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MODULAR ARCHITECTURES FOR SATELLITE PRODUCT LINES: IMPLEMENTING PLUG-AND-PLAY TECHNOLOGIES FOR CROSS-PLATFORM INNOVATION

Abstract

Satellites come in many sizes to meet mission needs, ranging from small research and development (RD) satellites to large, high-power communication and navigation constellations. These systems improve life on earth by connecting societies, enhancing safety, supporting commerce, and advancing science. Unfortunately, the specialized nature of satellite systems slows the speed of technology insertion and reduces the responsiveness of satellite deployment. This has resulted in inflexible designs and incompatible implementations across spacecraft platforms. If this approach continues, space services will not be able to keep pace with the demands of the market, especially in the areas of mobile telephony, navigation services, mobile computing, and military applications. We believe that a product line approach enabling cross-platform compatibility from small to large satellites provides the adaptability to meet the needs of existing satellite service markets and new technology-driven ventures.

This paper describes our hardware and software architecture approach to plug and play satellites. We discuss the application of this architecture to achieve compatibility of components across a wide-ranging product line: from small RD satellites in the 2kW class, up to large communications satellites approaching 20kW. This cross-platform compatibility increases our ability to introduce new innovative technologies and improves our ability to respond to new and emerging markets for satellite services.

We describe the key features of our common product line architecture. In particular, we address our approach to the use of enabling designs for modular systems, including off-the-shelf components, hardware-in-the-loop testing, common software architectures, and standardized interfaces. We also discuss our progress toward the development of an integrated software and hardware approach to a plug-and-play design philosophy to increase adaptability, flexibility, and ease of deployment across our product portfolio. This "right-sized" adoption of plug-and-play supports a range of satellites currently in production and anticipates the future adoption of common interface standards by suppliers.

To illustrate our design approach, we describe our data-centric software architecture to support modular designs. The data model provides an abstraction of the high level satellite components to support distributed processing and early integration and test. This approach allows spacecraft subsystems to adopt a services-based approach for real-time satellite functions that is agnostic to both the processor and the operating system. We believe the use of modular, reconfigurable satellite technologies will dramatically improve industry's ability to deploy missions rapidly and introduce a new wave of innovative space missions based on plug-and-play satellites.