IVS Technology Coordinator Report

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Abstract

The efforts of the Technology Coordinator in 2011 include the following areas: 1) support of work to implement the new VLBI2010 system, 2) e-VLBI development, 3) continuing development of global VLBI standards, 4) DiFX software correlator for geodetic-VLBI, and 5) creation of a new VLBI technical resources webpage. We will briefly describe each of these activities.

1. VLBI2010 Progress

Progress continues towards the goal of a next-generation VLBI2010 system. Much more detailed information about VLBI2010 development is presented elsewhere in this report; here we briefly report some of the highlights:

1.1. Development of the VLBI2010 Broadband System

The VLBI2010 system continues to develop at several locations:

1. A pair of VLBI2010 13-m 'twin-telescopes' has been installed at Wettzell and is currently under test. RMS surface accuracy is better than 60 micrometers, and the antenna and subreflector are aligned. A tri-band feed will be installed soon, followed by measurements of G/T and pointing tests. A new broadband "Eleven" feed and accompanying receiver and recording systems will be installed in the latter half of 2012.
2. Development of firmware for the FILA10G board for the dBBC continues at MPIfR and Metsahovi. This board is installed in the dBBC, developed by Gino Tuccari, to support bi-directional data-format conversions between VSI-H data format and 10GigE VDIF format.
3. The broadband 'QRFH' broadband feed from Caltech has been successfully tested on the VLBI2010 prototype antenna at NASA/GGAO and will soon also be installed on the Westford antenna. Experimental results for beam patterns and efficiencies closely match theoretical predictions. The QRFH feed can be easily re-designed to accommodate a wide variety of antenna geometries.
4. RDBE development continues at Haystack Observatory: The current working version accepts two 512 MHz IFs, channelizes each into fifteen adjacent 32 MHz-wide channels using polyphase filter band (PFB) technology; the user can choose any 16 of these channels to be sent to a 10GigE data link at an aggregate rate of 2 Gbps, which is then recorded on a Mark 5C data system in Mark 5B+ data format. A new 'quad-band' version under development will accept up to four 512 MHz IFs, for an aggregate output rate of 4 Gbps. Support for Tsys calibration has been completed and has been verified by tests at NRAO. A comprehensive set of tests comparing the RDBE performance against an exact software model has been highly successful, giving considerable confidence in its proper function.
5. Mark 5C VLBI data system: Mark 5C is now used routinely at 2 Gbps to a single 8-disk module and will enter service at 4 Gbps in early 2012. A 16 Gbps COTS-based Mark 6 system

is under development at Haystack Observatory; a successful 16 Gbps VLBI experiment using an early Mark 6 development system was conducted in November 2011. The Mark 6 is projected to enter service in mid/late 2012.

6. A number of VLBI2010 data-taking sessions between Westford and NASA/GSFC were undertaken during 2011. Most were recorded onto four Mark 5C units at each station using RDBE backend units as data sources, at an aggregate data rate of 8 Gbps/station. More of the processing of VLBI2010 data continues to be moved from the Mark IV correlator to the DiFX correlator at Haystack Observatory.
7. DiFX correlators at MPI, Haystack Observatory, and U.S. Naval Observatory continue to be developed and used for processing geodetic-VLBI data.

2. e-VLBI Development

2.1. Continuing Expansion and Development of Routine e-VLBI Data Transfers

MPI continues regular e-VLBI transfers of data for which the Bonn correlator is the correlation target. This includes data from Japan, Onsala, Ny-Ålesund, and Wettzell. All data recorded on K5 system at Tsukuba and Kashima are transferred either to MPI or Haystack depending on the target correlator. Syowa K5 data are physically shipped to Japan and electronically transferred to Haystack or MPI. UT1 Intensive data from Wettzell, Japan, and Ny-Ålesund are transferred to either MPI or the Washington correlator.

The Kokee station network connection is being upgraded from 100 Mbps to ∼600 Mbps to enhance turnaround for daily UT1 observations. Haystack Observatory has recently upgraded its network connection to 10 Gbps.

2.2. 10th International e-VLBI Workshop Held at South Africa

Participants in the 10th International e-VLBI Workshop (13-16 November 2011) were hosted by our South African colleagues at a beautiful and remote conference several kilometers from the Hartebeesthoek Radio Astronomy Observatory. The workshop was attended by 55 participants from 19 countries, including five countries in Africa.

The theme of the meeting was "Towards Global Real-Time e-VLBI". Within this context, e-VLBI has a lot to offer as a pathfinder technology for the proposed SKA telescope, and the presentations from both the e-VLBI and the SKA communities made for a particularly interesting forum. The workshop was three days in duration, with the first two days dedicated to scientific and technical presentations. The third day we were transported to the HartRAO observatory for tours and more presentations, focusing heavily on establishing VLBI on the greater African continent. A most enjoyable and useful meeting for all!

Presentations from the workshop are available on-line at *http://www.hartrao.ac.za/e-vlbi2011/e-vlbi2011.html*.

The 11th International e-VLBI Workshop will be held at MIT Haystack Observatory in Q3 2011.

