Brazil integration in the VLBI2010 System

VLBI is a fundamental technology for the realization and maintenance of the global reference frames (CRF, celestial reference frame and TRF, terrestrial reference frame) that are the basis for high-precision position referencing in Space and on Earth, and which are applied in many research areas including global climate change and other Earth-science applications. Uniquely, VLBI provides the complete set of Earth Orientation Parameters (EOP), which are needed for the combination of the Space-fixed, inertial, and the Earth-fixed rotating reference frame.

Some of the current equipment dates from the 1980s and cannot be repaired because key components are no longer available. Most electronics are analog with discrete components. Some antennas built in the 1960s and previously very active in VLBI observing programs have been closed because of failure and the costs of repair or upgrade were prohibitive. RFI from satellite, land, and consumer sources has become a serious problem at many sites, particularly at S-band frequencies. Original (1980s vintage) NASA masers still operate but require specialized equipment and expertise to maintain.

A new frontier of developments for the next generation VLBI must be implemented.

The International VLBI Services organization (IVS) recognized the frailty of the current VLBI system and initiated research into building a next generation VLBI system. The system has come to be known the VLBI2010 system. The VLBI2010 Committee of the IVS recently submitted a progress report about the design of the VLBI2010 system. A version of this report is available online at ftp://ivscc.gsfc.nasa.gov/pub/misc/V2C/TM-2009-214180.pdf.

To address these problems and to improve VLBI data to meet increasingly demanding requirements, an end-to-end redesign called VLBI2010 is in progress. The key concepts are a broadband signal acquisition chain (2 – 12 GHz) with digital electronics and fast, small antennas. In addition, the antennas should allow for a possible future inclusion of Ka-band (32 GHz) operations. By flexibly placing up to four RF bands in the 2–14 GHz range, RFI should be ameliorated and the requisite precision achieved. Fast antennas will provide higher temporal and spatial resolution for estimating the troposphere at each station, which simulations show as the largest noise source, as well as many more observations. High recording bandwidths are required to achieve the necessary sensitivity.

The VLBI2010 system (see Figure 1) is being developed to be minimally staffed, remotely controllable, broadband, RFI avoiding, fully digital, fast slewing, and capable of producing VLBI delays with uncertainties of 4 ps. The system is intended to observe continuously.

Two complete signal acquisition chains are needed for testing and validation prior to full network operations. Proof-of-concept systems have already been successfully tested using the MV-3 antenna at Goddard Geophysical and Astronomical Observatory (GGAO), Greenbelt, Maryland and the Westford antenna at the Haystack Observatory in Massachusetts. In addition, a fast 12-m antenna has been ordered from Patriot Antenna

Systems in Albion, MI and is scheduled for delivery to GGAO in December 2009.

Figure 1: VLBI2010 broadband receiver mounted on 5-m MV-3 antenna at GGAO. MV-3 will be replaced by a 12-m VLBI2010 antenna.

For EOP monitoring, adding a Brazilian location is very important, because observational networks with long north-south extent significantly improve the polar motion and nutation determination. An accurate TRF can only be obtained with a long time series for the stations' positions. Having an accurate TRF is a prerequisite for accurate EOP and CRF determinations.

It is intended to establish a globally distributed network of at least 16 VLBI2010 antennas observing every day to determine Earth orientation parameters, and that other antennas be added as needed for the maintenance of the celestial and terrestrial reference frames. A subset of antennas with access to high-speed fiber networks is also required to enable daily delivery of initial IVS products in less than 24 hours. A high priority is placed on increasing the number of stations in the southern hemisphere. Particularly important will be a location in Brazil, as a follow up of the highly successful VLBI observations carried out at Eusébio/Fortaleza.

The VLBI2010 site should take into account a large number of clear days and a relatively high and dry location, due to the high frequencies to be utilized and the desirable implementation of simultaneous satellite laser observations at the same place.

Approximated cost estimate: US$3.0 M. (including local infra-structure, constructions,

optical fiber data transmission)

Institutes involved:
Brazil: Mackenzie, INPE, UFPe, UECE, UFC, IBGE
US: NASA/GSFC
International: IVS