THE TIME LINK BETWEEN CSAO AND CRL

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Abstract

There are and will be a few techniques for time link between CSAO and CRL. The TWSTFT was set up in October 1998 via a Japanese communication satellite. The CSAO-CRL TWSTFT data have been accumulated for more than 1 year since the date when the link was established. The regular operations for the time comparison are well done in 30 minutes twice a week. The GPS Common View has been a regular time link between CRL and CSAO for TAI computation since June 1996. It is expected that there will be a third technique for the time link with GPS/GLONASS multichannel receivers in the near future.

INTRODUCTION

It was in June 1996 when Shaanxi Astronomical Observatory (CSAO) imported a GPS receiver, TTR-6, with which the modernized time link with GPS common view (CV) has been carried on between CSAO and the Communication Research Laboratory (CRL), the Ministry of Post and Telecommunications for the computation of TAI on a routine basis. The data exchange between the two time labs and the data reduction for the time comparison at CSAO have been continued for 2 years.

Two-Way Satellite Time and Frequency Transfer (TWSTFT) is one of the most advanced techniques for time and frequency comparison. By use of synchronous satellites, TWSTFT can optimally offset the errors caused by the path effects and the time labs are able to acquire the real-time results of the comparison. In order to improve the international time synchronization, the Bureau International des Poids et Mesures (BIPM) is carrying out a project for establishing the International TWSTFT Network.

The cooperation on TWSTFT between the National Time Service Center of China at Shaanxi Astronomical Observatory, of the Chinese Academy of Sciences (CSAO), and the Communication Research Laboratory, of the Japanese Ministry of Post and Telecommunications (CRL) will pl ay a very important rule in the International TWSTFT Network. Dr. Imae from CRL and Dr. Li Zhigang from CSAO started to discuss the possibility on the TWSTFT cooperation in March 1997 and the TWSTFT time link between CSAO and CRL via Japanese communication satellite was established in October 1998, when a set of Ku band ground station equipment, as well as related measurement devices, supplied by CRL were installed at CSAO. The TWSTFT laboratory at CSAO, which was established at the same time with the fund supplied by the Chinese National Science and Technology Department and the Chinese Academy of Sciences,

has made the time comparisons with CRL through the Japanese communication satellite JSAT1 since 25 October 1998. The CSAO-CRL TWSTFT data have been accumulated for more than 1 year since the link was established. The routine operations are undertaken every Tuesday and Friday with 30 minutes each time.

The period of validity for the CSAO - CRL TWSTFT cooperation project now being carried out, the agreement of which was signed three years ago, is five years and it is still in the early part of the period. Since the project started two years ago, the coop eration has greatly prompted the research work and improved the precision of the time comparison for both the two time labs.

Because of some trouble with RF Transceiver and Low Noise Converter (LNC), the TWSTFT had to be temporarily interrupted for the period September 1999-June 2000. A new step of the project has begun with a new satellite, changing Satellite from JSAT3 to JSAT1. The Satellite Company in Japan set the antenna for JSAT1 at CSAO on 18 July 2000. The TWSTFT between CSAO and CRL works again after 10 months' absence.

THE DATA ANALYSIS

The results of data reduction for GPS CV before the end of May 2000 show that the position error of the antenna at CSAO was large and should be redetermined. The standard variations (RMS) for the data points [UTC(CRL)-GPS]-[UTC(CSAO)-GPS] to their smoothing curves are about 15.1 ns on average for the period from January to April 2000 and 12.1 ns for May 2000 (after Selective Availability was removed). The accurate coordinates for the TTR-6 antenna at CSAO were introduced at the end of May 2000, which improves the precision of the time comparison. The rms's are about 6.84 ns in average for the period from June to August 2000. When the IGS TEC maps are used for calculating the time delay caused by the ionospheric refraction instead of the model, the rms's are reduced to 6.60 ns for the same period. However, it is still larger than it should be. The antenna of TTR-6 at CSAO has been tested and was verified to have some troubles, which causes fewer tracks, large noises, and jumps in the data of UTC(CSAO)-GPS.

To compare the TWSTT result UTC(CRL)-UTC(CSAO) [by Dr. Hirotaka Yukawa, CRL] with the GPS result UTC(CRL)-UTC(CSAO) [by CSAO], we use 55 groups of effective data for the period from January 1999 to August 1999. The profiles of TWSTFT results and GPS results coincide well. However, the larger fluctuations can be seen in the GPS time link, which is surely caused by the big noise in TTR-6 at CSAO (see Figure 1A).

On 18 July 2000 the TWSTFT between CRL and CSAO restarted. We have gotten better results for the last 5 months. The TWSTT results [by Dr. Hirotaka Yukawa, CRL] and GPS results for the period from 18 July to 24 October 2000 are shown in Figure 1B, from which the obvious improvement can be seen for the TWSTT results in the recent few months.

