Open Architecture SDR for Space

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This paper describes an open-architecture SDR (software defined radio) infrastructure that is suitable for space-based operations (Space-SDR). SDR technologies will endow space and planetary exploration systems with dramatically increased capability, reduced power consumption, and significantly less mass than conventional systems, at costs reduced by vigorous competition, hardware commonality, dense integration, reduced obsolescence, interoperability, and software re-use. Significant progress has been recorded on developments like the Joint Tactical Radio System (JSTRS) Software Communication Architecture (SCA), which is oriented toward reconfigurable radios for defense forces operating in multiple theaters of engagement. The JTRS-SCA presents a consistent software interface for waveform development, and facilitates interoperability, waveform portability, software re-use, and technology evolution.

These achievements are leveraged in the work described in this paper to create an open architecture that provides the scalability and programmability necessary to meet current and future space radio requirements. High-level requirements and mission scenarios that depict behaviors necessary to assess the expected level of complexity for Space-SDRs and the architectural impact of current emerging space communications requirements are assessed, using Crew Return Vehicle and Landsat-7 as case studies. Requirements for software support of key space waveforms (TDRSS, SGLS, proximity ranging and attitude sensing, crosslink communications, and GPS) are discussed.

The open-architecture approach allows radios to share hardware and software modules and a common infrastructure. Currently, the majority of radios for space missions are custom designed to fit the mission budget requirements of size, weight, power, and cost. Development of space-worthy technologies will promote technology sharing in space communications system deployments, improving cost savings in space mission radio procurement. This paper also describes architecture tradeoff assessment tools, which aid in estimating cost, performance, size, weight, and power. The tools aid in assessing the waveform interfaces, hardware modules, functional block allocation, and infrastructure support required for Space-SDRs.

Several important challenges to development and deployment of Space-SDR technologies are also discussed. First, creating advanced SDR platforms with modular, reconfigurable, low-power, high-throughput characteristics is significantly constrained by technology gaps in space-qualified technology. Characteristics and requirements for the high-reliability custom components (e.g., memory modules and digital signal processing hardware) required to close these technology gaps are described. Second, although significant market potential has encouraged substantial industry investment to create and maintain JTRS standards and technologies, the market potential for space SDRs is unlikely to be as attractive, so an affordable and suitable architecture for space must be created that relies on existing and planned space-worthy technologies. The architecture requirements described in this paper represent the first step towards meeting this challenge.

Future exploration systems will rely on the reconfigurable communications capability of Space-SDRs to rapidly adapt to changing mission needs. Space-SDR will accelerate new technology insertion to rapidly capture technological advances, and will enable and proliferate advancements in communications and computational techniques, resulting in modular, scalable, highly robust systems that promote space exploration safety and effectiveness. An open-architecture will enable Space-SDRs to meet current and future space exploration requirements while promoting competition, innovation, and advancement in Space-SDR technologies.