# Predictive Analysis of Uplink Resource Allocation in 5G Dual Connectivity using Machine Learning

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

# 5G 이중 연결에서 딥러닝을 이용한 업링크 자원 할당 예측 분석

하룬 우르 라시드, 정성호*
한국외국어대학교

## Abstract

To facilitate a seamless transition to 5G, most carriers opt for the Non-Standalone (NSA) mode, integrating with existing 4G infrastructure, a strategy known as dual connectivity (DC). This approach emerges as pivotal, enhancing network performance by combining 5G and 4G resources. Nonetheless, the uplink throughput in DC exhibits greater variability compared to conventional 4G networks due to the unreliable channel conditions of 5G radio affecting both mobile and stationary scenarios. The main objective of this study is to enhance the network efficiency by employing Long-Short Term Memory (LSTM) to analyze uplink resource allocation across multiple carriers' DC settings, considering diverse mobility patterns and cell-load conditions. The proposed LSTM models demonstrate enhanced predictive capabilities, achieving a minimal Mean Squared Error (MSE) of less than 0.04 during testing, thus offering a robust framework for optimizing uplink resource utilization in 5G DC environments.

## Ⅰ. Introduction

DC emerges as a crucial component of 5G networks, and service providers enable the smooth integration of 5G networks with current 4G infrastructure. In the context of 5G NSA, the 4G-5G DC allows the UE to engage in parallel data transmission via both 4G and 5G channels, establishing simultaneous connections with a 4G base station (BS) and a 5G BS. Similarly, in a 5G-5G DC scenario, both BSs manage the control plane. Within the coverage area of DC, applications such as autonomous vehicles often necessitate significant resources for uplink transmission.

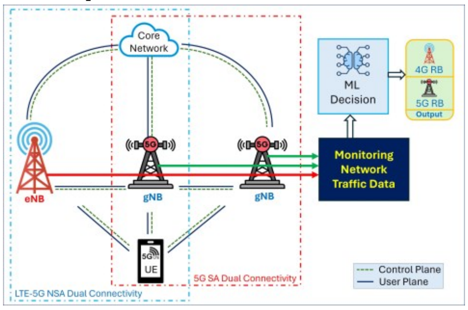


Fig. 1: ML based radio resource prediction in DC

However, these applications frequently encounter degraded performance, due to the frequent handovers experienced by 5G UEs compared to 4G networks. This increased handover frequency is a consequence of the smaller communication range characteristic of high-band signals and the operations of DC. The fluctuation of transport block size (TBS) arises from the positioning of UEs at the coverage boundary of a 5G BS, where the signal from the 5G BS is susceptible to attenuation or path loss, occurring with greater frequency. These analyses explain the challenges associated with accurately forecasting uplink radio resources in 5G DC networks [1]. To validate these assertions, we conducted an analysis of DC traffic data utilizing LSTM model to predict uplink radio resources in real-world 5G DC networks.

## Ⅱ. Method

The proposed approach employed DC traffic data encompassing RSRP, RB, RSRQ, and TBS, where TBS is identified as the targeted value for both 4G and 5G networks. A three-layer LSTM model was trained using a sliding window approach with a sequence length of 100, wherein the immediate first value was predicted as the targeted value. The results of model training depicted in Figure 2.

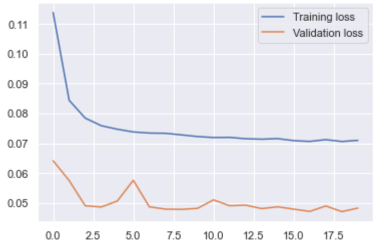


Fig. 2: Comparison of Training vs Validation Loss in Training

## Ⅲ. Conclusion

This paper identified the minimum MSE when predicting uplink radio resources in DC using a real DC dataset. Future research endeavors will concentrate on DL-based mobility management in DC settings.

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## REFERENCES

[1] Jung, J., Lee, S., Shin, J., & Kim, Y. (2023). Self-Attention-based Uplink Radio Resource Prediction in 5G Dual Connectivity. IEEE Internet of Things Journal.