**Consultative Committee for Time and Frequency**

Sixteenth Session

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# Report of the VSL TF section
# NMi Van Swinden Laboratorium
# July 2001- March 2004

## Introduction

In the period 2001-2004 activities have been mainly in the fields Two-Way Satellite Time and Frequency Transfer (TWSTFT), as well as GPS and Glonass time transfer. Research was done about the improvement of the SATSIM station delay calibrator. Research for the ESA Galileo Early Trial project on GPS and TWSTFT was done in 2002.

## The clocks and quality system

At VSL the UTC(VSL) time scale is generated by commercial caesium clocks. During the years 2001-2004 most of the Cs clocks were performing well. The deviation of UTC(VSL) from UTC was smaller than 50 ns. The data (GPS, Glonass, TWSTFT, clock) at our FTP-site is now daily updated in a fully automated way. A clock comparison with PTB and NPL was done with travelling clocks in June 2002. The RvA has accredited the quality system in place at the Time and Frequency Section in 2001 and 2003. The CMC for TF is in line with this.

## Two-Way Satellite Time Transfer

Two-Way Time Satellite Time Transfers were conducted firstly three times per week with European stations (PTB, NPL, OCA, ROA, IEN, OP and SP) and the North-American stations (USNO, NIST). The data is used by BIPM to calculate links for TAI. Uncertainties of the links VSL to PTB and NPL in 2001 have been determined [2]. The type A uncertainty TDEV was <1 ns at tau <2 d and type B uncertainty is 1.9 ns due to lack of precise calibration.
The TWSTFT schedule has been intensified. Since May 2003 one session per day, and since January 2004, four sessions per day are performed.
Since February 2003 a TWSTFT link to TL, Taiwan, is done two times per week. It shows the same good stability results as time links to NIST or USNO.

At VSL the fully automated station delay measurement system with an SATSIM was used, evaluated and improved [3]. The Transmit-Receive delay accuracy was less than about 5 ns.

Changes in receive frequencies had to be implemented and Sagnac correction changes have been calculated because of changes in the used INTELSAT satellites. These have been communicated to the TWSTFT partners. Also VSL performed the technical coordination in Europe of the WG on TWSTFT.

## GPS Time Transfer

An uncertainty evaluation of both GPS CV and TWSTFT was done during the year 2001 between PTB, NPL and VSL in an ESA Galileo research project. Reports have been published [1,2]. It was shown that TWSTFT has lower type A uncertainty (TDEV =1 ns at tau = 1 h to 2ns at tau =2 d), and that the type B uncertainty (2 ns) is dominating due to lack of precise calibration.

## Glonass Time Transfer

A GLONASS R100-40T receiver was used at VSL with which time transfer was done with BIPM, USNO, Russia and others. The data from this receiver is used by BIPM to publish the values UTC - Glonass Time in Circular T. A new multi-channel multi-system receiver (Topcon) has been acquired and will be modified into a timing receiver.

## Publications

1.
de Jong, G. and Kroon, E., Analysis of 0ne Year of Zero-Baseline GPS Common-View Time Transfer and Direct Measurement Using 2 Co-located Clocks, 34th Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting: 3 - 5 December 2002, Reston VA, USA, pp. 29 - 38.

2.
de Jong, G. and Kroon, E., Analysis of 0ne Year of GPS and Two-Way Time Transfer Results between PTB, NPL and VSL, 34th Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting: 3 - 5 December 2002, Reston VA, USA, pp. 367 - 380.

3.
de Jong, G. and van Bemmelen, R., Evaluation and Improvements of the Calibration of a TWSTFT Station using SATSIM, 34th Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting: 3 - 5 December 2002, Reston VA, USA, pp. 391 - 404.