Information Technology and Quantitative Management (ITQM 2015)

The use of queuing theory at research and optimization of traffic on the signal-controlled road intersections

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Abstract

The paper describes the methods of queuing theory to solve the problem of optimizing traffic light phases on signal-controlled road intersections. The flow of vehicles on multi-lane roads is described by Poisson processes. In this paper the concept of the effective number of lanes is used which indicates the maximum flow of cars with different modes of traffic lights. Methods of queuing theory helped to obtain explicit solutions of the problem of minimizing delays at signal-controlled road intersection.

1. Introduction

Mathematical modeling of traffic flows now is rather actual in connection with the great increase of the number of vehicles and with the growth of urban infrastructure. Almost any path between two points includes the passing of road intersections, including signal-controlled. For this reason, there is of great interest for study time lost caused by passing of signal-controlled road intersections.

Paper [1] describes vehicle behavior on signal-controlled road intersections by using numeric methods. This paper uses queueing theory methods for modeling transport flows.

Queuing theory for modeling traffic on crossroads was used in [2]. In the paper system $GI|G|\infty$ was considered in which all the requests received in the same busy period have the same service time. Service times in the different busy periods is independent distributed random values. This model originated in the description of «synchronous movement» arising in transportation systems with high traffic. With this model, for example, the authors obtained the distribution of the waiting time on a single-vehicle secondary road at the intersection of the main and secondary roads in the uncontrolled intersection, at the time of his appearance at the crossroads there are no other cars. In fact, the traffic on the uncontrolled crossroads can be formulated as the problem of controlled crossroads with a Poisson lengths phases. Similar methods are also considered in [3].

When considering the traffic light with a fixed duration of phases is more complex mathematical apparatus is required. In particular, this problem in the case of a single-lane road and traffic lights with two phases (green-red) was considered in [4].