OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG | INF

Communication and Networked Systems

Master Thesis
Implementing Prediction-Based Mobility Awareness into Routing Protocols

Motivation

Routing protocols such as Ad-hoc On-demand Distance Vector (AODV) [1] and B.A.T.M.A.N. Advanced [2] work well for Wireless Multi-Hop Networks (WMHNs) consisting of nodes with static geographical position. Even though nodes can join and leave the network, updated information is only propagated slowly to keep overhead minimal to meet the resource constraints of the devices.

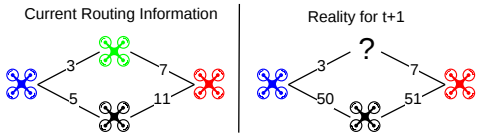

Figure 1. Routing graphs as modeled by currently available routing information on the left, and how reality looks like in the next time step on the right.

However, as of today, nodes tend to be more and more mobile in their nature. Unmanned Aerial Vehicles (UAVs) and Vertical Take-Off and Landing (VTOL) aircraft, forming Flying Ad-hoc Networks (FANETs), can drastically change their position from one second to another, and with complex trajectories. Routing algorithms take traditional routing metrics such as delay or bandwidth into account to choose an appropriate path from sender to receiver. Highly mobile nodes can change their position until a change of delays and/or bandwidths is even sensed, let alone propagated through the network, as visualized in Figure 1. As a worst case, nodes might not even be in range for the next frame anymore. Traditional protocols lack consideration of the highly dynamic nature of such nodes, and may be improvable to better meet the new requirements by adding positional and/or trajectoral information as metrics. With that kind of information, predictions on future availability and delays of nodes can be made to make better routing decisions. The idea is roughly depicted in Figure 2.

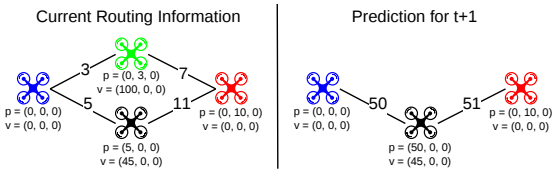

Figure 2. Routing graphs as modeled by currently available routing information on the left, and how the graph is predicted to be for the next time step based on the trajectory of the nodes.

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Goal

The goal of this thesis is to improve the performance of an existing routing protocol in networks with highly mobile nodes whose trajectories are predictable. In order to do that, an existing routing protocol needs to be extended conceptionally with routing metric(s) containing positional or trajectorial information. After that, the extension shall be integrated into an existing implementation of the chosen routing protocol, and experiments are to be conducted on the Magdeburg Internet of Things Laboratory (MIoT-Lab) testbed to evaluate performance gains [3][4].

Warning: This topic is highly demanding and very complicated. It requires good proficiency in C already, and general knowledge about routing algorithms.

Tasks

- research advancements in routing for mobile nodes
- extend existing routing protocol with positional and/or trajectorial routing metrics
  - either lightweight protocol suitable for Internet of Things (IoT) and embedded devices e.g. AODV or maybe Routing Protocol for Low-Power and Lossy Networks (RPL)
  - or protocols available for Linux kernel e.g. B.A.T.M.A.N. Advanced
- integrate extension into existing implementation
  - either into driver for embedded operating system e.g. RIOT OS
  - or into Linux kernel driver e.g. B.A.T.M.A.N. Advanced
- evaluate the extended implementation
  - simulate movement of nodes on MIoT-Lab
  - run experiments on tens or hundreds of wirelessly connected nodes
  - collect performance metrics such as throughput, propagation time, execution time of path selection algorithms
  - compare with existing solutions
- write a thesis about it

References

[1] S. R. Das, C. E. Perkins, and E. M. Belding-Royer, *Ad hoc On-Demand Distance Vector (AODV) Routing*, RFC 3561, Jul. 2003. DOI: 10.17487/RFC3561. [Online]. Available: https://www.rfc-editor.org/info/rfc3561.

[2] *Doc-overview - batman-adv - Open Mesh*, Mar. 2026. [Online]. Available: https://www.open-mesh.org/projects/batman-adv/wiki.

[3] K. Kientopf, M. Buschsieweke, and M. Güneş, "Technical report: Designing a testbed for wireless communication research on embedded devices," *18. GI/ITG KuVS Fachgesprach Sensornetze–FGSN 2019*, pp. 41–44, 2019.

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[4] *Communication and Networked Systems (ComSys) - MIOT-Lab*, Mar. 2025. [Online]. Available: `https://comsys.ovgu.de/MIOT_Lab.html`.