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"Smart Adaptive Beaconing Schemes for VANET"

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ABSTRACT OF DISSERTATION

Smart Adaptive Beaconing Schemes for VANET

Vehicular Ad hoc Networks (VANET) is a wireless ad-hoc network that includes two types of communications, Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I). In VANET there are two types of messages. The first type is the event-driven messages that are only triggered in case of emergency. The second type is the periodical messages named beacons that are exchanged frequently between vehicles. A beacon message contains basic information about the sending vehicle such as id, location and velocity. Beacons are frequently exchanged to increase the cooperative awareness between vehicles. Increasing beacon frequency helps increasing neighborhood awareness and improving information accuracy. However, this causes more congestion in the network, especially when the number of vehicles increases. On the other hand, reducing beacon frequency alleviates network congestion, but results in out-dated information. In this dissertation, we address the aforementioned challenges and propose a number of smart beaconing protocols and evaluate their performance in different environments and network densities. The four adaptive beaconing protocols are designed to increase the cooperative awareness, while alleviating the network congestion. All the proposed protocols take into account the most important aspects, which are critical to beaconing rate adaptation. These aspects include channel status, traffic conditions and link quality. The proposed protocols employ fuzzy logic-based techniques to determine the congestion rank, which is used to adjust beacon frequency. The first protocol considers signal to interference-noise ratio (SINR), number of neighboring nodes and mobility to determine the congestion rank and adjust the beacon rate accordingly. This protocol works well in sparse conditions and highway environments. The second protocol works well in sparse conditions and urban environments. It uses channel busy time (CBT), mobility and packet delivery ratio (PDR) to determine the congestion rank and adjust the beacon rate. The third protocol utilizes CBT, SINR, PDR, number of neighbors and mobility as inputs for the fuzzy logic system to determine the congestion rank and adjust the beacon rate. This protocol works well in dense conditions in both highway and urban environments. Through extensive simulation experiments, we established that certain input parameters are more effective in beacon rate adaptation for certain environments and conditions. Based on this, we propose a high awareness and channel efficient scheme that adapts to different environments and conditions. First, the protocol estimates the network density using adaptive threshold function. Then, it looks at the spatial distribution of nodes using the quadrat method to determine whether the environment is highway or urban. Based on the density conditions and nodes distribution, the protocol utilizes the appropriate fuzzy input parameters to adapt the beaconing rate. In addition, the protocol optimizes the performance by adapting the transmission power based on network density and nodes distribution. Finally, an investigation of the impact of adaptive beaconing on broadcasting is conducted. The simulation results confirm that our adaptive beaconing scheme can improve performance of the broadcast protocols in terms of reachability and bandwidth consumption when compared to a fixed rate scheme.

BIOGRAPHICAL SKETCH
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CONCERNING PERIOD OF PREPARATION & QUALIFYING EXAMINATION

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Published Papers:

M. Alhameed and I. Mahgoub, "Vanet adaptive beaconing based on fuzzy logic," in in Computer and Information Technology; Ubiquitous Computing and Communications; Dependable, Autonomic and Secure Computing; Pervasive Intelligence and Computing (CIT/IUCC/DASC/PICOM), 2017 IEEE International Conference on. IEEE, 2017, pp. 736–743.

M. Alhameed and I. Mahgoub, "High awareness adaptive beaconing based on fuzzy logic in vanet," in Proceedings of the 15th ACM International Symposium on Mobility Management and Wireless Access. ACM, 2017, pp. 153–157.

M. Alhameed and I. Mahgoub, "Vanet scalable fuzzy logic based adaptive beaconing," in Computational Intelligence, 2017 IEEE Symposium Series on. IEEE, 2017, pp. 1–8.

M. Alhameed and I. Mahgoub, "Intelligent high awareness and channel efficient adaptive beaconing for urban and highway vehicular environments," in IEEE Transactions on Intelligent Transportation Systems (Under review).