding scores then serve as an input to the allocation process of priority time, represented by a negotiation algorithm. The algorithm modifies the reference signal plan received from the signal controller. Requested prioritisation measures (special PT stages, adjusted green timings as well as one stage rotation per cycle) can be implemented. The algorithm simplifies the needed optimisation by creating multiple so called „candidate signal plans“ which offer a different combination of prioritisation measures. Additionally, an optimal time point is identified for every stage transition. In the end, the sums of all delay-weighted bidding scores that can be accommodated by a candidate signal plan are determined. The plan with the highest score will be returned to the signal controller together with additional information on decisive PT vehicles for the stage transitions, enabling the signal control to adjust the stage transitions to the real-time arrivals. The method therefore acts as a plug-in providing an advanced form of PT pre-requests.



Example of conflicting PT corridors in Singapore
Screenshot from PTV VISSIM 11 [PTV AG, 2018]

The negotiation aspect is represented by four variables influencing the negotiation process from a collaborative perspective: A „green time balancing factor“ makes it harder to repeatedly shorten a stage. Additionally, bids that request interruptive measures or lead to extreme short green times are penalised. Further, candidate signal plans with an increased number of stage transitions receive a reduced score.

The method differs from existing controllers in two ways. First, the control considers arrivals over the whole cycle time and is therefore able to act in a proactive rather than a reactive manner. Second, the approach provides a more flexible architecture compared to common rule-based approaches. The method has not been evaluated yet and is therefore subject of ongoing research.

References:
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