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What Next for CASPER? The Future of the Collaboration for Astronomy Signal Processing and Electronics Research

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1 Extended Abstract

For over a decade the Collaboration for Astronomy Signal Processing and Electronics Research (CASPER[1]) has been providing open-source FPGA-based hardware, programming tools, and reference designs to enable the wide-ranging scientific endeavors of the Radio Astronomy research community. Originally set up to develop the technological capabilities of UC Berkeley's Search for Extra-Terrestrial Intelligence (SETI) group, today CASPER's stated goal is "to streamline and simplify the design flow of radio astronomy instrumentation by promoting design reuse, through the development of platform-independent, open-source hardware and software."

With several hundred collaborators at dozens of academic and research institutions worldwide, CASPER instrumentation can be found at some of the world's largest radio-telescopes powering various astronomical spectrometers, beamformers and correlators. CASPER has had great success in designing instrumentation for targeted experiments (such as the Precision Array for Probing the Epoch of Reionization (PAPER) and the Search for Extraterrestrial Radio Emissions from Nearby Developed Intelligent Populations (SERENDIP)) as well as developing facility instruments such as the Robert C. Byrd Green Bank Telescope's Versatile Green Bank Astronomy Spectrometer (VEGAS) and Green Bank Ultimate Pulsar Processor (GUPPI). A recent survey of the CASPER community yielded a list of some 45 instruments powered by CASPER technologies [1]. More recently, a new generation of CASPER hardware is under-development to power the digital backend of the SKA precursor array, MeerKAT.

For years, the mantra of CASPER has been to develop modular designs, utilizing standard off-the-shelf interconnect solutions (primarily Ethernet) which are easy to upgrade as hardware tracks Moore's law growth. CASPER's programming environment has endeavored to both make it easy to effectively utilize FPGA hardware with limited specialist knowledge, and to provide a straight-forward process to update an existing design to target the latest CASPER hardware.

Historically, the CASPER programming environment has been based on MATLAB's Simulink design tool combined with Xilinx System Generator and Embedded Development Kit. These tools targeted a small number of dedicated hardware platforms designed by research institutions and based around Xilinx FPGAs. These include the Virtex 2 Pro based BEE2 and iBOB boards, the Virtex 5 based ROACH and the Virtex 6 based ROACH. However, with a growing number of attractively-priced off-the-shelf FPGA processor platforms now available, and a desire of CASPER collaborators to target FPGAs from vendors other than Xilinx, a new push is currently being made to make the CASPER environment more adaptable to new hardware and more approachable by hardware developers from outside the CASPER community.

In this talk I shall give a brief overview of some of the specific instruments enabled by CASPER technology, highlighting the power of the community development model championed by the collaboration. I will then discuss the avenues of development being pursued at UC Berkeley. These include the development of new FPGA design tools and control software, supporting both commercial hardware platforms and those under development by the collaboration.

References

[1] J. Hickish et al., "A Decade of Developing Radio-Astronomy Instrumentation using CASPER Open-Source Technology" *eprint arXiv:1611.01826*, November 2016.

[1] `https://casper.berkeley.edu`