Wireless Network and Computer/Communications Lab
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Master's Thesis

Heterogeneous Probabilistic Neighbor Management

Background

Creating and maintaining a 2-hop neighbor table in vehicular contexts has proven useful for various applications. In order to share their information regarding speed, heading, position, etc., vehicles send periodic beacons via wireless communication. Other vehicles in communication range can receive these beacons and save the information in a neighbor table. This set of vehicles is called the *1-hop neighbor set*.

By not only sending their own information, but also the identifiers of their 1-hop neighbors, a *2-hop neighbor set* can be created: Vehicles now *know* the neighbors of their neighbors.

However, for large amounts of vehicles the amount of data that has to be sent periodically can become very large, congesting the channel. This might lead to frame collisions and packets will be lost. In order to avoid this, the amount of data sent can be reduced using a probabilistic data structure. For example, a *Bloom Filter* can be used for sharing the 1-hop neighbors. Items can be added and the filter can be queried whether an item is contained. The answer is either a *definitely no* or a *possibly yes* - the filter has the risk of false positives, which is the cost of reduced size. Previous work has shown that using Bloom Filters for creating and maintaining a 2-hop neighbor set increases the size of the set when compared to a naive approach that uses simple lists [1].

In order to further increase the size of the 2-hop neighbor set, using multiple communication technologies proved beneficial [2]. However, [2] only used three variations of IEEE 802.11p communication.

Thesis Goals

The goal of this thesis is to revisit the previous work [2] and utilize multiple communication technologies, such as IEEE 802.11p, 5G, LTE, etc.. This is to be done using simulations in OMNeT++, Veins and INET. In addition to using Bloom Filters, the performances of other probabilistic data structures such as Cuckoo Filters and Morton Filters are to be evaluated. This thesis aims to answer the following research questions:

- How do the different communication technologies influence the metrics?
- How do the different (probabilistic) data structures influence the metrics?
- Which neighbor is a good candidate to forward a packet?

Milestones

- create a simulation where vehicles create and maintain a naive 2-hop neighbor table using one communication technology
- add the possibility to use probabilistic data structures instead of the naive approach
- add other communication technologies
- evaluate and analyze the results
- design and implement an algorithm that finds a good candidate for forwarding a packet
- answer the research questions

Required knowledge (or willing to learn)

- Good programming skills (C++)
- Experience using OMNeT++, Veins, INET
- Knowledge about probabilistic data structures is a plus

References

[1] F. Klingler, R. Cohen, C. Sommer, and F. Dressler. Bloom Hopping: Bloom filter based 2-Hop Neighbor Management in VANETs. *IEEE Transactions on Mobile Computing (TMC)*, 18(3):534–545, 3 2019.

[2] I. Turcanu, M. Kim, and F. Klingler. Towards 2-Hop Neighbor Management for Heterogeneous Vehicular Networks. In *12th IEEE Vehicular Networking Conference (VNC 2020), Poster Session*, Virtual Conference, 12 2020. IEEE.

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