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THE COLUMBUS DATA MANAGEMENT INFRASTRUCTURE (CDMI): A CLOUD ABOVE THE SKY ON THE ISS

Abstract

The ease of communication between payloads and their ground users is critical to the effectiveness of the ISS Columbus Module as a platform for (private) payloads. A recent development, the Multi-Purpose Communications Computer (MPCC), has made IP-based communication between Columbus and the Columbus Control Center (COL-CC) possible through both the NASA KU-IPS and COL-KA communication channels. This paper introduces the Columbus Data Management Infrastructure (CDMI), which aims to enhance the capabilities of MPCC by introducing new features and improving the system's resilience on both hardware and software levels.

CDMI comprises three single-board computers to be installed on board Columbus, along with a set of virtual machines to be hosted at COL-CC. The CDMI computers consist of CompactPCI COTS elements, which are an industrial standard providing robustness, scalability, hot-swappability, industry adoption, versatility, and long lifecycle support. Their setup is particularly designed to deal with space-specific challenges of power limitations, cooling solutions, and radiation susceptibility. They host CDMI's flight services as a cluster of hypervisors running the Proxmox Virtualization Environment (PVE). The PVE cluster enables a modular and redundant setup by containerizing services and replicating storage between nodes. The core services of CDMI ensure the continued functionality previously provided by MPCC. The IP Communications Service abstracts from the underlying KA and KU communication channels, while the File Exchange Service provides fast and resilient data transfer across both communication channels.

In addition, each payload will have its own redundant storage area within the cluster. This storage area is integrated with a flight SFTP server and Nextcloud on the ground making data easily accessible. Moreover, the use of a hypervisor enables payload users to request for personal virtual machines within CDMI. This has the potential to streamline flight data processing and further minimize the requirement for extensive data downlinks.

On the ground, CDMI follows the principle of distributing services across multiple virtual machines with a general preference for COTS software whenever possible. Monitoring services include Zabbix and Yamcs, which provide operators and payload users individual insights into CDMI's status. Operators can modify the system's configuration using Ansible via the AWX web interface. Furthermore, Ansible is crucial for CDMI's deployment process as its infrastructure is entirely represented as code. This enables fast release cycles by including security testing in our DevSecOps process. CDMI's services can be effortlessly updated and configured using Ansible both on the ground and in flight.