Multi-User and Multi-Satellite Dynamic Code Offloading Systems

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Abstract— As the digital landscape undergoes rapid transformation, the role of Low-Earth-Orbit (LEO) satellite communication becomes increasingly crucial. This paper presents a novel approach to LEO satellite edge computing, focusing on dynamic code offloading to observable multi-satellite edge servers. Users, strategically positioned, dynamically offload computationally intensive tasks to the most optimal satellite edge server, enhancing system performance. With a terrestrial gateway facilitating dynamic connections based on satellite visibility and user requirements, this model promises to address the challenges of high-performance internet access, offering a more efficient and sustainable satellite-based communication network for the future.

Keywords— Dynamic code offloading, LEO Satellites, Satellite edge server

In the rapidly evolving digital landscape, the significance of Low-Earth-Orbit (LEO) satellite communication is undeniably escalating. The advent of technologies like 5G, IoT, and AI underscores the imperative need for a robust and dynamic communication network. By 2022, it's projected that nearly 40% of the world's population will grapple with challenges related to high-performance internet access [1]. To address these challenges, LEO SAT communication emerges as a pivotal solution, not just rectifying terrestrial communication's coverage limitations but also alleviating latency issues inherent to traditional methodologies [2].

The dynamic code offloading model within LEO SAT edge computing is tailored to cater to the computational requirements of users by selectively offloading tasks to observable multi-satellite edge servers. Strategically positioned users generate tasks that necessitate dynamic offloading due to their computational intensity. In the celestial domain, a constellation of LEO SATs, orbiting in tandem, provides a network of observable edge servers that cover the target area. A terrestrial gateway (GW) serves as a pivotal point, capable of dynamically establishing connections with several observable satellites based on user requirements and satellite visibility. As satellites move across the sky, their connectivity with the GW and users dynamically changes, ensuring that connections are established with the most optimal satellite edge server based on factors like proximity, load, and task complexity [3]. The model's primary objective is to dynamically optimize task offloading in real-time, ensuring efficient system performance.

LEO SAT communication plays a pivotal role in meeting the communication demands of a digital world. This paper introduced a novel approach to LEO satellite edge computing, emphasizing dynamic code offloading to observable multi-satellite edge servers. Such an approach is anticipated to significantly enhance the efficiency and sustainability of satellite-based communication networks, paving the way for a more interconnected and responsive digital future.

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[1] Digital 2022: global overview report from Hootsuite.
[2] V. L. Foreman, A. Siddiqi, and O. D. Weck, “Large Satellite Constellation Orbital Debris Impacts: Case Studies of OneWeb and SpaceX Proposals,” in *Proc. AIAA Space and Astronautics Forum and Expo*, 2017.
[3] Y. Su, Y. Liu, Y. Zhou, J. Yuan, H. Cao and J. Shi, "Broadband LEO satellite communications: Architectures and key technologies", *IEEE Wireless Commun*., vol. 26, no. 2, pp. 55-61, Apr. 2019.