

Tsukuba VLBI Correlator

Morito Machida, Masayoshi Ishimoto, Kazuhiro Takashima

Abstract

This is a report of the activities at the Tsukuba VLBI Correlator in 2005.

1. General Information

The Tsukuba VLBI Correlator, located in Tsukuba, Ibaraki, is a part of VLBI components operated by the Geographical Survey Institute (GSI), as well as the Tsukuba 32-m VLBI station (TSUKUB32). Intensive sessions (IVS-INT02) performed on Saturday and Sunday with TSUKUB32 - WETTZELL baseline for monitoring UT1-UTC have been correlated by K5 correlation system at the Tsukuba VLBI Correlator. Processing of JADE series (geodetic sessions with domestic VLBI network of GSI, run for 24-hour) is also a major task for the Tsukuba VLBI Correlator.

2. Component Description

The Tsukuba VLBI Correlator fully switched to K5/VSSP correlation processing in April 2005, while efforts to shift correlations system from K4 to K5/VSSP had started in autumn of 2004. K5/VSSP enables us to process data on K5/VSSP software correlator for K5 acquisition system and to put raw data from every four channels per scan into Linux files which are stored in removable disk cartridges as formatted binary files.

Equipment for K5/VSSP software correlation system at the correlator currently consists of 24 Linux computers as the data servers—each of which can share a couple of disk cartridges at once through a drive unit with 16 drive slots, eight rack mount Linux computers with 3GHz Intel Xeon dual CPUs as the correlation servers and one Linux computer for file handling and management (Figure 2). Each disk cartridge from stations is connected to a data server in an external mounting mode. Accessing raw data and auxiliary files such as schedule, session log and a priori are transparent to the operator because directories are shared among computers by Network file system (NFS).

To make software correlation from raw data within the equipment, the most essential elements are four kernel programs: “apri_calc”, “cor”, “sdelay” and “komb”. They were originally designed and developed by National Institute of Information and Communications Technology (NICT). Based on an agreement of research cooperation between GSI and NICT, the Tsukuba VLBI Correlator is allowed to take advantage of these products which are licensed under NICT. “apri_calc” calculates a priori delay and rate for each scan per single baseline. “cor” executes software correlation. “sdelay” makes rough fringe directly from correlator output. “komb” is a bandwidth synthesis program to obtain multi-band delay.

The kernel programs have coverage to process only one scan data of single baseline. There was an increase in the number of sessions to process at the Tsukuba VLBI Correlator. The use of the four kernel programs alone in the software correlation was too simple to meet the demands for processing many scans for multi-baselines. As a solution, we have developed an intelligent

application software, “PARNASSUS” (Processing Application in Reference to NICT’s Advanced Set of Softwares Usuable for Synchronization), to handle sessions of multi-baselines, which gives the operator a tool at hand that provides a graphical user interface and facilitates multi-task control. The application succeeds in optimizing operator’s input into kernel program and comprehensively handling distributed correlation.

CALC/SOLVE developed by NASA/GSFC is installed on HP workstation to produce primary solution.

One problem with introducing K5/VSSP was that many computers together in a machinery room made a continuously low frequency audio noise, which could affect the operators working in close proximity. Therefore, we prepared operator’s room in another room.

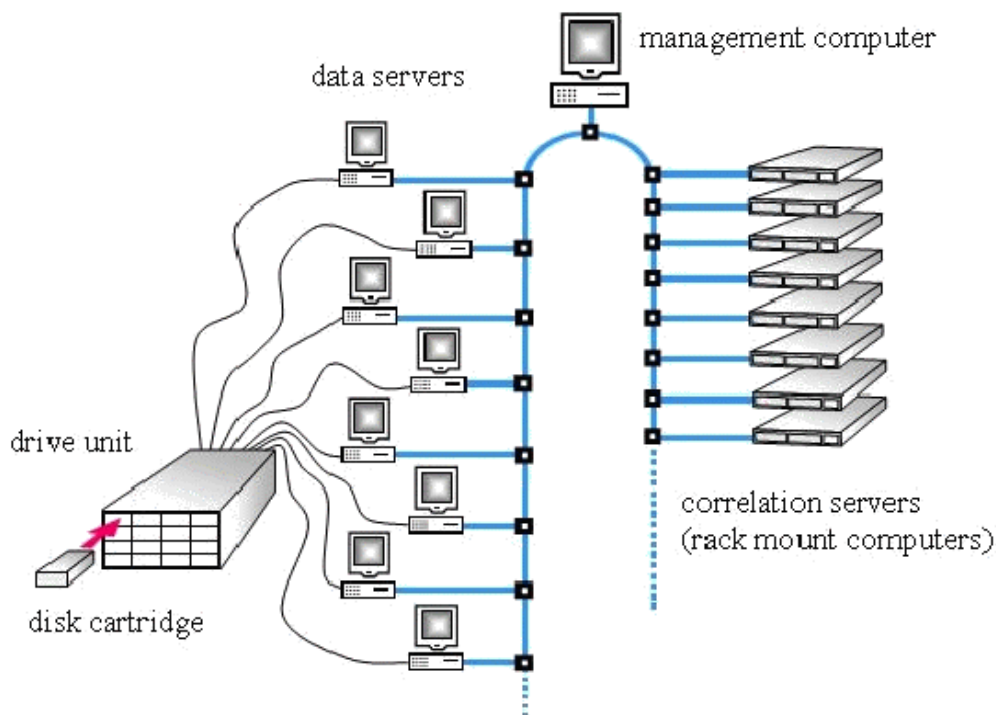


Figure 1. Equipment of K5/VSSP correlation system

3. Staff

List of the staff at the Tsukuba VLBI Correlator in 2005 is as follows. Staff in the field of observation team are listed in the table on the page of Tsukuba 32-m VLBI station in Network Stations section of this volume. S. Kurihara, skilled operator at Tsukuba 32-m, technical staff at the Tsukuba VLBI Correlator and VLBI analyst for six years in VLBI group of GSI, has left for a new career. In his stead, K. Kokado took over the responsibility of VLBI analysis with support from K. Takashima([1]). Routine operations were mainly performed under contract with Advanced

Engineering Services Co.,Ltd (AES) over 200 days in this year. AES was asked for 24 additional days of routine operations which were funded by National Astronomical Observatory of Japan.

