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Geographic Validity Aware Content Retention in Vehicular Networks

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Thesis submitted in partial fulfillment of the requirements for the degree Master of Science in Computer Science

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Abstract

In Vehicle-to-Vehicle (V2V) communication, interest-based content dissemination carries equal importance. For example, a group of vehicles involved in a safari may communicate with each other about the location of rare animals. These messages are useful only within a certain geography and within a certain timespan. Hence, messages injected into the V2V network should be retained within these boundaries regardless of the highly dynamic nature of the underlying V2V network. To ensure that the content is retained within the V2V network both efficiently and with high certainty, it is important to address problems such as how and when to disseminate content, how to maintain order and honor priorities of content, how many replicas to maintain, and when to evict the content. However, if the content message is passed every time a pair of vehicles comes into each other's range, it will lead to message implosion while sub-optimally utilizing the wireless links, power, and content storage. Therefore, to ensure that all the vehicles get the message without high certainty and efficiency, it is imperative to identify with what probability a message should be disseminated.

In this research, we identify this probability value that could lead to successful retention of the message within the network given the parameters such as the valid geographical boundary, time span, and vehicle arrival rate. We developed a model that estimates the minimum probability that needs to be maintained to ensure that the specific content is seeded among other nodes. The model was developed for straight roads, T-junctions, and four-way intersections by varying other parameters such as the valid geographic area, vehicle speed, and density. Simulation bases analysis shows that the proposed model could reasonably estimate the minimum probability that needs to be met for the message to be replicated in other nodes.

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ABS	Anti-lock braking system
ASTM	American Society for Testing and Materials
CCH	Control Channel
DREAM	Distance Routing Effect Algorithm
DSRC	Dedicated Short Range Communication
DTN	Delay Tolerant Networks
FCC	Federal Communications Commission
GPS	Global Positioning System
GLS	Grid Location Service
IDE	Integrated Development Environment
IVC	Inter-Vehicle Communication
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transportation System
LAN	Local Area Network
MAC	Media Access Control Layer
MANET	Mobile Ad hoc Network
MSG	Message
MSG PSD	Message Passed
MSG RET	Message Retained
NED	Network Description (Language)
OBU	On-Board Unit
ON	Opportunistic Network
PHY	Physical layer
RSU	Road Side Unit
SAE	Society of Automotive Engineers
SCT	Signed Certificate Timestamp
SUMO	Simulation of Urban Mobility
VANET	Vehicular Ad-hoc Network
Veins	Vehicles in Network Simulation
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to Any other
WAN	Wide Area Network
WAVE	Wireless Access in Vehicular Environment