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)" twice 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/ka/radioastro/tdc/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, 2005 (alphabetical).

Name	Works
ICHIKAWA, Ryuichi	Delta VLBI, 2.4m Antenna system
ISHII, Atsutoshi	2.4m Antenna system
KAWAI, Eiji	34m Antenna system
KIMURA, Moritaka	e-VLBI, Giga-bit system, PC-VSI, Software correlator
KONDO, Tetsuro	e-VLBI, K5/VSSP32, Software correlator
KOYAMA, Yasuhiro	e-VLBI, ADS2000
KUBOKI, Hiromitsu	Antenna system, CARAVAN system
NAKAJIMA, Junichi	Giga-bit system, CARAVAN system
SEKIDO, Mamoru	Delta VLBI, PCAL system
TAKEUCHI, Hiroshi	e-VLBI, VLBI@home, ADS3000
TSUTSUMI, Masanori	e-VLBI

3. Development of New Samplers

Samplers developed by NICT are categorized into two series: 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.

3.1. ADS Series Sampler

Figure 1. ADS2000 (left) and ADS3000 (right).

Table 2. Specifications of the ADS series sampler.

	ADS1000	ADS2000	ADS3000
Reference Signals	10 MHz, 1 PPS	10 MHz, 1 PPS	10 MHz, 1 PPS
Number of Input Ch.	1	16	1
A/D bits	1, 2	2	8
Sampling Freq.	512 MHz, 1024 MHz	2, 4, 8, 16, 32, 64 MHz	2048 MHz
Output Interface	VSI-H	VSI-H	VSI-H $\times 2$
Function	—	PCAL detection	DBBC etc.

Table 2 summarizes specifications of ADS series. ADS2000 and ADS3000 (Figure 1) have been newly developed in the ADS series.

ADS2000 is a 16-ch sampler dedicated to a geodetic VLBI observation and was developed to substitute for DFC2000. ADS2000 was used for the actual geodetic VLBI experiment on March 11, 2005 at the data rate of 1024 Mbps. Results indicate that the performance of the system is fine[1].

ADS3000 is a successor to the ADS1000 but it is equipped with two VSI-H ports and is greatly improved in the performance. By use of a high-performance FPGA it is possible to output in a variety of modes shown in 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. A test observation using ADS3000 was carried out on Nov.25, 2005 at the data rate of 4096 Mbps and we got the first-ever 4 Gbps fringes successfully.

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. VSSP Series Sampler

K5/VSSP32 has been newly developed (Figure 2) in the VSSP series. K5/VSSP32 is a successor to the K5/VSSP, but a USB 2.0 is newly adopted as an interface with a host PC. Maximum sampling frequency per channel is increased up to 64 MHz. 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. In the meantime, a K5/VSSP32 can connect to a notebook PC or a laptop PC through USB 2.0 interface. First observation using the K5/VSSP32 and note PC was carried out on Nov.10, 2005, and soon the first fringes were successfully found by the software correlator. Table 4 summarizes specifications of VSSP series.

Figure 2. K5/VSSP32 unit (left) and 16 ch module (right).

Table 4. Specifications of the VSSP series sampler.

	K5/VSSP	K5/VSSP32
Reference Signals	10 MHz, 1 PPS	10/5 MHz, 1 PPS
Number of Input Ch/unit	4	4
A/D bits	1, 2, 4, 8	1, 2, 4, 8
Sampling Freq.	0.04, 0.1, 0.2, 0.5,	0.04, 0.1, 0.2, 0.5,
	1, 2, 4, 8, 16 MHz	1, 2, 4, 8, 16, 32, 64 MHz
Maximum Data Rate	64 Mbps/unit	256 Mbps/unit
	256 Mbps/4units	1024 Mbps/4units
Interface with PC	PCI-bus	USB2.0
Function	—	digital LPF

4. Development of 2.4m Antenna System

We have been developing a 2.4 m antenna system (Figure 3) with an X band receiver[2], which is an extended version of the CARAVAN (Compact Antenna of Radio Astronomy for VLBI Adapted Network) system, for a VLBI observation using our giga-bit VLBI system. First fringe was successfully detected on Dec.7, 2005. We will continue the development of the system with a goal of monitoring earth rotation and spacecraft tracking.

Figure 3. 2.4m antenna at Kashima.

References

[1] Koyama, Y., T. Kondo, M. Kimura, and H. Takeuchi, Multi-channel Gbps geodetic VLBI experiment, *IVS CRL-TDC News, No.26,* pp.9–12, September 2005.

[2] Ichikawa, R., H. Kuboki, Y. Koyama, J. Nakajima, and T. Kondo, Development of the new VLBI facility with a 2.4-m dish antenna at NICT, *IVS CRL-TDC News, No.26,* pp.13, September 2005.