Technology Development Center at NICT

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Abstract

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

1. TDC at NICT

National Institute of Information and Communications Technology (NICT) has published the newsletter "IVS NICT-TDC News (former IVS CRL-TDC News)" at least once a year in order to inform the development of VLBI related technology as an IVS technology development center. The newsletter is available through the Internet at following URL **http://www2.nict.go.jp/w/w114/stsi/ivstdc/news-index.html** (URL was changed in April 2006).

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, 2006 (alphabetical).

Name	Works
HOBIGER, Thomas	VLBI analysis, Small antenna system
ICHIKAWA, Ryuichi	VLBI for spacecraft navigation, Small antenna system
ISHII, Atsutoshi	Small antenna system
KAWAI, Eiji	34m and 11m antenna system
KIMURA, Moritaka	e-VLBI, Giga-bit system, K5/VSI, Software correlator
KONDO, Tetsuro	e-VLBI, K5/VSSP32, Software correlator
KOYAMA, Yasuhiro	e-VLBI,VLBI analysis
KUBOKI, Hiromitsu	Antenna system, CARAVAN* system
SEKIDO, Mamoru	e-VLBI, VLBI for spacecraft navigation
TAKEUCHI, Hiroshi**	e-VLBI, VLBI@home, ADS3000
TAKIGUCHI, Hiroshi	VLBI analysis
TSUTSUMI, Masanori	e-VLBI

* CARAVAN: Compact Antenna of Radio Astronomy for VLBI Adapted Network system
** moved to JAXA on March 1, 2006

3. Current Status and Activities

3.1. K5 Samplers

NICT has developed two types of samplers: 1) ADS series sampler equipped with a VSI-H interface; 2) VSSP series sampler not equipped with a VSI-H but directly connectable to a host PC. Samplers developed by NICT are summarized in Table 2.

Table 2. Specifications of the K5 samplers.

	ADS1000	ADS2000	ADS3000	K5/VSSP	K5/VSSP32
Ref. Sig.	10 MHz 1 PPS	10 MHz 1 PPS	10 MHz 1 PPS	10 MHz 1 PPS	10/5 MHz 1 PPS
# of Input Ch.	1	16	1	4	4
A/D bits	1, 2	2	8	1, 2, 4, 8	1, 2, 4, 8
Sampling Freq. (MHz)	512, 1024	2, 4, 8, 16, 32, 64	2048	0.04, 0.1, 0.2, 0.5, 1, 2, 4, 8, 16	0.04, 0.1, 0.2, 0.5, 1, 2, 4, 8, 16, 32, 64
Output Interface	VSI-H	VSI-H	VSI-H $\times 2$	PCI-bus	USB2.0
Function	—	PCAL detection	DBBC etc.	—	digital LPF

Figure 1. ADS3000 (left) and K5/VSSP32 (right).

Figure 1 shows ADS3000 and K5/VSSP32. ADS3000 is a successor to the ADS1000 but it is equipped with two VSI-H ports and is greatly improved in the performance[1][2]. By use of a high-performance FPGA it is possible to output in a variety of modes with a data rate of up to 4 Gbps (Table 3). Furthermore, FPGA code is rewritable so that it can be used for multiple applications such as digital baseband converter (DBBC) for multi-channel geodetic VLBI, software demodulator for spacecraft downlink signal in spacecraft VLBI or satellite communications, or spectrometer for broadband astronomical observations.

K5/VSSP32 is a successor to the K5/VSSP. Maximum sampling frequency per channel is increased up to 64 MHz[3][4]. As a K5/VSSP32 unit has 4 channel analog inputs, 4 units can cover 16 channels which is sufficient number of channels in case of geodetic VLBI. Maximum data rate is 1024 Mbps with 4 PCs. Although we have succeeded in some fringe tests using K5/VSSP32, we are improving both hardware and software to increase its reliability and performance.

Table 3. Selectable output modes of ADS3000.

Total rate	Sampling rate	# of AD bits	VSI-H clock rate	Output port
1 Gbps	128 MSps	8	32 MHz	VSI-H port1
2 Gbps	1024 MSps	2	32 MHz	VSI-H port1 + VSI-H port2
2 Gbps	512 MSps	4	32 MHz	VSI-H port1 + VSI-H port2
2 Gbps	256 MSps	8	32 MHz	VSI-H port1 + VSI-H port2
2 Gbps	256 MSps	8	64 MHz	VSI-H port1
4 Gbps	2048 MSps	2	64 MHz	VSI-H port1 + VSI-H port2
4 Gbps	1024 MSps	4	64 MHz	VSI-H port1 + VSI-H port2
4 Gbps	512 MSps	8	64 MHz	VSI-H port1 + VSI-H port2

3.2. K5/VSI

A VSI data capture board (VSI2000-DIM) developed by NICT can now capture data continuously with a data rate of up to 2 Gbps. Using a board with a PC equipped with a RAID disk system, we can record data with a recording rate of up to 2 Gbps. Table 4 and 5 summarizes characteristics of K5/VSI board and recording system.

Table 4. K5/VSI data capture board

Continuous Capture Rate (Mbps)	2048 1024 512 256
Input Interface	VSI-H
PCI Interface	PCI-X (64bit/66MHz)

Table 5. K5/VSI data recording system (VSI2000-DIM + RAID).

Disk Storage Interface	Dual Fiber Channel
Max Recording Rate	2048 Mbps
HDD size	3TB
Continuous Recording Time (hours)	3 @2048 Mbps 6 @1024 Mbps 12 @512 Mbps 24 @256 Mbps

3.3. e-VLBI

We have performed e-VLBI demonstration in the international conference of “Super Computing 2006” held at Tampa, Florida in USA. Pseudo data were transferred between USA and Japan at the demonstration, and the data transfer rate of 512 Mbps was achieved (see “VLBI Correlators in Kashima” in this issue for details).

3.4. Small Antenna System

We have been developing a 2.4 m antenna VLBI system (Figure 3) named CARAVAN2400 equipped with an X band receiver[5][6]. First geodetic VLBI observation using the CARAVAN2400 was conducted with Tsukuba 32 m antenna (baseline length is about 54 km) on Sept.21-22, 2006. Eight video channel signals with an 8 MHz bandwidth each in an X band were sampled using K5/VSSP samplers at both stations. The position of CARAVAN2400 was successfully estimated with a standard deviation error of better than 1 cm.

4. Future Plans

We will start the development of a 1-m class antenna system for a geodetic VLBI observation in collaboration with GSI, which is dedicated to a precise measurement of a reference baseline maintained by GSI for a calibration of surveying equipments. A combination of a diplexer and a wide band feed that covers 2-18 GHz will be adopted in the 1-m class system. In order to investigate the performance of a wide band feed, it will be installed in CARAVAN2400 system first. It will contribute to examine a feasibility of VLBI2010's recommendations for next-generation system.

Figure 3. 2.4m antenna (front) and 34 m antenna (back) at Kashima during a fringe test.

References

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