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Author: Mr. Owen Marr
SEDS, United States

ECONOMIC AND TECHNICAL FACTORS FOR DEPLOYING SPACE-BASED EDGE COMPUTING ON EARTH OBSERVATION SYSTEMS

Abstract

One of the fundamental challenges of Earth Observation is moving the data captured in space down to Earth. For many applications, the speed at which this occurs is critically sensitive. The space industry has come a long way from the days of CORONA film recovery over the Ocean, but we are still searching for ways to streamline the transmission of data. This paper examines the economic and technical factors to be considered for an emerging satellite communications paradigm: space-based edge computing.

The trend in recent decades has been focused on increasing the throughput of data. Earth Observation is highly data-intensive and as such higher data rates generally translate to faster turnaround times for getting data down to Earth. The inverse but more recently popularized idea for reducing turn time is to reduce the amount of data being transmitted. More specifically, the concept is to utilize in-space computing to distill results in real time while transmitting only the conclusions down to Earth. This can be thought of as a drastic compression algorithm which can substantially reduce the timeline between data capture and informing decision-makers on the ground.

This new architecture comes with associated costs and risks. There are complex technical trades dependent on the prioritization of temporal sensitivities relative to mass, power and development timelines. There are significant risks with both the hardware and software of space-based computing, as well as the consequences of incorrect distillation of conclusions from the raw data. Lastly, there are the programmatic concerns of developing and operating novel architectures with less certain cost and schedule structures.

The answer to whether or not space-based edge computing could be beneficial varies widely by type of organization and use case(s). This paper attempts to decompose this complex question into known segments, analyze those discrete questions, and provide the reader a more informed position from which to consider their unique use case(s). It does not conclude whether space-based edge computing is a blanket solution to Earth Observation's future; it empowers readers to consider where this architecture can be deployed to improve Earth Observation in the future.