Paper ID: 85306
student

31st IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Constellations and Distributed Systems (7)

Author: Mr. Vincenzo Messina
Technische Universität München, Germany

Prof. Alessandro Golkar
Technische Universität München, Germany

LATENCY OPTIMIZATION IN CENTRALIZED AND DECENTRALIZED COORDINATION OF TIME-VARYING SCALED SATELLITE NETWORKS: THE IMPACT OF DATA SIZE

Abstract

Effective minimization of latency in satellite network infrastructures is critical for ensuring efficient data transmission, communication, and resource allocation in space operations. With the escalating number of satellites and the growing complexity of in-space activities, conventional centralized optimization methodologies face impending limitations, necessitating the exploration of decentralized coordination techniques.

This paper presents a study on the effect of data size on latency in both centralized and decentralized coordination of scaled satellite network infrastructure. Building upon previous research, our investigation focuses on formulating a time-varying dynamic graph framework tailored for decentralized optimization of satellite networks. This includes the performance characterization of dynamic space networks and the comparative analysis of advantages and limitations between centralized and decentralized optimization algorithms for satellite operations management.

Decentralized optimization distributes decision-making processes across multiple network nodes, enabling each node to make informed decisions based on local data, constraints, and partial knowledge of other nodes. Through exploring specific operational assumptions on network topology and communication, we present scenarios where decentralized approaches outperform traditional centralized satellite network management, offering enhanced reliability, reduced data latency, scalability, and robustness.

Our paper presents findings on the influence of data size on latency in both centralized and decentralized settings. We identify thresholds that delineate the operational advantages of decentralized coordination over centralized management in satellite networks. By illustrating our approach through applying it to an object detection use case, we endorse the use of decentralized coordination for dynamically allocation of resources within federations of satellites. Our research aims to establish fundamental conditions and operational criteria for designing future decentralized satellite networks, facilitating the proliferation of information among satellites in orbit and promoting sustainable utilization of limited in-space resources and autonomous space operations.