SOME EXPERIENCES AND SUGGESTIONS

Because the RF transceiver (RFU) and the Low Noise Converter (LNC) are on the roof of the building in the open air, they would be easily damaged by environmental conditions. This situation did make trouble for RF Transceiver and Low Noise Converter (LNC) at CSAO, so that the TWSTFT had to be interrupted for 10 months. Some Asian labs have met the same problem. There could be nothing to do but send the RFU away for repair. It is necessary to

hood the antenna and cover the RF Transceiver, as CRL and CSAO do. They can preserve the instruments from water.

To seal all the connectors with mastic tape is a good way to keeping water from leaking in. Applying UPS to the whole system, either outdoors or indoors, can ensure that the instruments are well protected in order to avoid unforeseen power supply breakdowns.

THE POSSIBILITY OF ESTABLISHING THE TWSTFT LINK BETWEEN ASIA AND EUROPE VIA CSAO

CSAO is among the first group of institutes that has been granted by the Chinese Academy of Sciences (CAS) to be one part of the CAS's Innovation Project. CSAO will become the national center for research and service in the field of time and frequency and is going to be renamed as the National Time Service Center (NTSC). Therefore, CSAO will get more support from the Chinese Government. At CSAO a team of scientists and technicians working on the subject of time transfer, including TWSTFT, have made much progress in their research work.

Because of CSAO's geographic position, it should be a nice "bridge" of TWSTFT links between Asia and Europe. Figure 2 shows that the satellites located at the longitude zone from 50°E to 60°E can be used and their elevations would be higher than 20° for CSAO and some European time labs.

We are looking forward to establishing a new TWSTFT time link between CSAO and one of the European time labs, such as TUG and CAO, in the near future.

ALL-IN-VIEW TIME LINK WITH GPS/GLONASS MULTI-CHANNEL RECEIVERS

Both CRL and CSAO have been equipped with GPS/GLONASS multichannel receivers, R100, the products of 3S Navigation. The receivers are under testing. According to the primary results at CRL, the precision for the GLONASS P-code is much higher than the GPS and GLONASS C/A-code. Moreover, the stability with GPS C/A-code is about 3 times better than that with GPS single channel receivers [1]. Better time comparison results are expected when R100 receivers are used on a routine basis, which can also be used as a primary calibration for the TWSTFT link.

REFERENCE

[1] W. Lewandowski, and J. Azoubib 2000, *"Time transfer and TAI,"* 2000 IEEE/EIA International Frequency Control Symposium and Eexhibition, 7-9 June 2000, Kansas City, Missouri, USA, pp. 586-597.

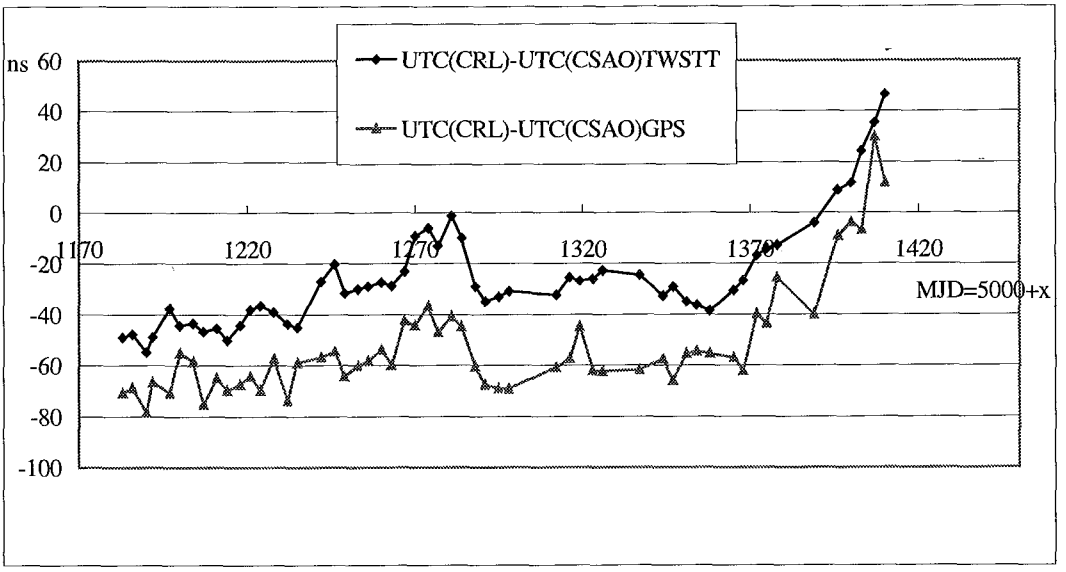

Figure 1A The comparison between TWSTT and GPS Common View (Jan.-Aug., 1999)

