Control Management of Signalized Junctions

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The main challenge of traffic control management is to ensure that the various types of road users (e.g., public transport vehicles, pedestrians, bicyclists and cars) are given relative priority at signalized junctions as dictated by regional policy. Performance Indicators (PI) for each type of road user, its desired values and its measured values serve as the basis for identifying situations in which the desired level of performance is not met.

In such situations, a more appropriate signal-program should be selected and implemented. Nevertheless, the selection process is not trivial, especially because signal-programs, particularly those containing transit-priority, tend to include a unique and complicated operational logic for each junction. This level of complexity, in conjunction with the need for ad-hoc selection of the most appropriate signal-program that addresses the trade-off among the priorities allocated to the various road users, requires the development of a general methodology for comparing alternative signal-programs.

Often, the three types of users compete with one another over the same resources, and improving the PIs of one user worsens the situation of the others. The expected values of the various PIs are used as thresholds to evaluate the observed performance level of each type of road user. The relative values of the projected PIs reflect the importance of and the priority assigned to each road user, and their absolute values reflect the expected influence of different traffic levels. The dynamics of traffic conditions call for a different level of projected PI for every type of day and each time of day.

Continuous monitoring is required in order to identify situations in which the desired PI values are not obtained. Whenever a deviation is discovered between the observed and

projected PI of one of the road users, a decision should be made regarding the selection of an alternative signal program. The selection process primarily takes into account the road user whose PIs are not met, but it should also address the effect of the selected signal program on the other road users. Therefore, the methodology developed for the selection process should address the unique characteristics of signal programs that incorporate PT priority.

This paper suggests a methodology for a comprehensive process that includes a structured definition of performance indicators for each type of road user, a standardized format for the definition of signal-program planning attributes, real-time identification of unfulfilled performance levels, implementation of an algorithm for signal-program comparison and the identification of inferior programs and tools. The entire process, which enables a final, human-based selection of the most appropriate signal-program, is based on a methodology developed for the formalization and analysis of the dependency of the different road users on the various planning attributes composing the junction and its signal-programs. The applicability of the proposed methodology was demonstrated by modelling a sub-network and controller operations at the junction in a micro-simulation environment. Results showed an improvement in meeting the objectives of the priority policy.

Each intersection has its own characteristic regarding the nature of each Signal Group (SG), the conflicts between various SGs and the priority policy required. Therefore, the signal planning logic and the PA embedded in it are tailor-made for each junction. The concept of Standard PAs (SPA) was defined with the aim of laying a foundation for comparing signal programs on the basis of PAs rather than on the basis of analyses of the complete operation logic.

The list of SPAs can be considered a data dictionary of signal-program planning. The SPAs that constitute the data dictionary represent the most common conditions and constraints typically integrated into the planning logic of signal programs that incorporate PT priority. The SPA data dictionary should be broad enough to reflect versatility among junctions and at the same time should be compact enough to serve as a basis for the formulation of a signal-program comparison process that can be used for various junctions.

Given the SPA as the basis for selecting the most appropriate signal program, the steps of the selection process can be listed as follows:

- Perform constant monitoring of each road user’s PI.
- When a deviation between the actual and the expected PI value is observed for one of the road users, identify the SG to which this road user belongs and mark it as "SG needing consideration."

- Compare the expected priority given to the "SG needing consideration" in each alternative signal program to its priority in the currently active signal program. The comparison should be performed on the basis of the type of PA implemented within the signal program operation logic and the PAT assigned to each signal program.

Given the "SG needing consideration," it is clear that treatment should refer to the PA directly associated with it. However, other PAs embedded within the signal program and their thresholds should also be taken into account. The threshold values assigned to the PAs differentiate the various signal programs. The PAs and their thresholds constitute the basis for comparing signal programs in conjunction with the interdependencies linking the various SGs. The proposed methodology logically formalizes the directivity of the effect of aggregated PAs on the different types of road users.