

A NEW APPROACH TO RADIO ASTRONOMY SIGNAL PROCESSING: PACKET SWITCHED, FPGA-BASED, UPGRADEABLE, MODULAR HARDWARE AND REUSABLE, PLATFORM-INDEPENDENT SIGNAL PROCESSING LIBRARIES

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Our group seeks to revolutionize the development of radio astronomy signal processing instrumentation by designing and demonstrating a scalable, upgradeable, FPGA-based computing platform and software design methodology that targets a range of real-time radio telescope signal processing applications. This project relies on the development of a small number of modular, connectible, upgradeable hardware components and platform-independent signal processing algorithms and libraries which can be reused and scaled as hardware capabilities expand. We have developed such a hardware platform and many of the necessary signal processing libraries for applications in antenna array correlation, wide-band spectroscopy, and pulsar surveys.

We present three hardware modules we have implemented for digitization, data preprocessing and packetization, and high end reconfigurable computing. Using this hardware and reusable signal processing libraries, we have developed applications in spectroscopy and antenna correlation as demonstrations of the technology and design methodology. Our implementations of a 128-million channel spectrometer with a selectable 200 MHz bandwidth and an 8-station, full Stokes, 1024 channel correlator demonstrate the agility and potential for rapid development that our system architecture and design toolflow allow. These instruments are currently deployed in a JPL SETI survey and prototype dipole array for redshifted 21cm detection of the Epoch of Reionization, respectively.

We also identify future directions for the development of this platform, such as packetization, RFI rejection libraries, and real-time imaging. These enhancements will expand the signal processing applications of this project, and introduce a new scalability in the ability to connect an arbitrary number of hardware modules into a Beowulf-like FPGA computing cluster.

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