

FPGA-BASED SPECTROMETERS, BEAM FORMERS, AND CORRELATORS

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We describe the design of real-time high-bandwidth spectrometers, beam formers, correlators, and imagers based on the recent development of a unified computational platform for high-performance signal processing that has enabled the rapid implementation of these instruments within a short timeframe. The instruments are built around field programmable gate arrays (FPGAs) and thus are dynamically reconfigurable, which allows the different applications to share a common hardware base. In addition, the concurrent creation of a complete supporting design flow speeds up application development for use on the hardware platform, while platform-independent parameterized signal processing algorithms and libraries keep core designs reusable. Along with standardized interconnect hardware and abstracted data interface protocols, a single hardware setup at a given location can even be time-shared between different applications as different instruments. The ability afforded by this architecture to focus on the data processing aspects of an instrument around a fixed platform has allowed our group to develop and deploy a number of instruments—three spectrometers, a VLBI data recorder, and several different approaches at a modular, expandable correlator in the time span of less than a year. With each module capable of up to one trillion operations per second (1 Top/s) and supporting packet-switched data transfer, the platform is well-suited for use at antenna arrays, where it is advantageous to have data-processing elements with high computational density that are easily scaled and can be dynamically reallocated. We present the architectures of current applications to demonstrate the flexibility and scalability of the system for highly-parallel, high-throughput, real-time signal processing. Characteristics of the instruments addressing the needs of large arrays of antennas are highlighted.

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