Trident Frequency Slice Architecture
Correlator/Beamformer Reference Design for ngVLA
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The Trident Frequency Slice Architecture Correlator/Beamformer (CBF) Reference Design describes a digital correlator/beamformer system that meets the science requirements of the ngVLA synthesis radio telescope – specifically, processing 28 GHz of aggregate bandwidth per polarization for 263 antennas with baselines up to 10,000 km. The reference design uses the Frequency Slice Architecture (FSA) developed by NRC which aims to optimize cost by reducing the processing hardware requirements while increasing modularity. Incredible flexibility is provided by delivering many independent Frequency Slice Processors (FSP) which can be allocated to continuum, spectral line (zoom), or beamforming work depending on the needs of an observation. The reference design implements an FSA CBF using NRC's TALON technology currently under development for the Square Kilometer Array Mid Frequency Telescope Correlator/Beamformer. The TALON technology is fiber-connected Intel Stratix 10 FPGA based signal processing boards in 2U (air-cooled) or 1U (liquid cooled) rack mount server boxes.

Key requirements for the correlator and beamformer and planned FSP function modes are discussed. FSP function modes include correlation, VLBI beamforming, and several flavors of pulsar beamforming. Pulsar beamforming FSP function modes include: true-delay beamforming using all antennas, true-delay beamforming using a fixed set of 130 antennas and phase-delay beamforming with using up to 168 antennas with a beamforming aperture diameter of up to 30 km. Each pulsar beamforming function mode provides trade-offs between sensitivity, channelization and number of beams. Finally, a description of the high level signal processing architecture and physical architecture/technology is presented.

While ngVLA will use future FPGA technology still in development, the reference design represents a low-risk solution using currently available technology that can be accurately costed. Cost, power consumption, and rack space requirements can be extrapolated to future technology nodes based on industry projections.