Tsukuba VLBI Analysis Center

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Abstract

The Geospatial Information Authority of Japan (GSI) became an IVS operational Analysis Center on April 7th, 2010. Our role is to submit dUT1 results from the IVS-INT2 session as soon as possible after the end of the session. GSI has been developing the real-time data processing and analysis system in cooperation with NICT. This report summarizes the progress and status of the ultra-rapid dUT1 measurement system.

1. Introduction

GSI has implemented the ultra-rapid dUT1 experiment in cooperation with the National Institute of Communications and Technology (NICT), Onsala station of the Onsala Space Observatory (OSO) in Sweden, and the Metsähovi station of the Metsähovi Radio Observatory in Finland since 2007. The purpose of this experiment is to obtain dUT1 results within the shortest possible time. After some experiments in 2007, we succeeded in obtaining the dUT1 results within 3 minutes 45 seconds of the end of the observing sessions on Feb. 21, 2008, on the Tsukuba—Onsala baseline. The system of the experiments was introduced into an IVS regular session "IVS-INT2" in 2008, and we have been carrying out the ultra-rapid dUT1 experiment in all of the INT2 sessions. Additionally, we have also implemented the ultra-rapid dUT1 experiment in 24-hour IVS regular sessions, such as "IVS-R1"and "IVS-T2", in which the Tsukuba and Onsala stations participated. Although the system is almost completed, we have not completed the quality check of the dUT1 results yet. After we confirm that the results are consistent with the results of the other Analysis Centers, we will start to submit the results within a few minutes after the end of the observing session for IVS-INT2 sessions.

2. Current Analysis Center Activities

Tsukuba VLBI Analysis Center has implemented the ultra-rapid dUT1 measurement to obtain the dUT1 results within a few minutes after the observing sessions. The ultra-rapid dUT1 measurement of IVS-INT2 sessions is implemented automatically, because there is no staff in the office during the INT2 session scheduled on the weekend. The detail of the automatic data processing system is described in this section. Figure 1 shows the process of the ultra-rapid dUT1 measurement system.

2.1. Automatic Data Transfer Program

For the IVS-INT2 sessions, we must transfer data from the Wettzell or Westford station to the Tsukuba correlator as soon as possible. Therefore, we introduced a real-time data transfer system developed by NICT into the sessions. The system adopts VLBI Data Interchange Format (VDIF) and Simple UDP (SUDP) protocol in the data transfer process. As the VDIF format data is converted to K5/VSSP format at the time of recording on the receiving server (Tsukuba's transfer server), it is not necessary to convert the data after the data transfer. It enables us to reduce the latency of VLBI sessions. This system requires the K5/VSI board in the station which

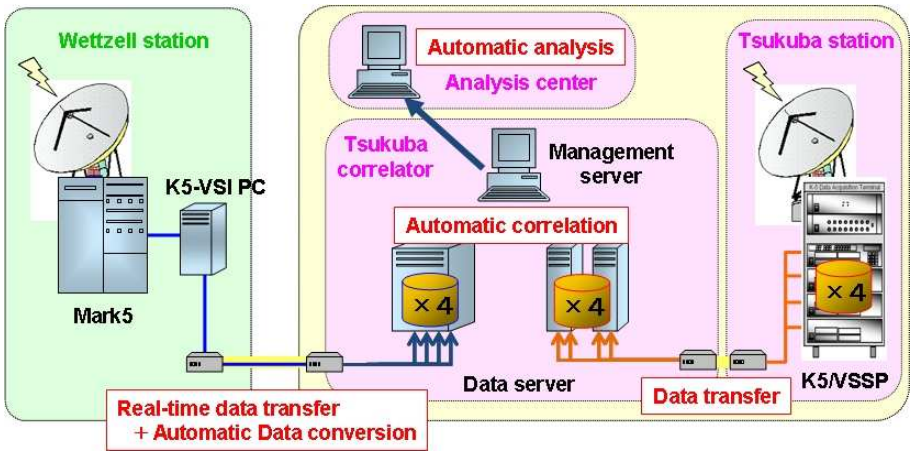

Figure 1. Ultra-rapid dUT1 measurement system

transfers the data to the correlator. NICT installed the K5/VSI board in the Wettzell station and succeeded in real-time data transfer from Wettzell to Tsukuba or Kashima station. The Onsala and Metsähovi stations have another real-time data transfer system which consists of the Tsunami protocol and PC-EVN. However, the other stations have not installed a real-time data transfer system yet, so we implemented the data transfer from the stations after the end of the session.

