IVS Technology Coordinator Report

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Abstract

The efforts of the Technology Coordinator in 2005 were primarily in the following areas: 1) completion of the IVS Working Group 3 "VLBI2010" study, 2) continued development and deployment of e-VLBI, 3) support of the 4th annual e-VLBI Workshop held in Sydney, Australia. We will describe each of these briefly.

1. IVS Working Group 3 - VLBI2010

The report of IVS Working Group 3, aka 'VLBI2010', was released in September 2005. The report examined all aspects of the geodetic-VLBI system, including all hardware and software, and recommends the next steps to be taken to create a global VLBI system that is significantly better than the system in place today, with a strategic goal of 1mm global accuracy. Among the issues explored were:

- Modernization of VLBI data-acquisition systems for higher stability and reliability, wider bandwidth, lower cost
- Small, low-cost, fast-moving antennas
- New observing strategies
- Optimum and practical observing frequencies
- Fully automated observations; remote monitoring
- Transmission of data via high-speed network (e-VLBI)
- Possible correlator upgrades
- Fast turnaround of results by full pipelining of data from antennas to correlator to final analysis

The VLBI2010 study concluded that, in order to develop and deploy this next-generation system, two classes of projects should be undertaken in the immediate future:

1. System studies and simulations are needed in the areas of observing strategies, network deployment, and transition planning.
2. Development projects and prototyping are needed in the areas of small antenna systems, the correlator, backend, and data management and analysis.

Thirteen specific areas of study and prototype development were identified as key enablers of the next-generation system. Many thanks are due to all those contributing to the VLBI2010 study, including particularly the following subgroup leaders:

- Brian Corey - antennas, RF/IF systems, calibration
- Hayo Hase - antenna systems

- Ed Himwich - control, data management
- Hans Hinteregger - digital backend systems, correlators
- Tetsuro Kondo - data systems, data transport, real-time
- Yasuhiro Koyama - data systems, data transport
- Chopo Ma - post-correlation analysis; data management
- Zinovy Malkin - post-correlation analysis
- Arthur Niell - atmospheric calibration, analysis
- Bill Petrachenko - antenna arrays, multi-beam VLBI, frequency standards
- Wolfgang Schlueter - antennas, observing strategies, frequency standards
- Harald Schuh - post-correlation analysis, cross-technique use
- Dave Shaffer - observing strategies, systems, analysis
- Gino Tuccari - digital backend systems
- Nancy Vandenberg - scheduling, observing strategies
- Alan Whitney - data systems, data transport, correlators

The final report of Working Group 3, entitled 'VLBI2010: Current and Future Requirements for Geodetic VLBI Systems', is reproduced as a special report in this volume.

2. e-VLBI Development

e-VLBI development is continuing on a number of fronts, which we will briefly mention here:

2.1. VSI-E Beta Testing

A reference implementation of the proposed VSI-E specification has been developed and is undergoing testing. The primary purpose of VSI-E is to provide a standardized specification for e-VLBI data formats and protocols that is compatible between both homogeneous and heterogeneous VLBI data systems. The VSI-E framework provides signaling, control, framing and statistics support and is an extension to the Internet standard RFC3550. It also provides flexibility for users to choose the transport protocol that best suits their networking environment (e.g. UDP, TCP or other variants). The first live testing of VSI-E is currently ongoing between Kashima and Haystack. This is a particularly useful testbed since data are collected on the K5 at Kashima, while Haystack uses Mark 5A systems, enabling testing on heterogeneous systems. Once the reference implementation is fully checked out, attention can be turned to optimizing the code for high-speed operation, followed by broader deployment.

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

Routine use of e-VLBI continues to grow. All data recorded on K5 systems at Tsukuba and Kashima are currently transferred via e-VLBI to Haystack Observatory, where it is transferred to Mark 5 disk modules and sent to target correlators at Haystack, USNO or MPI; approximately 100TB have been transferred over the last year, including all Tsukuba data from the CONT05

experiment. Daily UT1 Intensive data from Wettzell are transferred via e-VLBI to a site near USNO in Washington, D.C., where it is picked up and taken to USNO for correlation. Additionally, monthly UT1 Intensive data are transferred from Tsukuba to MPI for correlation. Regular e-VLBI data transfers from Ny-Ålesund are expected to begin within the next few months.

Transfer rates, especially across international networks continue to improve. Japan/U.S. transfer rates as high as ∼900 Mbps have been observed, with sustained rates as high as ∼700 Mbps. Real-time e-VLBI experiments are being conducted within the U.S. and between Europe and U.S. In November 2005 a successful 3-station real-time e-VLBI demonstration was conducted by sending data at 512Mbps from Westford, GGAO and Onsala to the Mark IV correlator at Haystack Observatory. We hope to soon include Japan in these real-time demonstrations as well. The biggest impediment to rapid e-VLBI expansion continues to be station connectivity to high-speed networks, but the situation is improving. Tsukuba, Kashima, Onsala, Westford, and Medicina are all connected with 1 Gbps links, though some issues remain in actually using some of the links at full speed. Wettzell is connected at ∼30Mbps and TIGO at ∼2Mbps. Projects are underway to connect Ny-Ålesund, Hobart, Fortaleza and Svetloe in 2006.

3. 4th International e-VLBI Workshop Held in Sydney, Australia

The 4th e-VLBI Workshop was held in Sydney, Australia July 12-14 and followed the success of the previous e-VLBI workshops held at Haystack (2002), JIVE (2003) and Tokyo (2004). It was organized and hosted by the Australia Telescope National Facility (ATNF) at its headquarters in Marsfield, Sydney. The workshop was generously sponsored and supported by the Australia Academic and Research Network (AARNet) and the LBA partners ATNF, the University of Tasmania and Swinburne University of Technology. It was attended by about 60 participants from 9 countries.

The workshop presented a new opportunity to share the experience of progress and developments in e-VLBI around the world and to explore possibilities for coordination and cooperation. The standard of presentations was again very high and many new results and plans were presented. e-VLBI is set for rapid progress around the world in the next few years.

The recently funded European EXPReS e-VLBI project will result in a production e-VLBI network at 1 Gbps within the next 3 years. All presentations from the workshop are available online at *http://www.atnf.csiro.au/vlbi/evlbi2005/*.

CSIRO announced that funds will be made available to build the 'last mile' fibre tails to the ATNF antennas (ATCA, Mopra, Parkes) and connect these antennas via the AARNet3 regional network. The CSIRO contribution is about A$2M and represents a very significant step towards eVLBI in Australia.

The workshop was followed by a quick "observatories tour" of the ATNF telescopes at Narrabri (ATCA, 6 × 22m), Mopra (22m), Parkes (64m) and the NASA DSN station at Tidbinbilla (70m, 34m). These are spread over great distances in New South Wales, Australia and the tour covered 1800km over 3 days! The tour also included a visit at a local vineyard and winery and it was greatly enjoyed by all participants, despite the long driving distances.

The workshop completes the first cycle of annual e-VLBI workshops around the world. A new cycle will commence with the next e-VLBI workshop in 2006 to be hosted by the Haystack Observatory.