Researchers propose new technology to improve observation sensitivity of QiTai radio telescope

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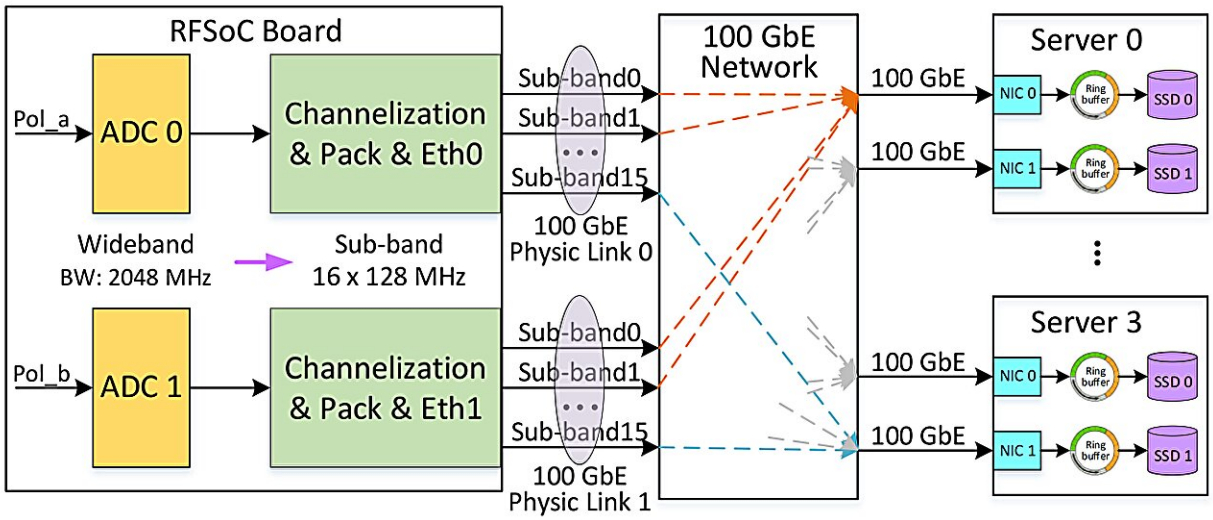

Architecture of UWB signal acquisition and processing system. Credit: XAO

The world's most powerful steerable 110-meter radio telescope, also known as the QiTai radio Telescope (QTT), will be built by Xinjiang Astronomical Observatory (XAO) of the Chinese Academy of Sciences (CAS) over a period of six years. Its ceremony kicked off on Sept. 21, 2022.

QTT will be equipped with multiple ultra-wideband (UWB) receivers,

which can improve the observation sensitivity of the telescope by increasing the bandwidth. However, it also poses challenges to signal acquisition, transmission and processing. In addition, the wider bandwidth will incorporate more electromagnetic interference signals, which will affect the quality of astronomical observation and cause a saturation effect on the system.

In order to avoid UWB signal phase and amplitude fluctuations caused by environmental and temperature changes in the analog transmission link, researchers from XAO designed a new UWB signal acquisition and processing experimental system that uses a high-performance, low-power RFSoC circuit to directly sample the radio-frequency signal at the receiver end. In addition, the new signal acquisition circuit uses higher quantization accuracy to increase the dynamic range of the received signal, thus avoiding saturation caused by strong interference.

The results were published in *Publications of the Astronomical Society of the Pacific* on July 24.

Aiming at real-time processing of UWB signals, the researchers divided UWB signals into multiple digital sub-bands, which are transmitted to the remote high-performance computer (HPC) cluster through 100 Gb high-speed digital fiber links for processing.

The proposed system is more flexible and expandable, and its control program can configure the involved computing resources according to the observation bandwidth and computational complexity. Furthermore, each HPC node is configured with NVMe SSD cards for high-speed baseband data recording to realize raw astronomical information capture and adaptive radio-frequency interference elimination.

To verify the actual observation effect of the system, the researchers deployed it on the Nanshan 26-meter radio telescope and conducted

pulsar observation experiments. They found that the signal-to-noise ratio of the band-merged pulsar is obviously stronger than that of the unmerged single subband data, which indicates that the system is working as expected.

More information: Xin Pei et al, QTT Ultra-wideband Signal Acquisition and Baseband Data Recording System Design Based on the RFSoC Platform, *Publications of the Astronomical Society of the Pacific* (2023). DOI: 10.1088/1538-3873/ace12d

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