2.2. Automatic Data Conversion Program

For the INT2 sessions' Tsukuba—Wettzell baseline, we do not have to convert the data any more because we have adopted the real-time data transfer system. However, it is necessary to convert the data from Mark 5 format to K5 format for the INT2 sessions' Tsukuba—Westford baseline. As the data transfer is executed immediately after the Mark 5 data is put on the transfer server at Haystack, we will convert the transferred data after all data is transferred. The data conversion is also executed automatically using a perl script. It takes about 1.5 hours to convert all the data. We are considering how to reduce the delay caused by data conversion.

2.3. Automatic Correlation Program

The correlation work for the ultra-rapid dUT1 sessions is implemented by the "Cor_mgr" program developed by NICT. We created some scripts to execute the Cor_mgr automatically. The script confirms if the K5 data of both stations is ready in the data server, and it distributes the correlation to the correlation servers if the data is available. We use about eight correlation servers for the correlation work. The processing factor of the correlation system will be less than 0.30 if all of the data are already available before we start the correlation program.

2.4. Automatic Data Analysis Program

We adopt mainly two kinds of analysis software for the ultra-rapid dUT1 measurement. The software is OCCAM developed by Vienna University of Technology and C5++ developed by NICT. We can analyze the VLBI data with the software automatically. The analysis time is less than

one minute. Therefore, we can obtain the dUT1 results within a few minutes if we complete the correlation work immediately after the end of the observing session.

3. Results of Our Activities

The Tsukuba Analysis Center analyzes the data of three kinds of ultra-rapid dUT1 sessions. This section shows the results of the experiments and the assignment for next one.

3.1. Ultra-rapid dUT1 Measurements in INT2 Sessions

We have analyzed the data of INT2 sessions for ultra-rapid dUT1 measurements using CALC/SOLVE, C5++, and OCCAM. The differences between solutions from pairs of analysis software are shown in Figure 2. The C5++ solution looks consistent with the CALC/SOLVE solutions. The differences are less than 40 microseconds. However, some of the OCCAM solutions have over 40 microseconds difference compared with the CALC/SOLVE solutions. We have to figure out whether the solution is right or not.

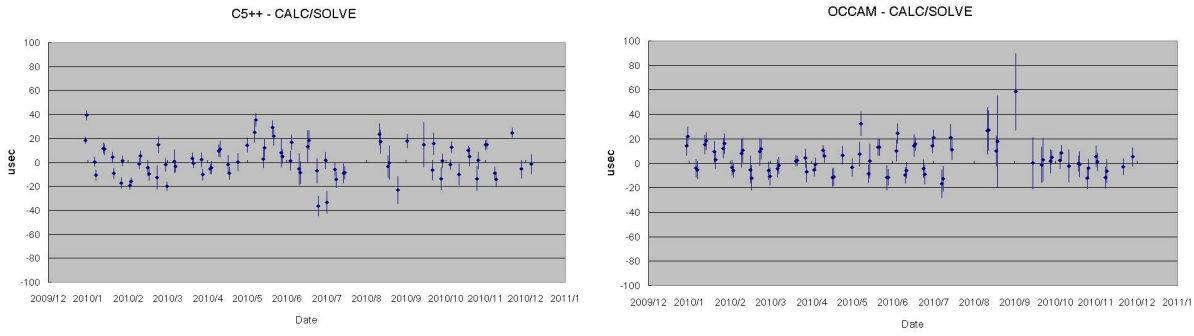

Figure 2. Comparisons of solutions estimated by each software.

