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BLOCKSAT: ON-DEMAND ACCESS TO SHARED-USE SATELLITE CONSTELLATIONS

Abstract

As space launch costs drop and the feasibility of "small-satellite" distributed sensing and imaging improves, we note a growing interest in satellite swarms across academic, government, and industry labs. Many corporate proposals already explore satellite constellations as the backbone of a global, space-based Internet service [1], [2]. However, these constellation proposals are usually owned by a single entity or conglomerate, and operated to serve a particular business model.

Building on the theme of crowd-sharing models and innovative research in distributed system-control algorithms, we propose a constellation-management system and multi-functional cubesat hardware platform that would allow communal use of satellite functionality, including opportunities for non-conflicting concurrent processes and re-purposing of satellite hardware. By coupling communication and data ledger protocols (e.g. modified blockchains) with machine learning algorithms for smart task distribution and execution management, this research describes a way to orchestrate peer-to-peer network collaborations where satellite constellation functionality is dynamically rented, shared or reused between many applications. We envision multi-purpose, shared-use satellite constellations, bringing this category of space hardware into the "on-demand" services market (along the lines of Amazon Web Services, but for broad space applications) and moving beyond more narrow applications of Distributed Ledger Technologies (DLTs) currently deployed in orbit [3].

This model for allocation of a shared research resource, where a ledger is kept to distribute access fairly, builds on years of scientific collaboration processes [4] created around expensive, limited-use hardware resources (e.g., multinational collaborations that split time on large telescopes or the CERN particle accelerator [5]). This research proposes to automate and enhance this process, exploring remote-activation and operations of space-based resources.

This paper will discuss the BlockSat mission architecture and ConOps (Concept of Operations), showing how the integration of a multi-functional hardware platform and cloud-computing participation model can create a new class of small satellite operations. We aim to free satellite deployments from the limitations of single-use applications, and propose a new "open space" market that can democratize access to LEO space technology.

[1] OneWeb. https://www.oneweb.world/
[2] "Starlink Microsat Experiment Purposes". FCC. FCC. https://apps.fcc.gov/els/GetAtt.html?id=185534.
[3] BlockStream Satellite Network. Blockstream. https://blockstream.com/satellite/

[4] Adams, Jonathan. "Collaborations: The fourth age of research." Nature 497, no. 7451 (2013): 557.

[5] Miranda Mowbray, et al. "Automatic grid assembly by promoting collaboration in peer-to-peer grids." Journal of Parallel and Distributed Computing 67, no. 8 (2007): 957-966.