

ATNF ATUC MEMORANDUM

To: ATUC
From: Tasso Tzioumis
Date: 2 June 2004
Subject: VLBI developments

Background

Very Long Baseline Interferometry (VLBI) has traditionally used tape recording systems to record the digital data from the antennas and playback into a correlator at a later time. This has resulted in to some serious limitations for VLBI:

- the cost and size of the tape systems have limited the recorded bandwidth and hence the sensitivity of the whole array.
- the delayed correlation (often weeks and months) has limited both the rapid checking out of the system and quick response to transient events.
- the extra complexity in processing has often discouraged new users.

In the last few years, the high capacity and lower price of computer disk systems have led to the development of disk-based VLBI systems. These can record much higher bandwidths at a very competitive price. With the concurrent developments in higher bandwidth internet connections, it has become feasible to directly transmit the telescope data to the correlator via the internet and possibly correlate at near real time (e-VLBI). The disk based systems have been used as interfaces and buffers for e-VLBI. To date, limited tests of e-VLBI have been performed but much development is under way at many places around the world (USA, Europe, Japan,...).

Australian VLBI - the LBA

The LBA connects all the radio telescopes in Australia into a VLBI network, using VHS video cassettes for recording (S2-system). This format has limited bandwidth but it is still much cheaper than other systems, even the new disk-based systems. The processing is at the ATNF LBA correlator in Sydney.

Some tests have been done and more are planned using disk-based systems and software correlation, utilising the supercomputer at Swinburne University of Technology. "First-fringes" on Vela were obtained in November 2003, and tests continued in 2004. An 8-station "global" observation with disk systems was done in April 2004 and the results are under evaluation. However, fringes were obtained for many of the Australian telescopes with ~2 minutes of acquiring the data!

An investigation is also underway to get access to the ESA antenna at New Norcia for VLBI observations. The technical requirements have been outlined in an ATNF project, as presented to the previous ATUC meeting. Informal approaches have been made to ESA but progress is slow. Efforts in this area will continue, especially on the question of collaborative arrangements for access to this telescope.

Opportunities

Recently, optical fibre connections have become available for research purposes and the inland backbone of the AARNet3 network passes close to the ATNF observatories. The "last-mile" fibre connections to the telescopes are planned via developments in corporate CSIRO. These connections will become available in 2004 and thus it will be technically possible to implement direct data transmission from the telescopes to a correlator, and implement e-VLBI capabilities for the LBA.

The ATNF is also upgrading the ATCA and it is providing a new wideband correlator, capable of processing 2 GHz bandwidths and all polarisations. This capability at the ATCA is scheduled to be available within 3 years. This correlator could also be used to process data from other telescopes (Parkes, Mopra, Tid) in e-VLBI mode, provided the necessary high bandwidth connections (10+ Gbps) become available.

Such an instrument would be 5-8 times more sensitive than current systems and about 2-3 times more sensitive than most other proposed VLBI system anywhere in the world. Thus, there is an opportunity to lead in this area of very high sensitivity coupled with the unparalleled resolution of VLBI. No other system is likely to achieve this in the 3-5 year timeframe that the ATNF could develop it.

Issues

A convergence of developments seems to be presenting unique opportunities for ATNF to lead the world in e-VLBI capabilities. At this stage it is contingent in the development of an appropriate high capacity network but this appears to be already underway. Meanwhile the ATNF needs to:

- ensure that the new wideband correlator is potentially capable of e-VLBI
- encourage network developments to acquire the high bandwidth connectivity to all antennas.

These issues were presented to the ATNF Steering Committee in April 2004. The ATSC recognised the strategic importance of e-VLBI and encouraged ATNF to pursue these opportunities. The ATSC suggested that ATNF implement e-VLBI at 1 Gbps for the ATNF antennas as soon as practicable.

The ATNF will need to resource the actual implementation of e-VLBI over a 3-4 year timeframe. A draft project plan has been drawn up within ATNF, as per the attached documents.

Advice sought

ATUC's advice is sought on the following issues/questions:

- e-VLBI as the future of the VLBI network in Australia
- comments on the proposed implementation plan
- ATNF's role in facilitating e-VLBI developments at non-ATNF telescopes.