IVS Newsletter

Issue 5, April 2003

Mark 5 and the EVN

–Walter Alef, Bonn Correlator MPIfR

In the last 2 to 3 years we have seen a race between Mark 5 - which has been developed by Haystack - and PC-EVN - mostly developed at Metsahovi, with Mark 5 staying in the lead by nearly 1 year. The competition was helpful for the development of Mark 5 and in the end led to a better Mark 5 system. Despite developing its "own" disk-based recording system the European VLBI Network (EVN) supported the development of Mark 5 financially with contributions from nearly all its members.

When in summer of 2002 the first Mark 5P (prototype) units were delivered to Bonn, Medicina, Noto, and JIVE it became obvious that the EVN had to take a decision soon as to which system to adopt as the standard. The decision for Mark 5 was not taken lightly and in December 2002 Mark 5 was only accepted as the new standard provided that the full advertised potential of the system could be proven and that the path and cost for an upgrade to serial ATA disks could be stated by Conduant. A concept for this upgrade currently exists, but the costs are not yet known.

In the lab the Mark 5A system has been used to record and play back data at a rate of 1 Gbps. The EVN has tested Mark 5 in its February session and will test Mark 5A up to the highest bitrates in its May observing session. In addition some EVN stations like MPIfR in Bonn, JIVE in Dwingeloo and Medicina are contributing to the testing and the further development of the various aspects of VLBI observing with Mark 5.

Several EVN observatories are ordering Mark 5 units now or will order them this year. In addition most of them will also provide a unit for the JIVE correlator. Towards the end of the year there might be 9 units at EVN telescopes, 7 at the JIVE correlator, and 8 at the Bonn correlator. The situation is less clear with respect to how many disks will be purchased this year for astronomical observations. Most of the EVN stations are also involved in geodetic observations and have to buy disks for those, which is another strain on their already tight budgets. The hope is that EVN will have enough systems and disks available by the time of the October session so that 1 Gbps recording can be advertised as a new enhancement of the EVN.

Mark 5A System Update

–Alan Whitney, MIT Haystack Observatory

The Mark 5A data system is now being deployed and will soon replace all prototype Mark 5P systems. The primary improvements are:

- Specially-designed chassis which accepts two 8-pack modules of 8 disks each (see figure).
- Either 8-pack module may be used to record or playback data up to 1024 Mbps.
- Plug-compatible replacement for Mark 4 or VLBA tape transport with 64 tracks.
- Supports 8, 16, 32 and 64-track modes; parity bits are stripped on record to save disk space, then restored on playback.
- Automatic compensation for slow or misbehaving disks to minimize any data loss.

The Mark 5A is now partially supported by the Field System, with plans for full support soon. Mark 5A systems are now supported on the USNO, Bonn, JIVE and Haystack correlators.

A Mark 5P system was used at the Westford antenna in October 2002 for 15 days of observing for the CONT02 campaign, the processing of which is now complete. Included in that processing is a 10-disk set of which two of the 10 disks were lost. The Haystack correlator was able to recover ~77% of the original data for processing (compared to the maximum possible 80%), even with the two missing disks. The capability to record and playback data in the face of mis-performing or missing disks is now undergoing testing and will soon be available in the released Mark 5A software.

Approximately 30 Mark 5 systems are currently in operation, with many of them now upgraded to Mark 5A. Mark 5A systems are available commercially from Conduant Corp of Longmont, Colorado, who are providing the systems to the VLBI community at a special price of $16,300 each (without data disks), well below the standard commercial price.

http://web.haystack.mit.edu/mark5/Mark5.htm

Hartebeesthoek Radio Astronomy Observatory

George Nicolson, the director of the Hartebeesthoek Radio Astronomy Observatory (HartRAO) will retire at the end of April, after 42 years at Hartebeesthoek. He was interviewed via e-mail by H. Hase about the history of the site, its capabilities, and plans for the future.

George Nicolson at GPS antenna with 26-m antenna and SLR in background. Below - location of south African site.

Q. How did HartRAO get its name and where is your site located?

Hartebeesthoek is the name of the farm where HartRAO is located and is named after the Hartebeest, a large African antelope having an elongated muzzle, lyre-shaped horns, and fawn-coloured coat. Hartebeest used to be plentiful in this part of the country. “Hoek” in Afrikaans means “corner” and probably refers to a bend in the hills surrounding the valley where the antenna is located. HartRAO is about 60 km NW of Johannesburg.

