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COMMUNICATIONS RESEARCH LABORATORY

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CONTENTS

Overview of the Tenth TDC Meeting

Tetsuro Kondo (*kondo@crl.go.jp*)

Kashima Space Research Center
Communications Research Laboratory
893-1 Hirai, Kashima, Ibaraki 314, Japan

The tenth meeting of the Technical Development Center was held on March 14, 1997 at the Kashima Space Research Center of Communications Research Laboratory.

Attendance

CRL members

Kuniaki Uchida, Taizoh Yoshino, Shin'ichi Hama, Hitoshi Kiuchi, Akihiro Kaneko, Hiroo Kunimori, Chihiro Miki, Jun Amagai, Kohichi Sebata, Hideyuki Nojiri, Toshimichi Otsubo, Yuko Hanado, Fujinobu Takahashi (KSRC: Kashima Space Research Center), Yukio Takahashi (KSRC), Ryuichi Ichikawa (KSRC), Yasuhiro Koyama (KSRC), Mamoru Sekido (KSRC), Junichi Nakajima (KSRC), Eiji Kawai (KSRC), Tetsuro Kondo (KSRC)

Special members

Nobuyuki Kawano (National Astronomical Observatory), Mikio Tobita (Geographical Survey Institute), Masayuki Fujita (Hydrographic Department, Maritime Safety Agency)

Following special members could not attend: Noriyuki Kawaguchi (National Astronomical Observatory), Kosuke Heki (National Astronomical Observatory), Kazuo Shibuya (National Institute of Polar Research), Hisashi Hirabayashi (Institute of Space and Astronautical Science), Yoshimitsu Okada(National Research Institute for Science and Disaster Prevention), Teruyuki Kato (Earthquake Research Institute, University of Tokyo),

Minutes

1. Opening Greeting

Kuniaki Uchida, the director of IERS TDC at Communications Research Lab., opened the meeting.

2. Activity Reports of Each Organization by the Special Members

The special members reported on the current status of the activities of their organizations.

Geographical Survey Institute (*Mikio Tobita*)

Mikio Tobita reported geodetic project at Asia-Pacific area in which GSI is involved.

The second meeting of the Permanent Committee on GIS infrastructure for Asia and the Pacific area was held in Sydney, Australia in October, 1996.

At this meeting it was proposed that geodetic observation should be carried out in October, 1997 using fixed space geodetic stations available. The purpose of these observations is to establish precise geodetic reference points in Asia Pacific area. In particular co-location of different techniques and local tie observations must be carried out. It is expected that 6 VLBI stations, 16-20 SLR stations, 20 DORIS stations, 6 PRARE stations and more than 50 GPS stations will participate in this project. As for VLBI observations, they are expected to be the Fairbanks, Hobart, GSI-Kashima, Kokee, Shanghai and Urumqi stations. Observation schedule will be prepared by Shanghai using a SKED program. Correlation processing will be carried out by GSFC. Baseline analysis and distribution of data will be carried out by Shangahi.

National Astronomical Observatory (*Nobuyuki Kawano*)

Nobuyuki Kawano reported current status and future plan of the National Astronomical Observatory (NAO).

The second stage of future plan will start from the 10th anniversary of NAO (next year). Reorganization on a fairly large scale is also planned. A review of NAO by outsiders has already begun. The VLBI and VSOP projects has already completed the first stage review process by domestic reviewers.

A VSOP satellite was successfully launched on February 12, 1997. A main dish antenna was also successfully deployed.

Budgetary request for VERA (VLBI Exploration of Radio Astrometry) for the fiscal year 1998 will be proposed to the Ministry of Finance. The number of antennas has been reduced from two antennas at each site to one. Investigation of dark matter is added to the purposes of the project.

In collaboration with ISAS and NASDA, a RISE satellite will be launched in 2003 using a HII-A rocket.

NIPR (National Institute of Polar Research) is promoting an Antarctic VLBI project. Equipments necessary for VLBI will be shipped to Syowa Station, Antarctica this year (Nov. 1997) by the 39th Japanese Antarctic Research Expedition (JARE-39).

Hydrographic Department, Maritime Safety Agency (*Masayuki Fujita*)

Masayuki Fujita reported on geodetic observations by the Hydrographic Department, Maritime Safety Agency.

The first round of measurements of first-order control points using a mobile SLR system were completed last fiscal year (FY1995). The second round of measurements started, and a Chichijima Island point was measured from September to December, 1996. Ishigakijima Island position will be measured from July to November, 1997.

A fixed SLR system at Shimosato has been operated since 1982. Current accuracy of the system is about 3-4 cm. Fujita said that he wants to improve it to 1 cm. Initially the photo-detection system will be upgraded.

Continuous GPS measurements (24 hours a day) are carried out in the Kanto area.

A D-GPS (1.5-2 m accuracy) system developed by the Aids to Navigation Department is preparing its routine service. About 30 reference sites will be established by 1999. The Hydrographic Department plans to make geodetic observations using reference D-GPS sites.

3. Report on TWAA96 (*Yukio Takahashi*)

Yukio Takahashi reported on TWAA96 (Technical Workshop for APT and APSG 1996) held in Kashima on December 10-13, 1996. See page 6 for details.

4. Technological Development Reports

4.1. Current Status of Key Stone Project (Crustal Deformation Observation System in the Tokyo Metropolitan Area) (*Yasuhiro Koyama*)

Yasuhiro Koyama reported on the current status of KSP VLBI as follows.

Daily observations on the full network (4 stations : Kashima, Koganei, Miura, and Tateyama) have been carried out since September, 1996. Recently the success rate for baseline analysis of the daily observations has become nearly a hundred percent. So far the results of baseline analyses can be announced at the latest within one and a half day after daily observation (00:00-05:00 JST) is finished. Kashima station had a problem with an air conditioner in a receiver room, and this makes a baseline analysis result much worse. However, accuracy of result was improved drastically by stopping operation of air conditioner temporarily. Present accuracy (formal error) is 2 mm in baseline length for a 2 MHz video frequency width observation.

As for unmanned operation at remote stations it is important how fast we can recover a system from any trouble. Koyama said, "We could make it in 3 days for the most inconvenient station, Tateyama."

Q: Why is accuracy improved by stopping air conditioner operation?

A: An air conditioner in a receiver room in an antenna at Kashima has a problem. When it works, room temperature changes periodically with a period of about 20 minutes with temperature amplitude of about 3 degree Celsius. This results in a fast apparent clock change difficult to remove. When the air conditioner is stopped, room temperature change becomes more gradual. Consequently the apparent clock change becomes estimatable. This may improve an accuracy in the analysis.

4.2. Current Status of KSP SLR System (*Hiroo Kunimori*)

Hiroo Kunimori reported on the current status of SLR system in the KSP as follows.

Kashima and Koganei SLR stations made an engineering level test observation on January 29 - February 14, 1997. The purpose of this test observation is to evaluate the total operational flow from an observation to an analysis and to determine any problems. Return signals were detected for more than 40 passes both at Kashima and Koganei. Single-shot rms value of the uncertainty in measured distance was 10-25 mm for LAGEOS and its variation within a pass was large. The normal point rms value was 3-8 mm. Stability of ground target was ± 5 mm for 7 days. None of these values meets the specification for the system. To satisfy the specifications both hardware and software will be upgraded and an engineering level test will be continued.

4.3. Multimedia Virtual Laboratory — Its Application to VLBI (*Shin'ichi Hama*)

Shin'ichi Hama reported on the Multimedia Virtual Laboratory (MVL) project, in particular emphasised in applications for VLBI use. The concept of the MVL was proposed by the Telecommunications Technology Council, in consideration of recent technological developments in telecommunications. At present there is no unified idea about MVL. Concerning VLBI applications, joint ownership of huge amount of data is attractive to provide good prospect for a distributed analysis system and for a virtual big antenna (see page 13 for details).

Q: Image of MVL is obscure. Is it to use a remote laboratory and to perform some experiment in an office without going to the site?

A: Each person has his own idea. Some merely considers the MVL as an extension of the current TV conference system. As for VLBI, it is considered as a way to transfer a huge amount of data with fast speed.

C: At GSI we are thinking about possibilities of applying MVL for circulation of remote sensing data. It will be of great help for distribution of information to the public.

5. Discussion About Significance of Development of Gigabit Recorder at CRL

5.1 Overview of Development of Next Generation VLBI Terminals and Their Compatibility (*Yukio Takahashi*)

Yukio Takahashi reviewed all types of VLBI terminals currently used in the world. He also summarized their compatibility and their accuracy in baseline analyses. Details are reported in this issue (see page 15).

5.2 Current Status of Development of Gigabit Recorder at CRL (*Junichi Nakajima*)

Junichi Nkajima reported on the current development status of Gigabit Recorder (GBR-1000) introduced in the last TDC news (VLBI TDC News CRL, No.9, pp.17-18, 1996). In addition to the report, he proposed the establishment of "domestic next generation VLBI development team" aiming to develop a millimeter wave length wide band VLBI technique on the basis of a bottom-up approach (not top-down one). He also stressed that CRL should return to its starting point (or spirit) when K3 VLBI system was developed. Namely CRL should be a user as well as a developer of VLBI technology. A plan and a developed technology should be announced world-wide. As for the development of recorder, we should recognize that an open-reel-type recorder is quite different from an cassette-tape-type one equipped with a helical scanning head. Hence we only think about minimum compatibility between them when a new recorder is developed.

Q: How about supply of tape? Is it easy to get at reasonable prices?

A: Yes. GBR-1000 itself is used at commercial TV stations. There is no problem concerning supply and price of tape.

C: Even though it is difficult to do radio astronomy as a main objective at CRL because it can not be an official goal right now, please proceed with the development of a millimeter wave length technology.

5.3. Development of High Density Recorder as an Expansion of K-4 Recorder (*Hitoshi Kiuchi*)

Hitoshi Kiuch reported on plans for high density recorder development. In his presentation he emphasized the following points. What TDC should do is to contribute system development to realize a high accuracy measurement. However development in the CRL is not a satisfactory condition at the present time. Development of VLBI system so far never exceeds but merely follows those in USA. To overcome this situation we should develop a high density recorder with a data rate of 2048 Mbps (64 Mbps $\times$ 32 ch or 128 Mbps $\times$ 16 ch) dedicated to geodetic VLBI. There are good prospects for realizing a video converter with a video bandwidth wider than 64 MHz. As for the recorder, there are thought to be no technical barriers for development.

Q: What is the difference between GBR-1000 and this system?

