



BLADE: Allen Telescope Array GPU Accelerated Real-Time Beamformer

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The Allen Telescope Array (ATA) is a radio interferometer currently composed of 42 antennas optimized for the Search for Extraterrestrial Intelligence (SETI). The array is made up of 6.1-meter diameter offset Gregorian telescope elements distributed randomly with a maximum baseline of 300 meters. The recently upgraded cryo-cooled log-periodic antenna feed (known as Antonio Feed) is sensitive to a wide and continuous range of frequencies ranging from 900 MHz to 12 GHz.

The Breakthrough Listen Accelerated DSP Engine (BLADE) is a C++20 GPU-based computer software developed in-house to process data produced by the ATA. It is being used in production at the Allen Telescope Array to combine signals received by individual antennas steering the sensitivity towards a target, a technique known as “beamforming”. BLADE is also capable of post-channelize the beam-formed data into high-resolution (<1.0 Hz/bin) spectrogram in real-time for SETI search. Currently, a twenty-antenna multi-beam observation routine at the Allen Telescope Array produces a 60 GHz of complex 8-bit integer stream of aggregated data that is processed (beamformed and channelized) in real-time by BLADE. Compute kernels are written in CUDA and leverage the power of NVIDIA GPUs.

In this talk, we are going to discuss how a software-defined telescope that processes observational data in real time can enable new scientific capabilities. The modular architecture of BLADE can handle the required data throughput at the same time as being easily extensible. As well, we will cover the importance of optimization techniques in processing data efficiently. Examples of techniques automatically applied in BLADE include CUDA Graphs, a just-in-time compilation of CUDA kernels, smart parallel batch processing, and smart heterogeneous memory management. The focus will be given on how the modular interface provided by BLADE implements optimization techniques in the background without developer input, allowing for more effective and efficient data processing.