Q. When was HartRAO founded, and when did you begin geodetic VLBI experiments?

The Hartebeesthoek valley was the site of the original NASA Deep Space Station 51. The station was built in 1961 and operated until 1975. I have been at Hartebeesthoek since 1961, my first position being that of Servo Engineer. As a NASA station, we tracked un-manned spacecraft to the moon and planets, including Rangers, Surveyors, Pioneers and Mariners.

In 1962 I began using DSS 51 for radio astronomy when it was not needed for tracking deep space probes. During this time we did our first “geodetic experiment” (recorded at 48 kb/sec) by measuring the projected E-W baselines to Australian DSN stations, achieving an accuracy of a few metres. The first dedicated geodetic experiment was in 1980, when we participated in a 6-station experiment at 18 cm arranged by James Campbell.

In 1982 Axel Nothnagel joined our staff from Bonn. He played a key role in developing the geodetic VLBI programme at HartRAO, and laid a solid foundation for what has followed since then.

After we bought the EFOS-6 maser in 1985, all that we then needed was a Mark III terminal and Bill Carter kindly loaned one from NGS for three months per year for the next few years. This resulted in the IRIS-S programme, and our entry into high accuracy geodetic VLBI. The terminal was upgraded to Mark IIIA in 1993 and to Mark IV in 1998. (For Axel’s information, the pin–a sewing pin, in fact–has long since disappeared from the video converter!)

Q. Due to its unique location HartRAO is one of the most scheduled radio telescopes for astronomy and geodesy. What type of front ends and recording systems are available at HartRAO? Why did HartRAO get a new antenna surface?

We have dual polarised cryogenic receivers for 1.6, 2.3, 5.0, 6.0/6.7, and 8.5 GHz, and a 12.2 GHz room temperature receiver. All receivers are permanently mounted at the secondary (Cassegrain) focus, and can be switched from one to another at will. For S/X VLBI we use a dichroic reflex reflector system. We have Mark IV and S2 recorders available.

The surface panels of the 26-m antenna were covered with perforated aluminium plate with 1 cm holes. The rms accuracy was 2 mm, just good enough for X-band. The aim of the surface upgrade project was to improve the efficiency, and extend the operating frequency to 22 GHz, which requires an rms better than 0.5 mm. We have replaced 240 out of 252 panels, and are now fitting panel adjusters to allow for the final adjustment which will be made with the aid of holographic measurements.

Q. How many staff work at HartRAO and who carries out the IVS observations?

The Space Geodesy Programme at HartRAO is integrated across VLBI, GPS and SLR. Dr Ludwig Combrinck is the Space Geodesy Programme Leader. Dr Jonathan Quick is Head of Instrumentation and Computing and is responsible for the Field System, the Mark IV and S2 recording systems, the hydrogen maser and receiver systems. Jon is also responsible for all the astronomical VLBI.

HartRAO staff members in front of VLBI equipment; Backrow: Ludwig Combrinck, Wilhelm Haupt, Attie Combrink, Willy Moralo; Frontrow: Pieter Stronkhorst, Marisa Nickola. (Not shown: Jonathan Quick)

We have a number of operators who set up and run VLBI, although most of their time is spent operating the SLR. Marisa Nickola is responsible for down loading schedules, ensuring correct set-up of VLBI experiments, maintaining operational procedures, assigning tapes. Pieter Stronkhorst, Willy Moralo and Solly Mohlabeng run the IVS VLBI shifts. Wilhelm Haupt, the SLR manager also turns a hand at VLBI operations when needed. Attie Combrink (not related to Ludwig) is a Masters student working with Ludwig on water vapour analysis using GPS data. He is also being trained to help with IVS support. Pieter Louw, our technical buyer, handles all the tape shipments.

Q. HartRAO has been transformed over the years to one of the rare fundamental stations for geodesy. Besides VLBI what kind of instruments are located at HartRAO?

Ludwig Combrinck must be credited with the growth of the HartRAO Space Geodesy Programme in recent years. In 1996 he installed the first two IGS stations in South Africa, which started the development of a Southern African Reference Frame. HartRAO is also a regional data centre for IGS and we plan to be a regional analysis centre as well.

In 2000 NASA transferred their MOBLAS-6 SLR to Hartebeesthoek and since then we have also been making SLR observations. GFZ (Potsdam) operates a superconducting gravimeter at Sutherland. Since 1999 the HartRAO VLBI reference point has been the National Reference Datum used by the Chief Directorate of Surveys and Mapping.

Q. The IVS community took notice that you will retire soon. Looking back to your professional career dedicated to radioastronomy and "your" HartRAO, what was your most inspiring experience?

It has been very satisfying to see HartRAO grow from the shell it was when NASA left to a thriving multi-frequency observatory. What we have achieved is a credit to the staff, past and present, who have helped to build HartRAO into what it is today.

