Technology Development Center at NICT

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Abstract

National Institute of Information and Communications Technology (NICT) has led the development of the VLBI technique and has been maintaining a high level of activity in both observations and technical developments. This report gives a review of the Technology Development Center (TDC) at NICT and summarizes its recent activities.

1. TDC at NICT

National Institute of Information and Communications Technology (NICT) has published the newsletter "IVS NICT-TDC News" (formerly IVS CRL-TDC News) at least once a year in order to report its development of VLBI related technology as an IVS technology development center. The newsletter is available through the Internet at the following URL: **http://www2.nict.go.jp/w/w114/stsi/ivstdc/news-index.html**.

2. Staff Members of NICT TDC

Table 1 lists the staff members at NICT who are involved in the VLBI technology development center at NICT.

Table 1. Staff Members of NICT TDC as of December, 2008 (alphabetical).

Name	Work
AMAGAI, Jun	K5/VSSP32, GPS analysis, TWSTFT[1]
HASEGAWA, Shingo	K5/VSSP32, K5/VSI
HOBIGER, Thomas	VLBI analysis, e-VLBI
ICHIKAWA, Ryuichi	MARBLE[2] system, Delta-VLBI, VLBI analysis
ISHII, Atsutoshi	MARBLE system
KAWAI, Eiji	34 m and 11 m antenna systems
KIMURA, Moritaka	Giga-bit system, K5/VSI, Software correlator, e-VLBI
KONDO, Tetsuro[3]	K5/VSSP32, Software correlator, e-VLBI
KOYAMA, Yasuhiro	e-VLBI, VLBI analysis
SEKIDO, Mamoru	e-VLBI, Delta-VLBI, VLBI analysis
TAKEFUJI, Kazuhiro	e-VLBI
TAKIGUCHI, Hiroshi	VLBI analysis, e-VLBI, GPS analysis
TSUTSUMI, Masanori	K5 system, e-VLBI
UMEMIYA, Yuka	Software correlator

[1] TWSTFT: Two-Way Satellite Time and Frequency Transfer
[2] MARBLE: Multiple Antenna Radio-interferometry of Baseline Length Evaluation
[3] On leave at Ajou University, Korea

3. Current Status and Activities

3.1. e-VLBI

e-VLBI technology has been intensively developed in recent years. International e-VLBI experiments for ultra-rapid UT1 measurements have been conducted as a pilot project for testing the operational stability of e-VLBI observing and correlation processing. A distributed correlation processing scheme has been developed and has been used for the rapid UT1 measurements. The schematic diagram of the scheme is indicated in Figure 2 of [1]. A record minimum latency of UT1 measurement of less than 4 minutes was achieved on February 22 on the Tsukuba-Onsala baseline with a 256 Mbps data rate. The observing and the correlation was performed by Onsala and GSI. NICT contributed to it by providing an automatic correlation system, automatic Mark III database creation via NetCDF[1] (MK3TOOLS [2]), and an automatic UT1 analysis scheme with OCCAM developed by T. Hobiger. Also we participated in several e-VLBI demonstration events with the K5 data acquisition system (DAS). Flexibility in data format conversion is one of the important aspects of e-VLBI. We developed a series of A/D converters for VLBI (ADS1000, ADS2000, ADS3000), and they can be used for a variety of observation modes. The first Asia-Oceania e-VLBI experiment between Japan, China, and Australia was realized by a combination of the ADS2000 and PC-VSI interfaces. (See Figures 1 and 2.) Additionally a Mark 5B emulator was developed, and international compatibility was further improved.

Figure 1. The ADS2000 can sample 16 baseband channels at the sampling rate of 64 Msps suitable for the bandwidth synthesis.

Figure 2. VSI-card can record high-bandwidth data to commodity PC.

3.2. MARBLE – Contribution to VLBI2010

We are developing a compact VLBI system with a 1.6 m diameter aperture dish in order to provide reference baseline lengths for calibration. (See Figure 3.) The 10 km reference baselines are used to validate surveying instruments such as GPS and EDM and are maintained by the Geographical Survey Institute (GSI) of Japan. The compact VLBI system will be installed at both ends of the reference baseline. We named the system for providing calibration over the reference baseline "Multiple Antenna Radio-interferometry of Baseline Length Evaluation (MARBLE)" [3]. We evaluated a front-end system with a wide-band quad-ridged horn antenna (QRHA/ type 3164-05 ranging 2 GHz - 18 GHz [4]) made by ETS-Lindgren for the compact VLBI system for

[1]http://www.unidata.ucar.edu/software/netcdf/

installation on the 2.4 m diameter dish at Kashima. We succeeded in performing two geodetic VLBI experiments on a 54 km baseline between the 2.4 m dish equipped with the QRHA and the Tsukuba 32 m station of GSI. The results of the determined baseline length between the 2.4 m station and the Tsukuba 32 m station agree well with the previous results which are used by X-band feed only on the 2.4 m dish (this issue of AR of NICT). On the other hand, the formal error of recent results are slightly worse due to low signal-to-noise ratio (SNR) of signal fringes caused by low aperture efficiency of the antenna. Since the new 1.6 m dish is optimized for the new front-end, we expect SNR of the new system will improve. We are now preparing to perform the first fringe detection experiment using the compact VLBI system with the 1.6 m dish in March of 2009.

