Direct LoRa Communication Between End Devices and Satellites for Flood Resilience Monitoring

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Abstract

This paper investigates the technical challenges of implementing direct LoRa communication be-tween terrestrial end devices and satellite-mounted gateways for flood resilience monitoring in remote areas. We analyze three critical challenges: Doppler effect caused by satellite motion, adaptive Media Access Control (MAC) requirements for energy-efficient operation, and interfer-ence mitigation in shared frequency bands. Through mathematical modeling and simulations, we demonstrate LoRa's inherent robustness to Doppler shifts up to 50 ppm, propose an adaptive MAC protocol that reduces energy consumption by 34-38%, and analysed cognitive radio and spread spectrum techniques for interference mitigation. Our results show that while significant technical hurdles remain, direct LoRa-satellite communication presents a viable solution for flood monitoring in areas lacking terrestrial infrastructure. The paper concludes with recommendations for system optimization and future research directions.

Keywords

LoRa, satellite IoT, flood monitoring, Doppler effect, adaptive MAC, interference mitigation.