

# High Performance Digital Instrumentation for Large Telescope Arrays

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## Abstract

Next generation antenna arrays will require correlators and beamformers with terabit/sec data rates and petaop/sec computation rates.

The Center for Astronomy Signal Processing and Electronics Research (CASPER), is a collaboration of thirty universities and observatories working together to develop hardware and software architectures to solve these peta-scale digital instrumentation problems.

We describe how we have utilized banks of general purpose FPGA boards, commercial 10 Gbit switches, and open source platform independent gateway modules to rapidly develop a variety of scalable and upgradeable array instrumentation, including correlators, beamformers, spectrometers, pulsar and VLBI backends.

For additional information, please see <http://casper.berkeley.edu>

## 1. Summary

Next generation radio telescopes arrays will require correlators and beamformers with terabit/sec data rates and 1E15 to 1E18 computations per second.

Traditional instrumentation has been built from highly specialized electronics (custom chips, many different boards and backplanes; custom cables and protocols, etc). Such instruments take five to ten years to design and debug; they are inflexible, expensive, require experts to maintain, and are usually out of date before they are working well.

We present some of the new architectures and tools that make it relatively easy to develop scalable and upgradable instrumentation.

We utilize open source FPGA hardware and platform independent software modules with commercial 10 Gbit ethernet switches to solve the large N interconnection problem. The general purpose FPGA computing hardware can be purchased at the last minute and upgraded as the array grows, similar to purchasing and growing a computer cluster.

We have used these techniques to rapidly develop and deploy a variety of correlators, beamformers, spectrometers, pulsar and VLBI backends.

The Center for Astronomy Signal Processing and Electronics Research (CASPER), is a collaboration of thirty universities and observatories. We provide open source hardware and software, workshops, web based documentation and training videos to enable experimenters to rapidly deploy high performance radio astronomy instrumentation. More information is available at <http://casper.berkeley.edu>

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