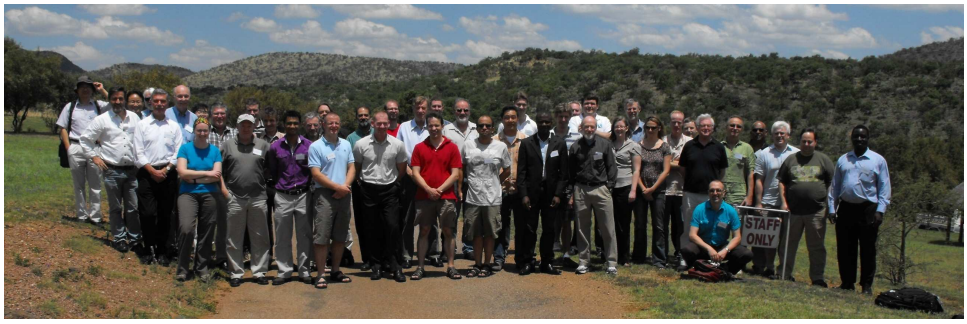

Figure 1. Attendees of the 2011 International e-VLBI Workshop held at Amanzingwe Conference Center, South Africa.

3. Global VLBI Standards

3.1. VLBI Standards Website Continues to Expand

http://www.vlbi.org has been established as a one-stop shop for access to global VLBI standards. These include VEX, VSI-H, VSI-S, VDIF, and standardized VLBI file-naming conventions, plus a brand new VLBI technical resources page. As new standards and technical VLBI resources emerge, they will be included in this website.

3.2. VDIF Data Format

Adoption of the VLBI Data Interchange Format (VDIF), ratified in 2008 at the Madrid e-VLBI workshop, continues to expand. The VLBI2010 project has adopted VDIF as the standard data format, and work is proceeding to fully implement it. Several other data systems now in development are also supporting the VDIF format, and VDIF is now moving strongly into the astronomical world as well. Broad adoption of VDIF across various VLBI disciplines will allow for more standardization and inter-operational capabilities that will benefit all of VLBI.

A VDIF2 data format is nearing completion to meet new demands, including the accommodation of arbitrary sample rates, including those that do not have an integral number of samples in a single second. Such 'non-standard' sample rates are being designed into some of the SKA-related systems that would like to participate in global VLBI. The new VDIF2 standard will also relax the constraint of an integral number of filled data packets per second and allow much more flexibility in the choice of packet lengths. This work should be completed by mid-2012.

3.3. VTP

A VLBI Transport Protocol (VTP) Task Force, led by Chris Phillips of ATNF, has developed a proposed standard which is now under review and is expected to be ratified early in 2012.

3.4. VEX2 Task Force Continues Work

The VEX file format is a standardized method to prescribe a complete description of a VLBI experiment, including setup, scheduling, data-taking and correlation, independent of any particular VLBI data-acquisition system or correlator. VEX has gained broad acceptance and is used to

support a large fraction of global VLBI observations, but it needs updating as new technologies and equipment become available. The VEX2 Task Force was created in late 2009 to undertake this job. The members of the VEX2 Task Force are Walter Brisken (NRAO, chair), Ed Himwich (NASA/GSFC), Mark Kettenis (JIVE), Cormac Reynolds (Curtin University), and Alan Whitney (MIT Haystack). This group continues working to craft the needed VEX updates and to incorporate them into several VLBI-support software packages. Again, the target for completion of this work is sometime in 2012.

4. DiFX Software Correlator for Geodetic VLBI

The so-called DiFX software correlator was originally developed at Swinburne University in Australia by Adam Deller, primarily for astronomical VLBI use. The development of an economical and powerful software correlator, a dream less than a decade ago, has been made possible by the relentless march of Moore's Law to provide powerful inexpensive clustered PCs with high-speed data interconnections that can distribute and correlate VLBI data in an efficient manner. Since the original DiFX development several years ago, the use of the DiFX correlator has spread, and a global DiFX user group has been formed to coordinate continued improvements and additions. Several institutions that support geodetic-VLBI correlation processing now have DiFX correlators (MPIfR, USNO, Haystack Observatory) and have been working to augment the core DiFX software to meet the needs of geodetic-VLBI. This includes the integration of much of the Mark IV-correlator software involving data-management, output data formats, fringe finding and delay estimates, and editing/quality-assurance software. In addition, a substantial amount of work has been done to integrate accurate multi-tone phase-calibration processing into the DiFX correlator, a task that is often not important for astronomical VLBI.

Progress towards developing the necessary additions and improvements to DiFX for geodetic VLBI has been rapid, allowing the DiFX correlator to take over the job of current hardware correlators. MPIfR closed its Mark IV hardware correlator at the end of CY2010. Haystack Observatory is planning to phase out its Mark IV correlator by the end of 2011, with USNO likely to follow soon thereafter.

5. VLBI Technical Resources Web Page

A new webpage with links to many on-line VLBI technical resources is now available at http://vlbi.org/resources.html. Presently 15 institutions worldwide have contributed to this webpage, and more are expected. If you are looking for technical information on a particular VLBI system or subsystem, check here first!