Scalable, Packetized Correlators for Large N Telescope Arrays

***Jason Manley*[1,5], *Don Backer*[1,2], *Aaron Parsons*[1,2], *Lyn Urry*[3], *Dan Werthimer*[1,3], *Henry Chen*[1], *David McMahon*[3], *Terry Filiba*[1,4], *Peter McMahon*[1,5], *Alan Langman*[5], *Arash Parsa*[1], *Mel Wright*[1,2,3]**

[1]Center for Astronomy Signal Processing and Electronics Research, University of California at Berkeley. Grizzly Peak Blvd. MS7450, Berkeley, CA 94720, USA. jason_manley@hotmail.com, dbacker@astro.berkeley.edu, aparsons@astron.berkeley.edu, danw@milkyway.ssl.berkeley.edu, arashparsa@berkeley.edu, wright@astron.berkeley.edu

[2]Astronomy Department, University of California at Berkeley, 601 Campbell Hall, Berkeley, CA 94720, USA. lurry@astron.berkeley.edu

[3]Radio Astronomy Laboratory, University of California at Berkeley, 601 Campbell Hall, Berkeley, CA 94720. USA. davidm@astro.berkeley.edu

[4] Department of Electrical Engineering and Computer Science. University of California at Berkeley, 253 Cory Hall, Berkeley, CA 94702, USA. tfiliba@eecs.berkeley.edu

[5]Karoo Array Telescope, SKA / KAT, Lonsdale Building, Lonsdale Road, Pinelands, 7405, South Africa. alan@ska.ac.za

Abstract

We describe new techniques for rapid development of high bandwidth correlators with hundreds to thousands of stations.

Traditional correlators have been built from highly specialized electronics (custom chips, many different boards and racks; 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five to ten years to design and debug; they are inflexible, expensive, require experts to maintain, and are usually out out of date before they are working well.

Next generation radio telescopes arrays will require FX correlators with 1E15 to 1E18 operations per second. We present some of the new architectures and tools that make it relatively easy to develop scalable and upgradable correlators.

We utilize commercial 10 Gbit ethernet switches to solve the large-N correlator interconnect problem, together with general purpose open source FPGA hardware and software modules. This enables computing hardware to 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 correlators, beam formers, spectrometers and other instruments of varying sizes. This paper focuses on the large-N correlator application.

In addition, examples of current packetized correlator implementations and further scaling techniques are described.