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FUTURE-PROOF MISSION CONTROL SYSTEMS: LEVERAGING AGNOSTIC DESIGN FOR AUTONOMOUS AND EVENT-DRIVEN SATELLITE OPERATIONS

Abstract

The number of small satellite missions launched over the past decade has increased by more than 150%.

Driven largely by the expansion of constellations in low earth orbit (LEO), this number continues to accelerate, and thus the demand for innovative mission-enabling capabilities has surged as well. In particular, the development of autonomous, event-driven mission control systems (MCS) will be integral to the successful scalability of this industry. For the operation of individual satellites and constellations, the challenges of architecting an agile MCS are considerable, and the MCSs of the future must be built to adapt on the fly.

To address these challenges and meet the need for reactive and autonomous satellite operations, Loft Orbital has developed Cockpit, a unique and proprietary MCS founded upon the principles of agnosticism and modularity. Structured with a clear decoupling of back-end/front-end architectures, Cockpit revolves around a set of micro-services connected via APIs to enable key benefits such as extensive scalability, focused testability, and reduced dependency on the underlying computing architecture. Capable of providing a simple and comprehensive experience for payload control and tasking onboard dedicated or rideshare configured missions, Cockpit balances the degree of control authority provided to each payload - from separate customers and users - with the feasibility, safety, and optimality of the overall mission. This design enables the same system to control multiple satellites from multiple vendors, each having multiple payloads from distinct customers, relying on various ground station networks – in a way that is completely abstracted away from the user and operator.

This paper presents the underlying frameworks and architectural approaches used in developing Cockpit as a future-proof MCS. It includes key innovations on partitioning the bus, ground stations, and payloads agnostically from the specific problem space, and leveraging GraphQL API technology to expose highly dynamical datasets. Altogether these capabilities provide a scalable, decentralized, and mission-agnostic system to better address the multi-node/constellation operations future smallsat missions will require.