A: Target is different. GBR-1000 is dedicated to a radio astronomy, while this system is mainly for precise geodetic applications.

C: Existence of two types of recorder is not happy for users.

5.4 Perspective Image of Next Generation VLBI Terminal (*Tetsuro Kondo*)

Tetsuro Kondo presented his expectations concerning the development of the next-generation VLBI terminal. In his presentation he summarized ideal feedback loop structures in the relation between technical development and scientific progress into following two categories. One is an "improve accuracy" pursuit loop. In this feedback loop, observation system is designed to achieve the best measurement accuracy from a technical point of view. Cost-effectiveness is sometimes regarded as an unimportant factor in system development. Measurement with high accuracy will be a seed for scientific study. Conversely, scientific results will stimulate more accurate system development. The other one is a "spread promotion" loop. Being different from the previous one, this type of loop aims to reduce cost instead of increasing accuracy to distribute the system widely in the world. Miniaturization of system can also be a goal. Even though accuracy of measurements is sacrificed, widely distributed terminals in case of VLBI will give a new perspective view in a scientific study. CRL should proceed with both types of development if possible.

6. Closing Greeting

The closing greeting was delivered by Fujinobu Takahashi, the vice-director of IERS TDC at Communications Research Laboratory.

Photo. KSP SLR system under test observation at Kashima. During period of January 30-February 14 in 1997, Kashima and Koganei stations have made observation for major geodetic satellites LAGEOS, AJISAI, STELLA and Starlette in order to check out ranging precision and accuracy stability. Forty five LAGEOS1&2 passes in total were analyzed to produce baseline length between Kashima and Koganei with accuracy of 20-30 mm, although the system were not fully equipped with those to meet final specification. The four systems have get together and will be configured with a single telescope for colocation, a comparison observation with each other at Kashima. (Hiroo Kunimori)

Report of the Technical Workshop for APT and APSG in 1996 (TWAA96)

Yukio Takahashi (*takahashi@crl.go.jp*), **Yasuhiro Koyama and All staffs of Radio Astronomy Applications Section of Communications Research Laboratory**

Kashima Space Research Center
Communications Research Laboratory
893-1 Hirai, Kashima, Ibaraki 314, Japan

Technical Workshop for APT and APSG 1996 (TWAA96) was held at a hotel near the Kashima Space Research Center of the Communications Research Laboratory from December 10 to December 13, 1996. The workshop was the first joint technical workshop for Asia-Pacific Telescope (APT) and Asia-Pacific Space Geodynamics (APSG) Project. Since we considered there are many technical issues commonly applicable to the APT and the Very Long Baseline Interferometry (VLBI) part of APSG, we decided to make the meeting a joint technical workshop for APT and APSG. While APT is a regional VLBI network established by the Asia-Pacific countries for Radio Astronomy and Geodesy, APSG was established to conduct Geodetic research of the Asia-Pacific region by utilizing Space Geodetic technologies such as VLBI, Satellite Laser Ranging (SLR), and Global Positioning System (GPS). Therefore, the workshop covered technical issues of VLBI, SLR and GPS, and sciences of both Geodesy and Astronomy. The agenda of this workshop consisted of the following four items.

(1) Developments and New Technologies in VLBI, SLR, and GPS.
    Compatibility issues of the VLBI data acquisition system were discussed.

(2) Status Report.
    Recent status of the APT and APSG projects, observation sites, and data processing centers (including VLBI correlator centers) were reported.

(3) Collaboration of APT and APSG.

(4) Other Projects.
    Other projects such as VSOP and Antarctica VLBI experiments were discussed.

A large part of the time was allocated for the status reports from many organizations to exchange the latest information among the APT and APSG community. These reports ranged from the recent activities of global networks to status of individual observatories. The status report sessions were then followed by technology development sessions and science sessions. After these sessions, the open discussion session concluded the workshop. On the last day (December 13, 1996), there were two excursion tours, one to Geographical Survey Institute in Tsukuba, and the other to the Tokyo Headquarters of the Communications Research Laboratory in Koganei, Tokyo and to National Astronomical Observatory in Mitaka, Tokyo. We were grateful that many colleagues from 9 countries worldwide attended the workshop. We believe the scientific outputs and discussions during the workshop definitely strengthened our collaboration for the APT and APSG. The importance of observations using space geodetic technology in the Asia-Pacific area are increasing, and there is much potential for collaboration in the APT and APSG. This workshop was helpful in their co-operation and the exchange of the valuable information.

All staffs of the Radio Astronomy Applications Section in the Kashima Space Research Center contributed to various aspects to ensure the success of this meeting.

1. Participants

We listed 39 foreign participants.

Australia(7); D.Jauncey, J.Manning, J.Reynolds, M.Costa, P.Harbison, J.Lauf and P.Edwards.

China(7); Y.Shuhua, Z.Junliang, Q.Zhihan, Z.Wenyao, C.Junyong, A.Yusup, and Z.Yang.

Russia(7); M.Kaidanovski, A.Finkelstein, I.Ipatova, I.Molotov, S.Likhachev, A.Rodin and E.Brumberg.

USA(6); J.Bosworth, T.Clark, A.Whitney, A.Niell, V.Altunin and E.Himwich.

India(4); A.Singal, S.Ananthakrishnan, H.Vats and T.Das.

Canada(3); W.Cannon, P.Newby and G.Feil.

Korea(3); J.Hoon, M.Chol and K.Jongsoo.

Netherlands(JIVE)(1); L.Gurvits.

Germany(1); Hayo Hase.

V.Migenes contributed only proceedings, although he could not attend this meeting.

For Japanese participants, 24 staff members of CRL attended this meeting. There were 34 participants from other institutes, and 32 participants from various companies. Total number of participants was 129.

2. Presentations

We summarize the presentations at this meeting. As the opening session, D.Jauncey in CSIRO presented the current status of APT and Ye Shuhua in the Shanghai Observatory presented the recent status of APSG projects. After the opening session, the status reports of individual observatories and projects were presented with regard to wide area networks and projects, regional networks and projects, and the activities of individual institutes. Many important topics were presented: "CORE" and NASA Geodesy program, JIVE, GPS networks (WING), SLR network (WPLTN), Antarctica VLBI experiments, space VLBI projects (VSOP), LBA in Australia, KSP by CRL, the Japanese VLBI network and VERA by NAO, VLBI in DSN, status report of GSI (GPS, SAR and VLBI) and GMRT in India. Furthermore, it was very valuable to have status reports from Korea, China, Australia and other countries. In this session, there were 21 presentations.

The third was a discussion about developments of technology. There were 26 presentations. We divided them into 6 parts as follows: (1) Antenna and Receivers and Front-end, (2) Real Time VLBI, (3) Field system and scheduling, (4) Recorders and Acquisition terminals, (5) Correlator, (6) Tropospheric Delay Correction. Each topic was discussed eagerly. Especially, the compatibility of scheduling, VLBI terminals and correlators were important for this meeting, together with the exchange of information for the new VLBI techniques.

The fourth session was concerned with Science and others topics. There were 7 presentations concerning VLBI and APT and geodesy and astronomy.

14 topics were presented by poster. The total number of presentations at this meeting was 70. For details we refer to the published proceedings of this meetings.

3. Resolutions

There was an open discussion at the end of this meeting. The conclusions and resolutions made in the open discussion session are summarized by Dr. David L. Jauncey and Dr. John Reynolds. One was to encourage the formation of the fundamental reference and calibration stations in Asian-Pacific region. The modern space techniques (VLBI, SLR, GPS etc.) together with other techniques are colocated and operated on a long term basis for the establishment and maintenance of the global reference frame. Second was an expression of APT support for the acquisition of geodetic VLBI data as a contribution to GIS (Geographic Information System). The committee on GIS has initiated an Asia and Pacific Regional Geodetic Project for October 1997. Third was to deliver information concerning the new Field System which has been developed by NASA. Fifth was to adopt the proposals for APT experiments.

4. Proceedings

We believe that this proceedings is a valuable source for information in the APT and APSG community, and also in the worldwide VLBI group. Numerous copies of the TWAA96 proceedings are available. For copies of the proceedings of this meeting, please contact Y. Takahashi (E-mail: takahashi@crl.go.jp).

Acknowledgments

We could hold this meeting as the host institute with full support from Science and Technology Agency (STA) and Japan International Science and Technology Exchange Center (JISTEC). Furthermore, the staff of the administration section in the Kashima Space Research Center, and the staff of Standards and Measurements Division supported us in holding this workshop. We are grateful to them for this support. Many participants visited this meeting from various countries. We are also grateful to all participants.

Recent Status of the Key Stone Project VLBI System

Yasuhiro Koyama (*koyama@crl.go.jp*)

Kashima Space Research Center
Communications Research Laboratory
893-1 Hirai, Kashima, Ibaraki 314, Japan

1. Introduction

In addition to the three VLBI stations for the Key Stone Project (KSP) at Kashima, Koganei and Miura, the fourth VLBI station at Tateyama on the tip of Boso Peninsula became ready for the VLBI observations in August, 1996 (Figure 1). Immediately after the first check-out observations at Tateyama on August 20, 1997, daily operation of the Tateyama station began on September 1, 1996. It is a notable achievement that the new VLBI station started regular observations without major problems. This was possible because the construction and the preparation of the KSP VLBI stations were well organized and carefully designed. Since the Tateyama station started participating in daily KSP VLBI experiments, these experiments have been carried out with its full 4-station-6-baseline configuration with on a daily basis. In this report, the current status of the KSP VLBI system as of the time when 10th IERS TDC Meeting was held on March 14, 1997 will be mainly described. In addition, the improvements of the KSP VLBI system since then, and the future plans for the project will also be reported in the last section.

