Technology Development Center at NICT

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Abstract

National Institute of Information and Communications Technology (NICT) (former Communications Research Laboratory (CRL)) has led the development of VLBI technique in Japan 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) (former Communications Research Laboratory (CRL))[1] has published the newsletter "IVS NICT-TDC News (former IVS CRL-TDC News)" twice a year in order to inform about developments in VLBI related technology in Japan as an IVS technology development center to the world. The newsletter is available through the Internet at the 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, 2004 (alphabetical).

Name	Works
Ichikawa, Ryuichi	Delta VLBI
Kawai, Eiji	Antenna system
Kimura, Moritaka	e-VLBI
Kondo, Tetsuro	e-VLBI
Koyama, Yasuhiro	e-VLBI
Kuboki, Hiromitsu	Antenna system
Nakajima, Junichi	Giga-bit system
Sekido, Mamoru	Delta VLBI
Takeuchi, Hiroshi	e-VLBI

[1]Under the "Reorganization and Rationalization Plan of Special Public Institutions" adopted at a Japanese Cabinet meeting held in December 2001, CRL and the Telecommunications Advancement Organization of JAPAN (TAO) were reorganized as the National Institute of Information and Communications Technology (NICT) on April 1, 2004.

3. Recent Activities

3.1. K5 Software Development

The processing speed of K5 software correlator has continued to increase with the improvement in PC performance as well as the use of a better algorithm. Throughputs of the K5 software correlator for a geodetic use are shown in Figure 1 for various kinds of CPUs and clock frequencies, such as Pentium III, Pentium 4, AMD, Celeron, etc. Data used for this measurement are 4ch 1bit-8MHz sampling (=32 Mbps) data, and 32-lag complex correlation function is computed. At present time, the throughput of about 17 Mbps is achieved for an AMD Athlon64 3200+ CPU in case of computing 32-lag correlation, which corresponds to 34 Mbps for 16-lag correlation considering a linear relation between the number of lags and the throughput. The throughput in the case of using a Pentium4 2.5GHz CPU is about 12 Mbps for 32-lag correlation and 24 Mbps for 16-lag correlation. It is clear from the figure that the processing speed increases with the clock frequency, so that we can expect a faster throughput in the future if the progress in CPU performance continues [4].

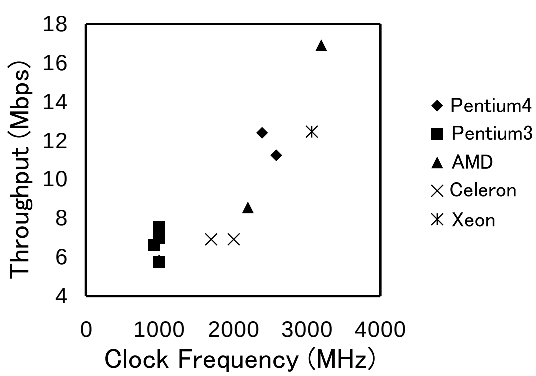

Figure 1. Throughputs of K5 software correlator for a geodetic purpose for various kinds of CPUs and clock frequencies. Throughputs for computing 32-lag correlation function is plotted.

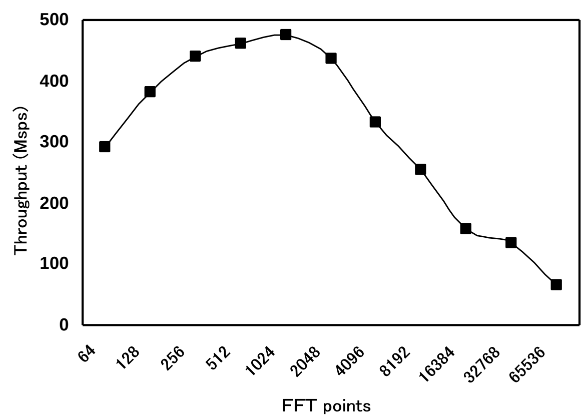

Figure 2. Throughputs of FX-type software correlator for astronomical purposes running on an Xserve G5 equipped with dual 2GHz G5 processors. Throughputs are measured for different numbers of FFT points.

