e-VLBI activity in NICT

M. Sekido, Y. Koyama, H.Takiguchi, M.Kimura,H. Harai, M. Hirabaru

NICT: National Institute of Information and Communications Technology

★ Precise UT1 and Latency

UT1 is an important parameter to represent orientation of the Earth in the celestial reference frame (ICRF) and it is indispensable for space mission which requires precise orbit, especially in deep space. **DUT1=UT1-UTC** is the parameter practically used for UT1 measurement and it is know that VLBI (very long baseline interferometry) is the only one space geodetic technique which can measure the DUT1 with long time stability. IERS (International Earth Rotation and Reference Systems Service) has been providing final solution of the earth rotation parameters every month (Bulletin-B) and prediction of that as Bulletin-A based on combination of space geodetic techniques (VLBI, GNSS, SLR, and DORIS). Bulletin-B has high precision though, its latency is more than one month. Prediction value of Bulletin-A is forecasting the DUT1 up to one year ahead, but its precision degrades rapidly as the date gets far away from the date of issue (See Fig.1). To satisfy requirements of rapid and precise DUT1vaule, IERS is also providing rapid DUT1 solution derived from the latest VLBI observation data and atmospheric angular momentum (AAM) by 1 week latency. Although, precision of the rapid DUT1degrades as close as present time (see Fig. 1). Typical accuracy of rapid DUT1 is about 60 μsec for one day after the date of issue. e-VLBI enables drastic improvement of the latency and precision of DUT1 measurements.

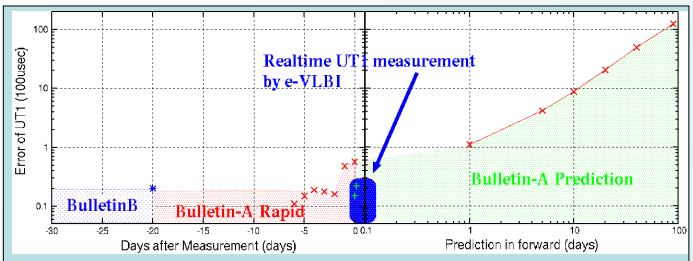

Fig.1 Precision of DUT1 and latency. Error of final solution（Bulletin-B), Rapid solution (Bulletin-A), and Prediction（Bulletin-A) of DUT1 data are plotted. Center is present, left is past, and right is future. The panel in right hand is log-log plot and left is semi-log plot with horizontal axis as time.

★ What is e-VLB ?

e-VLBI is a fusion of information technology including high speed network and VLBI (very long baseline interferometry). Large diameter radio telescopes in the world are connected via high speed network to form a interferometer in the scale of Earth diameter. The e-VLBI brings multiple benefit to VLBI observations (1)quick result after the observation by real-time data transfer, (2) easy compatibility and data conversion between different observation systems, (3)Enabling automatic data transport and processing. (4)Flexible adoption to specific data processing.

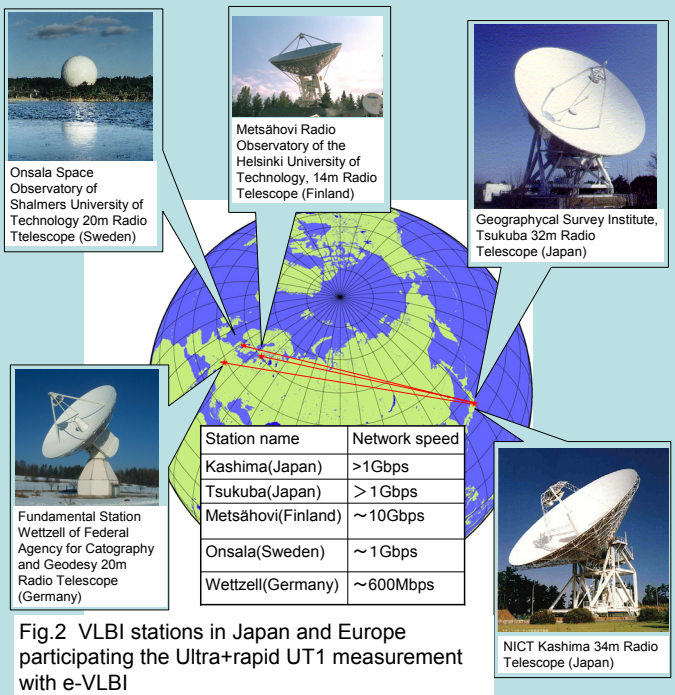

Fig.2 VLBI stations in Japan and Europe participating the Ultra+rapid UT1 measurement with e-VLBI