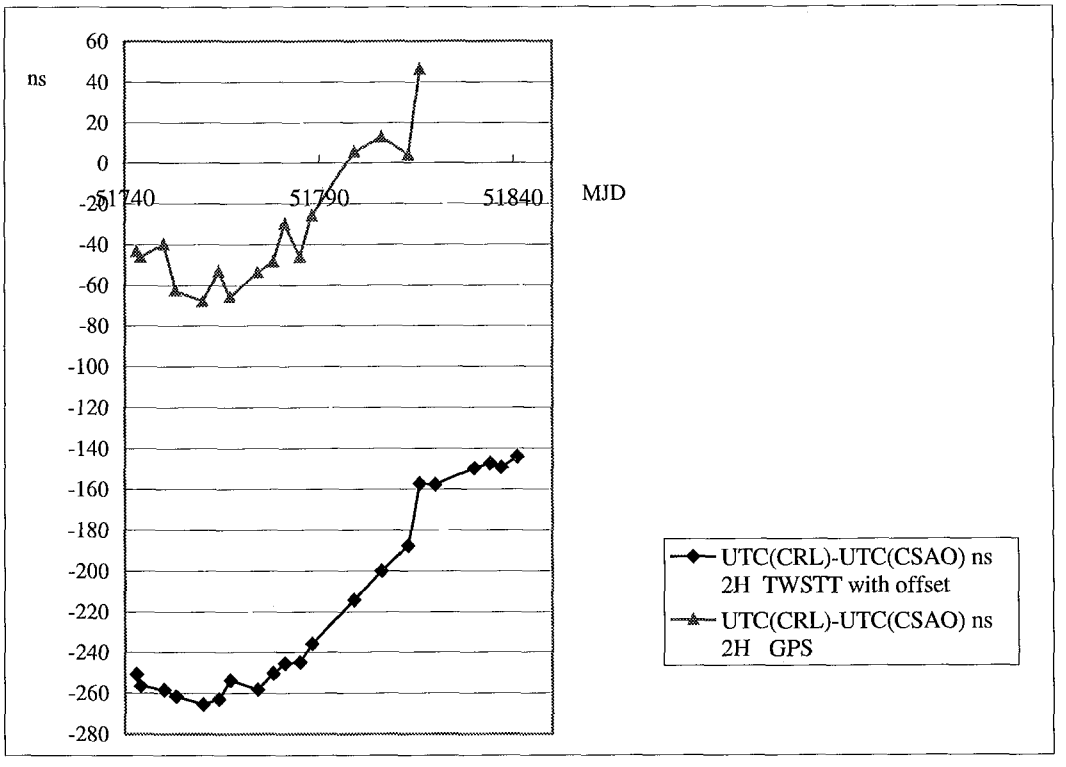

Figure 1B The comparison between TWSTT and GPS Common View (July 18-Oct.24,2000)

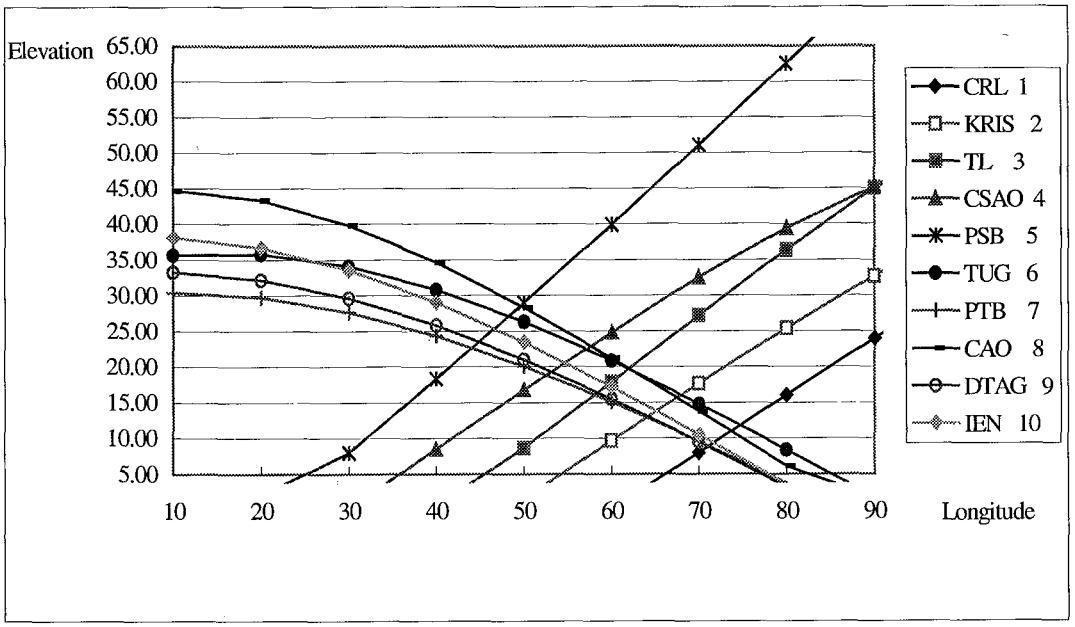

Figure 2 The elevation of satellite for some stations