

Ultra Rapid UT1 Experiment with e–VLBI

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Abstract. Tsukuba 32 m performed intensive experiments for ultra rapid UT1 measurement. The purpose of the experiments is to obtain the UT1 result within 30 minutes after the end of the observing session. The stations that participated in the experiments are Tsukuba 32 m, Kashima 34 m, Onsala, and Metsahovi with high-speed network. One of the key factors to enable the ultra rapid UT1 measurement is to transfer and convert the data as fast as possible. Therefore, we established some systems, such as real time data transfer and automatic data conversion system. As a result, we succeeded in obtaining UT1 result within 4 minutes after the end of the observing session with Onsala on Feb. 21, 2008.

1. Introduction

The Earth Orientation Parameters (EOP) describe the relation between the Celestial Reference Frame (CRF) and Terrestrial Reference Frame. UT1 is one of the EOP, and it is the rotation angle of the earth. EOP parameter is necessary in orbit control of satellites for space exploration, such as Deep Impact mission and Mars Global Surveyor by NASA. Many analysts need a present and a future value of EOP. The prediction data of EOP for one year into the future is weekly published in IERS Bulletin-A from the Rapid Service and Prediction Center at USNO. However, the accuracy of the prediction value degrades rapidly with time. The error of the prediction value of UT1 becomes over 1 millisecond in 10 days. The rapid solution of EOP is produced by combined analysis with the latest available data (VLBI, GPS, AAM) and published with the prediction data in Bulletin-A. Therefore, obtaining the UT1 result rapidly will contribute to the improvement of the prediction value.

2. IVS Intensive VLBI Sessions

IVS schedules 3 intensive sessions which yield a UT1 measurement a day. From Monday through Friday, INT1 session is performed on the Kokee-Wetzell baseline; INT2 session is performed on the Wetzell–Tsukuba baseline on Satur-

Table 1. IVS Intensive VLBI Sessions (Kk–Kokee, Wz–Wetzell, Ts–Tsukuba, Ny–NyÅlesund, On–Onsala, Mh–Metsahovi)

| Session | Sending data | Processing time | Stations | Correlator |
|-------------|---------------------|-------------------|----------------|------------------|
| INT1 | Network | 3–5 days | Kk, Wz | Washington |
| INT2 | Network (BBFTP) | 1–3 days | Ts, Wz | Tsukuba |
| INT3 | Network (Tsunami) | Within 1 day | Ts, Wz, Ny | Bonn |
| Ultra Rapid | Network (Real-time) | Within 30 minutes | Ts, Kb, On, Mh | Tsukuba, Kashima |

day and Sunday. INT3 is performed on Wetzell-Tsukuba-NyÅlesund network between INT1 and INT2 (Monday). The data of all intensive sessions are transferred from the observing stations to the correlator directly (INT2 and INT3). In the case of INT1, Wetzell data are transferred to a place near the correlator where the data is written to disk and picked up by the correlator, and Kokee data are sent as a disk by airmail. Tabl. 1 shows the data processing times of these sessions. Ultra rapid UT1 experiment enable us to obtain UT1 result far more rapidly than the other sessions.

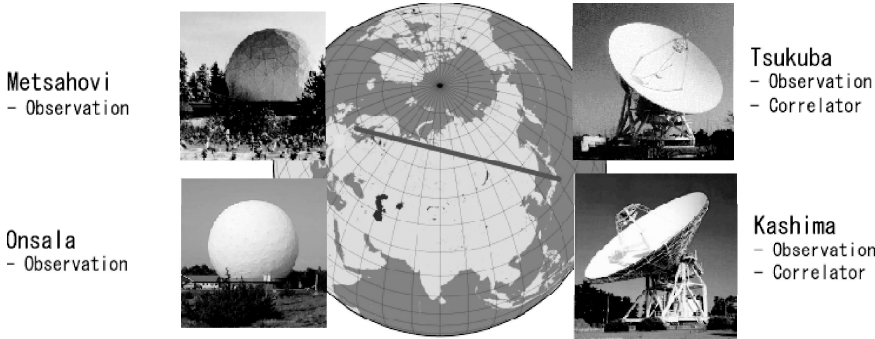


Figure 1. The Stations of Ultra Rapid UT1 Experiment

3. Ultra Rapid UT1 Experiment

The stations that participated in the experiment are showed in Fig. 1. All of the stations have a high-speed network. We have performed the experiments since July 2007. In the experiments, we performed a real-time data transfer and data conversion from Mark 5 format to K5 format. A high-speed network and UDP-based data transfer protocol “Tsunami” assisted the real-time data

transfer from Europe to Japan. After the data conversion, we performed a correlation and data analysis with OCCAM automatically. These automatic processes enable us to obtain the UT1 result within a few minutes after the end of the observing session.

The session's duration is 1 hour which is the same as existing IVS intensive sessions. Before the main session, we add 30 minutes observation for finding fringes, which is a procedure to detect the clock offset between two VLBI stations.