3.2. Ultra-rapid dUT1 Measurements during 24-Hour VLBI Sessions

In 2010, we also implemented the ultra-rapid dUT1 measurements for 21 IVS 24-hour sessions (R1, RDV, T2 etc.) in which Tsukuba, Onsala, or Metsähovi stations participated. In the case of 24-hour sessions, we can obtain a number of dUT1 value during the observing session because the data analysis is done every 35 scans. Although we failed to transfer data of some scans due to overload of transfer server on some of the sessions, we could obtain dUT1 values at more than 80 points on each session. After IVS 24-hour sessions, Tsukuba and Onsala stations implemented an additional ultra-rapid dUT1 experiment, which is optimized for dUT1 measurement. We could observe about 430 scans in 11 hours and obtain dUT1 at more than 330 points during the observing session. Figure 3 shows the UT1-UTC values obtained by C5++ or OCCAM software on the "UR0355" session on Dec. 22, 2010. The results of the C5++ analysis fluctuates more than the OCCAM results. We have to investigate whether the results are reliable or not.

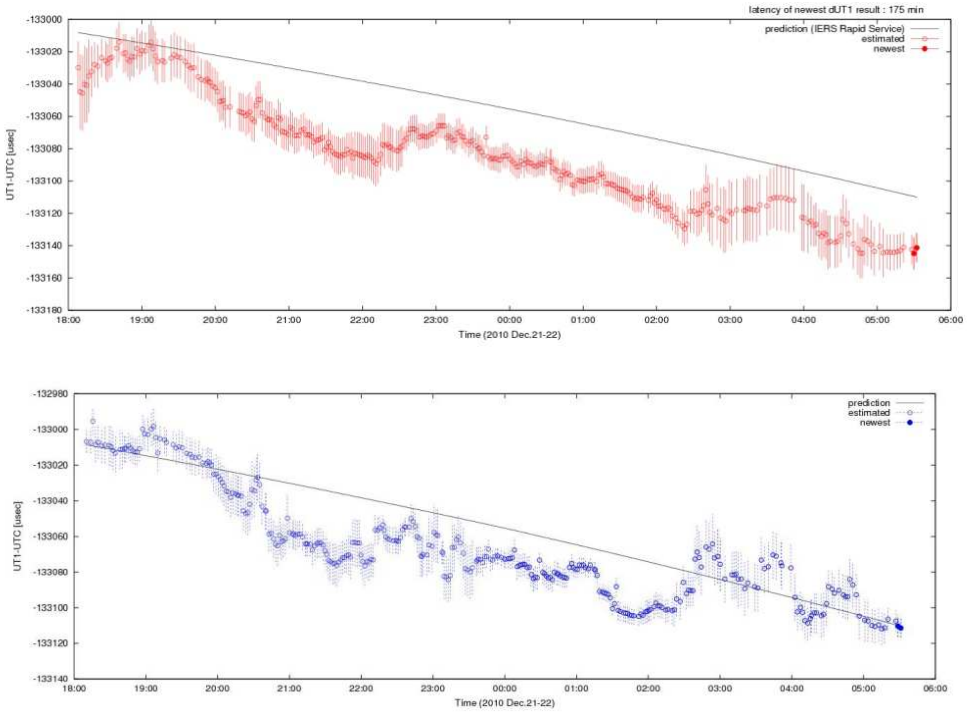

Figure 3. Top: OCCAM solutions on additional ultra-rapid dUT1 session. Bottom: C5++ solutions on additional ultra-rapid dUT1 session.

4. Staff

Kensuke Kokado: Technical Official (GSI)

Management of overall activity of Tsukuba Analysis Center.
Maintenance and support of real-time data transfer system
Maintenance/support of K5 software correlation system and e-VLBI system

Kentaro Nozawa: Technical Operator (AES)

Main operator of the analysis work
Maintenance of the real-time correlation and analysis system

Toshio Nakajima: System Engineer (I-JUSE)

System Engineer for maintenance of computers and e-VLBI network

5. Plan for 2011

Although our Analysis Center has tried ultra-rapid dUT1 measurements on INT2 sessions, we have not submitted the results officially to the IVS Data Centers yet. As we stabilize the data processing system, we will start to submit the C5++ results from the end of February 2011. We plan to implement ultra-rapid dUT1 measurements with the Auckland 12-m antenna in New Zealand (WARK12M). If we succeed for a North-South baseline, we will be able to obtain X/Y polar motion parameters immediately after the observing session. We would like to implement two baseline ultra-rapid dUT1 experiments including West-East and North-South baselines in 2011.