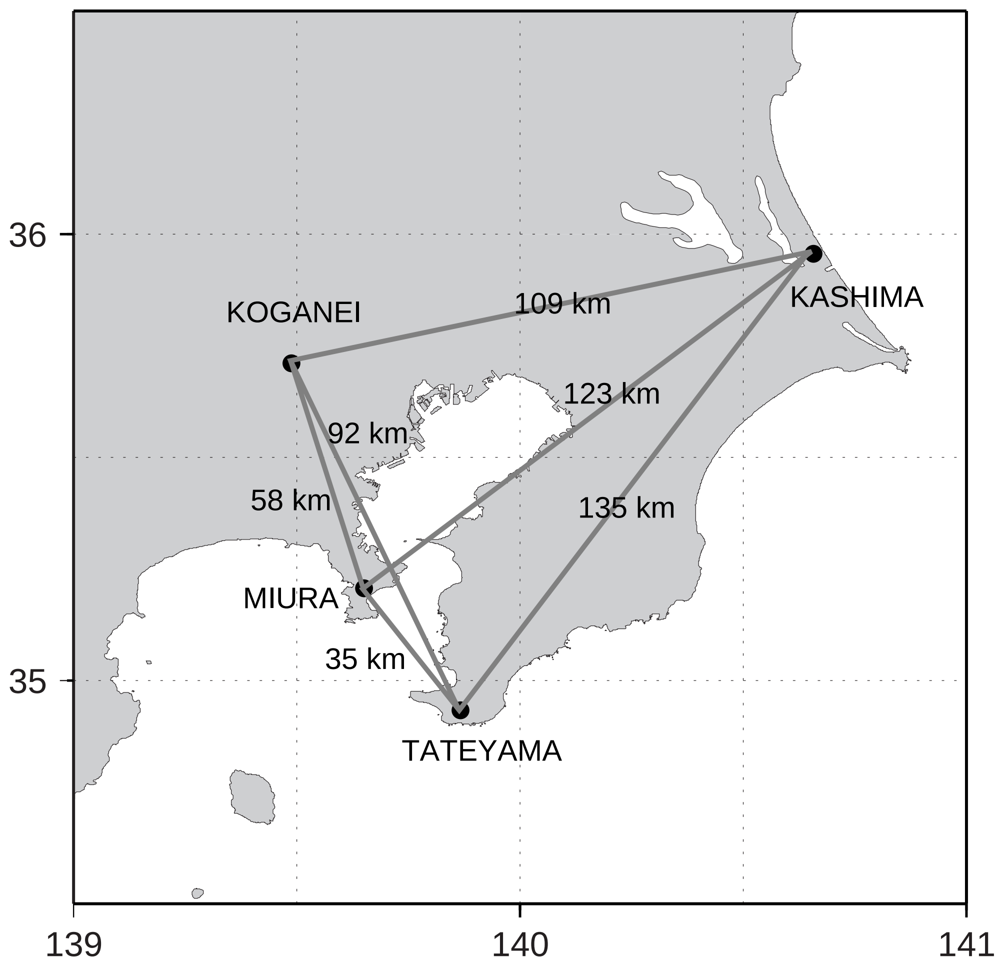


Figure 1. Configuration of the Key Stone Project VLBI Network.

Table 1. Percentage of the successful experiments for each station

Month	Kashima	Koganei	Miura	Tateyama
September,1996	96.7	96.7	83.3	93.3
October,1996	93.5	96.8	96.8	93.5
November,1996	80.0	93.3	93.3	83.3
December,1996	90.3	96.8	100.0	100.0
January,1997	96.8	90.3	100.0	100.0
February,1997	100.0	100.0	100.0	100.0
March,1997	100.0	100.0	100.0	66.7

2.Daily Operation

The daily observations of the KSP VLBI system are performed automatically. All four stations are equipped with two engineering workstations, one of which is for the control of the observation system and the other is for continuous data acquisition including the calibration data and the system monitoring data. These workstations are controlled and organized by the central control workstations located at Koganei central station and at Kashima sub-central station. There are two central control workstations to reduce the possibility of failure of the daily experiments. Since these two central control workstations are functioning identically and independently, the observations at remote sites are still under control even if one of the two central control system has a problem. The computer network of the KSP Network is also highly reliable since there is a redundant dial-up network line between Miura and Tateyama and it acts as a backup route when one of the three network lines connecting four VLBI stations loses connection for any reason. Table 1 shows how the reliability of the KSP VLBI system has been improved. The percentage of the successful experiments are counted for each station and tabulated in Table 1. In this table, an experiment is considered to be successful for one station, if the site coordinates of the station can be estimated with sufficient reliability. The redundant central control system at Kashima started full operation in January 1997 and it improved the success percentage. Especially in February, it is noted that all experiments were successful during the month.

Every morning, the observation tapes are replaced by human operators at each station during one hour from 9:00 o'clock by Japanese Standard Time (JST). After all the observation tapes are set in the Digital Mass Storage (DMS24) system, all tapes to be used in the next observation schedule are mounted into the DIR1000 data recorder and the quality of the tapes and whether the tapes are write-enabled are investigated, and in the end, all the tapes are rewound and set in place for the next experiment. This procedure is also performed automatically, and it tells system operator at Koganei station by e-mail if there is any problem. When the system operator receives an alarm message by e-mail, the cause of the problem is investigated and then resolved, if it is possible to do so from Koganei remotely. If an on-site repair is found to be necessary, related hardware vendors and CRL staffs are notified with detailed information. For example, a PC at Tateyama station which controls the Antenna Control Unit failed to keep the internal clock, although the PC clock is usually synchronized with UTC by using a GPS receiver signal. This problem caused data loss for the Tateyama station for three consecutive experiments but the system was recovered within three days. On the other hand, this case can be considered as a demonstration of the robustness of the KSP VLBI Network in the sense that an unpredictable failure at a remote site can be recovered within three days. In addition, the overall software system is being implemented so that the same type of problem can be resolved from central control system at Koganei or at Kashima.

3. Quality of the Observed Data

Starting on March 1, 1996, the VLBI observations are performed with 16 channels each of which have 2 MHz of video band width. Total speed of data recording is 64 Mbps, which is 1/4 of the maximum recording speed of the KSP VLBI system. 10 channels are assigned for X-band and the other 6 channels are assigned for S-band. Figure 2 and Figure 3 show the various aspects of the data quality of the observed data for two baselines, one is between Kashim11 and Koganei stations and the other is between Kashim11 and Miura stations. In each figure, (a) the formal error of the baseline length estimates expressed by the standard deviation, (b) root mean squared of the residual of the observed delay after the least square estimates, and (c) the ratio of the number of delay observable which are not used for the least square estimates to the total number of the data included in the Mk-3 database

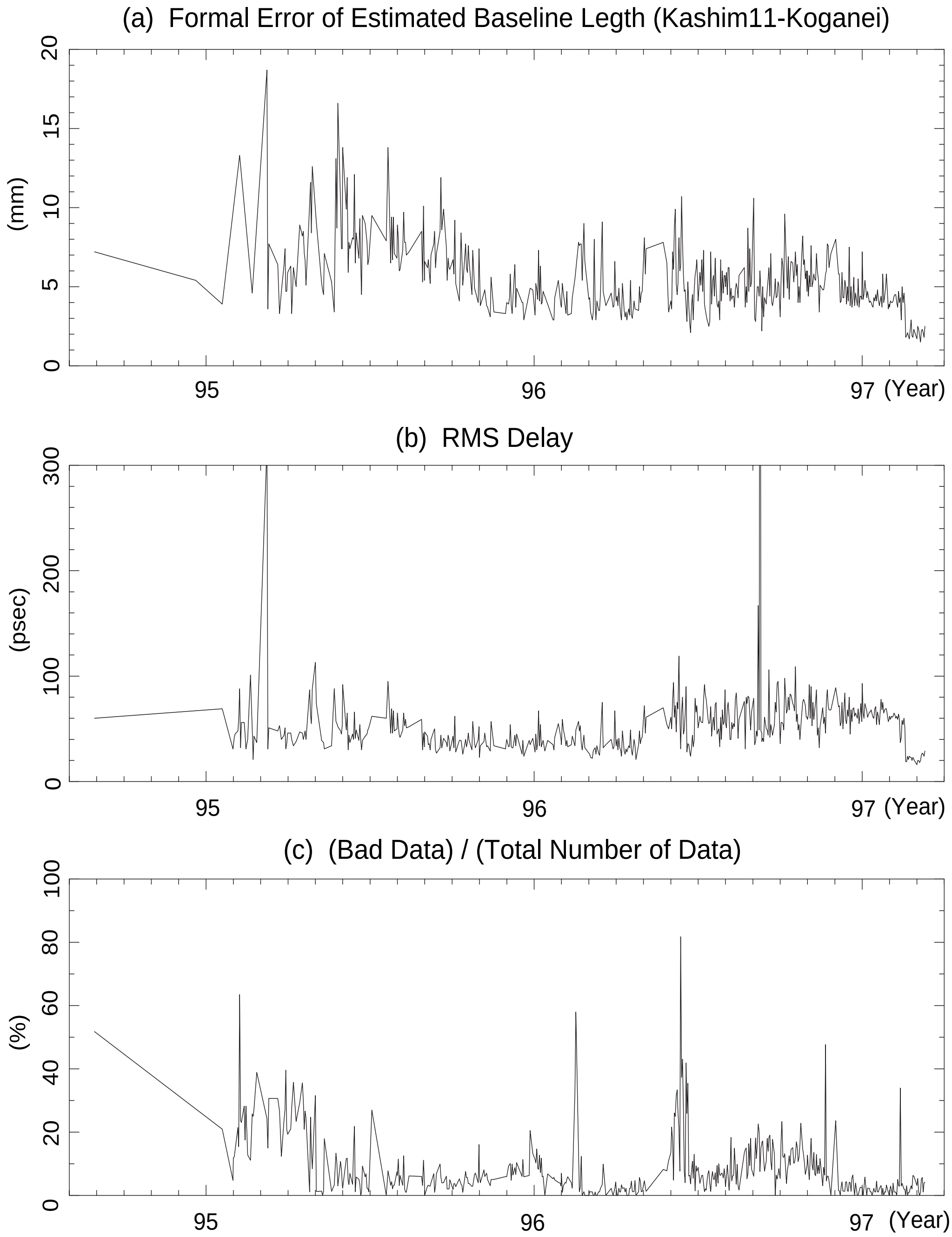


Figure 2. Three indices to evaluate the data quality of Kashim11-Koganei Baseline.

for each individual experiment session, are evaluated and plotted.