We have also developed an FX-type software correlator, which is specialized for processing speed to process gigabit VLBI system data, mostly for astronomical use [1], [2]. In order to bring out the maximum performance, various kinds of optimizations, such as an effective use of multi-processors and utilization of SIMD (Single Instruction Multiple Data) technology for parallel processing, are applied into the software. An assembler language program is also used partially to improve the performance. Figure 2 shows results of a benchmark test of the software correlator that runs on an Xserve G5 equipped with dual 2GHz G5 processors. Throughput is measured for a number of different FFT points. It reaches up to about 500 Msps (sample per second) at 1024 FFT points, which corresponds to the processing speed of 1 Gbps for 2 bit sampling data. The size of cache memory of CPU affected the performance at large number of lags, results in the performance loss.

In addition, efforts have been made to realize distributed processing by using multiple CPUs. One of the efforts is to utilize unused CPU power of the conventional PCs by developing a screen saver program to download the data files from a server and perform the software correlation [6]. We named this system VLBI@home which consists of a server PC and client PCs. The screen saver program runs on the client PCs. The server program run on the server PC processes the requests from the clients. Currently, the screen saver program has been developed on the Microsoft Windows operating systems. Any PCs connected to the Internet can be used as the clients. Once the screen saver program is installed, the program begins to communicate with the server program over the Internet and begin to download the data files and then perform the correlation processing. After the processing completes, the results will be reported to the server program and then the client system begins to process the next data set. If the user of the PC system starts to use the CPU for the other purposes, the screen saver program promptly terminates the processing but the processing can be resumed later when the CPU is not used for a certain time specified by the screen saver configuration.

3.2. US-Japan e-VLBI for a Rapid UT1 Measurement [3]

On June 29, 2004, one hour e-VLBI session between Westford and Kashima stations was performed to obtain UT1 estimation as soon as possible. The observed data were transferred and processed promptly after the observing session, rapid turnaround UT1 estimation was demonstrated as fast as about 4.5 hours after the session.

The session was performed for about one hour. After the session, data observed at Westford with the Mark-5 were transferred to Kashima through Abilene/TransPAC/JGNII networks. The data of 13.5 GBytes were transferred in about 1 hour and 15 minutes and the average data transfer rate was 24 Mbps. The transferred data were then converted to the K5 file format. During the one hour session, 18 scans were recorded in total. Thirteen scans were assigned to the NFS based distributed software correlation using 12 CPUs running on Linux and FreeBSD. The remaining 5 scans were assigned to VLBI@home and 9 CPUs were used. As soon as the data format conversion completed, the software correlation was started. Although this software correlation processing has a potential to process all scan data within 30 minutes, it took about 2 hours and 38 minutes due to the problem of local area network (LAN) at Kashima. Immediately after all the correlation processing completed, database files were generated and the data analysis was performed by using CALC and SOLVE softwares developed by the Goddard Space Flight Center of NASA. The data analysis was completed at about 4 hours and 30 minutes after the last observation in the session was completed. If the LAN problem does not occur, it will be possible to estimate UT1-UTC from the similar test session within 3 hours after the observing session.

3.3. Delta e-VLBI for Spacecraft Positioning [5]

Technology development of e-VLBI for spacecraft positioning was continued using the "HAYABUSA" that is a Japanese spacecraft launched in May, 2003 aiming at the sample return from the asteroid. Delta VLBI observations were carried out on October 16–18, 2004. The tool to utilize closure phase relation for connecting phase delay from a scan to the next scan has been developed.

3.4. Software Baseband Converter [7]

We have been developing a software-based baseband conveter (BBC) which down-converts intermediate frequency (IF) signals to baseband using data aquired by our PC-based gigabit data acquisition system K5/PC-VSI. IF-signals are sampled by an ADS-1000 with the rate of 1Gbps or 512Mbps. The data are filtered by band-pass filtering software and are converted to base-band signals, of which bandwidth is selectable from 512kHz to 32MHz. Quantization bits can be set to 1,2,4, and 8, and one or two baseband channels can be extracted in real-time with a PC.

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