Enhancing the Fairness in LoRa-based Linear Wireless Mesh Networks

N. Udugampola[*,1], *Y. Li*[*,2], *X. Ai*[3], *B. Li*[4], *and A. Seneviratne*[5]

1. Postgraduate Researcher, UNSW, Sydney NSW 2052. Email: n.udugampola@unsw.edu.au
2. Undergraduate, UNSW, Sydney NSW 2052. Email: yikun.li@student.unsw.edu.au
3. Postdoctoral Fellow, UNSW, Sydney NSW 2052. Email: x.ai@unsw.edu.au
4. Associate Professor, UNSW, Sydney NSW 2052. Email: binghao.li@unsw.edu.au
5. Professor, UNSW, Sydney NSW 2052. Email: a.seneviratne@unsw.edu.au

* These authors are equal contributors to this work and designated as co-first authors.

Keywords: LoRa, network fairness, linear wireless sensor networks, network simulations, multi-hop mesh networks, underground mines, tunnels

ABSTRACT

Although LoRa is commonly used in LoRaWAN, a single-hop protocol, there has been significant recent research on utilizing LoRa for multi-hop linear wireless sensor networks (LWSN). These networks are used to deploy LoRa tags (sensor nodes) in pipelines, tunnels, roads, railways, underground mines, etc. LoRa repeaters are placed along these infrastructures to establish a chain-type multi-hop network through which the sensor data traverses to a gateway located at the end of the network. Due to the low data rate in LoRa, the network bandwidth is highly limited, making it unfeasible to implement complex medium access control (MAC) protocols that involve the exchange of control and acknowledgment messages between the tags and the gateway. Therefore, simple ALOHA-based protocols, featuring randomized repeater waiting periods, are predominantly used for contention management, but they heavily suffer from the lack of network fairness. In these networks, since the packets generated by LoRa tags farthest from the gateway have to hop through many repeaters, their probability of successfully reaching the gateway is significantly lower compared to the tags closer to the gateway. In this paper, we specifically analyse this fairness issue and propose mechanisms to equalize the packet success rates of the tags throughout the network, thereby improving the overall fairness. The proposed solutions include enhancements to the repeater algorithm, waiting periods, transmission ranges, and placement strategies.