These figures indicates the data quality of the data obtained in the daily KSP VLBI experiments. The most notable point is the evident improvement in the formal error and RMS residual delay for both of the baselines from February 22, 1997. Before that day, the formal errors of the baseline length estimates were around 4 mm but improved to approximately 2 mm. The RMS delay was improved from the level of 60 psec to about 20 psec. This was a result of the improved short time phase stability of the phase calibration signal at Kashima station. Before the improvements, the temperature inside the receiver unit located below the 11m antenna dish was controlled in the range $25 \pm 1^{\circ}$ C. But it was found that this temperature control had been causing the short time periodic variation of the temperature inside the unit. The phase of the phase calibration signal is quite sensitive to the am-

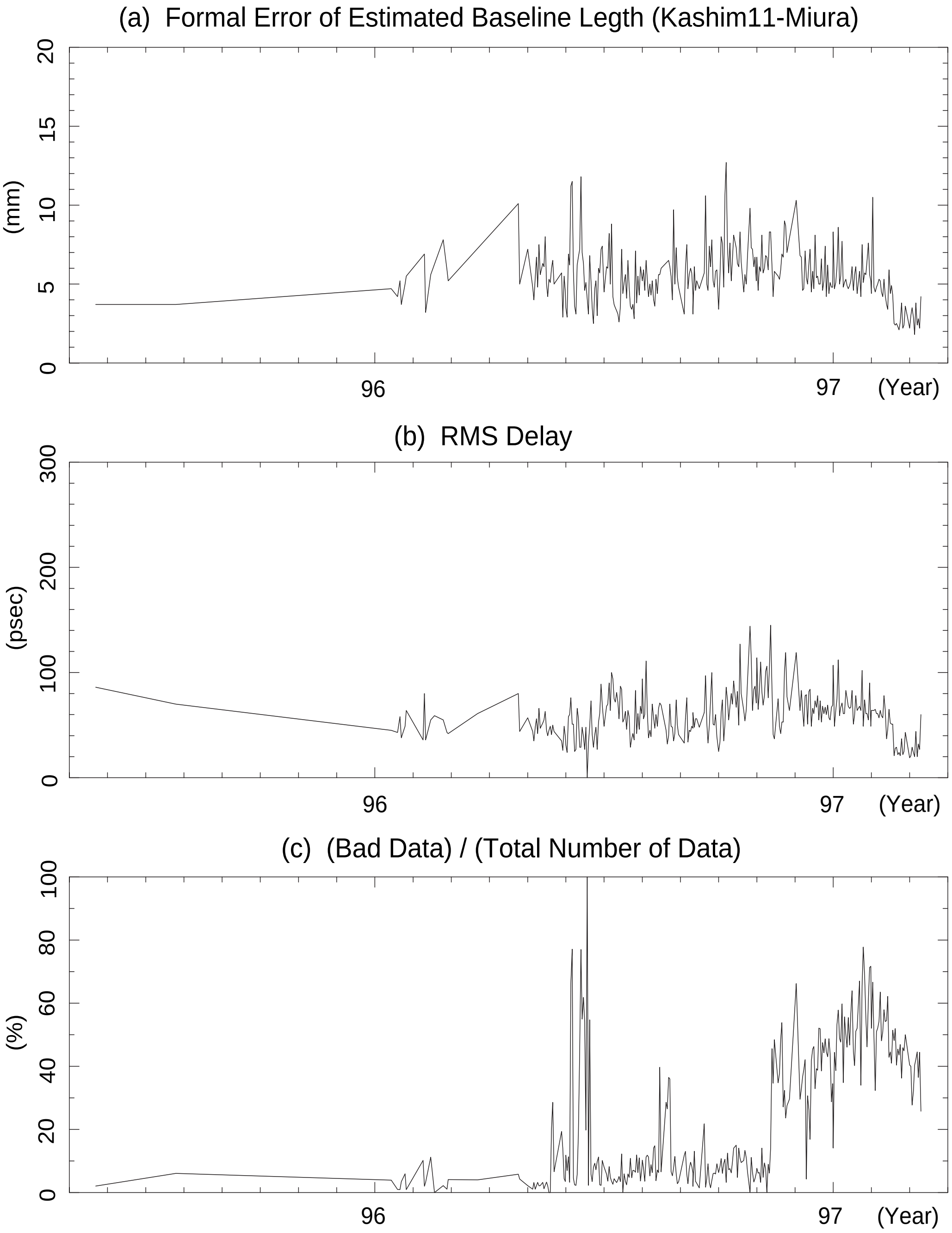


Figure 3. Three indices to evaluate the data quality of Kashim11-Miura Baseline.

bient temperature and the phase variation causes error in the observed delay. If the variation is slow, the error of the time delay can be removed as the clock difference between two stations through the VLBI data analysis. If the variation is faster than the interval of the clock parameter epochs which is 1 hour for the KSP data analysis, the delay error can not be removed and it degrades the estimated results and increases the residual delay. At present, the receiver units of all four stations are not temperature controlled and the observations are performed in the time range from 00:00 to 05:30 local time when the temperature is most stable during the day. An improvement of the temperature control system of the receiver unit with slow and smooth temperature control is considered and will be implemented in the future. The phase calibration signal unit will also be improved with a small temperature control system inside the case of the unit to stabilize the phase of the signal.

The other characteristic thing of concern in Figure 2 and 3 is the high percentage of invalid data to the total number of the available data for the Miura station. This is shown in Figure 3 (c) only for the Kashim11-Miura baseline, but it is also true for the other two baselines which include the Miura station. This is caused by weak phase calibration signals recorded in specific channels at Miura station. The band-width synthesis software automatically rejects a data channel if the amplitude of the phase calibration signal recorded in the channel is below 1% of the total power of the channel. At Miura station, the amplitude of the recorded phase calibration signal is not uniform for all channels. When the system noise temperature is high at low elevation angle or due to rainy conditions, up to four observation channels are removed from the band-width synthesis software. In this case, much data becomes invalid because of false detection of side-lobe of the delay resolution function. The cause of the weak phase calibration signal was diagnosed to be a problem in the Input Interface (DFC2100) of the KSP data acquisition system. At present, solutions are being considered and the problem will be solved in a near future.

4. Recent Improvements and Changes

After the 10th IERS TDC Meeting was held on March 14, 1997, following new changes and improvements have been applied to the KSP VLBI system.

First of all, real-time VLBI test observations were performed for four consecutive days starting April 7, 1997. The observations were done using the maximum data rate of 256 Mbps for 22 hours from 10:30 local time each day. The tests were nearly totally successful and the results obtained from the real-time VLBI data were consistent with the daily tape-based VLBI experiments performed at 64 MHz prior to April 6, 1997. At present, minor problems and software developments for the automated processing are in progress. The 256 Mbps real-time VLBI experiments will be routinely started near future.

In the data analysis, a program **dbupdate** was revised to obtain the nutation offsets from the IAU80 model provided in the IERS EOP Bulletins and include the offsets in the Mk-3 database. These offset values are now used in the data analysis.

Lastly, the phase calibration signal unit at Tatayema station was replaced on April 8, 1997. Before it was replaced, the phase stability of the unit was insufficient. Now, the phase stability has been improved and the formal errors of the baseline lengths of the three baselines towards Tatayema are at same level as the other three baselines. The power of the phase calibration signal at Miura station was increased and since then the ratio of invalid data to the total number of available data decreased. Although the Input Interface of the Miura station must still be repaired to make the phase calibration signal level uniform among the 16 observation channels, the data quality of the Miura station is now satisfactory.

5. Future Prospects

At present, the daily VLBI experiments of the KSP VLBI system are producing daily baseline lengths and horizontal station positions with formal errors close to 2 mm. Vertical station positions are estimated with formal errors of about 10 mm. The system development of the automated data processing system for the real-time VLBI observations are in the final stage, and the daily real-time VLBI experiments will start on a daily basis very soon.

The Multimedia Virtual Laboratory (MVL) and Its Application to Cooperative Research

Shin'ichi Hama (*hama@crl.go.jp*)

Communications Research Laboratory
4-2-1 Nukui-kita, koganei, Tokyo 184, Japan

The concept of an MVL (Multimedia Virtual Laboratory) was proposed by the Telecommunications Technology Council in May 1996, in consideration of recent technological development in telecommunications. The MPT (Ministry of Posts and Telecommunications, Japan) strongly recommends the creation of the MVL, and began efforts toward this end in 1997.

The MVL has many potential applications, such as in teleconferencing, application sharing, wearable computers, virtual reality using "cave," and so on. But we would like to demonstrate the possibilities for cooperative research in the VLBI field, the MVL is not merely "an improved TV phone." Researchers in distant places have been able to communicate with each other for development of network technology, as shown in Table 1. But large quantities of data has not been able to be transported by network.

Some of the MVL projects needing cooperation between industries, academies, and administrative organs, are carried out by TAO (Telecommunications Advancement Organization of Japan). And some, which should be led by the government, are carried out by the CRL (Communications Research Laboratory, Japan). The latter ones are generally ambitious and science-oriented projects. We expect to establish the basic system in the first two or three years, and carry out experiments later.

With the construction of the MVL, researchers in different laboratories, institutes and universities can be connected for mutual cooperations to increase efficiency and to reduce the costs of research and development. Particularly in VLBI and earth environment sensing, sharing a large quantity of raw data between researchers is highly useful. By connecting the radio telescopes and VLBI data processors of the CRL's KSP (Key Stone Project), NAO (National Astronomical Observatory), ISAS (Institute of Space and Astronautical Science), and other institutes, as shown in the Figure, we expect to achieve such benefits as distributed VLBI data processing, comparison of correlation processing between different systems, and realtime feedback of observation parameters.

Table 1. Communication between distant researchers

Communications Medium	Type of information: Talk, Atmosphere	Document, Small data	Figures, Photos	Control, Monitor	Large data (~1 Gps)
Conventional (telephone)	(TV)phone TV conferencing	Fax	Fax TV conferencing	modem	– (send MT)
Network	TV phone, VR* TV conferencing	E-mail, ftp, NFS	E-mail (MIME) WWW, X terminal	ftp rsh	?