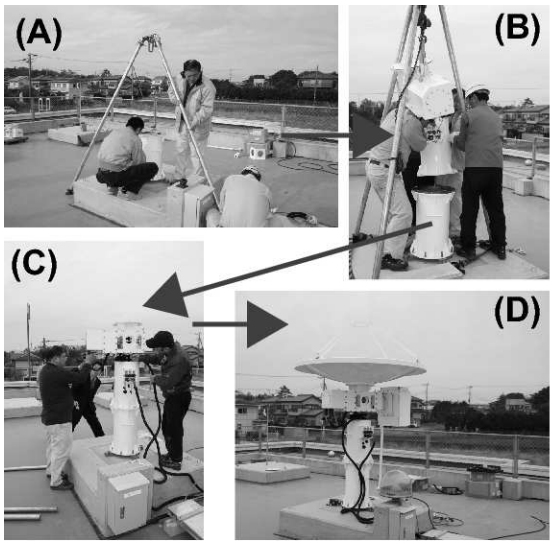

Figure 3. Installation of MARBLE compact VLBI system.

3.3. ADS3000+ — Geodetic VLBI with a Gigabit System

NICT has been developing VLBI observation systems and data processing systems since the 1970s. The K5 VLBI system is designed with commodity products such as personal computers, hard disks, and network components. This strategy has been quite successful for developing highly flexible and high performance observation systems and data processing systems for VLBI. Two independent series of systems, the K5/VSSP (K5/VSSP32) and the K5/VSI systems, have been developed. The concept of the K5/VSSP and K5/VSSP32 systems is to develop A/D sampling units interfaced to the commodity PC systems by using the PCI expansion bus (VSSP) and USB2.0 interface (VSSP32) with simultaneous recording of 16 channels of signals. On the other hand, the K5/VSI series are realized by high speed A/D sampler units and a commodity Linux PC system to record data with the VSI-H (VLBI Standard Interface - Hardware specifications). Three high speed A/D sampler units, ADS1000, ADS2000, and ADS3000, have been developed to support various sampling modes. Currently, a next generation A/D sampler ADS3000+ which supports 4 Gbps * 1 ch and 2 Gbps * 2 ch sampling modes with a faster A/D sampler chip was developed in 2008 [5]. (See Figures 4 and 5). ADS3000+ are equipped with FPGA chips to realize a digital baseband converter (DBBC) with a user-selectable bandwidth of 2 to 16 MHz.

4. Future Plans

- Geodetic VLBI experiments between two small MARBLEs and a large-aperture antenna to confirm a concept of 10 km length baseline measurement.
- Coding digital baseband conversion of ADS3000+ (16 channel extraction).

- VLBI experiments at 4 Gbit sampling with ADS3000+.

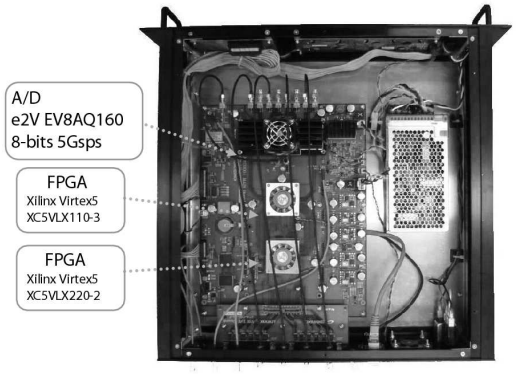

Figure 4. Outside features of ADS3000+. The ADS3000+ has user-friendly interfaces. Initial configuration and control of the ADS3000+ can be done several ways—by pressing buttons, with the network (telnet), and with RS-232C local control.

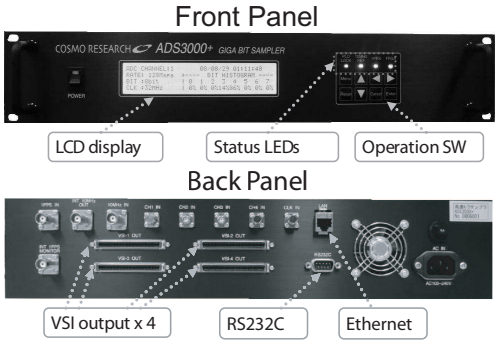

Figure 5. Inside layout of ADS3000+. The ADS3000+ contains a fast A/D converter chip which enables it to sample 4 Gbps * 1 ch and 2 Gbps * 2 ch and two FPGAs which can operate quickly and process high-bandwidth data. With these FPGAs, a digital baseband converter can be realized. Therefore, the ADS3000+ already meets VLBI2010 requirements.

References

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