Abstract

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Modelling Bus Bunching under variable transit demand using Cellular Automata.

Bunching is an operational problem, in bus transit systems with high service frequency, that can lower capacity and affects user satisfaction. The headway (i.e. amount of time between transit vehicle arrivals at a stop) is intrinsically unstable, such that minor disturbances can cause divergence from the scheduled service. In this paper, a bus route is modelled using a one-dimensional cellular automata to investigate the effects of variations in passenger demand on headway instability and the bus bunching phenomenon. Unlike previous research, this study utilizes a typical route design approach, rather than obtaining a phase diagram from random passenger demand and service frequency. The results show that a one-second decrease in boarding and alighting times per passenger can significantly reduce bunching formation. Such a reduction can be achieved by adopting in-station fare collection methods as opposed to onboard ones, and/or using low-floor buses with wider/multiple doors/channels. In addition, an active mitigation strategy is proposed to prevent the formation of bunching. It is shown that limiting the waiting time for the delayed bus at stops has a great effect on regulating headways and mitigating bunching. Further, to compare different bunching situations, a new index is proposed to evaluate bunching severity (i.e. the number of buses involved in bunching) and intensity (i.e. the overall deviation from the scheduled headway). Using the developed index, it is found that a high Peak-Hour Coefficient acts like an uncontrolled traffic light that regulates the bus flow, resulting in less severe bunching, regardless of the subsequent total delay in the service.