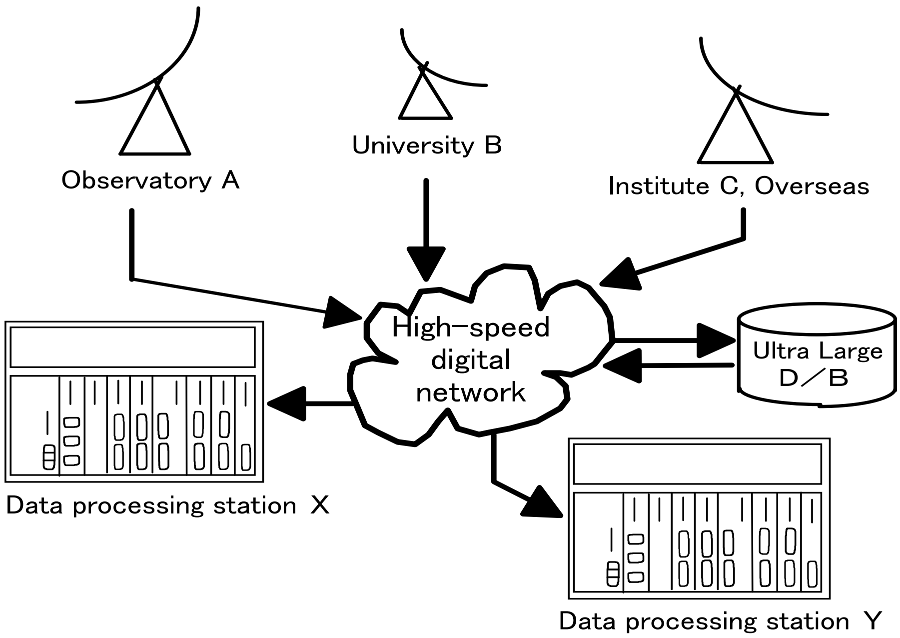
* VR: Virtual reality

Realizing a Virtual Laboratory by sharing large quantities of observation data

<u>Present Status</u>

VLBI (geodesy and astronomy), observation of faint radio sources
→ need to transport data on MTs → a week for obtaining results

<u>Concept Image</u>



<u>Effects</u>

- Sharing of a large quantity of observed data (both stored and flowing)
- Rapid detection of small crustal movement
- Flexible observation (dynamic feedback of parameters)
- Distributed processing of VLBI and synthesis of faint sources
- Comparison of different processing methods

Figure 1. Multimedia virtual laboratory.

Overview of Development of High-speed VLBI Terminal and the Compatibility of VLBI Terminals

Yukio Takahashi (*takahashi@crl.go.jp*)

Kashima Space Research Center
Communications Research Laboratory
893-1 Hirai, Kashima, Ibaraki 314, Japan

I reported the compatibility of VLBI terminal in TDC News No.9 in 1996, and would you like to refer it.

The international VLBI observations have been conducted using Mark-IIIa VLBI terminal. The recording rates of the system are 56 or 112 Mbps /14 channels, and 112 or 224 Mbps /28 channels. The recording capacity is 1.1 Tb/tape. This is the standard VLBI system.

K4 and KSP system developed by CRL in Japan has been used for 64 Mbps, 128 Mbps and 256 Mbps/16 channels. The recording capacity is about 0.8 Tb/tape. The VSOP terminal is similar to K-4 system, but only 4 channels. Any operator for tape change is not necessary for 24 tapes. S2 VLBI terminal developed by Canada has used at 128 Mbps. It has 4 or 8 or 16 channels. The VLBA terminal developed by USA is 256 Mbps/4ch or 16ch is used in radio astronomy or geodetic VLBI. These three types of VLBI terminals are presently available.

Recently, Mark-IV which will be used for 1 Gbps (or /2Gbps ?) was developed in USA and the correlation center has been established in JIVE and other countries. Mark-IV is upward compatible with VLBA. CRL has developed a new VLBI terminal which is used for 1 Gbps/1 channel (or 4 channels?) mode to record on cassette tape. We call this the "GBR system". These terminals are considered to be a next generation VLBI terminal.

I summarize the characteristics of VLBI terminal in Table 1. It is divided into two groups of recording format. One group records the time signal in the observation signal. Another group records the time signal on another track. The latter provides excellent time control.

Concerning the compatibility of VLBI terminals, the correlation center is important. I also summarize the correlation centers in the world as shown in Table 2. I introduce the correlation center for multi-baselines. The most familiar correlation centers are Haystack, Washington and Bonn for Mark-IIIa VLBI terminals. Recently, the NRAO

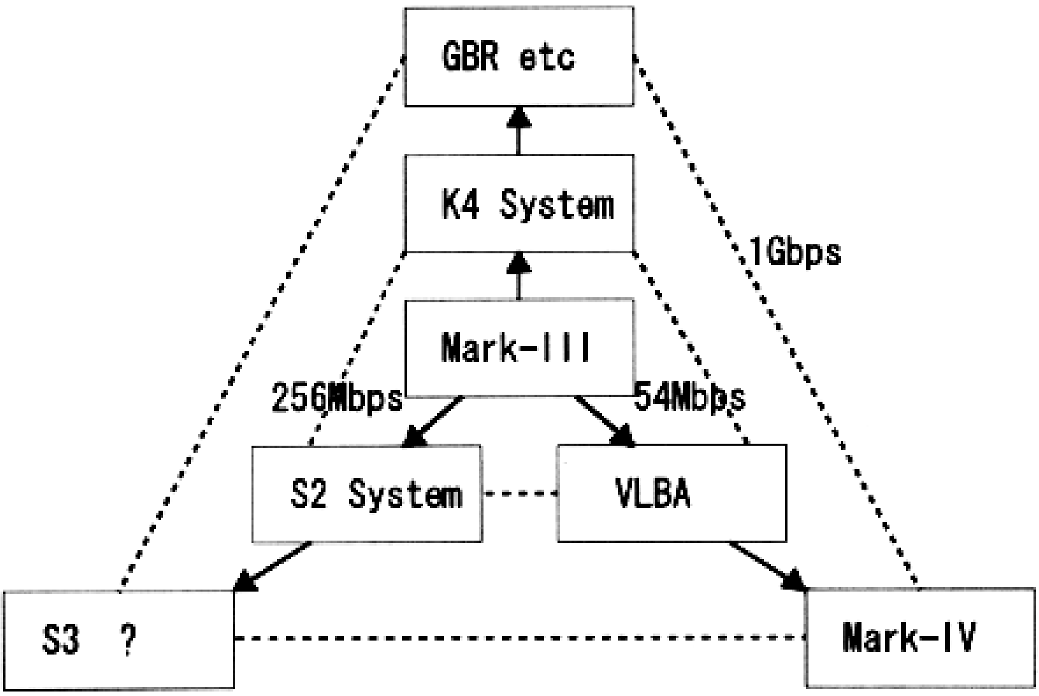


Figure 1. The generation relationship of VLBI terminals.

correlator was established for VLBA terminals, and Canada and ATNF in CSIRO (Australia) are established for S2 terminals. The S2 correlation center in ATNF is important for APT (Asian Pacific Telescope).

In Japan, there are three correlation centers for multi-baseline. First is the NAO FX correlator for VSOP. Second is KSP correlation center at CRL. It is available for the real time VLBI experiments for the first time in the world. Third is GSI correlator, which is similar to the KSP correlator.

I represent two correlations; one is the correlation which mixes types of terminals, and another is the correlation using next-generation VLBI terminals. CRL succeeded in performing mixed correlation between K4 VLBI terminal and Mark-III [*Takahashi et al.*, 1995]. CRL also developed the first copying system from the K-4 system to Mark-IIIa systems. Recently, the VSOP group at NAO has developed a copying system between the different VLBI terminals of the VLBA, S2, VSOP-K4 systems. Observations which mix the various VLBI terminals cannot be available until the development of this system. Table 3 shows the copying systems.

The correlation center of Mark-IV which is one of the next generation VLBI terminals will be JIVE in Europe. Bonn and others are planning for a Mark-IV correlation center. CRL has also developed the correlator for GBR which is the next generation VLBI terminal. It is for a single baseline, but observations of high sensitivity and wide bandwidth will be possible for astronomy. If GBR can perform correlation processing of 4 channels, then it is possible to use the GBR system for geodesy. Table 5 shows the performance of GBR system when used for geodesy in two cases: 1 channels in the 22 GHz band and 4 channels in the S and X bands.

Finally, we summarize the available VLBI terminals of stations in Japan.

In December 1996, the technical workshop for APT and APSG (TWAA96) was held at Kashima, CRL in Japan. These topics were discussed at this workshop and the different VLBI terminals were represented in the proceedings of the workshop. Please refer there for detailed information concerning VLBI terminal.

Reference

Takahashi Y., et al. Data Processing Software and Data Analysis Software, J. Commun. Res. Lab., **42**, pp31-42, 1995.

Table 1. Characteristic of VLBI terminals

	channel	Maximum recording speed
1. time signal in the observed signal		
Mark-IIIa	14 ch/28 ch	56 Mbps/112 Mbps/224 Mbps
K4 standard (DFC1100 I/F)	16 ch	64 Mbps
VLBA	4 ch	256 Mbps
Mark-IV	16 ch	1024 Mbps/2048 Mbps
2. time signal on the special track (No time signal in the observed signal)		
S2	4 ch/8 ch/16 ch	128 Mbps
KSP (K4/256M version) (DFC2100)	16 ch	256 Mbps
VSOP	4 ch	256 Mbps
GBR	1 ch(/4 ch)	1024 Mbps

Table 2. Correlation center for various VLBI terminals

VLBI terminal	Correlation Center
USA, Europe	
Mark-IIIa	Mark-III correlator (XF type)
	Haystack, Washington(USNO), Bonn
Mark-IV	Mark-IV correlator (XF type) (BON, JIVE, WCO?)
	JIVE, Bonn?, Washington(USNO)?
VLBA	VLBA correlator (FX type)
	NRAO
Canada, Australia, USSR	
S2	S2 correlator (XF type)
	Canada, Australia(CSIRO/ATNF)
Japan	
K4 standard	K3 correlator (XF type) (CRL)
	NAOCO (XF type) (NAO,GSI)
Mix of K4 and Mark-III	K3 correlator (XF type) (CRL)
	NAOCO (XF type) (NAO,GSI)
KSP (K4 256Mbps)	KSP correlator (XF type) (CRL, GSI)
	NAOCO (XF type) (NAO,GSI)
VSOP (K4 TCU)	NAO FX correlator (FX type) (NAO)

XF: FFT after cross correlation. FX: FFT before cross correlation.

Table 3. Copying (dubbing) system between the various VLBI terminals

Station	Dubbing type		
CRL	K4 standard	→	Mark-IIIa
NAO	S2	↔	VSOP
	VLBA	↔	VSOP
GSI	K4 standard	→	Mark-IIIa (will be)
	K4 KSP	→	VLBA, Mark-IV (will be)

Table 4. VLBI terminals at stations in Japan

	Kashima		KSP	GSI	USUDA	Nobeyama	Mizusawa	Kagoshima
	34m	26m	11m×4	32m	64m	45m	10m	6m
K4 standard (64Mbps)	○	○		△	○	○	○	○
+TCU	○				○	○	○	○
KSP (K4/256Mbps/16ch)			○					
VSOP (256Mbps/4ch)	○				○	○	△	△
Mark-IIIa (54Mbps/14ch)	○	○			○	○		
VLBA (256Mbps/4ch)					○	○	△	
Mark-IV (1Gbps/16ch)				△				
S2 (128Mbps/4 or 16ch)					○			

Table 5. Performance of GBR system for geodetic VLBI (Correlation amplitude: 0.07%, antenna slew speed: 1deg/s, the mean angle between observations: 30deg, correlation synchronization: 10s, SNR at X band > 30, SNR at S band > 25, ionospheric delay error < 20ps, the observation error: 50ps, IF: 100-1000MHz, experiment: 24 hours & one baseline, the duration of observation is enough to identify the ambiguity.)

