Methodological Prioritization of Road Users in Urban Traffic Control Considering Different Request Types

Master‘s Thesis of Nadine Hrabia

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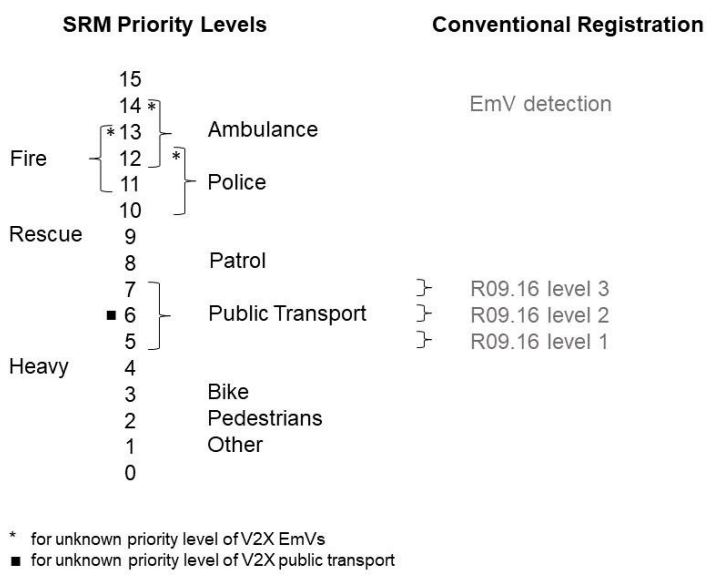

Figure 1: Assigning Vehicle Roles to the Request Importance Levels of a SRM and Matching Conventional Transmission Technologies

Some road users have a superior role in the traffic environment where for example emergency vehicles (EmV) are rescuing people in need, where the safety needs to be maintained or further damages need to be prevented. For such road users, a facilitated passage through intersections is aimed, where green is given to the requesting road users. Some registration technologies had already established over the past decades, where road users like EmVs and buses had been provided with localization and transmission technologies. Over time, digitalization had also reached the traffic environment, where for the so-called Vehicle-to-Everything (V2X) communication message specifications had been developed and examined on test fields. The message format Signal Request Message (SRM) is enabling V2X-equipped road users to request for green signal. Operating strategies for conventional registrations are already implemented in signal control systems, but an operating strategy is missing for the V2X technology, as well as a combination of both. Therefore, this thesis is providing methodologies for rule-based and model-based signal control systems to operate multiple requests from different road users and by various message types.

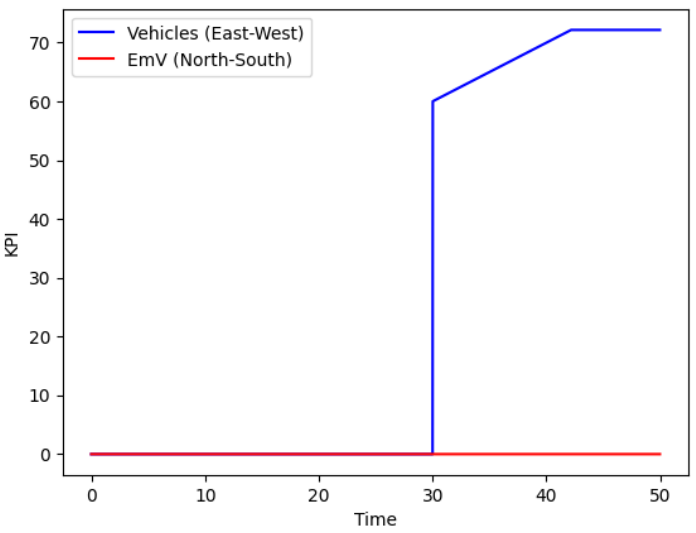

Figure 3: KPI Value of the Applied Signal Program from the Traffic Flow of *Figure 2*

After investigating the functioning of rule-based and model-based signal control systems, different registration methods on conventional basis are analyzed and the content of the most used conventional message format on European level, the R09.16 telegram, is examined and compared with the SRM. By meeting the needs of control systems to operate a request, SRM data elements like the Estimated Time of Arrival (ETA), the exiting lane and the request importance level need to be obtained by alternatives, as these are set to optional in the specifications of the ISO. After knowing when a request will arrive at the stop line and for which signal group it is demanding for, some constraints were defined to prepare for the change of the signal program. The main strategy for operating a request is to determine whether the request is already arriving at a green signal, whether the demanded stage can be reached through shortening and extending green times, or if the stage needs to be provided with a prioritization. The prioritization for both methodologies is obtained through the priority levels that can be achieved through the vehicle role. On rule-based level, the operating strategy is gained by querying constraints that are conducted in a flowchart.

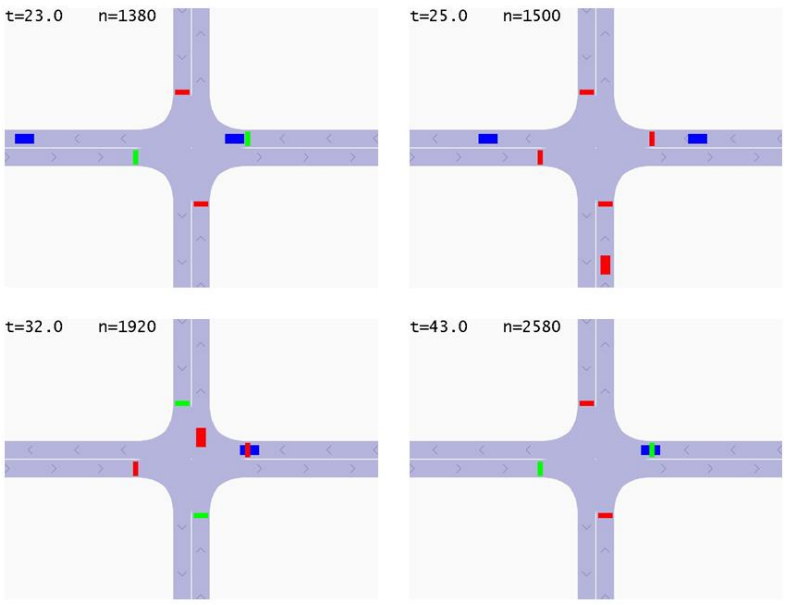

Figure 2: Traffic Flow of an EmV Approaching a Two-Way Intersection from South and Three Vehicles from East

On the other hand, the model-based approach is provided with a Key Performance Indicator (KPI) that calculates the impact that certain signal programs are displaying to the traffic states in terms of waiting times and number of stops. Among other parameters are the weighting factors of the requests making an impact on the KPI value. The signal program with the lowest KPI value is applied to the intersection and the entire network. KPI calculation for a model-based signal control system for different signal programs were performed with a third-party traffic simulation that is realized in the Python package pygame, where a visualization and examination of three different signal programs for a two-way intersection with the respective KPI values is provided. The best-performing solution is illustrated in *Figure 2,* which is not wasting too much green ahead of time, by letting other vehicles pass the intersection before the EmV. As the EmV does not have to stop and the first two vehicles of the eastern approach neither, only the third vehicle is included in the KPI value, which is at the height of around 70 and can be depicted from *Figure 3*.