Tsukuba VLBI Correlator

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Abstract

This report briefly summarizes the activities at the Tsukuba VLBI Correlator in 2010. The Tsukuba VLBI Correlator processed 96 IVS-INT2 sessions and eight JADE sessions with the K5/VSSP correlation system, which includes the K5/VSSP kernel software. The software correlation system and high-speed data transfer network enabled us to correlate the data of the IVS-INT2 sessions during observation. We correlated all of the data of the INT2 sessions with the real-time correlation system in 2010.

Figure 1. Tsukuba VLBI Correlator

1. Introduction

The Tsukuba VLBI Correlator is part of the VLBI facilities operated by the Geospatial Information Authority of Japan (GSI) as is the Tsukuba 32-m VLBI station (TSUKUB32). A principal component of our correlation system is the K5/VSSP correlation software package developed by the National Institute of Communications and Technology (NICT). We can install the software on commercially-based computers operated by Linux operating system (OS). We processed several IVS-INT2 sessions and domestic VLBI sessions (JADE sessions) with a number of computers which

had the K5/VSSP software package installed. The sessions we processed in 2010 are described in Section 4.

2. Component Description

The system components of the Tsukuba VLBI correlator are described in Table 1. We have two systems to process the observed data of international sessions or domestic sessions. System 1 is for JADE sessions and other domestic sessions, which make use of the VLBI stations of Japan Aerospace Exploration Agency (JAXA) or the compact VLBI system (MARBLE) developed in a collaboration between GSI and NICT. The system is operated by the management application "PARNASSUS" (Processing Application in Reference to NICT's Advanced Set of Software Usable for Synchronization) designed for distributed correlation processing.

System 2 is for INT2 sessions. We introduced the management application "Cor_mgr" in the system. The application is developed with the Perl programing package. We are able to correlate the VLBI data automatically using "Cor_mgr" and other utility programs. MK3TOOLS is the program that creates the Mark III database from the output files of the K5/VSSP bandwidth synthesis program.

The entire hardware is based on commercial products. Although the operating systems of some data or correlation servers were Redhat Linux release 9, we replaced it with CentOS version 5.4 or 5.5 in 2010. Now, all of the servers work well.

For the INT2 sessions, we have been transferring the data observed at Wettzell or Westford station via high-speed network. The Tsukuba VLBI Correlator is connected to the high-speed network "SINET3 (Science Information NETwork3)" operated by the National Institute of Informatics (NII). The network enables us to do real-time data transfer from Wettzell to Tsukuba.

3. Staff

The technical and engineering staff of the Tsukuba VLBI Correlator are as follows. Yuji Miura, who was a technical staff member in 2009, moved to another department in June 2010. Most of our staff are subcontracted engineers from either of two private companies: Advanced Engineering Service Co., Ltd (AES) or The Institute of Japanese Union of Scientists and Engineers (I-JUSE).

Kensuke Kokado: Technical official (GSI)

Correlation Chief, Management of overall activity of Tsukuba VLBI correlator

Maintenance/support of K5 software correlation system and e-VLBI network system

Kentaro Nozawa: Technical Operator (AES)

Main operator of the correlation work

Maintenance of the real-time correlation system (System 2)

Yasuko Mukai: Technical Operator (AES)

Sub-operator of the correlation work

Routine correlation processing, Management of media shipping

Toshio Nakajima: System Engineer (I-JUSE)

System Engineer for maintenance of computers and e-VLBI network system

Table 1. Specifications of the K5/VSSP correlation system components

	System 1	System 2
Management Server (CPU)	1 server (Intel Pentium 4, 3.0GHz)	1 server (Intel Xeon 3.4GHz dual CPU)
Correlation Servers (CPU)	24 servers (Intel Xeon 3.06GHz dual CPU)	8 servers (Intel Xeon 3.4GHz dual CPU)
Data Servers (CPU)	24 servers (Intel Pentium 4, 3.0GHz)	
Data Format	K5/VSSP or K5/VSSP32	
HDD type	Serial ATA Disk	
K5/VSSP Archive Version	ipvlbi_cor_20100723 komb20100811	
Main application	PARNASSUS 1.3 MK3TOOLS	Cor_mgr MK3TOOLS
Operating System	CentOS version 5.4, version 5.5	
Processing Session	JADE Additional domestic session	IVS-INT2 session etc.

