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A REVIEW OF SMALL SATELLITE CONSTELLATIONS FOR IOT CONNECTIVITY

Abstract

The global Internet of Things (IoT) market was valued at 160Bn euros in 2018 and it is projected to reach 930Bn euros by 2026, exhibiting a compound annual growth rate of 24.7% in the forecasted period. The Low Power Wide-Area Network (LPWAN) connectivity is expected to reach more than 1.1Bn devices by 2023. IoT allows to manage and monitor ecosystems of interconnected devices. LPWANs are a group of low/medium bandwidth wireless technologies used to deliver affordable and very power-efficient IoT connectivity to large numbers of devices over wide geographic areas. LPWAN technologies are suitable for IoT applications that require long-range connectivity, low power consumption, and near real-time communication, such as fleet management and asset monitoring. The problem arises when those assets are in remote areas where it is economically inefficient to deploy ground infrastructure networks. Thus, a number of LEO small satellite constellations from different players are planned to provide in the upcoming years affordable Low Power Global-Area Network (LPGAN), enabling the management of remote assets anytime, anywhere. This work provides an in-depth review of the LPGAN state-of-the-art, in particular in what concerns the available and upcoming small satellite constellations for IoT connectivity, as well as of their development, launching, deployment, or operational status. The different satellite payload technical specifications are covered first, introducing the satellite IoT communication technology currently available. A comparative analysis between all the current features on the technology used is provided, parameters related to the communications, such as frequencies, modulation, data rates, link budget, interference immunity are analyzed, as well as power and security requirements. Secondly, the satellite platform and mission analysis and design strategies used by each player to deploy their respective constellations are addressed. Orbital parameters such as orbital altitude, inclination, and planes are analyzed, but also the choice of launchers and main satellite platform drivers to host the payload. Thirdly, each of the referred satellite constellations uses radio spectrum resources to deliver IoT services, which will be reviewed accordingly, including their respective applicable international regulatory framework. Each of these scarce resources is unique, offering opportunities, but also posing challenges, thus not being surprised that such targeted resources depend on the business strategy, playing a major role in the technical solution planning and design, as well as on its operation and decommission phases. In short, this paper intends to constitute a useful resource for identifying challenges and emerging trends for IoT satellite connectivity.