

An Interleave-Division Multiple Access Technique for 6G Non-Terrestrial IoT Networks

Yong Jin Song

Department of Artificial Intelligence
Convergence Network
Ajou University
Suwon, South Korea
Email : wiclyjsong@ajou.ac.kr

Young-Seok Lee

Department of Artificial Intelligence
Convergence Network
Ajou University
Suwon, South Korea
Email : youngseoklee@ajou.ac.kr

Bang Chul Jung

Department of Electrical and Computer
Engineering
Ajou University
Suwon, South Korea
Email : bcjung@ajou.ac.kr

Abstract— In sixth-generation (6G) mobile communication systems, non-terrestrial networks (NTNs) are attracting significant attention as technologies capable of providing global coverage [1]. Representative NTN platforms include satellites, high-altitude platforms (HAPs), and unmanned aerial vehicles (UAVs). Among them, low Earth orbit (LEO) satellites are particularly highlighted due to their advantages such as wide coverage, low latency, and reduced path attenuation. Specifically, low Earth orbit (LEO) satellite-based Internet of Things (IoT) systems hold the potential to overcome the limitations of terrestrial networks by connecting numerous low-power, low-cost devices distributed across coverage-constrained environments such as maritime, aerial, and remote regions. These capabilities have recently become practically feasible thanks to advancements such as the deployment of LEO satellite constellations by companies like Starlink and OneWeb [2]. However, efficiently implementing such large-scale IoT systems requires multiple access technologies capable of reliably supporting the explosively increasing number of simultaneous device connections while operating within limited satellite resources [3, 4]. Interleave-division multiple access (IDMA) assigns a unique interleaver to each device to distinguish users and provides the advantage of maintaining low hardware complexity at the transmitter (i.e., the individual IoT device) [5]. Therefore, it is expected to be well suited for the NTN-IoT system considered in this paper.

In this paper, we propose an NTN-IoT system employing IDMA for low-power, low-cost IoT devices. Within the same beam/cell, each IoT device is assigned a unique interleaver, and repetition is introduced by considering the distance to the LEO satellite. Furthermore, with channel coding applied, the proposed system enables the receiver to perform iterative decoding. Since decoding is carried out independently for each device, the receiver complexity increases linearly with the number of devices, thereby ensuring high scalability. Simulations were conducted using the 3GPP NTN-TDLC5 channel model to accurately reflect practical environments, and the results verified that even with multiple IoT devices, the system can achieve frame error-rate performance comparable to that of a single-user system when sufficient repetition and iterative decoding are employed.

Keywords— 6G, Internet-of-Things (IoT), non-terrestrial networks (NTN), interleave-division multiple access (IDMA), low Earth orbit (LEO), frame-error rate (FER)

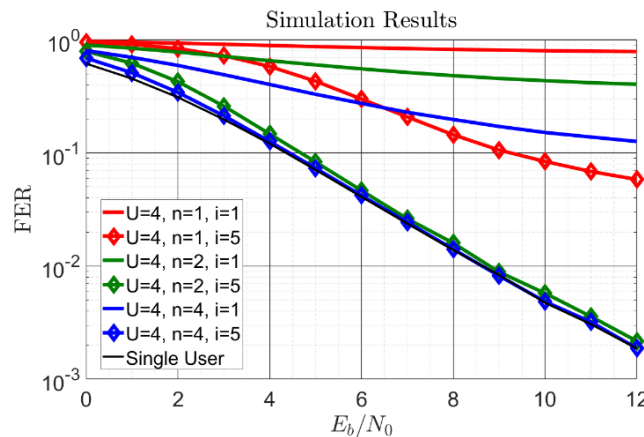


Figure 1. Simulation Results of IDMA for NTN-IoT

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