Digital Back End Processing at the ATA

William C. Barott[1*], Oren Milgrome[2], Melvyn Wright[2], Jill Tarter[3], Peter Backus[3], Tom Kilsdonk[3], and the ATA Team[2,3]
[(1)] Embry-Riddle Aeronautical University, Daytona Beach, [(2)] University of California, Berkeley, [(3)] SETI Institute, Mountain View

The Allen Telescope Array (ATA-42) consists of 42 wide-beam antennas to support commensal centimeter-wave observing. Independent observing programs use a selection of back-end digital signal processing hardware to analyze 104-MHz of bandwidth from any of four IF tunings. Recent additions to this back-end hardware have expanded the observing capabilities of the ATA. Four FX-style correlators perform simultaneous interferometry on separate tunings, and two dual-polarization beam-formers deliver single-pixel data to a variety of back-end users. Additionally, unprocessed or beam-formed complex voltage data can be recorded to disk for software-defined-radio-telescope (SDRT) analysis.

The ATA back-ends utilize a mix of architectures that include general purpose FPGA processors, commercial-off-the-shelf computing arrays, and off-line or near-real-time analysis on single computers. In each case the processing method is matched to the bandwidth and requirements of the application. These architecture choices are relevant to the SKA, which will require orders-of-magnitude higher data rates for beam-forming and correlation (of individual antennas as well as sub-beams). For the ATA as well as the SKA it is also necessary to efficiently transfer calibration and operational data between instruments.

We present the architecture and results from the beam-former back-end systems and its client instruments. The FPGA-based beam-formers reduce 42 inputs (70 Gbps) to a single beam (1.7 Gbps) while allowing for arbitrary steering and null-placement. The SETI computing arrays served by the beam-formers process in real-time, further reducing the amount that must be recorded to disk. Offline processing using the high-rate (many Gbps) data-to-disk modes allows correlation of sub-beams as well as high-resolution single-pixel spectroscopy.