SPACE OPERATIONS SYMPOSIUM (B6)
New Operations Concepts and Commercial Space Operations (2)

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MISSION-INDEPENDENT, PROTOCOL-DRIVEN GROUND SOFTWARE: A SYSTEMS ENGINEERING APPROACH TO A MULTI-MISSION "APP-STORE"

Abstract

Ground applications used to manage missions are coupled to the technical implementation and frameworks supporting each mission; visualization, data translation, decommutation, and other services are bound by language, hardware, operating system, and Commercial-Off-The-Shelf (COTS) product selection. For long-duration missions this coupling constrains hardware and software refresh options and limits migration to newer technical means such as mobile devices, cloud services, and server consolidations. Similar constraints are seen by enterprises supporting multiple, heterogeneous missions, where coupling either requires duplicative software engineering or engineering to the lowest common mission parameters.

The use of software protocols amongst applications and between applications and infrastructure prevents changes to one part of the ground system from altering the remainder of the system. This insulation allows applications to be written in a variety of languages and optimized for a variety of hardware platforms regardless of the technical constraints of a particular mission back-end. Practically, this approach creates a software "app-store": any mission supporting the core, standardized protocols may benefit from an existing library of applications without further development or testing. This allows the adoption of new applications and end-user hardware refreshes on long-duration and legacy missions without significant modification to mission infrastructure.

This paper presents a systems-engineering approach to building a lightweight, flexible protocol-based ecosystem for ground software applications. We identify common ground segment interactions regarding configuration, telemetry, and commanding. We show how protocols built around these areas can be merged into an architecture supporting a variety of ground software and operation-center support. This analysis includes a presentation of use cases from a variety of long-duration, active NASA missions including STEREO, New Horizons, and MESSENGER. Finally, we present the results of a case study in telemetry visualization. In this study we describe a general-purpose telemetry request protocol (TRP), a protocol adapter for a mission ground system, and a visualizer "app" fed from this protocol.

We present a novel approach to the deployment of protocols within an organization to reduce the cost and schedule associated with changes to both mission infrastructure and operation centers. We conclude that this approach is technically feasible and based in emerging infrastructure best practices from the mobile device market using the "app store" paradigm. We further conclude that this approach is optimal for organizations that must accommodate future mission diversity while remaining compatibility with operational legacy systems.