LLM-Assisted Network Management Using Digital Twins

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디지털 트윈을 활용한 LLM 지원 네트워크 관리

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Abstract

Digital twin technology enables realistic evaluation of cellular network management by constructing virtual replicas of physical networks. In this paper, we study an LLM-assisted network management framework based on digital twins, where large language models reason over digital twin states to support non-real-time management decisions. The system model follows a measurement-driven digital twin cellular network, and management actions focus on infrastructure-level capacity enhancement in congested scenarios. Simulation results obtained from the digital twin demonstrate that the proposed approach effectively reduces peak resource utilization and improves load balance under realistic traffic conditions.

Ⅰ. Introduction

Traffic demand in dense cellular networks is often highly uneven, leading to persistent congestion at a subset of network elements. While real-time scheduling can mitigate short-term overload, long-term network management requires infrastructure-aware decisions supported by realistic system evaluation. Digital twin technology enables high-fidelity modeling of cellular networks[1], and recent advances in large language models (LLM) provide new opportunities for assisting such management by reasoning over digital twin states[2]. In this work, we investigate an LLM-assisted network management approach based on a digital twin cellular network, focusing on non-real-time infrastructure-level optimization under realistic traffic conditions.

Ⅱ. Simulation Results

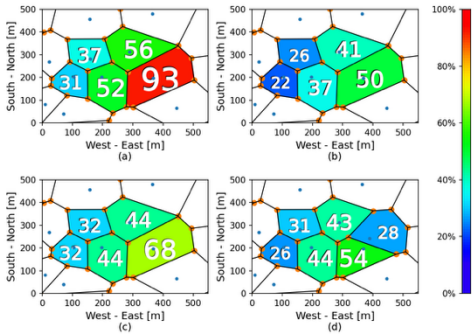

Fig. 1. Resource Utilization under LLM-Assisted Network Management.

The figure illustrates the spatial distribution of resource utilization under different network management configurations. In the baseline scenario, a clear congestion hotspot is observed, with the maximum resource utilization reaching approximately 93%, indicating that the cell is close to saturation. After applying the LLM-assisted network management solution generated based on the digital twin, the peak utilization is significantly reduced to around 50%, and the load becomes more evenly distributed across cells. These results demonstrate that LLM-assisted digital twin- based non-real-time network management can effectively alleviate persistent congestion and improve overall network capacity without additional spectrum.

Ⅲ. Conclusion

This work shows that LLM-assisted network management based on a digital twin can effectively reduce peak resource utilization and improve load balance in dense cellular networks without additional spectrum.

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