Technology Development Center at CRL

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Abstract

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 CRL and summarizes recent activities.

1. TDC at CRL

Communications Research Laboratory (CRL) has been leading the development of the VLBI system in Japan. CRL started the development of the K3 VLBI system in 1979 which is compatible with the Mark III VLBI system developed by the US group and successfully carried out a US-Japan VLBI in 1983. CRL then developed the K4 VLBI system, which facilitated ease in both operation and transportation. In October 1990, the International Earth Rotation Service (IERS) designated the Communications Research Laboratory (CRL) and Haystack Observatory (in the United States) as Technical Development Centers (TDC). In September 1996, the IERS directing board designated CRL as TDC again. In accordance with the establishment of the International VLBI Service (IVS) for Geodesy and Astrometry on March 1, 1999, the function of the IERS VLBI Technical Development Center was taken over by that of the IVS Technology Development Center. CRL participates in IVS as one of the Technology Development Centers.

VLBI Technology Development Center (TDC) at the Communications Research Laboratory (CRL) is supposed

1) to develop new observation techniques and new systems for advanced Earth's rotation observations by VLBI and other space techniques,
2) to promote research in Earth rotation using VLBI,
3) to distribute new VLBI technology,
4) to contribute the standardization of VLBI interface, and
5) to deploy the real-time VLBI technique.

The CRL TDC meeting, attended by the ordinary members from inside the CRL and special members from the outside, is held twice a year. The special members advise the committee concerning the plan of technical developments. The TDC newsletter is published biannually by CRL to inform the VLBI community about its current activities. The newsletter is also available through the Internet at following URL **http://www.crl.go.jp/ka/radioastro/tdc/index.html**.

2. Staff Members of CRL TDC

Table 1 lists the staff members at CRL who are members of IVS and are involved in the VLBI technology development center at CRL.

Table 1. Staff Members of CRL TDC (alphabetical).

Name	Works
Amagai, Jun	Optical-linked RF Interferometer
Ichikawa, Ryuichi	Analysis software
Kaneko, Akihiro	Operation software
Kawai, Eiji	Antenna system
Kiuchi, Hitoshi	K4 (KSP) VLBI system, real-time VLBI, and high-speed recorders
Kondo, Tetsuro	Leader of the CRL TDC
Koyama, Yasuhiro	Operation, monitoring, and analysis softwares
Kurihara, Noriyuki	Antenna System
Nakajima, Junichi	Giga-bit VLBI system
Sebata, Kouichi	Observation support system
Sekido, Mamoru	Correlation processing software
Takahashi, Yukio	Analysis software
Yoshino, Taizoh	Leader of the Key Stone Project team in CRL

3. Recent Activities

3.1. Real-Time VLBI

CRL has developed a compact VLBI network named KSP which consists of four stations around the Tokyo metropolitan area and is dedicated to monitoring the crustal deformation (Figure 1)[1][2]. In 1995, the KSP started regular observations. Observations and analyses are fully automated in the KSP. Real-time VLBI technique using a 2.488 Gbps ATM communications network (STM-16) was also developed on the KSP network in cooperation with the Nippon Telephone and Telegraph Corporation (NTT)[3]. Now routine observations spanning 24 hours are carrying out every other day using the real-time VLBI technique. Measurement accuracy in terms of the repeatability of baseline length measurements reaches about a 2-mm level in our VLBI network [4].

This real-time VLBI technique is now used to realize a large virtual radio telescope by connecting a 64-m antenna at USUDA and a 34-m antenna at Kashima besides KSP stations to increase sensitivity to detect very weak radio sources. Test observation was successfully carried out in December 1998 [5].

3.2. Giga-bit VLBI System

In parallel with the KSP operation, the Giga-bit VLBI system consisting of a high speed sampler (1Gsps/4ch/2bit) and a high speed digital data recorder (1024 Mbps) has been developed to increase the sensitivity of observations (Figure 2). Test observations using this system were carried out on the Kashima-Koganei baseline of KSP VLBI network on July 10, 1998, and the first fringes were successfully detected [6]. Data were processed by GICO (Giga-bit COrrelator) which consists of UWBC (Ultra Wide Band Correlator) originally developed for the Nobeyama Millimeter array of the National Astronomical Observatory. The processor is an XF type correlator