	Mark-IV (1Gbps/16ch)	GBR (1Gbps/1ch)	GBR (1Gbps/4ch)
configuration of band	S:6ch, X:10ch 32MHz/ch, 1bit	22GHz:1ch 500MHz/ch, 1bit	S:1ch, X:3ch 64MHz/ch, 2bit
Effective Freq. Width at X band	355MHz	144MHz	311MHz
Side-lobe	0.58	–	0.58
ambiguity	50/100ns	–	4ns
observation duration (sec)	8sec	7sec	12sec
number of observations	1730 obs	1800 obs	1660 obs
precision horizontal	1.1mm	1.0mm	1.1mm
vertical	3.2mm	3.1mm	3.2mm

Plan for a High-rate Data Recorder and a New Data Acquisition Terminal

Hitoshi Kiuchi (*kiuchi@crl.go.jp*), **Michito Imae, Shin'ichi Hama, and Mizuhiko Hosokawa**

Communications Research Laboratory
4-2-1 Nukui-kita, koganei, Tokyo 184, Japan

Abstract

At the Communications Research Laboratory (CRL), we have been developing VLBI data acquisition terminals (K series) for mainly geodetic purpose. The latest one is the K-4 system, which has a maximum recording rate of 256 Mbps. The high-end version of the K-4 system, which has fully automatic operation is utilized in the Key Stone Project and formal error of a few millimeter over 100 km baselines is performed in daily observation, which is published on the WWW (http://ksp.crl.go.jp). Recently CRL has been developing a new VLBI recording system using a GBR recorder for a near-future system which is based on a data recorder that has a maimum recording rate of 1 Gps, which is the state of the art. Besides the development of the GBR system, CRL, as the IERS-VLBI Technical Development Center, is planning to construct a next-generation VLBI system which will have a maximum recording and data processing rate of 2048 Mbps in order to achieve highly sensitive and accurate VLBI. This system will be applicable to various fields of VLBI observation, such as the micro-arcsecond-order radio astrometry to investigate the whole image of our Galaxy using the apparent positional movement of quasars due to gravitational lensing effects [*Hosokawa et al.*, 1997].

Concept of new system

The aim of this plan was not to develop a low-price system but to develop a pioneering technology system in order to comprehend the whole image of the Galaxy by detecting dark matter. A low-price system will be developed in another plan.

We are starting the design of the new system for discussion as follows;

(1) Phase and delay calibration system
   TDB,

(2) Video signal converter
   multi-channel and wide video bandwidth (32 MHz/ch * 32ch or 64 MHz/ch * 16ch),

(3) Input interface (or formatter)
   Using high-speed A/D converters which have maximum sampling rate of more than 150 Msps and 8-bit sampling in each channel.
   Using digital filtering to minimize the phase flatness,

(4) Data recorder
   Target maximum recording rate of 2048 Mbps, helical scan recording head (for long-term continuous integration), cassette tape, low bit error rate (better than 10^{-10}), etc.

(5) Output interface
   Having modes comaptible with other VLBI acquisition systems,

(6) Correlation processor
   64 MHz clock 32 channels, using ASIC technology for flexibility, etc.

We welcome suggestions and comments about this development project from a wide range of VLBI users, especially concerning;

(1) high rate data recorder
   interface specifications, recording time per volume, bit error rate, etc.

(2) accurate instrumental delay calibration method for bandwidth synthesis method,

(3) input interface
   number of sampling bits, specifications of digital filter, sampling frequency, etc.

(4) compatibility with Mark-III, IV, VLBA, S-2, K-4, etc.
   We are planning that the output interface will have an output mode for all or several of the ones of the present VLBI acquisition systems.

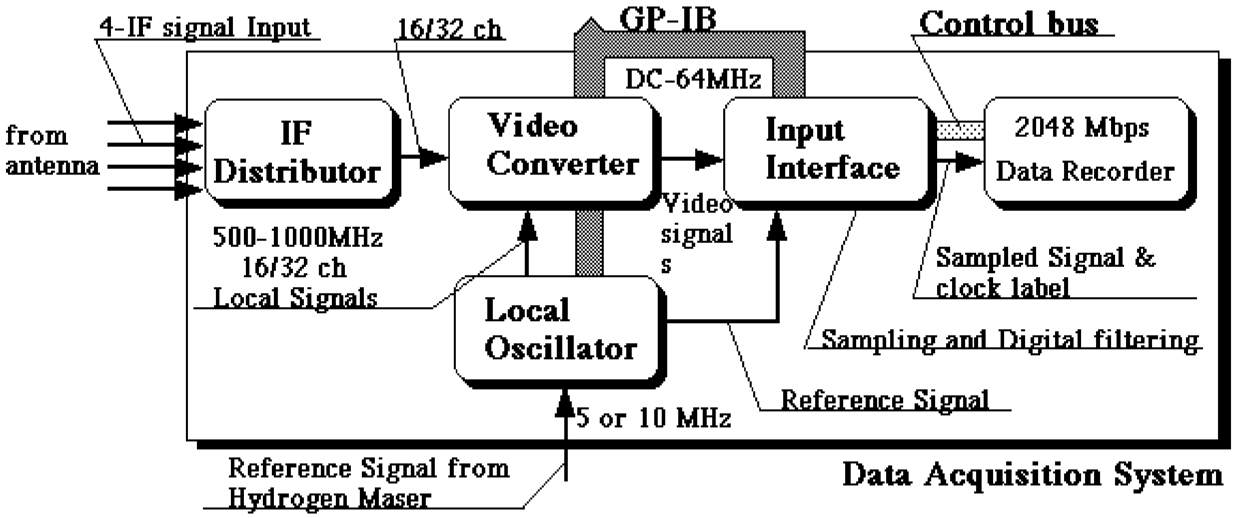
Suggestions for applications and science targets of the new VLBI acquisition system are also requested.

Reference

Hosokawa, M., K. Ohnishi, and T. Fukushima, Fluctuation of extra galactic reference frame due to gravitational lensing in our Galaxy, to be published in the Astronomical Journal, 1997.

500-1000 MHz /IF	DC-32 MHz /ch	2048 Mbps
4 IF	32 ch Video	Digital

500-1000 MHz /IF	DC-64 MHz /ch	2048 Mbps
4 IF	16 ch Video	Digital



Recording format : TBD
Time code : Data does not include the time code.
Interface : TBD

IF distributor and Local oscillator are possible to be replaced with Mark-III/VLBA system.

Figure 1. Concept of new system

Next Generation VLBI Terminals (Should be) Planned at CRL

Tetsuro Kondo (*kondo@crl.go.jp*)

Kashima Space Research Center
Communications Research Laboratory
893-1 Hirai, Kashima, Ibaraki 314, Japan

Generally speaking, a technical development is closely connected with scientific progress, and vice versa. We summarize this relation as follows.

Two feedback loops are considered between their relations (Fig.1). One is an "accuracy improvement" loop. In this feedback loop, the observation system is designed to achieve the best measurement accuracy from the technical point of view. Cost-effectiveness is sometimes regarded as an unimportant factor in a system development. High-accuracy measurements will stimulate scientific study, while scientific result will stimulate more accurate system development.

The other one is a "spread promotion" loop. Being different from the previous one, this type of loop aims to reduce cost rather than to increase accuracy, in order to permit wide dissemination of the system in the VLBI community. Miniaturization of the system can also be a goal for portability. Even though accuracy of measurements is sacrificed, widely distributed VLBI terminals will produce new observational data which bring a new insights in science.

The former one, pursuing an accuracy improvement, can be divided into two types of terminal which are planned or almost developed at the Communications Research Laboratory (CRL) (Fig.2).

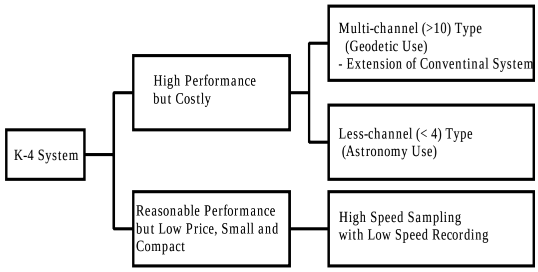


Figure 2. Next generation VLBI recorder system.

One is a multi-channel type mainly dedicated to geodetic rather than astronomical applications (see *Kiuchi's* report in this newsletter). Even though this system is still in the planning phase, almost all technical key items regarding this system are already or will soon be realized. The other type is one having fewer channels but wider bandwidth per channel (*Nakajima, 1996*). The recording and reproducing part of this system has been already developed.

In addition to persuing accuracy we should be concerned about the distribution of terminals. If the price of VLBI terminal goes down with total performance being kept as accurate as current one, terminals will be easily distributed widely. Furthermore if it becomes compact in size, we will be able to bring it easily anywhere in the world.

CRL should proceed with both types of development if possible.

References

Kiuchi, H., Plan for a high-rate data recorder and a new data acquisition terminal, VLBI TDC News CRL, No.10 (this issue), pp.19-20,1997.

Nakajima, J., Current status of the gigabit VLBI recorder system, VLBI TDC News CRL, No.9, pp.17-18, 1996.

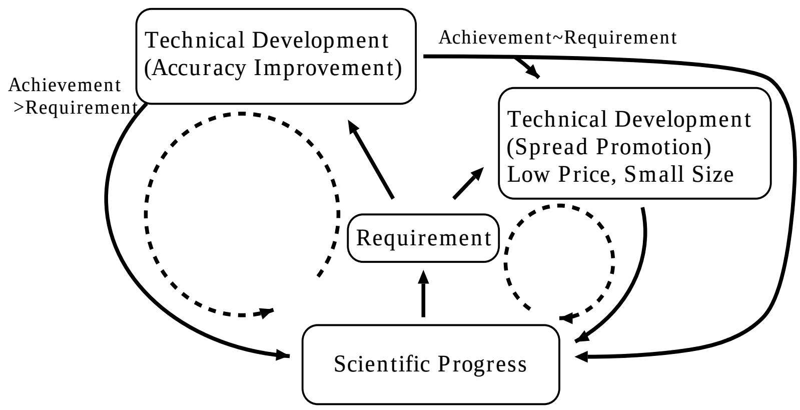


Figure 1. Relation between technical development and scientific progress.

