

Connecting the Global VLBI Array in the New Era of High Speed Networks

Summary of workshop at MIT Haystack Observatory, 8-9 April 2002

Alan R. Whitney, 18 April 2002

Introduction

Approximately 70 attendees representing 15 institutions worldwide participated in a 2-day workshop held at MIT Haystack Observatory on 8-9 April 2002. The purpose of this workshop was to explore the current state of high-speed astronomy data transmission, concentrating on the transmission of pre-correlation VLBI data, dubbed 'e-VLBI'. Among the topics discussed were:

- International networking facilities – now and future
- User requirements for high-speed networking
- Networking protocols for real-time data transmission
- Public vs. dedicated networks
- International standards for e-VLBI data transfer

Presentations from the workshop are available on-line at <http://web.haystack.mit.edu/e-vlbi/abstract.html>.

National and international networking facilities

Representatives from several major research networks outlined their current status and future plans. Within the U.S., the Internet2 research network provides backbone connections spanning the country at 10 Gbps, primarily between major research institutions and universities, but 'last-mile' connections to most antennas remains a major hurdle. In Europe, the Geant network is in the process of establishing a similar network; again, 'last-km' problems pose a major cost obstacle for direct connections. In Japan, several dedicated high-speed networks, as well as the research network Scinet, have already been used for e-VLBI at data rates to 2 Gbps. For the short term most global e-VLBI usage will have to share bandwidth with other users on research networks.

A number of international research links exist, but the only truly high-speed links are between Japan, U.S. and Europe. TransPAC, jointly sponsored by Japan and the U.S., links Chicago and Tokyo at ~600 Mbps, while Surfnet, the national research network of The Netherlands, links Chicago and Amsterdam at ~2.4 Gbps, with connections to other high-speed European networks. A new high-speed network links Japan and Korea. High-speed network connections between other international geographical areas do not yet appear to be available.

Though there exists a well-advertised excess capacity of installed national and international fiber, most of this fiber remains unlit and will likely continue to be unlit until commercial demand is sufficient. The time scale for such demand is unclear. Research uses of this excess capacity remains problematical at best, though there has been some success in some instances of fiber and communications companies allowing access to research users at low cost. That being said, most government-supported research networks are developing rapidly and are looking for users to fill their available bandwidth. *It was made quite clear that these networks are not likely to expand significantly unless there is sufficient usage and demand to justify such expansion.*

Protocols for e-VLBI

Based on current usage statistics, most shared high-speed research networks operate, on average, at only a small fraction of their available capacity. Usage tends to be 'bursty', with average length high-speed bursts ranging from seconds to minutes. e-VLBI has the potential to fill a significant fraction of this unused capacity, but it must do so in a non-obtrusive manner that does not significantly affect other users. This suggests that special protocols might be developed which keep e-VLBI as a lower-priority 'background' usage; but it also suggests that large buffers may be required at the correlators in order to accommodate large time 'jitter' (seconds, minutes, hours?) in data return.

e-VLBI experiments done or in progress

Several networks have already been established and demonstrated in Japan capable of data rates as high as 2 Gbps. Primarily, these have been over dedicated non-IP links, but work is now in progress to use shared IP networks as well. The Merlin array in England is in the process of developing and installing a multi-Gbps dedicated network. Haystack Observatory is preparing a Gbps e-VLBI demonstration experiment between Haystack and NASA/GSFC in Maryland using IP over shared networks.

The general consensus at the meeting among networking experts was that 1 Gbps over a WAN is now 'possible, but difficult', requiring special skills. However, it is the goal of the networking community to make 1 Gbps connections 'easy' in the near future.

Networking technology

The advent of relatively inexpensive wavelength-division multiplexing (WDM) on optical fibers is having a huge impact on the telecommunications industry and promises to considerably expand available bandwidths at a reasonable cost. 'Private' e-VLBI wavelengths on existing lit fibers are a future possibility.

The development of COTS-based VLBI/e-VLBI data systems makes transfer of e-VLBI data to/from high-speed networks relatively straightforward using standard network interfaces.

'Last-mile' problems

The connection of telescopes to high-speed nodes, dubbed the 'last-mile' problem, remains a high barrier for many sites. For almost all cases, the cost of fiber installation is the dominant cost and is not likely to fall significantly. A cost of several tens of thousands of dollars per km is expected to be typical, though in some special cases it may be as low as a few thousand dollars per km. Lighting the fiber with the bandwidths needed by e-VLBI is becoming quite affordable, the cost usually being small compared to fiber-installation costs.

Action Items

Follow-on e-VLBI workshops are planned for Dwingeloo in 2003 and Japan in 2004, perhaps with a rotation back to the U.S. in 2005.

Much interest was expressed by both network providers and VLBI users to pursue both national and international e-VLBI efforts. Charles Yun of Internet2 generously offered the support of Internet2 to assist in the organization and propagation of e-VLBI initiatives; a web site for e-VLBI has been set up at www.internet2.edu/vlbi as part of this effort, which is now under construction.

A provisional working group consisting of Jon Romney, Richard Schilizzi and Alan Whitney was established to draft a white paper to set e-VLBI goals, determine current observatory connectivities, provide the beginnings of a master global e-VLBI development plan, and establish the tasks of a permanent e-VLBI working group. Among the tasks of the permanent working group will be:

- Coordinate standardization of e-VLBI data formats
- Identify continuing goals, both scientific and technical
- Coordinate international e-VLBI efforts and proposals
- Maintain current state of connectivity of global VLBI observatories
- Maintain e-VLBI as a visible user of global high-speed networks
- Promote continued interactions with networking specialists

Bottom line

The time for e-VLBI to enter into the use of national and international high-speed networks appears ripe. These networks not only need credible users, but e-VLBI has a real need to use them. It is incumbent upon the global VLBI community to develop a well-structured and rational program to pursue e-VLBI goals. This workshop is the first step in that direction, and mechanisms have been put into place with the goal of maintaining this initial momentum and seeing e-VLBI through to a successful international realization.