- K. Takashima : Operation manager (GSI)
- M. Ishimoto : technical staff, Intensive set-up & e-VLBI, technical development (GSI)
- M. Machida : technical staff, correlation chief, evaluation of correlated data (GSI)
- K. Nozawa : main operator in routine correlation processing (Advanced Engineering Services Co., Ltd)
- K. Takano : sub operator in routine correlation processing, software engineer for “PARNASSUS” (Advanced Engineering Services Co., Ltd)



Figure 2. (from left) K. Takashima, M. Ishimoto, M. Machida, K. Takano, K. Nozawa

4. Current Status and Activities

During 2005, 80 Intensive sessions (IVS-INT02) with TSUKUB32-WETTZELL single baseline for UT1, two Intensive sessions (IVS-INT02) with TSUKUB32-ONSALA60 single baseline for UT1, one Intensive session (IVS-INT02) with TSUKUB32-ONSALA60-WETTZELL baselines for UT1, 12 geodetic sessions by domestic network for 24-hour (JADE series) were processed at the Tsukuba VLBI Correlator. Y. Fukuzaki (GSI) processed three Syowa VLBI experiment (SYW sessions) using K4 correlator: SYW027, SYW031 and SYW032.

As mentioned, it was one of the major issues at the Tsukuba VLBI Correlator in 2005 to shift toward K5/VSSP correlation processing. Before the switch was accomplished in April, 24 Intensive and three JADE sessions were processed on K4 correlator. Remaining 59 intensive and nine JADE sessions were processed with K5/VSSP correlation system.

There were some steps toward a full combination of “PARNASSUS”, just referred to as “K5 utility software” in the previous annual report. The idea of developing application to aid operator’s input came to us in autumn of 2004. To start with, we divided its general function into calculating apriori delay & rate, executing correlation, bandwidth synthesis and creating databases. As a private advisory group, K. Takashima, M. Ishimoto and M. Machida were in charge of planning, primary design, requirements definition and functional specification to the application. K. Takano took control of structural design, coding, programming, testing and installation as a developer. The development is still ongoing.

- March 2005, PARNASSUS 1.0 covered calculating apriori delay & rate
- September 2005, PARNASSUS 1.1 covered executing correlation

- December 2005, PARNASSUS 1.2 covered bandwidth synthesis

K5/VSSP got along with e-VLBI in processing Intensive sessions. Data were recorded on K5/VSSP at TSUKUB32 and on Mark 5 at WETTZELL. Shortly after observation, recorded data at WETTZELL were transferred to GSI through internet. After converting Mark 5 to K5 in one or two hours, correlation was processed on K5/VSSP in distributed computing at the Tsukuba VLBI Correlator. Processing and making primary solution of Saturday and Sunday Intensives were usually completed in a day. Emphasis of processing Sunday and Saturday Intensive sessions by K5/VSSP with data transfer via e-VLBI was getting database submission to IVS within one or two days after observation. K5/VSSP correlation system, performing more efficiently in processing data, and e-VLBI, being one of next generation VLBI technique, was a close association which led to convenience not only for the correlator staff, but also users expecting UT1 as soon as possible for navigation, spacecraft control mission or land survey. Especially, “Deep Impact” in July was a sort of challenge even for us to assist with processing VLBI data of Intensive sessions for UT1. The success of the mission brought an encouragement to us since rapidly processing data came from our usual practice with distributed computing of K5/VSSP and transferring data via e-VLBI.

The Tsukuba VLBI Correlator has presented its detailed current status and activities at the VLBI community in Japan ([2]).

5. Plan for 2006

- It is planned to process the TSUKUB32/WETTZELL Intensive sessions (IVS-INT02) with the K5 system. The sessions are to be performed on both Saturday and Sunday with K5 (TSUKUB32) and Mark 5 (WETTZELL) systems. The Tsukuba VLBI Correlator is also expected to be responsible for processing 12 geodetic sessions (JADE) of domestic VLBI network of GSI.
- One of our aim to speed up processing is to work on expansion of our K5 correlation system. We will add eight correlation servers and eight data servers to existing K5/VSSP correlation system.
- Development and test of interactive “PARNASSUS 1.3”, having coverage from calculating a priori to making up database is one of the priorities in the first half of 2006. Some implementation plans for “PARNASSUS 2”, run in batch mode will be discussed in the advisory group of VLBI team of GSI.
- Former K4 correlator equipment will be removed by March 2006.
- We have a plan for estimating antenna thermal deformation from antenna elements, expansion coefficients, elastic stiffness constant, measured body temperature of antenna mounting frame, with taking approach of finite element method.

References

- [1] K. Kokado, K. Takashima, J. Fujisaku: Global Solutions of International VLBI experiments data, 104th Meeting of the Geodetic Society of Japan, Kyoto, October, 2005 (in Japanese).
- [2] M. Machida, K. Takashima, M. Ishimoto: Improvement of VLBI data processing system using the K5/VSSP, 104th Meeting of the Geodetic Society of Japan, Kyoto, October, 2005 (in Japanese).