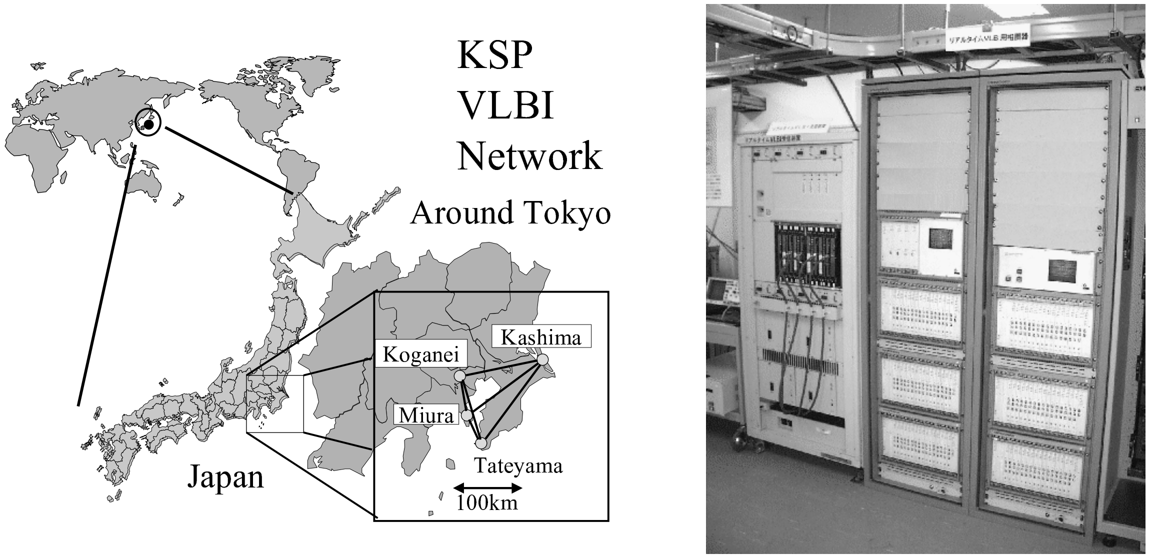

Figure 1. Location of the Keystone Project VLBI network (left) and the real-time correlation processing system (right).

with 256 lags of cross-correlation function capable to process at 2048 Mbps.

3.3. Optical-linked RF Interferometer

In addition to these technology developments, a different approach to increase the accuracy of measurements has been investigated. It is an optical-linked RF interferometer aiming to measure phase delay precisely [7]. The concept of optical-linked RF interferometer is a connected-element interferometer. RF signals received by antenna are directly converted into optical signals and then transmitted through a fiber optic link instead of use of metal lines like a coaxial cable. In a connected-element interferometer, common local oscillator signals are used for the frequency conversion of RF signals from each antenna. Thus no clock parameter estimation is necessary in a baseline analysis unlike in general VLBI analysis for geodetic purpose. Even though higher stability against the temperature change is expected for optical fiber link than metal lines, delay change occurred in the transmission line should be compensated for the application of precise geodetic observation. Maximum fiber length capable to use in this system was estimated from signal-to-noise ratio analysis at fiber optic links. It was estimated to be about 40 km when the combination of Ortel 3541A laser diode and Ortel 4515A photo detector is used.

3.4. VLBI Standard Interface

Besides these technology developments, CRL TDC is contributing to establish the VLBI standard interface (VSI) which is first proposed by Dr. Alan R. Whitney, Technology Coordinator of IVS. We have had meeting several times to discuss VSI in Japan.

Figure 2. Completed Giga-bit recorder (left) and UWBC-GICO experimental correlator (right)

4. Future Perspectives

CRL TDC will continue to make efforts to develop new technologies introduced in this report and to apply them to actual observations. We also have a plan to develop "Internet VLBI" system in cooperation with the NTT which is the succession of the current real-time VLBI technique but aims at realizing more economical (lower running cost) and flexible connections between VLBI stations by using the Next Generation Internet (NGI).

Acknowledgements. The real-time VLBI technique for the KSP has been developed in cooperation with the Telecommunication Network Laboratory Group of Nippon Telegraph and Telephone Corporation (NTT). We thank all staff members of NTT involved in the real-time VLBI Project for their efforts to maintain the high speed network of the KSP. The large virtual radio telescope project has been promoted in collaboration with the Institute of Space and Astronautical Science (ISAS), National Astronomical Observatory (NAO), and NTT. The Giga-bit VLBI system has been developed under a cooperative effort by Communications Research Laboratory, NAO, and Tokyo University. We would like to express deep appreciations to colleagues in these organizations.

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