IAF SPACE SYSTEMS SYMPOSIUM (D1)
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SYSTEMS ARCHITECTURE STUDY OF SATELLITE CONSTELLATIONS FOR INTERNET OF THINGS CONNECTIVITY

Abstract

The New Space community started launching satellite constellation projects for enabling global connectivity of the Internet of Things. IoT is expected to become a massive market of future connectivity, as millions of devices are getting connected through LoraWAN networks around the world. Relatively low connectivity requirements (¡ 50 kbps), large customer base (¿ 1-3 million devices) and a global-scale spatial distribution of IoT devices make up for an interesting use case for satellites being used for connecting LoraWAN networks at planetary scale.

Several competing space-based connectivity options are available to answer these needs, such as hosted payloads, dedicated nanosatellite constellations operating in Low Earth Orbit, or small satellite constellations at higher orbital altitudes. In order to characterize the engineering tradeoffs in light of the foreseen market requirements, this paper presents a comprehensive systems architecture analysis of Internet of Things connectivity via satellite constellations. Starting from an initial characterization of market demand in terms of market volume, performance (throughout and latency) and cost requirements, the analysis explores the effects of key architectural decisions having the greatest effect on system performance and lifecycle cost. We analyze system architectures varying by platform type (dedicated spacecraft versus hosted payloads), platform size, orbital altitude, number of orbital planes, number of satellites per plane, and communications architecture. We explore the corresponding tradespace of feasible system architectures and benchmark them against foreseen market requirements in terms of data volume, throughput, and latency.

The comprehensive architectural analysis provided in our paper is based on open-source data. As such, it provides a useful benchmark to objectively compare proposed and existing space-based IoT connectivity projects, and support decision-making in further development of these projects.