Resource Hopping-based Grant-Free Multiple Access for LEO Satellite-Assisted 6G IoT Networks

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Abstract—In the era of sixth-generation (6G) wireless networks, the Internet of Things (IoT) is expected to play a pivotal role in providing a new level of quality of service (QoS) [1]. To satisfy the QoS, including global coverage discussed in 6G networks, IoT and non-terrestrial networks (NTN) integration is being actively explored [1, 2]. Among NTN technologies, low earth orbit (LEO) satellites have mainly attracted attention due to their low latency, reduced path loss compared to the other satellites, and ability to provide extensive coverage, making them ideal candidates to support massive IoT deployments for 6G. However, efficient NTN-enabled IoT systems face challenges, such as accommodating massive IoT devices, sporadic access, severe path loss, and traffic heterogeneity [3]. These factors can be addressed by developing efficient multiple-access schemes. Over the years, several multiple access technologies have been proposed to address various communication environments [4]. Among them, grant-free multiple access (GFMA) has emerged as a promising solution for NTN-IoT due to its ability to accommodate the unique characteristics of LEO-based systems, such as high mobility and dynamic channel conditions [5].

In this study, we propose a technique to improve the reliability and latency performance by applying resource hopping-based GFMA (RH-GFMA) [6, 7] to NTN-IoT environments. Specifically, RH-GFMA can utilize unique resource hopping patterns for each transmitter and jointly combine signals that have experienced various resource collisions to obtain channel diversity gains. Therefore, we propose RH-GFMA with a repetition framework for NTN-IoT systems considering LEO satellite environments with severe path loss. Through computer simulations, we verify that applying RH-GFMA with a repetition technique to NTN-IoT systems significantly improves the bit error rate (BER) performance.

Keywords— 6G, IoT networks, non-terrestrial networks, grant-free random access, low earth orbit (LEO), bit-error-rate (BER)

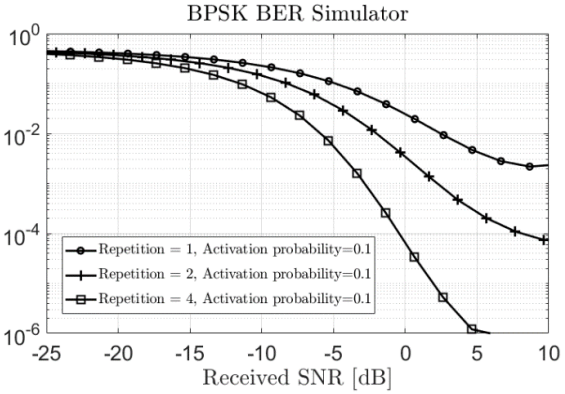

Figure 1. Simulation Results of RH-GFMA for NTN-IoT

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