★ Ultra-rapid DUT1 measurement with e-VLBI

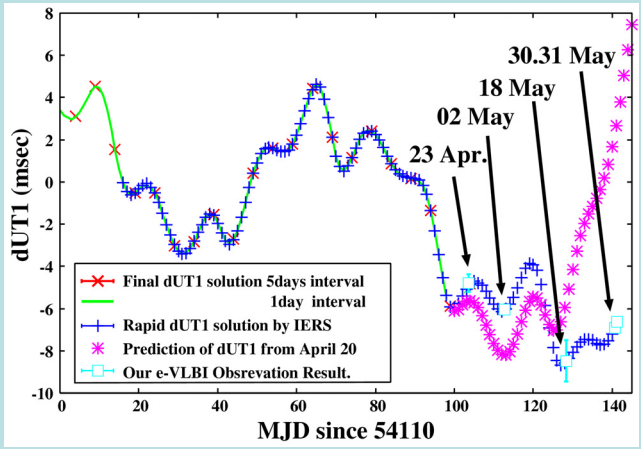

Fig. 3. DUT1values measured by e-VLBI technique with Kashima and Onsala/Metsähovi baseline are plotted with Final, Rapid, and Prediction value published by IERS. Linear trend of DUT1 is removed from all the data to show the comparison clearly. DUT1 data have been obtained by e-VLBI (1 hour observation with one baseline) just half an hour after the experiment with high accuracy and stability.

NICThas been collaborating with Onsala Space Observatory (Sweden), Metsähovi Radio Observatory (Finland), and Wettzell Fundamental station (Germany) for Ultra-rapid UT1 measurement with e-VLBI technology (Fig.1). These VLBI stations are accessible to high speed network. We have been organizing several e-VLBI sessions for rapid UT1 measurements. In the experiment on 31 May, finally we have achived a new record of quick and accurate DUT1 measurement on Kashima-Onsala baseline. The DUT1 has been obtained with 8μsec precision within 30 minutes after one hour long VLBI session. Fig.3 shows the DUT1 data obtained from a series of e-VLBI experiment with Kashima-Onsala/Metsähovi baselines (Table 1).

Table1. UT1 experiments with e-VLBI on Kashima-Onsala/Metsähovi Baseline

Exp code	Date	Observation Time (UT)	Data Rate (Mbps)	Counterpart Station	Precision of DUT1 (μsec)	Latency (hours)
U7113	23 April	15:00-16:00	128	Onsala	43	2
U7122	02 May	14:30-15:30	128	Onsala	15	1
U7138	18 May	08:00+09:00	128	Metsähovi	97.6	3
U7150	30 May	16:00-17:00	128	Onsala	8.6	1
U7151	31 May	06:30-07:30	128	Onsala	8.1	0.5

These e-VLBI experiments were performed by using inhomogeneous VLBI systems (K5/VSSP32 VLBI system at Kashima, Mark4 formatter and PC-EVN system at Onsala). VLBI data were transferred from Onsala to Kashima by Tsunami protocol(*) in real-time. Then data format was converted from Mark5 to K5 and processed by software correlator developed by NICT. Since availability of data rate up to 600Mbps was confirmed by Tsunami between Kashima-Onsala, further increase of VLBI date rate easily acceptable.

Based on the success of accurate and Ultra-rapid UT1 measurements, we are planning to propose regular observation session for DUT1 by using e-VLBI for provision of Ultra-rapid UT1 as a product of the IVS (International VLBI Service for Geodesy and Astrometry).

The impact of Information and Communication Technology (ICT) is really changing the VLBI productivity and quality.

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*: Tsunami is a protocol originally developed by Indiana University and then successfully adapted by the Metsähovi group to support realtime and non-realtime VLBI applications.