Open Source Hardware and Gateware for Wide-band Radio Astronomy Instrumentation

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We describe collaborative techniques for rapid development of high performance radio telescope digital instrumentation.

Traditional instrumentation for telescope arrays has been built from specialized custom chips, many different boards and racks, using custom cabling and protocols, taking several years to develop.

We present some of the new architectures and tools that make it relatively easy to develop a variety of scalable real time signal processing instrumentation. We utilize commercial 10 Gbit ethernet switches (to solve the large-N correlator and beamformer interconnect problem), together with general purpose open source field programmable array (FPGA) hardware and software modules. This general purpose FPGA computing hardware can be purchased at the last minute, and upgraded as an array grows, similar to purchasing and growing a computer cluster. We and our collaborators have used these techniques to rapidly develop and deploy a variety of correlators, beamformers, spectrometers, pulsar/transient machines, and VLBI instrumentation.

Increasing attention is being paid to replacing analog IF processors on the front end of these instruments by sampling faster, and on more general realtime computing nodes on the backend that can perform such algorithms as calibration, imaging, and RFI excision.

Open source source hardware, software, libraries, tools, and reference designs are currently utilized by 30 observatories and universities, and is available at http://casper.berkeley.edu