

Bachelor/Master Thesis

Ad-Hoc Wireless Multi-Hop Networks over LoRa

Motivation

Long Range (LoRa) is a wireless communication technology based on Chirp Spread Spectrum (CSS) modulation for low bandwidth communication up to 15 kilometers of range (Line of Sight (LoS)) [1]. Few protocols exist that run over LoRa yet. One of the most popular ones is Long Range Wide Area Network (LoRaWAN), which is a whole network stack and architecture based on LoRa for low power sensor networks, with a wide range of use cases e.g. home automation, smart metering, environmental monitoring, agricultural & industrial applications [2]. LoRaWAN is based on a centralized architecture with gateways and servers, that use a single hop to reach end devices like sensors and vice versa.

For applications that require or favor a more decentralized architecture, a Wireless Multi-Hop Network (WMHN) protocol stack that runs in a decentralized manner and is more lightweight than LoRaWAN would be useful. Use cases are, for example, home automation where LoRaWAN is not feasible to set up (installation, maintenance, operational cost) and where support for multiple hops would be desirable (think large properties, gardens et cetera), or emergency situations where centralized hardware is not easily deployable and multiple hops are actually required (think environmental disasters like floodings et cetera).

Goal

The goal of this thesis is to design and implement a simple protocol stack based on LoRa that enables communication between multiple peers over multiple hops.

This project idea is very open to your ideas and preferences, and not fixed at all. Also, the scope can be adjusted according to your level of knowledge and experience as well as depending on the type of thesis (Bachelor or Master).

Tasks

- research similar solutions
- design and implement a simple LoRa-based protocol suite for multi-hop communication of peers
 - network driver(s) and applications on embedded operating systems (e.g. RIOT OS)
 - nodes should be able to join and leave the network dynamically
 - addressing, reliability (e.g. retransmissions), routing
 - routing: simple flooding or more sophisticated distance vector or link state approach

Project type Bachelor/Master Thesis
Software Project

Language(s) English, German

Field Computer Science



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- adherence to governmental regulations (duty cycle, transmission power et cetera)
- evaluate the protocol stack on the Magdeburg Internet of Things Laboratory (MIoT-Lab) [3][4]
 - setup realistic scenarios for your solution
 - compare your solution with existing ones
 - run experiments on tens or hundreds of embedded nodes to stress test your implementation(s)
- write a thesis about it

References

- [1] *LoRa vs WiFi vs BLE: Which One to Use in Your IoT Project?* Apr. 2026. [Online]. Available: <https://pcbonline.com/blog/lora-vs-wifi-vs-ble.html>.
- [2] *LoRa vs. LoRaWAN: Unterschiede einfach erklärt | GIS*, Apr. 2026. [Online]. Available: <https://www.gis-net.de/lora-vs-lorawan-unterschied/>.
- [3] K. Kientopf, M. Buschsieweke, and M. Güneş, “Technical report: Designing a testbed for wireless communication research on embedded devices,” *18. GI/ITG KuVS Fachgespräch Sensornetze–FGSN 2019*, pp. 41–44, 2019.
- [4] *Communication and Networked Systems (ComSys) - MIOT-Lab*, Mar. 2025. [Online]. Available: https://comsys.ovgu.de/MIOT_Lab.html.

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