It has also been inspiring to work with so many people in the international community, who have helped to promote astronomy and geodesy and the development of HartRAO. They are too numerous to mention them all by name, but James Campbell and Axel Nothnagel both played key roles in developing our geodetic VLBI programme. The people at Haystack, NGS, GSFC, NVI, ATNF and the EVN have been a great help over the years, and I thank them all for their support and friendship.

Q. What are you going to do after your last day at HartRAO?

My wife and I will visit my son and his family in Amherst, Massachusetts. After that I will get back to some astronomical research and keep track of technical developments at HartRAO.

A dramatic view of the HartRAO antenna during a lightning storm.

–interview by H. Hase

Improving Station Performance by Operator Comments

–Rich Strand

The network stations, data reduction centers and finally the data analysis scientists have to work as a team to provide the IVS with a quality product for space geodesy. A good team effort starts with communications between each group and the comments made by operators in the session logs begin the process.

Need to know. Weather reports are necessary every hour to archive with the "WX" data and are a well defined task for the station operators. Not as well defined is operator comments made in the data log. These are usually left up to each individual observing the session. One way to view the value of these comments is to assume you would be the correlator operator as well. Any comment that would make the correlating task easier should be logged. Anything outside of normal observing parameters should be mentioned. A very simple guideline is this: If someone else needs to know what you know then make the comment in the log.

All comments are of value. Comments made during observing provide the best information to all the other team members that view the data after it leaves the station. The correlator operators have the advantage where they can view all the comments post session and arrange their schedule to handle any problems. The team that does hardware failure analysis for the IVS can often find solutions faster by reviewing the operator's comments using the log's time line as the failure happened. Data analysis members review archived operator comments when making frequency sequence and source selections. Deleting a data point might be considered after reviewing an operator's comment made during that scan.

Ready, Start, Stop. IVS network stations should be sending the standard three operational messages (Ready/Start/Stop) to the IVS e-mail list. The contents for these messages are well described in the Field System manual. Also available is the application MSG that can be run from Linux. This program provides the network operators with a "fill-in-the-blank" page of data entry for the information that is required in the operational messages. This page is then sent to the IVS mail. A nice feature of MSG is that an automatic "Start" message will be sent at the time the tape actually starts rolling indicating the session started at the correct time. The "Stop" message keeps an on site blank tape count which is handy for those that supply the station with tape as well as a "comment" box for problem scans.

Rich Strand retired at the end of 2002. This is the last column he will write for the Newsletter. The editors would like to thank Rich for his many contributions to IVS and the VLBI community, and especially for his useful and well-written "How to" columns.

We are looking for someone to write this column for future Newsletters. If you are interested in contributing your ideas, please let us know!

NEWS

News from the IVS Analysis Coordinator

–Axel Nothnagel and Christoph Steinforth, Geodetic Institute of the University of Bonn

From the beginning of 2003 the IVS Analysis Coordinator's office publishes celestial pole offsets (dX, dY) with respect to the models proposed in the IAU2000 Resolutions, i.e. IAU2000 precession/nutation together with the Celestial and Terrestrial Ephemeris Origins. Since no VLBI software package in use at the IVS Analysis Centers has been modified thoroughly yet for the transition to IAU2000 Resolutions, the nutation offsets relative to the IAU1980 nutation model are transformed into dX, dY components by software provided by the IERS EOP Product Center in Paris. In order to keep continuity with the old series the offsets relative to IAU1980 will be maintained for some time in addition to the new offsets. For clarity reasons the old and the new offsets are published in two separate files (e.g. ivs03r1e.eops and ivs03r1X.eops) with identical polar motion and UT1-UTC values in IVS EOP file format. Thanks to the IVS Coordinating Center the IVS Products Web page now permits a selection of the files by explicit labels rather than directory listings. This provides verbose information especially for users who are not familiar with recent IVS developments.

As advertised in the last issue of the IVS Newsletter a second IVS EOP series which covers all VLBI sessions back to 1984 (ivs03q1e.eops) is being published and updated quarterly. On special request this series now also covers the period back to 1979, the very beginning of dual frequency Mark III observations. Although sometimes rather sparsely distributed in time before 1984 this data is a valuable extension of the unique VLBI high quality nutation observation series.

The fourth quarter of 2002 has shown a sudden severe increase in the residuals of the IVS rapid EOP series (ivs03r1e.eops). Due to the concurrence of several disadvantageous circumstances outliers remained undetected and distorted the picture of the residuals. However, the final EOP products were affected only marginally since the outliers entered the combination with low weights.

