

# Chapter 7

## Conclusion and future work

This thesis has made four major research contributions to resource allocation in the LoRa network. The main focus of the study was to effectively allocate the resources for extending the performance of the LoRa Network.

In chapter 3, we considered a scenario where multiple LNs communicate with LGs for transferring the data. We used game theory for estimating the time of a LN for accessing the SFs such that it satisfies its service requirement and the network maximizes its revenue. We considered the effective transmission rate between LNs and the NS. Such transmission rate contributes more practically. We proposed centralized and distributed algorithms to implement the proposed solution. We conclude from this work that the effective use of SFs reduces the interference problem and increases the network revenue.

In chapter 4, we considered a scenario, where multiple LNs communicate with a single LG for transferring the data. We used a smart home scenario, where end users generate the sensory data and network transfers it to the server. We proposed an approach for optimal SF allocation and scheduling the LNs that are connected to the LG. We used Poset for finding the feasible subset of the SFs. We estimated the transmission time duration of each LN for using the SFs. The LNs are scheduled for using the SFs. This contribution helps to reduce the waiting time of the network.

In chapter 5, we proposed an approach for identifying best LGs within the communication range of the LNs and time duration for data transmission on those LGs. Different from previous contributions, here we considered incomplete information, *i.e.*, the LNs do not share the complete information with other LNs. We used BG for modeling the LoRa network which can have variable transmission power. We have demonstrated an application of the analysis to design an ITS based on LoRa network called TILR. TILR was deployed along the road-side to gather the information of EUs. It does not involve multi-hop communication or power-hungry technologies and reduces the effort of replacement of batteries.

Finally, in chapter 6, we proposed an Energy Efficient Smart Metering (EESM) system using edge computing in the LoRa network. We presented an algorithm for selecting the suitable SFs in LoRa network to communicate the compressed EMS from the consumer to the operators. The EESM system has achieved high energy efficiency and successfully transfers the EMS within the given time.

## Future directions

The effective resource allocation in the LoRa network presented in this thesis is still an ongoing research problem. The first contribution motivates further research in the cost-effective deployment of a LoRa network, *i.e.*, design a network which satisfies the service requirement of LNs with a minimum number of LGs in the network. The second contribution motivates us to schedule the LNs on multiple LGs. Multiple LGs cover a large field of interest with more LNs. We also planning to consider a fault tolerance LoRa network. Along with these contributions, secure communication of data is an essential future direction which is not covered in this thesis.