The capacity of two neighbour intersections considering the influence of the bus stop

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ABSTRACT

In this paper, we use a two-lane CA model to investigate the effect of a bus stop between two neighbouring intersections on the capacity of the bus. Both the case of a bus stop with a special stopping lane and that of one without are considered. The capacity versus the distance $L_B$ ($L_D$) between the stop and the upstream (downstream) intersection is studied, with respect to the entering probability $P_e$ and the traffic light cycle $T$. It is found that a bus stop near an intersection can act as a bottleneck and cause a drop in the capacity when the $L_B$ (or $L_D$) is below a critical point $L_{Bc}$ (or $L_{Dc}$). However, the situation when the stop is located near the downstream intersection is worse than that of the upstream one. Furthermore, the simulation results show that the negative effect varies with the increase of the cycle time $T$ and the capacity can be maximized by adjusting $T$. Comparisons between the two cases suggest that the stopping lane can improve the capacity to some extent. These results mean that the capacity can be exploited by changing the position of the bus stop or the cycle time, and adding a stopping lane if necessary. These findings may be useful in offering scientific guidance for the management and design of traffic networks.

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1. Introduction

Recently, traffic flow theories have attracted considerable attention. To understand the dynamics of various traffic phenomena, different traffic models have been developed [1,2], such as cellular automaton (CA) models, car-following models, gas kinetic models and hydrodynamic models. In particular, the CA models have been extensively studied in order to understand traffic behaviour, because of their simplicity and flexibility in modelling different aspects of real traffic.

Traffic lights control intersections and play important roles in the management of the traffic systems. The study of intersections is of significance in both offering scientific advice for real traffic management and the development of traffic theory. The traffic dynamics controlled by traffic lights have been revealed in different ways over the past several years, and some useful achievements have been obtained. Brockfeld et al. have studied optimizing traffic lights for city traffic and found that the problem of the optimal cycle time in a network is equal to that of a single street [3]. Sasaki and Nagatani studied the traffic flow controlled by traffic lights, based on an optimal velocity car-following model [4]. The effects of traffic flow states on different roads on the capacity of a T-shaped intersection system are analyzed by Wu et al. [5]. Jiang et al. developed a stopped time dependent randomization CA model to explain the dependence of a saturated current on the cycle time [6]. Up to now, researches on the traffic behaviour controlled by traffic lights mainly focus on the effects of different traffic policies on the traffic capacity, without considering the interference with other traffic conditions, like neighbouring bus stops. Bus stops are crucial for urban public transport. In urban traffic systems, it is often observed that a bus stop locates between two

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intersection is small. The capacity reaches a maximum at two critical points $L_{B1}$ and $L_{B2}$, and remains when $L_{B1} < L_B < L_{B2}$. However, the situation where the stop is located near the downstream intersection has a much larger capacity drop than that of the upstream one. Also it is found that the capacity can be maximized by adjusting the traffic cycle time $T$. In additional, comparisons between two cases reveal that there is no qualitative difference between them, however the capacity using the special stopping lane is superior to that without the lane. These findings imply the following,

- The capacity is affected by the location of the bus stop and the traffic light cycle time, and can be maximized by adjusting these two factors.
- The special stopping lane can bring benefits to the capacity of the intersections.
- It is favourable to replace the downstream bus stop with the upstream one, because the latter will cause much smaller damage than the former.

These implications may provide suggestions on exploiting the capacity of intersections by changing the positions of bus stops and the design of the traffic light cycle time. This work primarily studied the negative effects of a bus stop between two neighbouring intersections. Future work is still needed to study much more suitable models to validate in practice.

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References