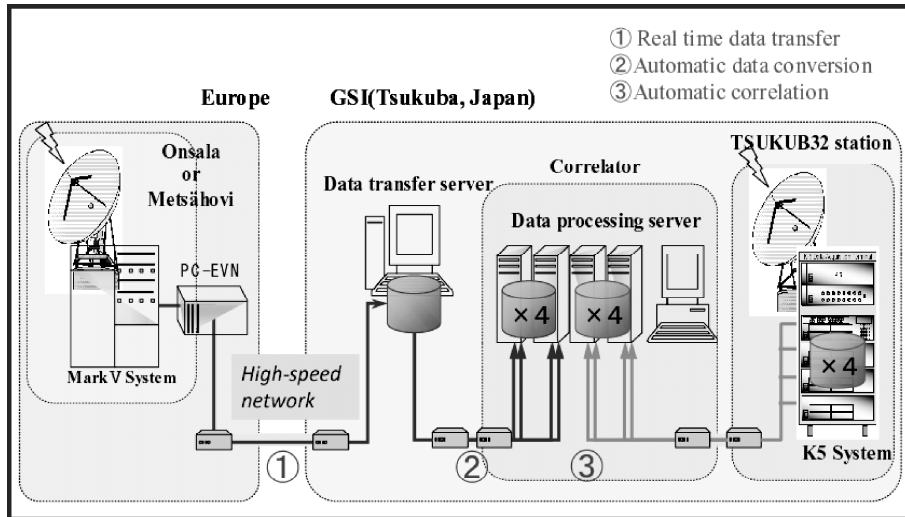


Figure 2. Data Processing of Ultra Rapid UT1 Experiment

4. Results of Ultra Rapid UT1 Experiments

The results of the experiments performed since July 2007 are showed in Tabl. 2. Since the environments of the automatic data processing were not completed in the early stage, we failed in the real-time data transfer and the data conversion. Therefore we improved these processes every time we failed in the experiments. Eventually we could obtain the UT1 result within 4 minutes after the end of the last scan of the session on Feb. 21, 2008.

Fig. 3 shows the comparison of the dUT1 estimated by ultra rapid UT1 experiment with the Rapid Service of Bulletin-A. The accuracy of the dUT1 measurement by ultra rapid UT1 experiment has the same accuracy with the Rapid Service, which is about a few tens of microseconds.

Table 2. Results of Ultra Rapid UT1 Experiments

| | Date | Stations | Results |
|-----|---------------|------------|---|
| 1st | Jul. 14, 2007 | Ts, Kb, On | We confirmed how to perform the experiment. We failed in real-time data transfer. |
| 2nd | Sep. 07, 2007 | Ts, On, Mh | We failed in automatic data conversion. |
| 3rd | Oct. 29, 2007 | Ts, On | We succeeded in real-time data transfer and conversion, but we failed in finding fringes during the experiments. |
| 4th | Nov. 22, 2007 | Ts, On | We succeeded in all of the automatic processes, but the data conversion took more time than we thought. We could obtain UT1 result within 1 hour after the experiment. |
| 5th | Feb. 21, 2008 | Ts, On | We succeeded in obtaining UT1 result within 3 minutes 45 seconds after the experiment. |

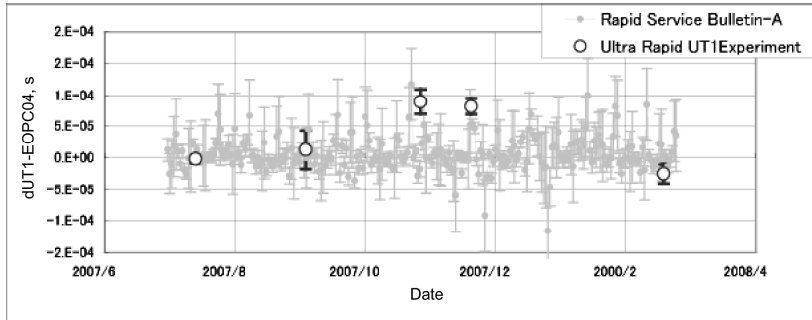


Figure 3. Comparison of the dUT1 Results with Rapid Service of Bulletin-A

5. Conclusion

We succeeded in obtaining the UT1 result within 4 minutes after the VLBI observation. This is based on several automatic processes, such as real time data transfer and automatic data conversion. The accuracy of the dUT1 measurement was the same level with Rapid Service of Bulletin-A. In the current situation, it is possible that we perform the ultra rapid UT1 experiment in 256 Mbps. However, we can not perform the experiment in over 512 Mbps, because we can not transfer the data faster than 500 Mbps. Therefore, we have to maintain the environment of the network at Tsukuba Correlator if we perform the experiment at over 512 Mbps. In the near future, we plan to introduce the system of ultra rapid UT1 experiment at steadily sessions scheduled by IVS.