Preliminary Experiments of Radio Interferometer Using Fiberoptic Links Modulated in Radio Frequency

Jun Amagai (*amagai@crl.go.jp*), **Hiroo Kunimori, and Hitoshi Kiuchi**

Communications Research Laboratory
4-2-1 Nukui-kita, koganei, Tokyo 184, Japan

1. Introduction

In Very Long Baseline Interferometer (VLBI), extremely stable frequency standards are required for each station. Data recorders are also needed to record the signals detected at each observation site. Recently, real-time data transmission using ATM switches has been initiated with VLBI by the Communications Research Laboratory [*Kiuchi*, 1996]. Data recorders are not needed in that system, although frequency standards are still necessary.

It is possible to make a radio interferometer that has neither a data recorder nor frequency standards at each observation site by introducing fiberoptic links modulated in radio frequency. In this type of radio interferometer (optical-linked RF interferometer) we can utilize absolute delay, and we do not have to estimate the clock offset for baseline analysis because we use common local signals and every instrumental delay can be calibrated. According to *Heki*, [1990], the vertical component error of the estimated position is larger than the horizontal component error because it is difficult to distinguish the parameter for the vertical component of the station position from that for the clock offset in least-square parameter estimation. We can improve the vertical position error by introducing baseline analysis, which does not need clock offset estimation.

In conventional VLBI, it is impossible to use phase delay because an unknown phase introduced by an independent local oscillator is added to the observed phase. For the optical-linked RF interferometer, however, we use a common local oscillator for frequency conversion so that the phase difference observed by this interferometer can be treated as a phase difference caused by group delay in the case where no dispersion medium exists. We can improve delay determination accuracy considerably by introducing the phase delay.

2. Configuration of the System

Figure 1 shows the configuration of the optical linked RF interferometer. The signal of the radio

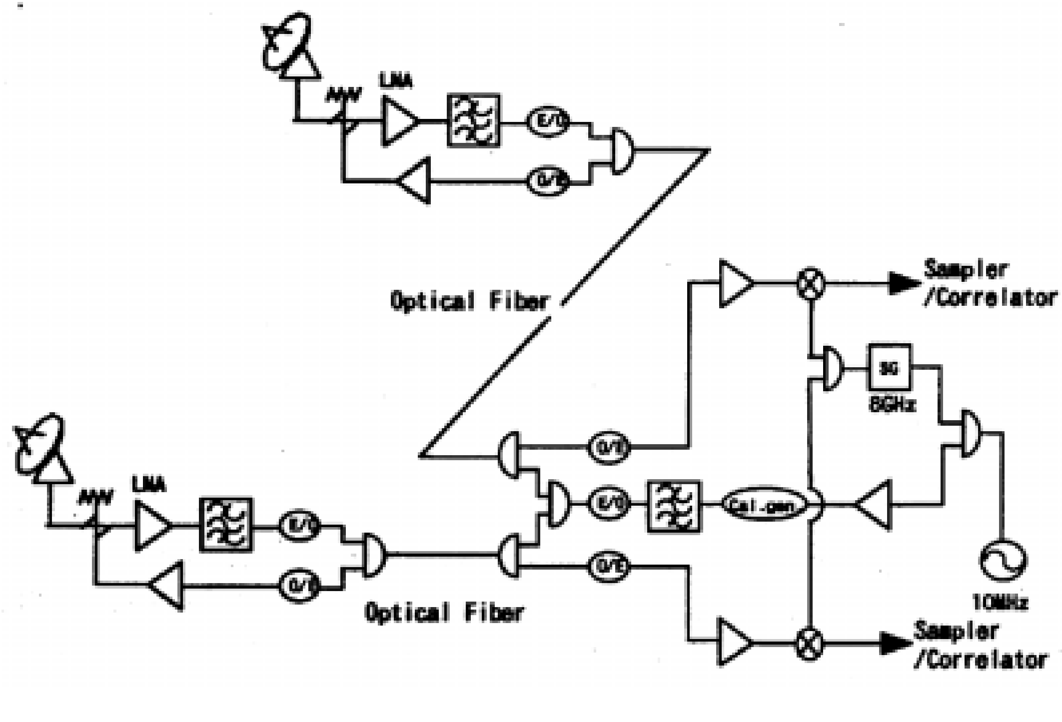


Figure 1. System configuration of the optical linked RF interferometer.

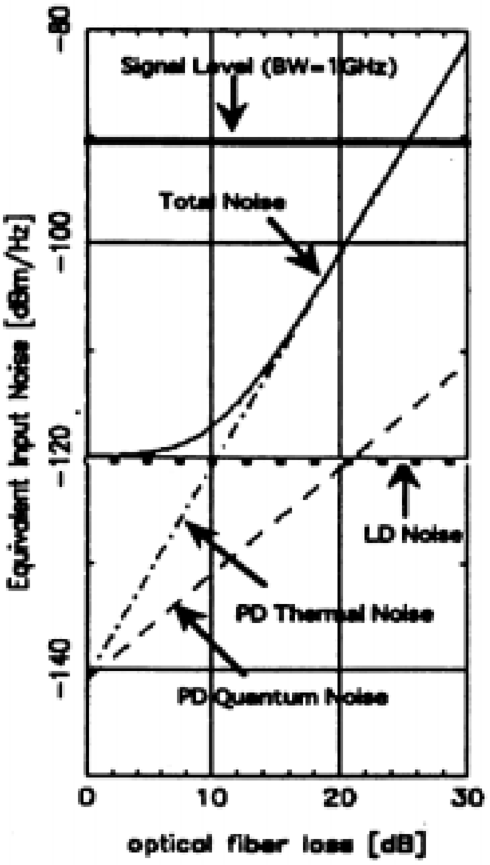


Figure 2. Equivalent input noise of optical link (factory data). A practicable cable length is expected to be 65 km in the case that allowable signal to noise ratio is 10 dB and optical fiber loss for unit cable length is 0.35 dB/km.

frequency at 8 GHz detected by the antenna at each observation site (objective signal) is amplified by a low noise amplifier (LNA) and converted to an optical signal at the wavelength of 1.31 μm. The optical signals are transmitted through optical fiber to the analysis station, where the electric signals are reproduced from the received optical signals. By using a common local signal the reproduced signals are converted to video signals, which are processed by a correlation processor.

Delay changes that occur in the optical fiber are compensated for by the calibration signal, which makes a round trip between the analysis station and the observation sites. A calibration signal generated at the analysis station is converted to an optical signal at the wavelength of 1.55 μm and is divided into signals by an optical power divider. The divided optical calibration signals are transmitted to the observation sites through the same optical fibers through which the objective signals pass. At each observation site the calibration signal is reproduced from the optical signal and injected into the receiving system through a directional coupler installed just before the LNA. The calibration signal returns to the analysis station via the same path through which the objective signal is transmitted.

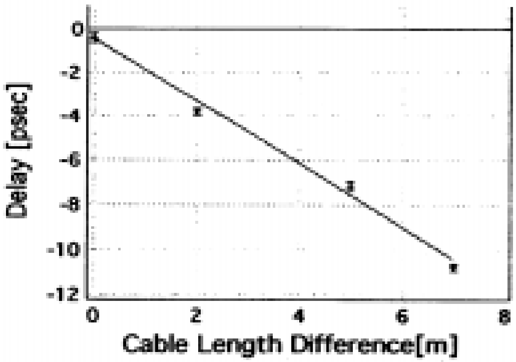


Figure 3. Relationship between the measured delay obtained by the phase delay and the cable length difference. Although the measured delay is expected to be 0, it decreases in proportion to the difference in the cable length.

3. Results of preliminary experiments

We investigated a radio interferometer with fiberoptic links modulated in radio frequency and found that the practicable cable length was 65 km (Fig. 2).

We carried out preliminary experiments with a common signal instead of the signal coming from antennas and with optical fiber cables whose length was less than 10 m [*Amagai et al.*, 1996]. The results of the preliminary experiments suggest the following conclusions:

a) Short-term phase stability of optical signal transmission is sufficient to maintain the correlation amplitude.

b) Long-term delay fluctuation is less than 0.3 psec when the system is kept under the temperature condition of 1 deg peak to peak.

c) The optical fiber delay is successfully compensated for by a calibration signal in the radio frequency which makes a round trip between the analysis station and the observation sites. We can determine the absolute delay not only by group delay but also by phase delay. To use this cable delay compensation method, however we must know the the precise ratio of the refractive indices for 1.31 μm and 1.55 μm (Fig. 3).

We plan to solve the refractive indices problem by measuring the time necessary for a optical signal at a wavelength of 1.55 μm to move back and forth between the analysis station and the observation site.

Acknowledgements

The authors would like to express their appreciation to Mr. Takeda and Mr. Kikuchi of Sumitomo Osaka Cement Co., Ltd for their help with the signal-to-noise analysis of the optical link. The authors are also grateful to Dr. Kondo of the Communications Research Laboratory for his assistance with the correlation processing analysis.

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Effects of Precession and Nutation on Short (a few Hours) VLBI Experiments

Yukio Takahashi (*takahashi@crl.go.jp*)

Kashima Space Research Center
Communications Research Laboratory
893-1 Hirai, Kashima, Ibaraki 314, Japan

Errors in VLBI measurements are caused by many reasons, such as noise, atmospheric scintillation, clock fluctuation, the pseudo delay by the calibration system, and inaccurate physical model. I investigated the effects of the differences of the precession and nutation parameters from the model on the station positions.

The theoretical delay model of the Wahr's nutation model (1980), and the Lieske's precession model (1976), which were adopted in IAU'80, was used. The precession error is included in the estimated nutation parameters. Therefore, I show only the difference of nutation parameters from the Wahr's model in Figure 1.

The differences reach about -30 mas (mili arcsec) for nutation in ecliptic longitude, and -10 mas for the ecliptic obliquity prior to the end of 1995. The amplitude of the modification for the nutation model is a few mas for some periodical terms. The main reason for the differences is due to modification of the precession, which corresponds to the rate of ecliptic longitude of -3 mas/year.

