

Practical Performance Analysis of Multiuser ICS-LoRa Networks

Project Overview:

LoRa is a long-range energy-efficient patented modulation drastically used in the field of Internet of Things (IoT) especially in the low power wide area networks (LP-WAN) applications within smart cities. LoRa is a patented chirp spread spectrum modulation which has recently gained a huge interest both in research and practically. The number of countries with LoRaWAN deployments is fast approaching 150 countries (currently standing at 142 countries)¹. LoRa adopts the ALOHA medium access which results in multiple inevitable collisions that limit the LoRa capacity.

The Interleaved Chirp Spreading LoRa (ICS-LoRa) is a newly developed LoRa based modulation which results from the interleaving of the nominal LoRa chirps. The ICS-LoRa chirp signals possess good correlation properties with the LoRa chirp signals. Moreover, different ICS-LoRa interleaving patterns have been designed such that the cross-correlation among all the resultant interleaved chirp signals are minimized.

The project aims at enhancing the LoRa capacity by utilizing the different ICS-LoRa chirp signals in order to serve multiple users. The advantage of using these different ICS-LoRa chirp signals is that they have good cross-correlations with each other. Thus, the interference effect on each one from the others is mild compared to the case of LoRa interferers together with a LoRa user.

Project Expected Results:

The project results are not only simulations but also practically implementing it over a software-defined radio (**SDR**) platform using the python software and the USRP devices present in our labs at the GUC campus. SDR is a radio in which some or all of the radio functionalities are software defined. This provides practical and more reliable results compared to simulations. Thus, the project aims to implement a practical decoder for the ICS-LoRa chirp signal and testing its performance compared to the simulations.

Moreover, the commercial LoRa chip (which is also present in our GUC labs) could be used to test its receiving capabilities in case of ICS-LoRa interference on a LoRa signal.

It would be highly preferable to write a **conference paper** at the end of this project.

¹ <https://lora-alliance.org/>

Eligible Departments:

Communications	✓
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Software/Hardware:

Software: Python

Hardware: USRP, and the commercial Dragino LoRa Shield chip

Relevant References:

1. T. Elshabrawy and J. Robert, "Interleaved chirp spreading lora-based modulation," IEEE Internet of Things Journal, vol. 6, no. 2, pp. 3855–3863, April 2019.
2. P. Edward, E. Tarek, M. El-Aasser, M. Ashour and T. Elshabrawy, "Further LoRa Capacity Enhancement through Interleaved Chirp Spreading LoRa Expansion," 2019 International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob), Barcelona, Spain, 2019, pp. 1-6.
3. P. Edward, A. Muhammad, S. Elzeiny, M. Ashour, T. Elshabrawy and J. Robert, "Enhancing the Capture Capabilities of LoRa Receivers," SmartNets 2019; 2019 International Conference on Smart Applications, Communications and Networking, Sharm El Sheikh, Egypt, 2019, accepted and pending publishing.

Pre-requisites:

Wireless Communications, Modulation I, Modulation II, Python programming is a plus

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