Title: Resource Allocation Techniques for extending the performance of Long-Range Network

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Bio:

I am Dr. Preti Kumari, a postdoctoral fellow at the National University of Singapore, where I work in the area of applying machine learning and deep learning for Beyond 5G/6G Radio Access Network. Before this, I served as a Scientist in DRDO, contributing to the "Automatic Radar and ESM Track Association" project. I developed an application based on the Angle of Arrival and Time parameters using a machine-learning approach. Additionally, I previously worked on the "Mission Planning and Analysis System" project using the ArcGIS tool. I completed my Ph.D. from IIT-BHU in 2020 and my Masters from IIT Patna in 2016. My areas of interest include Long-Range Networks, Wireless Communication Networks, the Internet of Things (IoT), Game Theory, machine learning, and deep learning.

Abstract:

The Internet of Things (IoT) framework can be widely used to remotely monitor and manage everything such as lighting, traffic congestion, road warnings, and early detection of things. One of the energy-efficient wireless communication technology of Low Power Wide Area Network (LPWAN) is Long-Range (LoRa) that supports sustainable IoT due to its capability to offer tradeoffs among power consumption, communication range, and data rate. The LoRa architecture consists of end users, nodes, gateways, servers, and applications. Nodes acquire and transfer the data to the gateways by using LoRaWAN protocol. LoRa supports high-density deployment of nodes because of its physical layer which offers degrees of freedom in carrier frequency, bandwidth, coding rate, and spreading factors to orthogonalize transmissions. The spreading factors act as virtual channels. A lower spreading factor provides high data rates but reduces transmission range, whereas, a higher spreading factor provides longer range at the low data rate. Despite the above advantages of LoRa, it suffers from the interference problem. The interference problem occurs when multiple nodes are connected with a gateway using the same spreading factor and thus subject to collisions. The transmissions of data with different SFs are also not completely immune to the adjacent SFs due to the imperfect orthogonality within SFs. Therefore, the performance of the network deteriorates due to the interference problem. An efficient way of allocation of the resources can reduce the interference problem.

In my research work, I proposed techniques to allocate the resources for extending the performance of the LoRa network. I first studied the allocation of spreading factors based on the needs and requirements of the nodes, which helps to handle the interference problem. I estimated the required time of a node for accessing the spreading factors, such that it satisfies its service requirement and the network maximizes its utility. Unlike earlier work in the literature, I used an end-to-end network to compute the effective transmission rate and time duration for using the allocated SF with the interference problem in the network. I proposed centralized and distributed algorithms to implement the solution. Next, I proposed an approach for optimal spreading factors allocation and scheduling the nodes that are connected to the gateway. I used a game theory-based approach for computing the time duration of nodes on suitable spreading factors which maximizes network utility. The obtained optimal time duration of nodes are then scheduled to minimize the waiting time. Further, I proposed an approach for identifying the best gateways within the communication range of the nodes and optimal time duration for data transmission on those gateways. Bayesian game have been used for modeling the LoRa network in which the nodes can have variable transmission power. I also demonstrated an application of the analysis to design a traffic information acquisition system based on the LoRa network. Finally, I

proposed an energy efficient smart metering approach for transferring information about energy consumption to the operator. The approach used CompressionDecompression model that incorporates deep learning techniques. The model compresses the multivariate data of the smart meter (from different consumer devices) at the node and transferes it to the gateway. The gateway decompresses the received data using a similar architecture as Compression model. Further, the gateway transfers the decompressed data to the electricity provider, which can be utilized for accurate decision making.