The IVS Newsletter is published three times annually, in April, August, and December. Contributed articles, pictures, cartoons, and feedback are welcome at any time.

Please send contributions to ivs-news@ivscc.gsfc.nasa.gov. The editors reserve the right to edit contributions. The deadline for contributions is one month before the publication date.

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The newsletter is published in color with live links on the IVS web site at http://ivscc.gsfc.nasa.gov/.

Directing Board Elections Results

–Harald Schuh, University of Technology Vienna
–Arthur Niell, MIT Haystack Observatory
–Nancy Vandenberg, NVI Inc./GSFC

Elections for representative and at large positions on the IVS Directing Board were held in January, 2003, under the guidance of the Election Committee, consisting of Harald Schuh (Chair), Arthur Niell, and Nancy Vandenberg.

Elections for Directing Board positions are held every two years. This year the terms of the representatives of the Network Stations and Correlators and Operation Centers ended (total of three positions) and the terms of two of the three at large positions ended. The IVS Terms of Reference allows board members to serve a once-renewable term.

The results of the elections showed the confidence that the Associate Members placed in the current board members, re-electing all three representative positions: for Network Stations: Wolfgang Schlüter, BKG/Germany and Shigeru Matsuzaka, GSI/Japan; for Correlators and Operation Centers: Kerry Kingham, USNO/USA. They will serve a 4-year term to February, 2007.

The Directing Board then considered nine candidates for two at large positions, facing a difficult decision as to how best to balance representation from as many countries and institutions and IVS interests as possible. The new board members are: Bill Petrachenko, NRCan/Canada and Zinovy Malkin, IAA/Russia. They will serve a 2-year term to February, 2005.

The committee would like to thank all the Associate Members who stood as candidates in the elections. We would also like to thank all the Associate Members who exercised their privilege to vote. The next Directing Board meeting will be at Paris Observatory on April 5, 2003.

A Taste of History....

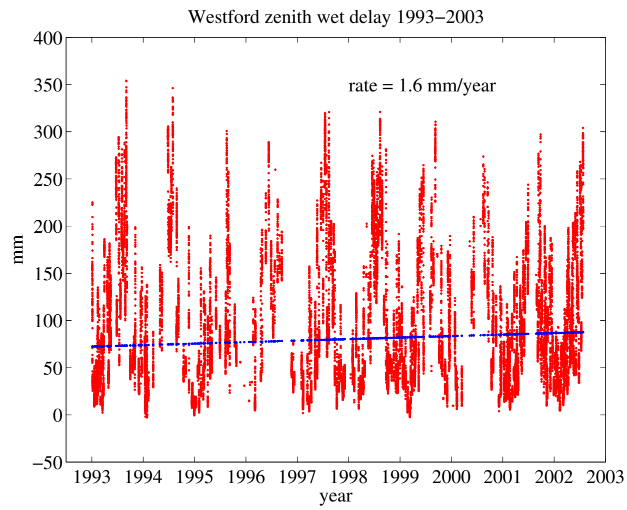
In the 1980s, the observation room of the 26m antenna at Kashima, Japan, was almost completely full, occupied by large "mini"-computers for antenna control and data analysis, a large correlator unit for only one baseline, and several racks for data recorders and backend systems. But now the VLBI observation and correlation equipment is amazingly small. The K5 prototype system (4 channel version) fits in a suitcase (see photo). This small Pentium PC system replaces the formatter, the data recorder, and even the correlator. This system was used in the e-VLBI test observations in October, 2002.

–Yasuhiro Koyama, Tetsuro Kondo

A Role for VLBI in Climate Studies

–Arthur Niell, MIT Haystack Observatory

There is a lot of concern about climate change. Most often the worry seems to be global warming, but it is also possible that the amount of water vapor in the atmosphere is changing with time, leading either to drought conditions or to flooding. How is this related to our measurements of the shape of the Earth, plate tectonics, the changes in rate of rotation, and wobble of the spin axis? The radio waves that make up the signal from the quasars have to pass through the atmosphere, and they are slowed down by an amount that depends on how much water vapor is there and on the temperature of that water vapor. In the process of analyzing the VLBI data to figure out the Earth's motions, we also estimate the amount of delay by the atmosphere at each VLBI site. Thus we have a twenty-year history of the effect of water in the atmosphere at many places around the world.



For climate studies the consistency of results over long periods of time is most important, since it is the change with time that is of concern. VLBI measurements are very good for this because all of the data can be reanalyzed at any time that an improvement is made in the models which might affect the results. Furthermore, the antennas do not change with time, and improvements in equipment usually reduce the scatter but do not affect the average values.

