Machine Learning based Network Slice Scheduling in SDN-Controlled Integrated Satellite and Terrestrial Networks

Harun Ur Rashid and Seong Ho Jeong*
Hankuk University of Foreign Studies
harun@hufs.ac.kr, *shjeong@hufs.ac.kr

SDN 제어 통합 위성 및 지상 네트워크에서 ML 기반 네트워크 슬라이스 스케줄링

하룬 우르 라시드, 정성호*
한국외국어대학교

Abstract

The 6G wireless network is anticipated to provide worldwide coverage and ultra-low latency through the implementation of network slicing. These necessitate the seamless integration of satellite and terrestrial networks (STN), which can be simplified by artificial intelligence for optimized resource allocation. Typically, satellite networks support traffic offloading and extend coverage to rural and remote areas lacking gNB coverage. However, Ultra-Reliable Low Latency Communication (URLLC) network slices pose challenges when using satellites. Therefore, efficient scheduling of network slices, either for offloading or serving users, is imperative. This paper proposes a machine learning (ML) based approach for network slice scheduling, leveraging user diversity, wherein Software-Defined Networking (SDN) plays a pivotal role in orchestrating slices across integrated STNs. With this, quality of service (QoS) and service capabilities can be enhanced.

Ⅰ. Introduction

6G networks envision ambitious performance indices, including data rates exceeding Tb/s, latency below 1 ms, and reliability reaching 99.9999%. To achieve these goals, the integration of satellite constellations is essential to enhance coverage, capacity, and resilience. Additionally, advanced algorithms, particularly AI-based ones, are crucial for optimizing network resources and improving QoS provisioning, particularly in terms of data rates and latency. Building upon the concept of network slicing introduced in 5G, 6G networks include three major slices: enhanced Mobile Broadband (eMBB), Massive Mobile Type Communications (mMTC), and URLLC for latency-sensitive applications like autonomous driving. However, direct-to-satellite connections of delay-sensitive services require update and adjustment of existing protocols. To address these challenges and improve slice scheduling in 6G networks, this paper proposes an ML-based approach with SDN control for downlink slice scheduling across integrated STNs [1].

Ⅱ. Method

Integrated STNs offer improved and extended coverage, but URLLC requirements cannot be met by satellites due to the increased latency caused by propagation delay. Therefore, delay-sensitive applications are directed to terrestrial networks, while delay-tolerant applications are served by satellites during network overload. For services such as eMBB and V2X, traffic is initially routed through terrestrial networks, with satellites employed for offloading during network congestion, ensuring acceptable QoS. Additionally, satellite networks serve uncovered areas. This process is orchestrated by an SDN controller, with ML utilized to make decisions regarding service shifting between slices and between STNs. Hence, various networking data including CSI, CQI from both satellite and terrestrial sides, user-requested slice information, and user diversity will form the basis for constructing the ML model.

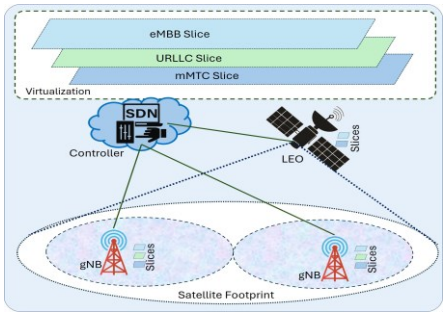

Fig. 1: ML based slice scheduling in the integrated STN

Ⅲ. Conclusion

We have presented an ML-based SDN-controlled slicing scheduling strategy for integrated STNs. With the proposed architecture, QoS and service capabilities can be increased.

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REFERENCES

[1] Mendoza, Fabian, et al. "An SDN based testbed for dynamic network slicing in satellite-terrestrial networks." 2021 IEEE international mediterranean conference on communications and networking (MeditCom). IEEE, 2021.