These differences affect the station positions as shown in the following equations.

$$\begin{aligned} \Delta(PN)D(W\vec{B}) &= D\Delta(W\vec{B}) \\ \Delta(W\vec{B}) &= D^{-1}\Delta(PN)D(W\vec{B}) \end{aligned}$$

where P, N are the rotation matrixes for precession and nutation. D is the diurnal rotation matrix, and W is the wobble. $\vec{B}$ is the baseline vector or station position vector. The effect of the differences of the precession and nutation parameters from the model on the wobble is similar to its effect on station position. I represented the station positions ΔX, ΔY, ΔZ for the estimated nutation parameters $\Delta\psi$ (ecliptic longitude) and $\Delta\varepsilon$ (ecliptic obliquity).

$$\begin{aligned} \Delta X &= -\Delta\psi\cos\varepsilon_0 Y \\ &\quad -(\Delta\psi\sin\varepsilon_0\cos H + \Delta\varepsilon\sin H)Z \\ \Delta Y &= \Delta\psi\cos\varepsilon_0 X \\ &\quad -(\Delta\psi\sin\varepsilon_0\sin H - \Delta\varepsilon\cos H)Z \\ \Delta Z &= (\Delta\psi\sin\varepsilon_0\cos H + \Delta\varepsilon\sin H)X \\ &\quad +(\Delta\psi\sin\varepsilon_0\sin H - \Delta\varepsilon\cos H)Y \\ \Delta L &= (X\Delta X + Y\Delta Y + Z\Delta Z)/L = 0 \\ H &= \omega t + H_0 \end{aligned}$$

where ω is the angular velocity of the earth (1 cycle is about 23 hours and 56 minutes) and t is a time. H is the hour angle which changes diurnally.

There are two types of effects on the station positions (the wobble). One is an offset and another is a periodical term. Therefore, the station position changes with a period of 23 hours and 56 minutes. It is shifted by 4 minutes. When the observation time is shifted by about 4 minutes every day, the hour angle H is the same for every experiment. Therefore, the effects of the modification for the precession and nutation parameters on the positions are a bias. When the observation time is fixed, the mean station position during the experiment has an annual variation. Figure 2 shows the image of the changes in the mean station positions when experiments are conducted during 1 am to 6 am. The sine curve means the daily variation of station position caused by the modifications of precession and nutation parameters (the abscissa is time). The variation is shifted by 4 minutes per day. The mean position during 1 am to 6 am is also changeable annually. If the schedule time is changed (for example from day to night), the estimated station position becomes discontinuous.

CRL has conducted the VLBI experiments of KSP (the Crustal Deformation Monitoring System for Tokyo Metropolitan Area) since 1995. These experiments are conducted during 5 hours every day. The time of experiments is nearly fixed. I investigated the effects of the differences of the precession and nutation parameters from the model on the station positions. In the data of KSP experiments, the annual variations and the discontinuity at the change of the observation time were appeared [*Takahashi et al.*, 1996]. These variations may be caused by the differences of the nutation and precession parameters from the IAU80 model. The typical baseline length is about 100 km, and the differences for the ecliptic longitude of -40 mas and for the ecliptic obliquity of -10 mas correspond to about 20 mm in components of the station position. For an east-west baseline such as Kashima-Koganei, the amplitude of periodic variation is about 9 mm for Z component, while the effects on X,Y components are like a bias. The variation of Z components will be corresponding on north and vertical movements.

Reference

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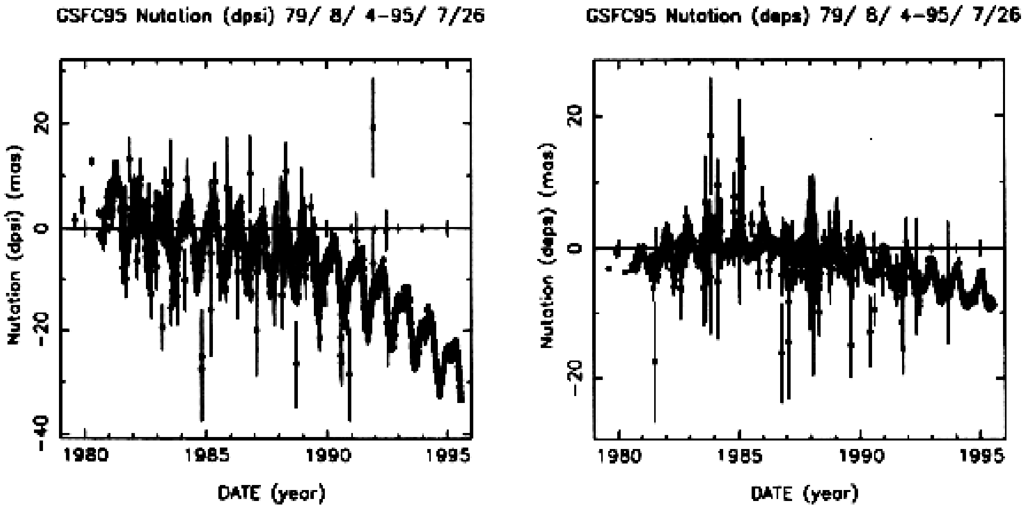

Figure 1. Differences of adjusted nutation parameters ($\Delta\psi$ (dpsi) and $\Delta\varepsilon$ (deps)) from IAU80 model.

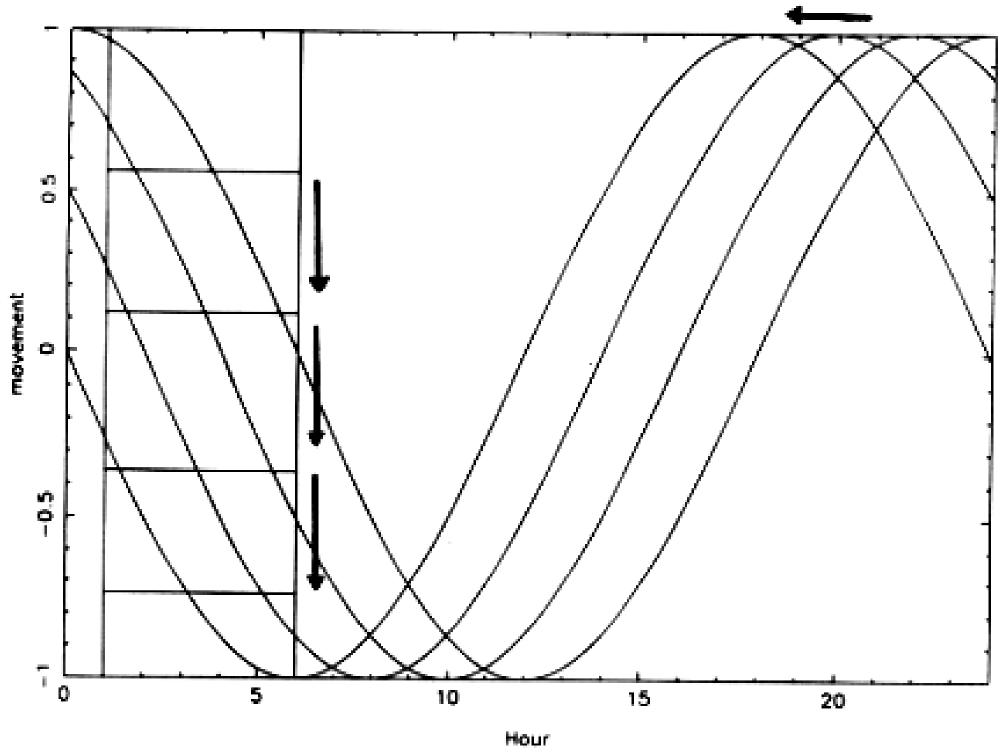

Figure 2. The image of the change in the mean station positions when experiments is conducted during 1 am to 6 am. The sine curve means the daily variation of station position caused by the modifications of the precession and nutation parameters. Abscissa is a time.

Furuya, Y. Koyama, and N. Kurihara, VLBI Error and the Short Term Variation in VLBI, Proceeding of the Technical Workshop for APT and APSG 1996, pp.225-230, 1996.

GSI's New Correlation Processing System

Yoshihiro Fukuzaki
(*fukuzaki@gaos.gsi-mc.go.jp*)

Geographical Survey Institute
Kitasato-1, Tsukuba, Ibaraki 305, Japan

The Geographical Survey Institute (GSI) introduced a new correlator system. It has an ability to calculate 3 station 3 baseline data at the same time. Correlator unit is made by Cosmo Research Corp. The software which controls the each unit is made by Kety Corp. Ltd. These has been developed as KSP correlator in Communication Research Laboratory (CRL). Bandwidth Synthesis software and software making database developed by CRL are installed in the GSI correlation system. As a result, the GSI's system is almost same as the CRL's one. In addition, we are using SOLVE which is produced by NASA/GSFC as a baseline analysis software. At present, we are analyzing observation data after 1993. The results will be used as reference points of new Japanese Geodetic Datum which will be published by 2000.

The GSI has a plan to re-construct the domestic VLBI network and have 5 permanent VLBI sites. The permanent sites will be used for regular observation. The new correlation system will analyze the observation data which are recorded in the permanent sites.

Figure 1. System control workstation and it's terminals.

Figure 2. A part of workstation (left) and correlators in racks (right).

Figure 3. Three auto-tape changers equipped with K-4 recorders.

Figure 4. Whole correlation system.

VLBI Technical Development Center (TDC) at the Communications Research Laboratory (CRL) is supposed to do

1) the development of new observation techniques and new systems for advanced Earth's rotation observations by VLBI and other space techniques,

2) the promotion of research in Earth rotation by advanced methods in VLBI,

3) the distribution of new VLBI technology.

The TDC meeting, attended by the ordinary members from inside the CRL and the special members from the outside, is held twice a year. The special members advise the committee, concerning the plan of technical developments. The TDC newsletter is published biannually by CRL to inform the IERS community its current activities.

This news was edited by Tetsuro Kondo and Yasuhiro Koyama, Kashima Space Research Center, who are editorial staff members of TDC at the Communications Research Laboratory, Japan. The editors wish to thank Dr. O. J. Sovers for his kind help in the correction of the news translated from Japanese to English. Inquires on this issue should be addressed to T. Kondo, Kashima Space Research Center, Communications Research Laboratory, 893-1 Hirai, Kashima, Ibaraki 314, Japan, TEL : +81-299-84-7137, FAX : +81-299-84-7159, e-mail : kondo@crl.go.jp.

Summaries of VLBI and related activities at the Communications Research Laboratory are available from the home page of the Radio Astronomy Applications Section of the Kashima Space Research Center on the World Wide Web (WWW). The URL to view the home page is : **"http://www.crl.go.jp/ka/radioastro/"** (Note! URL was changed from "http://apollo.crl.go.jp/").

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