The only complication is that the atmosphere effect that we measure with VLBI depends on both water vapor and temperature, and we can't separate them ourselves. Fortunately, the temperatures in the atmosphere, not just at the surface, are pretty well known, so we should be able to use the meteorologists' temperatures and then determine the water vapor from the VLBI data.

An example of VLBI measurements of atmospheric water vapor is shown for Westford, Massachusetts, USA, in the Figure. The zenith wet path delay appears to be increasing with time at an average rate of 1.6 mm/year, which might correspond to an increase in the average amount of water vapor in the atmosphere, since the delay is directly related to the amount of water vapor. (The straight line is a least-squares fit to the data.) However, if at the same time the temperature has been increasing (global warming), then the amount of water vapor would be increasing even more rapidly, since a higher temperature causes smaller delay. On the other hand, if the temperature has been decreasing over this period, then the amount of water may not have changed significantly. These effects will have to be analyzed very carefully.

For comparison, Harald Schuh found a rate of 0.8 mm per year for Wettzell using twenty years of data. Although all sites will have some degree of variability, and they may not all be increasing, a clear problem in determining the significance of a constant increase or decrease is the uneven distribution of the zenith wet delay due to seasonal effects. This means that the uncertainties in the rates estimated from the data are sensitive to the distribution of measurements through the year. The VLBI observing program benefits in this respect by providing regularly spaced measurements throughout the year.

The significant factors in the value of the VLBI measurements for climate studies are that the data will continue to be collected for a long time because of the fundamental importance of the Earth rotation information, and the results we do get will have long-term stability.

I thank Leonid Petrov for the ZWD data and Harald Schuh for priming this work with his presentation of the Wettzell ZWD data at the IVS Directing Board meeting.

Upcoming Meetings...

4th IVS Analysis Wkshp.
Paris Observatory
Paris, France
April 3-4, 2003

European Geophysical
Society Meeting
Nice, France
April 6-11, 2003

16th Working Meeting on
European VLBI
Leipzig, Germany
May 9-10, 2003

2nd e-VLBI workshop
Dwingeloo, the Netherlands
May 15-16, 2003

Future Directions in High
Resolution Astronomy:
A Celebration of the 10th
Anniversary of the VLBA,
Socorro, NM
June 8-12, 2003

IVS Technical Operations
Workshop
Haystack Observatory
Westford, MA.
September 22-25, 2003

http://ivscc.gsfc.nasa.gov/meetings

VIPs at the TIGO Inauguration (left to right): General Gran, Instituto Geografico Militar; Rector Gimenes Larrain, Universidad Catolica de la Santisima Concepcion; General Cheyre, Commander in Chief of the Chilean Army; Governor Toha, 8th Region of Chile; Rector Lavanchy, Rector of Universidad de Concepcion; Ministrial Director Rosen, Federal Ministery of Interior, Germany; Professor and President Grünreich, Bundesamt für Kartographie und Geodäsie, Germany; First Secretary Schäfer, German Embassady, Chile. Rector Hernandez, Universidad del Bio Bio is not in the photograph.

TIGO inaugurated on January 15, 2003

One year and two days after the arrival of the TIGO containers at the TIGO platform, the only fundamental station for geodesy in South America was officially inaugurated in the presence of representatives of both countries.

The day before the inauguration was used by the Directing Board of TIGO to discuss the future prospects for TIGO in Concepcion. Initially TIGO was sent for a three year period to Concepcion. The Chilean and German representatives agreed that all the efforts in preparing the infrastructure for TIGO, installing TIGO and getting TIGO recognized by four international services during 2002 was the result of the good cooperation between the five participating institutions. The Directing Board decided to extend the period of TIGO in Concepcion at least until 2007.

Second e-VLBI workshop to be held at JIVE 15-16 May 2003

–Steve Parsley, JIVE, LOC

Following the success of the first e-VLBI Workshop held at MIT Haystack Observatory in April 2002, numerous tests and trials of e-VLBI have been staged around the world. In May 2003 JIVE will host a second workshop aiming to share the experience gained from these experiments and explore possibilities for coordination and cooperation. As well as members of the VLBI community there will be talks from networking specialists and providers.

Topics to be discussed:

- Reports on e-VLBI tests and demonstrations
- Plans for ongoing e-VLBI development
- Status of interaction with network providers and developers
- International networking facilities - now and future
- Standards and protocols for e-VLBI data transfer.
- Hardware and software interfaces to telescope back-ends and correlators

For further details see the conference web pages at www.jive.nl/jive/evlbi_ws where registration and abstract submission pages are now active.

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