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Software Enabled Wideband Spectroscopy for Breakthrough Listen

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Breakthrough Listen is a 10 year, $100 million project to search for signs of intelligent life beyond Earth. Two of the three initial facilities used by Breakthrough Listen are radio telescopes: the 100 meter Robert C. Byrd Green Bank Telescope (GBT) in Green Bank, West Virginia, USA and the 68 meter Parkes Radio Telescope (The Dish) in Parkes, New South Wales, Australia. Breakthrough Listen has partnered with these facilities to install a high performance computing cluster for use as the digital back end performing the SETI search. The aggregate instantaneous bandwidth available on the GBT is roughly 10 GHz: eight bands each nominally 1.25 GHz wide (depending on receiver). The aggregate instantaneous bandwidth at Parkes is roughly 4 GHz: thirteen beams each nominally 300 MHz wide using the Parkes multi-beam receiver.

Despite the various differences between the two telescopes, the Breakthrough Listen signal processing pipeline is quite similar at both sites. The analog IF signals are digitized and coarsely channelized using FPGA systems based on CASPER hardware and gateware. After coarse channelization the data are packetized and distributed across multiple computers, referred to as "compute nodes". Each compute node receives and processes a subset of these coarse channels using a software pipeline, producing several different radio astronomy output products. The corresponding output products from the compute node pipelines are subsequently recombined into final datasets. This paper describes the evolution of the Breakthrough Listen software pipelines from their initial deployment to their present day capabilities and discusses some of the challenges that were encountered along the way. Highlights of previously published results from data taken with the Breakthrough Listen backend are also presented.