LoRaWAN Multiple Gateways Network Planning and Simulation

Project Overview:

LoRaWAN networks are making a remarkable progress from design, standardization, to commercialization. Improved network performance is claimed to its simple network architecture. Gateways form the bridge between end-devices and the server. End-devices send their packets and all gateways within reach of a device will receive the device's messages and forward them to the server. A single gateway can serve thousands of devices. However, deployment of multiple gateways within the same vicinity may have an effect of the probability of correct packets delivery. i.e.: packets lost or collided at one gateway may still be received by another one. Thus this increases the overall network performance. The aim of the project is to plan and develop a simulation model for an efficient multiple gateways LoRaWAN network. This is achieved by extending the currently built single LoRaWAN simulation model "LoRaSim" and testing overall network performance using a defined metric: Date Extraction Rate (DER).

Tasks Outline:

1. Reviewing a pre-implemented LoRaWAN simulation model using Omnet++ that will guide you through LoRaWAN simulations development.
2. Conducting intensive literature review on LoRa technology limitations, it's advantages and use cases.
    - Surveying properties and limitations of multiple gateways deployment where there is no notion of gateway-device association.
3. Efficiently plan multiple LoRa gateway network
4. Simulation of the proposed deployment by extending current "OLoRaSim" single gateway simulation model.
5. Exploring the impact of multiple gateways on network success rate and network probability success.
6. Perform a research for related publications and current state-of-the-art

Eligible Departments:

Networking

Software/Hardware:

Omnet++ & Matlab

Relevant References:

- B. Ousat and M. Ghaderi, "LoRa Network Planning: Gateway Placement and Device Configuration," *2019 IEEE International Congress on Internet of Things (ICIOT)*, Milan, Italy, 2019, pp. 25-32.
- Adelantado F. & al., "Understanding the limits of LoRaWAN", IEEE Commun. Mag., vol. 55, no. 9, pp 34-40, Sept. 2017.
- Christiaan Bor M. & al., "Do LoRa Low-Power Wide-Area Networks Scale?", MSWiM '16 At Malta, Nov. 2016

Investigating the impact of medium access control mechanisms on energy consumption and network capacity for LoRa IoT networks

Project Overview:

Given the incredible worldwide uptake of Long-Range (LoRa) networks for a large variety of innovative Internet of- Things (IoT) applications and the high flexibility in deploying private ad-hoc LoRa networks, it is important to consider dense environments and to improve the robustness of LoRa transmissions with more advanced channel access mechanisms. The MAC mechanism incorporating sensing consumes more battery power compared to conventional Aloha-like LoRaWAN. Yet, it enhances network performance by decreasing collision rate. This project will examine the battery power consumption trade-off experienced when utilizing a Carrier Sense MAC mechanism. The project undergo the various steps towards the development and implementation of a LoRa end-device energy model. Simulation results should be run to test the LoRa network performance under CSMA compared to conventionally used AlOHA MAC.

Tasks Outline:

1. Reviewing a pre-implemented LoRaWAN simulation model using Omnet++ that will guide you through LoRaWAN simulations development.
2. Conducting intensive literature review on LoRa technology limitations, it's advantages and use cases.
    - Surveying currently used CSMA medium access control techniques and battery consumption models in LoRaWA networks.
3. Implementing a LoRa end-device battery power consumption model and deploying it in a realistic LoRa simulated model.
4. Exploring the impact of various medium access techniques on LoRa end-device battery consumption and inspecting the gain in relation with network collision rate and network probability success.
5. Exploring the utilization of different MAC solutions in different parts of a LoRaWAN cell, orchestrated by a smart gateway.
4. Perform a research for related publications and current state-of-the-art

Eligible Departments:

Networking

Software/Hardware:

Omnet++ & Matlab

Relevant References:

- A. B. Khalifa and R. Stanica, "Performance Evaluation of Channel Access Methods for Dedicated IoT Networks," *2019 Wireless Days (WD)*, Manchester, United Kingdom, 2019, pp. 1-6.
- T. To and A. Duda, "Simulation of LoRa in NS-3: Improving LoRa Performance with CSMA," *2018 IEEE International Conference on Communications (ICC)*, Kansas City, MO, 2018, pp. 1-7.
- Adelantado F. & al., "Understanding the limits of LoRaWAN", IEEE Commun. Mag., vol. 55, no. 9, pp 34-40, Sept. 2017.