Heuristic Offset Optimization in Urban Signalized Corridors Based on Cell Transmission Model

Master‘s Thesis of Mohammad Akrma Ali

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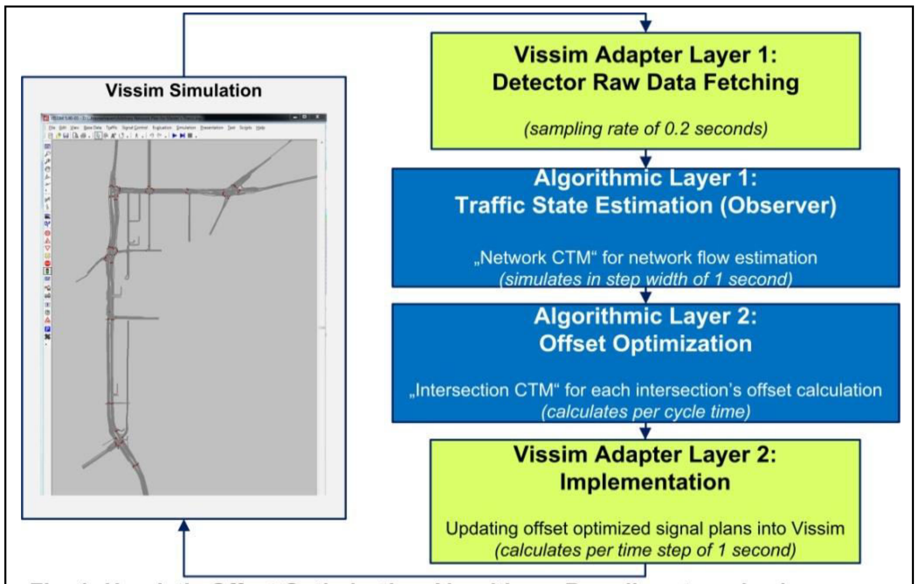
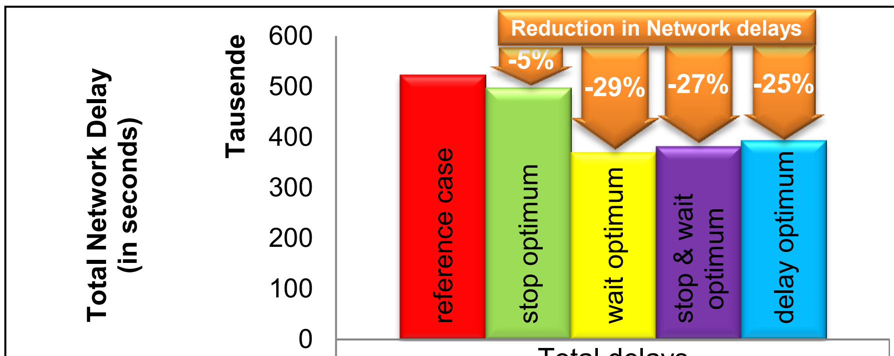


Fig. 1: Heuristic Offset Optimization Algorithm – Broadly categorized

The broadly categorized methodology contains four major layers as shown in Fig. 1 which communicates in a hierarchal manner with Vissim Simulation. Network CTM is used to calculate network wide CFP based on stage recall detectors and without usage of system loop detectors (~160m to stop-line) which is considered necessary in SCOOT. The Network CTM builds an online traffic state estimator which can be used independently of an offset optimization algorithm.

The offset optimization algorithm uses a set of Intersection CTMs to perform local optimization for each intersection on a cyclic basis. It uses CFP as an input from the Network CTM and evaluates certain offset variations. With CFP and each offset variation, a prognosis based on rolling horizon is performed which in turn is used to calculate the performance indices (PI) as per Fig. 2. For each intersection the offset variation with the minimum PI is chosen as the best offset. The PI is either a weighted sum of number of stops and/or waiting time or of delay.



	Total delays
reference case	523296,80
stop optimum	497261,20
wait optimum	369724,50
stop & wait optimum	382290,70
delay optimum	393602,50

Fig. 3: Reduction of overall network delay based on different PIs

The solution to offset optimization of road network corridors has considerable spatial and time complexity. It is a kind of composite type of NP problems which cannot solve the local optimal solution to the global optimum convergence of degree. In order to find a solution for the NP optimization problem, this research is based on a comprehensive review of the state-of-the-art of offset optimizations, followed by an overview of the existing Advance Traffic Control Systems: Sitraffic Motion & SCOOT. After the review, the principles of SCOOT have been followed using cyclic flow profiles (CFP) to optimize the offset of each intersection independently while allowing only small changes of the offsets. Also, the vertical queue modeling has a drawback of capacity reduction. Therefore, a horizontal queuing method with an already developed extended version of Cell transmission model (CTM) has been used in a twofold way viz. Network CTM and Intersection CTM. This is the first time ever a local offset optimization technique is based on horizontal queuing model.

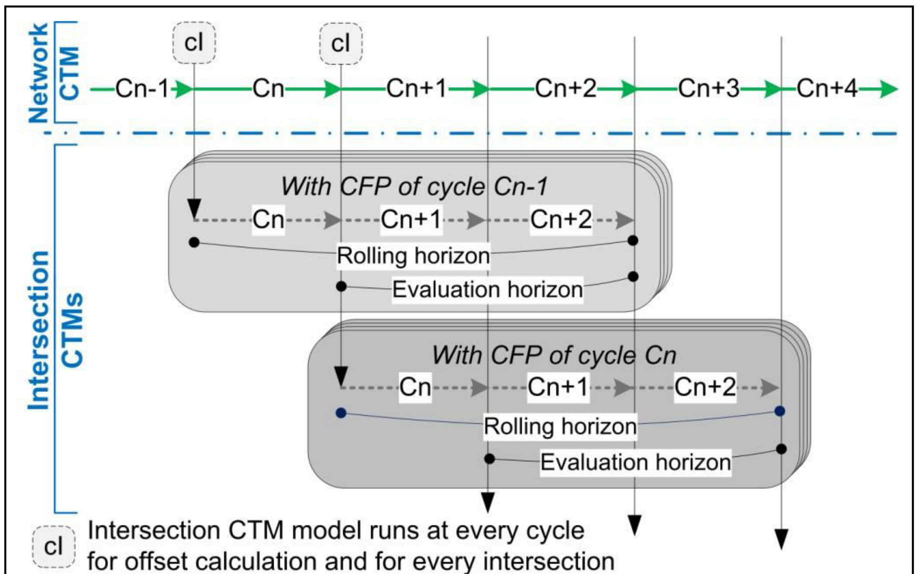


Fig. 2: Rolling and evaluation horizon for Intersection CTMs

In contrary to SCOOT, an extension of the SCOOT offset optimization technique has been proposed which allows the usage of stage recall loops. Using such loops, this algorithm could also be applied in Sitraffic Motion while providing for both – SCOOT and Sitraffic Motion – the advantage of horizontal queue modeling.

The new heuristic algorithm has been adapted into a Vissim simulation environment which allows evaluation of its effects. After performing the first simulation study on an urban signalized network with close to realistic traffic demand, it is found that the algorithm converges and shows good results. There is not only an improvement according to the reduction of overall network delay as shown in Fig. 3, but also visually perceivable good platoon coordination in both driving directions of the network corridor. The time space plots for visual inspection also revealed that the algorithms take the whole network into account though the optimization of each controller is done based on a local optimization per intersection only.