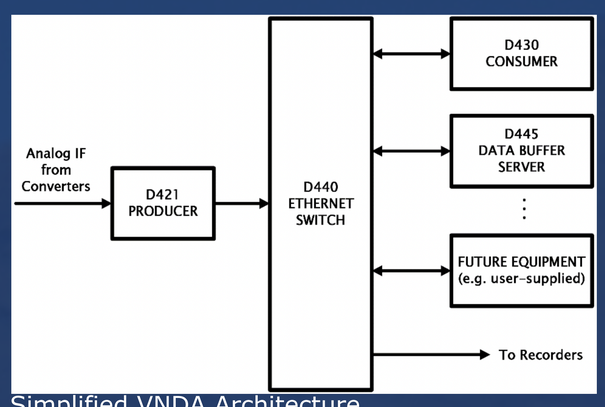
Ongoing Upgrades to the Very Long Baseline Array

Steven Tremblay (NRAO), Walter Brisken (NRAO),
and the NRAO NM Electronics Engineeriing Division

Abstract:
Operating since 1993 the Very Long Baseline Array (VLBA) has been a workhorse in radio astronomy, providing a dedicated year-round VLBI array with baselines ranging from 200-8000 km. The VLBA is currently undergoing a series of electronic upgrades (Digital Backend, GPS Timing, Real-time System) which will replace aging components, increase the reliability of the instrument, and finally enhance the capabilities of the array. These upgrades will also provide opportunities for research into better ways to observe, calibrate, and reduce VLBI data. The goal of this poster is to inform the community about these upgrades and what they can expect to see in the near future.

Digital Backend:
The current VLBA digital backend, the aging ROACH digital backend (RDBE), has been in place since 2011. We are currently in the process of updating this with a more modern and robust system we call the VLBA New Digital Backend (VNDA). Some of the key features being added by VNDA is higher sampling bit-rate (up to 8 bit science data) , time stability at the sample level, and reduction of the operations footprint. One of the core ideas in the VNDA implementation is a central ethernet switch which all of the data passes through. This makes the system very accessible for users to install their own guest equipment at each station for specifc science goals (i.e. Pulsar, SETI, etc.).



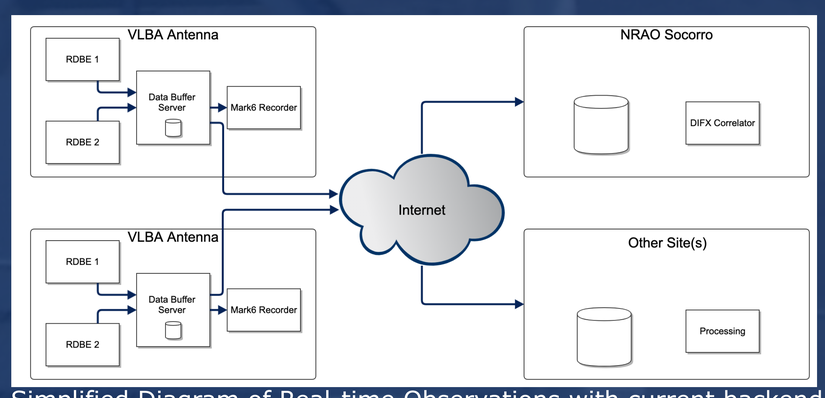
Simplified VNDA Architecture

Timing:
While each VLBA station uses a hydrogen maser as a frequency standard, the absolute timing at the stations is governed by GPS receivers. We are currently in the process of upgrading the GPS unit at each station to be a research grade GNSS tied into up to three new local geodetic monuments, which will greatly improve the timing accuracy at each station. In fact, this might fundamentally change the way timing is handled at VLBA stations in the future.

Image Credit: MOBATIME

Synthesizers:
Another currently ongoing upgrade is to the synthesizers that make up the local oscillator at each antenna. This upgrade will make it easier to 'tune' to a given frequency within the observing band, whereas there has been a more complicated and coarsely quantized set of observable center frequencies up until now. This should make it easier to tune around known RFI, as well as target certain spectral lines.

Real-time Observations:
The core data transfer process for the VLBA has always been to record locally at each station and then ship the physical media back to the Operations Center to be correlated. The implementation of the new data buffer servers (DBSs) will enable us to start implementing a robust system to transfer (and correlate) at least small bandwidths of data in real-time. Practically, this mode is currently limited by the data transfer capacity at each VLBA station.



Simplified Diagram of Real-time Observations with current backend

Interested in testing any of these upgrades?
If you, or your group, would like to test any of these before they are generally available in normal proposals contact us and let us know what you have in mind. In particular, if you think of innovative uses for these upgrades that we haven't covered we would obviously be very interested in collaborating through our Shared Risk Observing Program (QR code for details)..

Contact: strembla@nrao.edu, wbrisken@nrao.edu