Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 138 (2014) 358 – 367

Procedia
Social and Behavioral Sciences

The 9th International Conference on Traffic & Transportation Studies (ICTTS'2014)

Comparison of the effectiveness of common cycle computing models

Ting Lu*, Alexander Sohr, Xiaoxu Bei

Institute of Transportation Systems, German Aerospace Center (DLR), Rutherfordstrasse 2, Berlin 12489, Germany

Abstract

In a coordinated road network, the common cycle is selected by evaluating the performance of the network in the given cycle length range. There are some models to compute the common cycle length. This study give a review of these current models which are TRANSYT, Synchro, "90% rule" and "largest rule". This paper proposes a comparing model by using the Webster delay model as well. The network composed of 4 intersections is used to test the effectiveness of these five models. 15 volume levels for the main street from 250 vehicles/hour to 750 vehicles/hour are estimated. The simulation of all common cycles by all models at all volume levels are conducted by four simulation tools which are TRANSYT-14, Synchro-7, SUMO and Simtraffic. The conclusions of the effectiveness of these models are drawn through amount of experiments. It can't say simply that which model is the best and which is the second best and so on, because MOEs at different volume levels are different. Overall, TRANSYT and "90% rule" have better MOEs at most volume levels, while the common cycle time calculated by "90% rule" is too short. The effectiveness of comparison model in this paper is not as good as commercial program, but the difference is small.

Peer-review under responsibility of Beijing Jiaotong University(BJU), Systems Engineering Society of China (SESC).

Keywords: Common Cycle; Traffic Signal Coordination; TRANSYT, Synchro; Webster delay; 90% rule

1. Introduction

In a road network, all controllers operate on the same cycle length or some controllers operate on the half or multiple of this cycle length. This is fundamental to signal coordination or synchronization. This ensures that the offsets are repeated in each cycle, and offsets have a profound impact on progression between controllers. This cycle

* Corresponding author. Tel.: +49-30-6705-5292; Fax: +49-30-67055-291.
E-mail address: ting.lu@dlr.de

Peer-review under responsibility of Beijing Jiaotong University(BJU), Systems Engineering Society of China (SESC).
doi:10.1016/j.sbspro.2014.07.214

length is called the "Common Cycle" or "Network Cycle". When the common cycle time is mentioned, the other similar definition, resonant cycle time, should be explained. The notion of resonant cycle is, "a cycle length that will provide the optimum two-way progression" (Henry, 2005). The essential element of a resonant cycle is that it provides good two-way arterial progression. In this paper, the common cycle we recommend is to minimize the total delay of all vehicles in the road network.

On one hand, selecting a common cycle length has a significant impact on performance. The well-chosen common cycle length yield better delay, stops and progression. On the other hand, operation on a good common cycle length can improve road network performance compared to mixed cycle length. This is contradictory to a common held belief among traffic engineers, that mixed cycle length operation has optimal performance since there is a large differential in the volume by individual signals. But researches indicated mixed cycle length operation is of a more limited application. Kreer (1977) showed that mixed cycle lengths usually result in narrower progression bands than those obtained under a common cycle length. He also demonstrated that mixed cycle lengths disrupt the platoon structure. Kesur (2012) also found mixed cycle lengths result in inferior network performance.

The goal of this study is to compare the effectiveness of current models of calculating the common cycle length.

2. Review of related research

Traffic engineers seek to preserve the quality of progression by selecting the optimal common cycle length for a corridor or network system. Ways for traffic engineers to get the optimal common cycle are computer programs such as TRANSYT (Binning et al., 2010), Synchro (David et al., 2006) and PASSER (Transportation Operations Group, 2009). They perform exhaustive searches for each cycle length in the user defined range. They use network approach methodology that to optimize cycle lengths based on specified performance measures such as minimization of vehicle delay, travel times, number of stops and maximization of green wave bands. Since the complication of computing, cycle length optimization for an arterial containing several intersections takes a couple of seconds to a couple of hours. Especially in TRANSYT optimization time increases rapidly with increasing the number of intersections. For pre-timed control, these programs could be a way to obtain the common cycle time. But for adaptive control, they are not suitable.

The guidelines for traffic signals in Germany (RiLSA, 2010) recommend the use of the optimal cycle length of the critical intersection of a network as the common cycle length. In fact, the critical intersection's cycle is the largest cycle of all intersections in the coordinated network. The optimal cycle length of the critical intersection can be calculated by using basic equations such as Webster's $c_o=(1.5L+5)/(1-Y)$ (Webster, 1957). Here L is the total lost time, Y is the sum of ratios of traffic volume and saturated flow rate of all critical movements.

Henry (2005) stated resonant cycle length is a function of the speed of the traffic on the links between intersections and the link distance between intersections. The equations are *Resonant cycle=2·Distance / Speed* (1), *Resonant cycle=4·Distance / Speed* (2), *Resonant cycle=6·Distance / Speed* (3). Here the speed of traffic is set based on what the average driver considers reasonable, not on an arbitrary speed that provides the maximum bandwidth. Select the shortest resonant cycle that is longer than the optimum cycle of individual intersections and the pedestrian minimum cycle. If none of the resonant cycles are longer than the optimum cycle, select the longest resonant cycle.

Denney et al. (2008) proposed the principle of resonant cycles, which suggests using a single cycle length for a range of volumes. The study of Shelby et al. (2005) demonstrated, based on a simulated network and fixed time signal plans, that resonant cycles lengths provide good arterial progression over a range of traffic flows.

Shelby et al. (2005) developed the 90% rule as cycle length selection strategy. This strategy is based on monitoring the degree of saturation for all approaches in the network. If any approach to an intersection becomes more than 90% saturated, the common cycle length of the whole system is increased by a few seconds. Conversely, if all approaches are less than 90% saturated, the network cycle length is incrementally reduced. This cycle time adjustment strategy is used by SCOOT (Hunt, 1981) and VFC-OPAC (Stallard, 1998). Similar strategies, based on the degree of saturation or volume-to-capacity (V/C) ratio measures, are also used by SCATS (Lowrie, 1982) and the Los Angeles Department of Transportation's adaptive traffic control system (Skehan, 1996).