GR190

DRL-FHSS: Dynamic Reinforcement Learning based Frequency Hopping Spread Spectrum Algorithm for Maximizing Data Rate and Minimizing Collision in Edge-enabled LoRaWAN

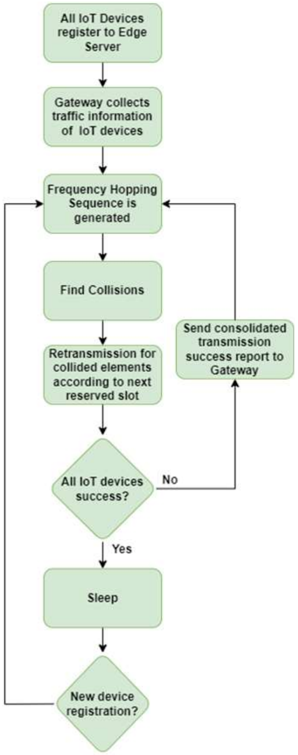
Abstract

With increase in use of IoT devices in various applications, there is need of low power consumption solutions for these sensor networks. IoT applications are resorting to LoRa networks which is long range and low power-based solution. The main disadvantage of LoRa however is exactly what enables its strengths, namely the low bandwidth. Furthermore, the protocol doesn't allow continuous sending, due to rules on the frequency band it utilizes. Because of this, LoRa is only suited for short and periodical communications. Frequency Hopping further improves channel utilization. But due to its current pseudo random nature, it faces high collision rate. We have proposed an edge based LoRa architecture which is network sliced based on IoT device network requirement by SDN controllers. Edge Servers have all IoT devices registered and generates frequency hopping sequence for all of them This method helps to reduce collision and improve data rate.

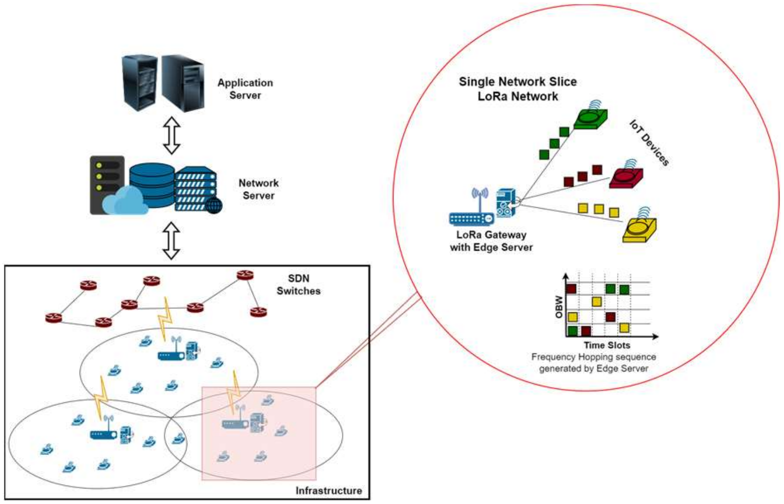
Motivation

1. Large number of IoT applications deployed in a network reduces data rate and increases collision
2. Pseudo random hopping sequence fails to provide better solution as users increase
3. Duty cycle being 1% or 400 ms per 20 second being less for real-time traffic, there is need to utilize underutilized channels

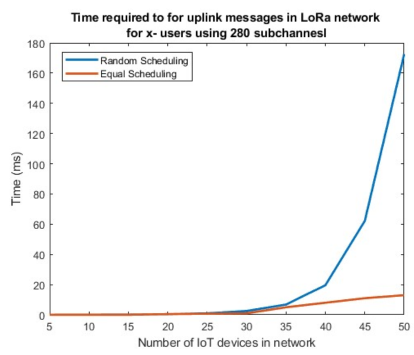
Methodology



Architecture



Analysis



We show how time required to transmit messages increases when number of IoT devices in network increase. We observe that increase in time for random scheduling where frequency hopping sequence is randomly generated is exponential for higher devices. On other hand, the equal scheduling, where each device is assigned a frequency by edge server and see to it that other device is not assigned that frequency decreases collision. This further reduces time to send all data.

Conclusions

Pseudo random assignment of channels has high collision rate. When there is central entity, in our case an edge server, it decides hopping sequence which reduces collision. Hence data rate and overall throughput increases. Dynamic Reinforcement learning algorithm would help to optimize the sequence by considering busy channels, most frequently used channels. Moreover, network slicing based on urgency and volume of traffic helps to virtually assign more channels to hungry IoT devices. This helps in reducing their wait time and improve performance.

Future work

As part of future work, we design the dynamic scheduling algorithm for hopping sequence. This algorithm would aim to increase throughput and data rate by reducing collision. It would consider current channel conditions to predict future sequence.

Acknowledgments

We would like to thank my Professor, Dr. Ahyoung Lee for guidance and motivation provided to us time to time. I would like to thank Department of Computer Science and Software Engineering to provide me this opportunity.

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