Multimodal Level of Service for urban Streets: cross-comparison of estimation methods

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Abstract:

Modeling multimodal transport systems of urban space is a topic of increasing concern (Daganzo and Geroliminis, 2008, Gayah and Daganzo, 2010, 2012, Geroliminis and Boyaci 2011a, b, etc.). Many of these papers are focused on describing vehicular traffic stream on an aggregate level. Unfortunately, among this considerable body of research, only few papers are focused on urban multimodal corridor dynamics (Geroliminis and Boyaci 2011b). This is not only due to the difficulty of the data collection in city, but also because of complexity of the interrupted and inhomogeneous natures of such mixed traffic flow. Consequently, it is worth studying how a multimodal urban corridor can be modeled and evaluated through a macroscopic model. To fill this gap, our paper seeks to shed some light in macroscopic urban corridor modeling of traffic flow with bus rapid transit system. To this aim, we introduce two methods to incorporate buses into macroscopic fundamental diagram (MFD). Accordingly, dynamics of the urban corridor can be assessed through and will be compared to outputs of micro simulation software (method M3). Level of service will also be derived, cross-compared and confronted to the HCM2010.

The first method (M1) proposes to incorporate impacts of buses endogenously and then to estimate the associated MFD. This is done by extending the work of Geroliminis & Boyaci (2011a) who provide a convenient way to estimate MFD for a corridor. They develop a technique based on moving observers running a series of many intersections with variables characteristics. In this method, buses are not explicitly represented. Their effect is reproduced by reducing the capacity of the links when a bus is present. This local and temporary capacity reduction will influence the number of vehicles that can overtake the observers and the directly modify the shape of the corridor MFD. Thus, method M1 endogenously accounts for buses.

The second method (M2) will exogenously account for impacts of buses. To this end, time-space diagram of an urban corridor is analytically calculated based on its associated MFD without buses and MB theory (Newell, 1998). This associated MFD can be obtained from the analytical formulation of Daganzo & Geroliminis (2008) or through the simulation technique of Geroliminis & Boyaci (2011a). Thereby, dynamics of urban traffic flow can be easily assessed.

The previous two analytical methods have advantages in term of mathematical and solution properties, but their ability to reproduce realistic traffic dynamics is limited, especially with bounded acceleration and lane-changing phenomena. Hence, method M3 tries to overcome this limitation through a refined approach by using the microscopic simulation package SymuVia, which is based upon a Lagrangian resolution of the LWR model (Newell 2002; Leclercq 2007). This software is fully consistent with the MFD of a homogenous network with traffic signals (Courbon and Leclercq, 2011). Therefore, we will resort to SymuVia to simulate multimodal traffic on an urban corridor.

Finally, the results of the three methods will be expressed in terms of levels of service (LOS) and cross-compared. These results will also be confronted with the multimodal LOS provided in the HCM2010. Among of the results, travel times of vehicles and buses are calculated regarding to the upstream traffic flow demand, the downstream offer and the bus headway. It is worth noticing that calculation of travel times are based on Eddie's definition. Furthermore, these methods are expected to contribute to further investigation of bus priority with dynamic control strategy of urban traffic flow. To this end, impact of bus headways will be investigated in the final version of the paper.

Keywords: Urban corridor, multimodal level of service, macroscopic fundamental diagram, Kinematic Wave, LWR model, Travel Time

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