Haystack Observatory VLBI Correlator

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Abstract

The Haystack Correlator continued to be used for a wide variety of operational, testing and developmental projects. Mark 5B was developed to the level of routine production use. Several repair and maintenance issues were addressed at all the Mark IV correlators. Migration of correlator software to a linux platform continues. Raw correlator output for all experiments dating back to late 2002 was exported to Goddard. Non-real-time e-VLBI transfers continue. Activities are increasingly focused on R&D rather than routine production.

Figure 1. Partial view of the Haystack Mark IV correlator, showing 3 racks containing 7 Mark 5A correlator playback units, 2 Mark 5B DOM correlator playback units with associated correlator interface board units, 1 Mark 5A e-VLBI transfer unit, decoder, the correlator rack, 3 tape drives, and 1 rack containing 4 Station Units. In the foreground is the new linux-based correlator control computer display.

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

Mark 5B is now in use for routine production. Three R&D experiments with data recorded in parallel in both Mark 5A and Mark 5B format at Westford have been processed, and another has been processed with only Mark 5B data from Westford. Many Mark 5B related development and verification tests, as well as a wide variety of other tests, were performed throughout the year. These tests were related to various software and hardware components, some examples being testing DOMs and CIBs, modifications to the messaging system, suman/domino software changes, data conversions between Mark 5A and Mark 5B, and testing for digital back end development. Testing of Mark 5A software revisions and new operating systems continues, with the intention of releasing a new version of the Mark 5A code using Conduant's latest SDK release and a contemporary O/S. Efforts to migrate the correlator software to a linux platform continue, along with the addition of a new computer dedicated to the project. Many maintenance issues have been addressed, both locally and at the Bonn and WACO correlators. Local examples include diagnosis and repair of two separate incidents of failed amplifiers in the TSPM splitter box, and repair and testing of failed input and control boards from all correlators. Bonn and WACO maintenance includes provision of replacements for failed input boards and SU parts, diagnosis of a tape library corruption problem at Bonn, and consultation with WACO on various problems. Leonid Petrov's corel_export program, which allows for the export of raw correlator output data to Goddard, was installed and used to export all experiments processed at Haystack since (and including) CONT02 in late 2002. Real-time e-VLBI testing has taken a hiatus this year due to the temporary loss of our use of a high speed link out of Lincoln Laboratory, but non-real-time transfers continue, with 63 experiments from four stations transferred this year. These non-real-time transfers included data from Kashima and Tsukuba, Japan; Ny-Ålesund, Norway; and Syowa, Antarctica.

3. Experiments Done

In 2006, 33 geodetic-VLBI experiments were processed at the Haystack correlator, consisting of 11 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 3 tape units, 7 Mark 5A units, 7 station units, 2 Mark 5B units (DOMs) with their associated correlator interface boards (CIBs), 16 operational correlator boards, 2 crates, and miscellaneous other support hardware. Another minor rearrangement of correlator hardware took place this year, with tape drive 5 removed to make room for a new rack containing the two Mark 5Bs and their associated CIB units. Also, a new linux based PC was procured to act as the new correlator control computer, and is in use (see Figure 1). In order to reduce noise and save electricity, only one tape drive is kept powered up, though it has rarely been used in the past year. We have the capacity to process all baselines for 9 stations simultaneously in the standard geodetic modes, provided the aggregate recordings match the above hardware matrix. In 2007, expansion of the Mark 5B units may allow for the retirement of Station Units and an increase in available playback units.

5. Staff

John Ball, long time software team member and Mark 5A guru, retired in June 2006, but is still able to assist us on Mark 5 issues on a part-time basis. Staff who participated in aspects of Mark IV, Mark 5, and e-VLBI development and operations include:

5.1. Software Development Team

- John Ball - operator interface; playback; Mark 5A/5B; e-VLBI
- Roger Cappallo - correlation software leader; system integration; post processing; Mark 5B; linux conversion
- Kevin Dudevoir - correlation; maintenance/support; Mark 5A/5B; e-VLBI; linux conversion
- Chester Ruszczyk - e-VLBI
- Jason SooHoo - e-VLBI
- Alan Whitney - system architecture; Mark 5A/5B; 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

The increased use of Mark 5B will improve capability, as each Mark 5B that is integrated will allow either the retirement of a station unit or an increase in the number of stations that can be simultaneously correlated. Retirement of station units should increase efficiency and throughput due to several factors: reduction in the need for reprocessing, routine use of a 32 MHz playback clock, and the smaller setup time required by Mark 5B. Upgrade of other correlators and stations to Mark 5B will follow. e-VLBI tests and experiments will hopefully resume, include more stations, and be more extensive. Non-real-time e-VLBI transfers will continue, possibly including more stations. Correlator operations have been focusing more on R&D and development work than on routine production, and this mode of operation will continue. The effort to move operational correlator production tasks to more modern Linux-based systems over the next year will continue, possibly including the correlator run-time software. Development in support of VLBI2010 is anticipated to increase next year. All the above work should result in a greatly improved data processing system as well as provide greater capability and a higher quality end-product to the IVS community.