

Tools for Describing the Reference Architecture for Space Data Systems

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Focus Issues:

- Architectural representation and analysis
- Standards and interoperability
- Space and ground communication architectures
- System architecture models and tools

ABSTRACT

Architectures for terrestrial data systems that are built and managed by a single organization are inherently complex. In order to understand any large-scale system architecture, and to judge its applicability for its nominal task, a description of the system must be produced that exposes a number of distinct viewpoints. At a minimum such descriptions will typically cover the uses that are to be made of the system, the functions that the system performs, the elements that compose the system, the information that flows among these elements, and the specific technologies that are integrated into the system.

There are a variety of approaches that can be used to describe such system architectures and to capture these various viewpoints and their relationships. UML is a powerful and currently popular tool for describing software systems, but it does not include all of the constructs for readily describing distributed system architectures and hardware. A standard called Reference Model for Open Distributed Processing (RM-ODP) has been developed within ISO and ITU to provide a common way to describe large, multi-organization systems. This modeling approach provides views on a system that go from the organizational (Enterprise) to the abstract (informational, computational), to the more concrete (Engineering, Technology).

Within the CCSDS Architecture Working Group we have adapted RM-ODP to describe large, multi-national, space data systems. These systems exhibit all of the complexities of typical terrestrial systems, but are frequently compounded by involvement of several space agencies, some unusual organizational cross-support arrangements, and use of contractors in a number of roles. We also must deal with the complexities of operating systems in space, including all of the physical constraints and challenges that that environment brings. The most fundamental challenge is the physical space environment (motion, obscuration, long round trip light times, episodic connectivity, low signal strength, asymmetric data paths) which constrains how these systems are engineered and operated, and often requires different applications and different protocols for communications than those that can be used terrestrially.

We have produced a methodology, based upon RM-ODP, which provides the necessary concepts and notation for describing these complex space data systems. The reference architecture is intended for use by two different, but related, user communities: the system users and the system and standards developers. The system users are typically concerned with what is “outside” the box that is the system. They want to know what it does for them, what the interfaces look like, and how they can use its services, but may not be particularly interested in how it provides these services. On the other hand, the developers of these systems, and the developers of the standards that ensure interoperability and cross-support, are vitally concerned with how the system provides these services for users and with how elements made by one organization can interoperate with, and provide cross support, to elements developed by another

organization. Our approach clearly identifies these two user viewpoints and describes their relationship as well.

The approach is intended to be general enough to permit description of civilian, military, and commercial space data systems, the spacecraft, ground systems, processing and communications resources, and organizational arrangements. We will describe the methodology and the set of viewpoints that we have derived, and describe their relationship to RM-ODP.

We are now exploring tools to capture these architectures and the behavior of the described elements in a machinable way, such that we can reason about the completeness and accuracy of the system as described. Eventually these tools are expected simulate at least the coarse grained overall behavior of such systems based upon their descriptions, and to provide means to assess performance and explore design trades. The granularity of such models is intended to be scalable to permit finer grained detail where it is required. This paper will also describe the results of our evaluations of these tools and the results of our initial experiments.