Preface

In recent years, efforts have been made to deploy communication capabilities in vehicles and the transport infrastructure, leading to a potential of vehicular ad hoc networks (VANETs). Enabling vehicular communications is expected to revolutionize the transport infrastructure and support not only public-safety applications, but also a wide range of infotainment applications. Urban roads and highways are highly susceptible to high relative speeds and traffic density variations from time-to-time and from point-to-point on the same roads. High node mobility in VANETs can cause frequent network topology changes and fragmentations. The spatiotemporal variations in VANET topology directly (or indirectly) affect the performance of network protocols through their impact on the switching of the links between connection and disconnection. Characterizing the spatiotemporal variations in VANET topology requires a mathematical model that describes vehicle mobility and its temporal variations, that is, a microscopic mobility model. Despite its high speed and randomness, the vehicle movement is restricted by road topology, speed limits, traffic rules, and movement of nearby vehicles. Therefore, vehicle movement follows certain patterns. This brief presents a stochastic microscopic mobility model that describes the temporal changes of intervehicle distances, accounting for the dependency between these changes. The model is consistent with simulated and empirical vehicle traffic patterns. Using stochastic lumpability method, the proposed mobility model is mapped into an aggregated mobility model that describes the mobility of a group of vehicles. In addition, the proposed mobility model is utilized to analyze the spatiotemporal VANET topology. Two characteristics are proposed to describe the impact of vehicle mobility on VANET topology: the time period between successive changes in communication link state (connection and disconnection) and the time period between successive changes in node's one-hop neighborhood. Using the proposed lumped group mobility model, the two VANET topology characteristics are probabilistically described for different vehicular traffic flow conditions. Furthermore, the limiting behavior of a system of two-hop vehicles is investigated in terms of the overlap-state of their coverage ranges and the number of common vehicle neighbors between them. The steady-state number of common vehicle neighbors between two-hop vehicles is approximately derived. The proposed mobility model is a promising candidate model to be utilized for traceable mathematical analysis in VANETs. The spatiotemporal VANET topology analysis provides a useful tool for the development of mobility-aware vehicular network protocols.

Waterloo, ON, Canada

Khadige Abboud
Weihua Zhuang

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