4. Current Status and Activities

4.1. Processing of JADE Sessions

JADE is a domestic 24-hour VLBI session type scheduled by GSI. The participating stations are four GSI stations (TSUKUB32, SINTOTU3, CHICHI10, and AIRA) and two VERA stations (VERAMZSW and VERAISGK) of the National Astronomical Observatory of Japan (NAOJ). TSUKUB32 and VERAISGK stations are connected to broad-band network, so we can transfer the data via network. However, the other stations' transfer rates are too slow to transfer the data to the correlator. Therefore, we have to send the data by shipment of the hard disks. These disks sent by shipment are injected into the disk array of the correlation system. We have more than 100 hard disks for the shipment, because we need more than four disks per station for each JADE session.

The JADE sessions and the other domestic sessions processed at the Tsukuba correlator in 2010 are described in Table 2. Additional domestic sessions have been observed for the determination of the positions of USUDA64 and UCHINOUR stations operated by JAXA. GSI commenced the additional domestic sessions with JAXA in 2006. The participating stations are GSI's four stations and USUDA64 or UCHINOUR stations. The session has not been registered yet with the IVS, so we have not submitted the database.

The processing factor of each JADE session is described in the rightmost column of Table 2. They depend on the number or performance of the correlation servers. We could reduce the processing time if we had a lot of high-performance servers. The processing factors per baseline of JADE1009, JADE1010, and JADE1011 were more than 1.00. The cause for the delay was that we had some trouble with the hard disks or the network file system.

Table 2. JADE sessions processed in 2010 (Ts:TSUKUB32, Ai:AIRA, S3:SINTOTU3, Cc:CHICHI10, Vm:VERAMZSW, Vs:VERAISGK, Uc:UCHINOUR, Kb:KASHIM34).

Session	Stations	Processed Baseline #	Processing Factor
JADE-1001	TsAiCcS3VmVs	11	3.94
JADE-1003	TsAiCcVm	6	2.82
U10073	TsAiCcUc	6	2.38
JADE-1005	TsS3	1	0.43
JADE-1006	TsAiCcS3	6	3.41
JADE-1008	KbAiCcS3Vm	10	8.32
JADE-1009	KbS3	1	1.72
JADE-1010	TsS3	1	1.45
JADE-1011	TsS3	1	1.12

4.2. Processing of IVS-INT2 Session

As the method of data transfer has been improved with the development of the e-VLBI system, we introduced a real-time data transfer system developed by NICT in 2010. The transfer system enables us to convert the Mark 5 format data to K5 format data at the same time as the data transfer. We have adopted the real-time data transfer system on the Ts-Wz baseline only. On the other baselines, the data is transferred using the UDP-based protocol "TSUNAMI" after the observing sessions. The data transfer rate reached up to 300 Mbps between Tsukuba and Wettzell. As the data of the INT2 sessions are processed in real-time, the processing factor of the session is about 1.00. If we process all of the data with PARNASSUS or Cor_mgr after the observing session, the processing factor will be under 0.4.

Table 3. IVS-INT2 sessions processed in 2010

Session	Stations	Processed session #
IVS-INT2(K)	Ts-Wz	64
IVS-INT2(H)	Ts-Wf	16
IVS-INT2(D)	Kb-Wz	4
IVS-INT2(F)	Kb-Wf	9
Ts:TSUKUB32, Kb:KASHIM34, Wz:WETTZELL, Wf:WESTFORD		

5. Plans for 2011

We plan to register the domestic sessions with the JAXA VLBI stations as IVS sessions and will then submit the databases to the IVS Data Center. The Tsukuba VLBI correlator will process eight JADE sessions, 101 IVS-INT2 sessions, and two IVS-INT3 sessions. All of the INT2 and the INT3 sessions will be processed with the real-time correlation system.