Haystack Observatory VLBI Correlator

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Abstract

This report summarizes the activities of the Haystack Correlator during 2007. Linux correlator runtime software was developed and migrated to Bonn. Testing of new observing modes and equipment, primarily Digital Back Ends (DBE), was conducted. Mark 5B capability was migrated to Bonn and Washington, and Mark 5A/B development continues. One real-time e-VLBI test was conducted, and real-time e-VLBI capability was restored. Non-real-time transfers continue, and that software and capability were installed at Bonn. Investigation of 1 Gb/sec EOP results were conducted. Engineering support of other correlators continues.

Figure 1. Partial view of the Haystack Mark IV correlator, showing 2 racks containing three Mark 5A correlator playback units, four Mark 5B DOM correlator playback units with associated correlator interface board units, and a laptop monitor.

1. Introduction

The Mark IV VLBI correlator of the MIT Haystack Observatory, located in Westford, Massachusetts, is supported by the NASA Space Geodesy Program and by the National Science Foundation. The available correlator time is dedicated mainly to the pursuits of the IVS, with a small portion of time allocated to processing radio astronomy observations for the Ultra High Sensitivity

VLBI (u-VLBI) project. The Haystack Correlator serves as a development system for testing new correlation modes, for e-VLBI, for hardware improvements such as the Mark 5B system, and for diagnosing correlator problems encountered at Haystack or at one of the identical correlators at the U.S. Naval Observatory and the Max Planck Institute for Radioastronomy. This flexibility is made possible by the presence on-site of the team that designed the correlator hardware and software. Additionally, some production correlator time is dedicated to processing geodetic VLBI observations for the IVS.

2. Summary of Activities

2.1. Linux Correlator Run-time Software Conversion

This year many run-time programs were migrated to the more contemporary Linux O/S platform Red Hat Enterprise 4. That architecture was installed and is in use at the Bonn correlator. Washington is expected to upgrade roughly at the time of this writing also. Programs converted include the messaging system, opera, and conductor. Considerable performance improvements have been obtained with this conversion at both Haystack and Bonn.

2.2. New Observing Equipment and Methods Testing

Many test experiments related to the application of Digital Back Ends to future observing methods were conducted. These experiments are a part of the VLBI2010 project and a high-sensitivity astronomy project called u-VLBI whose goals include mm-wavelength observations of the galactic center. In particular, the experiments related to VLBI2010 involve the use of the Westford and GGAO antennas as test beds for a new very wide band receiver, and a specially devised observing mode which combines the outputs from two DBE IFs onto one VSI cable, in support of dual polarization observations.

2.3. Mark 5A/5B Recording System Related Projects

Installation of Mark 5B capability was completed at both the Bonn and Washington correlators this year. Testing of Mark 5A and 5B software on the correlator continues. One effort is to correct bad disk-handling limitations on Conduant's SDK 7 version of their software. These limitations have become an impediment to upgrading field stations to later versions of the Mark 5A software. This problem seems close to resolution. Another effort is to add e-VLBI capabilities to the Mark 5B system. This effort is progressing well and should be implemented on the Haystack correlator soon. Help enabling Mark 5B capabilities at the JIVE correlator is a part of this effort.

2.4. e-VLBI

One real-time e-VLBI test was conducted on the Haystack correlator this year, involving one VLA antenna and the Westford antenna. This was a proof-of-concept demonstration for NRAO. e-VLBI efforts have been curtailed for more than a year at the Haystack correlator due to the removal of our high speed link by Lincoln Laboratory. This link was restored at a 10Gbps data rate late in 2007 so resumed testing is planned. Non-real-time transfers have continued through this period, and the software which facilitates this process was installed and is now in use at Bonn,

where transfers of data destined for their correlator are conducted on a regular basis. Thirty-two experiments from four stations were transferred to Haystack this year. These non-real-time transfers included data from Kashima and Tsukuba, Japan and Syowa, Antarctica.

2.5. Other Projects

Investigations of poor EOP results from 1 Gb/sec geodetic R&D experiments became a priority this year after a report by Leonid Petrov. Those investigations are continuing. General support of the other correlators continues, with some examples being repair and testing of Bonn input boards, loan of a crate control computer to Bonn to replace a failed unit, and much support for software issues. Many software issues were related to the Linux conversion and installation of Mark 5Bs at both correlators, but there were other support issues not related to these two major upgrades as well.

3. Experiments Correlated

In 2007, thirty-one geodetic-VLBI experiments were processed at the Haystack correlator, consisting of 9 R&Ds, 3 T2s, and 19 test experiments. The test experiments cover a wide assortment of projects, some of which were touched on in the summary above. There was also a large number of smaller tests not included in the above count because they were too small to warrant individual experiment numbers.

4. Current/Future Hardware and Capabilities

Currently, functional hardware installed on the system includes 2 tape units, 7 Mark 5A units, 7 station units, 3 Mark 5B units (DOMs) with their associated correlator interface boards (CIBs), 16 operational correlator boards, 2 crates, and miscellaneous other support hardware. Changes in the above described matrix compared to last year are the addition of one Mark 5B unit (a USNO purchased unit currently borrowed for testing), and the reduction of one functional tape unit due to cannibalization of hardware from the third previously functioning unit. We have the capacity to process all baselines for 10 stations simultaneously in the standard geodetic modes, provided the aggregate recordings match the above hardware matrix. In 2008 expansion of the Mark 5B units may allow for the retirement of Station Units and an increase in available playback units.

5. Staff

Staff who participated in aspects of Mark IV, Mark 5, and e-VLBI development and operations include:

5.1. Software Development Team

- John Ball - (part time) - Mark 5A/5B; e-VLBI
- Roger Cappallo - real-time correlator software and troubleshooting; system integration; post processing; Mark 5B; Linux conversion; e-VLBI
- Kevin Dudevoir - correlation; maintenance/support; Mark 5A/5B/5C; e-VLBI; Linux con-

version

- Chester Ruszczyk - e-VLBI; Mark 5C
- Jason SooHoo - e-VLBI; Mark 5C
- Alan Whitney - system architecture; Mark 5A/5B/5C; e-VLBI

5.2. Operations Team

- Peter Bolis - correlator maintenance
- Brian Corey - experiment correlation oversight; station evaluation; technique development
- Dave Fields - playback drive maintenance; Mark 5 installation and maintenance; general technical support
- Glenn Millson - correlator operator
- Arthur Niell - technique development
- Don Sousa - correlator operator; experiment setup; tape library and shipping
- Mike Titus - correlator operations oversight; experiment setup; computer services; software & hardware testing
- Ken Wilson - correlator maintenance; playback drive maintenance; general technical support

6. Conclusion/Outlook

Further migration of run-time programs to the Linux platform is expected in the coming year. Expansion of Mark 5B units at all correlators will continue as more field stations convert to Mark 5B. Mark 5C testing should begin. For information regarding the Mark 5C recording system, please refer to the "Haystack Observatory Technology Development Center" report. e-VLBI testing should increase this year with the return of the high speed link. Further testing of Digital Back Ends will continue, with the intent of transforming standard observing techniques to higher data rates in the coming years. This is an exciting time at the Haystack correlator, with many new systems coming on-line, promising vast improvements in all aspects of observing.