Reconfigurable Transceiver and Software-Defined Radio Architecture and Technology Evaluated for NASA Space Communications

The NASA Glenn Research Center is investigating the development and suitability of a software-based open-architecture for space-based reconfigurable transceivers (RTs) and software-defined radios (SDRs). The main objectives of this project are to enable advanced operations and reduce mission costs. SDRs are becoming more common because of the capabilities of reconfigurable digital signal processing technologies such as field programmable gate arrays and digital signal processors, which place radio functions in firmware and software that were traditionally performed with analog hardware components.

Features of interest of this communications architecture include nonproprietary open standards and application programming interfaces to enable software reuse and portability, independent hardware and software development, and hardware and software functional separation. The goals for RT and SDR technologies for NASA space missions include prelaunch and on-orbit frequency and waveform reconfigurability and programmability, high data rate capability, and overall communications and processing flexibility. These operational advances over current state-of-art transceivers will be provided to reduce the power, mass, and cost of RTs and SDRs for space communications. The open architecture for NASA communications will support existing (legacy) communications needs and capabilities while providing a path to more capable, advanced waveform development and mission concepts (e.g., ad hoc constellations with self-healing networks and high-rate science data return).

A study was completed to assess the state of the art in RT architectures, implementations, and technologies. In-house researchers conducted literature searches and analysis, interviewed Government and industry contacts, and solicited information and white papers from industry on space-qualifiable RTsand SDRs and their associated technologies for space-based NASA applications. The white papers were evaluated, compiled, and used to assess RT and SDR system architectures and core technology elements to determine an appropriate investment strategy to advance these technologies to meet future mission needs.

The use of these radios in the space environment represents a challenge because of the space radiation suitability of the components, which drastically reduces the processing capability. The radios available for space are considered to be RTs (as opposed to SDRs), which are digitally programmable radios with selectable changes from an architecture combining analog and digital components. The limited flexibility of this design contrasts against the desire to have a power-efficient solution and open architecture.

The project team has two major upcoming activities, developing a space transceiver open-architecture for NASA missions and establishing an in-house test bed. The study and associated modeling effort are planned to explore the technologies, cost, benefits, and risks to establish an open-architecture for RTs and SDRs for NASA, possibly leveraging the Joint Tactical Radio System Software Communication Architecture (JTRS SCA) or its approach for use in space. The JTRS SCA is an example of an open-architecture SDR system being developed for terrestrial-based, tactical radios. It is part of a Department of Defense program to develop a family of multimode, multiband programmable radios with ad hoc, mobile networking and cross-banding capabilities based on a common, open architecture. Currently, this program has requirements for systems operating from 2 MHz to 2 GHz with recent extensions to 55 GHz for satellite communications terminals with wideband waveforms. The second activity is the establishment of a test bed that will be used for architectures and technologies testing and evaluation. The trade-off between reconfigurability versus traditional performance (speed, size, weight, power) will be examined. Specifically, architectures capable of high data rates will be investigated.

Find out more about this research:
Glenn's Digital Communications Technology Branch at
http://ctd.grc.nasa.gov/5650/5650.html
Joint Tactical Radio System at http://jtrs.army.mil/

Glenn contact: Richard C. Reinhart, 216-433-6588, Richard.C.Reinhart@nasa.gov
Authors: Richard C. Reinhart and Thomas J. Kacpura
Headquarters program office: OSF
Programs/Projects: SCDS