Past, Present and Future of the Collaboration for Astronomy Signal Processing and Electronics Research (CASPER)

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Designing, building, and upgrading real-time, in-situ, digital signal processing (DSP) instrumentation poses distinct challenges. These include the manipulation of data at several terabits per second (or higher) though a parallel computing environment. Such challenges can be solved by the development of specialized computing hardware, employing processing architectures that depart from those of traditional, general-purpose systems. Such specialization has traditionally meant that these systems have been developed independently for each project, with substantial investment and reinvestment of time and money. The Collaboration for Astronomical Signal Processing and Electronics Research (CASPER) works toward providing solutions to the processing requirements of DSP instrumentation, and reducing both the development time, and cost, of such systems.

Beginning at Berkeley in 2005 as an open source program for sharing the development of real time processing engines for astronomy, CASPER now has worldwide participation in the radio astronomy community. CASPER pools the expertise of constituent researchers and engineers around general purpose open source hardware and software resources for the timely development of real time instrumentation. A recent survey showed that CASPER underpins over 70 ratio astronomy instruments, including systems developed for MeerKat, the Five-hundred meter Spherical Aperture Telescope, and the Robert C. Byrd Green Bank Telescope.

A key part of the CASPER philosophy is that developing new hardware and software is expensive. As such, CASPER works toward supporting a set of Analog to Digital Converter (ADC) and Field Programmable Gate Array (FPGA) hardware which can be reused. This is coupled with a DSP library that supports the most common requirements for an instrument (such as polyphase filter banks and fast Fourier transforms). Additionally, CASPER makes use of a modular “switched architecture”, where the different elements of the system are connected via ethernet. This allows flexibility in the hardware, where anything capable of receiving ethernet packets can be attached to the network to complete the processing.

While compatible with different high speed data capture codes, and often used in hybrid systems where the data is formatted for ethernet on an FPGA before completing processing on a GPU, the toolflow has traditionally only officially supported FPGA design. In this next stage of development, CASPER is seeking to standardize and further integrate the GPU and high speed data capture pipelines into the ecosystem.