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Contribution of the
NMi Van Swinden Laboratorium
period 1999-2001,

G. de Jong

P.O. Box 654, 2600 AR Delft, the Netherlands

Introduction

In the period 1999-2001 activities have been in the fields of clock data acquisition system improve-ment, Two-Way Satellite Time and Frequency Transfer, as well as GPS and Glonass time transfer. Some research was done about the measurement and improvement of reflections in GPS and Glonass antenna cables.

The clocks and data acquisition

At VSL the UTC(VSL) time scale is generated by commercial caesium clocks. During the years 1999-2001 the Cs beam tubes of two of the four clocks have been replaced. Apart from this, most of the clocks were performing well. The deviation of UTC(VSL) from UTC was smaller than 100 ns.
The new coaxial multiplexer system with a resolution of 10 ps for the clock signals performed well. New frequency distribution amplifiers for 5 and 10 MHz have been installed recently together with new cables with SMA connectors in stead of the less reliable BNC type.
The data (GPS, Glonass, TWSTFT, clock) at our FTP-site is now daily updated in a fully automated way.

Two-Way Satellite Time Transfer

During all 3 years Two-Way Time Satellite Time Transfers were conducted 3 times per week with European stations (DTAG, PTB, TUG, NPL, OCA, ROA, IEN) and the North-American stations (USNO, NIST). The data is now used by BIPM to calculate links for TAI.
At VSL the fully automated delay measurement system with an improved Satellite Simulator was in use. Some of the coaxial relays have been replaced because of the occurrence of erosion.
Very much time was needed to contact the INTELSAT signatory about the lease of satellite time. Several changes in frequencies had to be done. The proposed change to a schedule of 5 days per week is being investigated by the signatory.

GPS Time Transfer

Calibrations using BIPM GPS receiver #5 (AOA TTR6) at VSL were performed. It was discovered that the 1 pps REF input had an input impedance of 100 ohms, where 50 ohms was expected; the trigger level was +1.4 V, but +0.5 V was assumed. This seems to be the case in all AOA TTR6 receivers. This means that past calibrations with a AOA TTR6 GPS receivers might need corrections. For VSL this can be up to 12 ns, see next two figures.

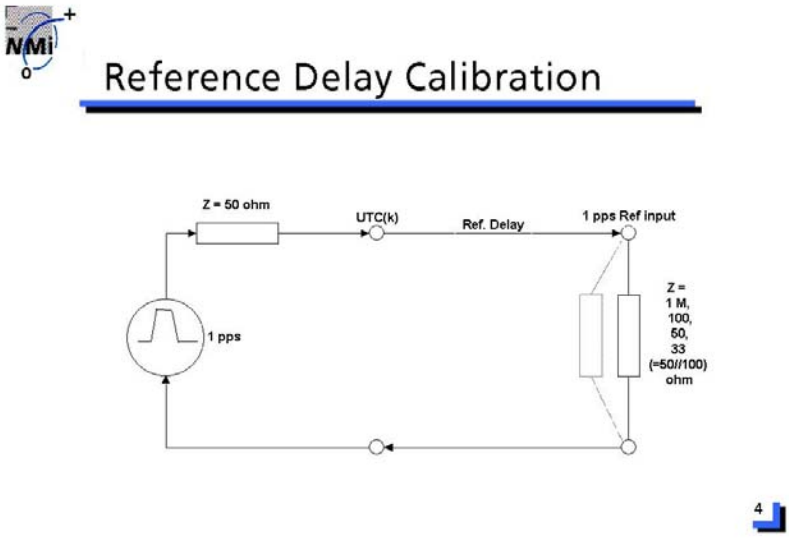

Fig. 1 Output level dependency on termination value

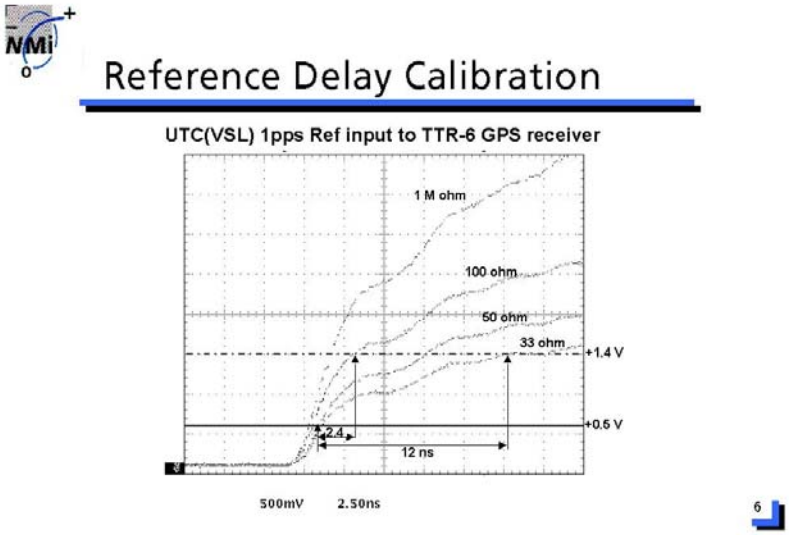

Fig. 2 Delay dependency on trigger level and on termination value

This may explain part of the -21 ns step change of the GPS receiver delay calibration at VSL by a BIPM GPS receiver during 31 Oct.- 3 Nov. 1997 and 13-23 February 1998 and later, with respect to the calibration during 16-23 June 1997. See the following table.

Differential time correction d to be added to $[UTC(k_1)-UTC(k_2)]$.
A single 1σ uncertainty, $u(d)$, has been estimated for each trip: 3 ns for 1st trip and 2 ns for 2nd and 3rd trip.

$[UTC(k_1)-UTC(k_2)]$	D/ns		
	1st trip	2nd trip	3rd trip
$[UTC(VSL)-UTC(OP)]$	-2	-23	-20

Glonass Time Transfer

The GLONASS R100-40T receiver with its temperature-controlled antenna TSA-100 still had some hardware and software problems from time to time. The solving of these took a lot of time. The Introduction of isolators has been improving the errors due to reflections in the antenna cables (next two figs).

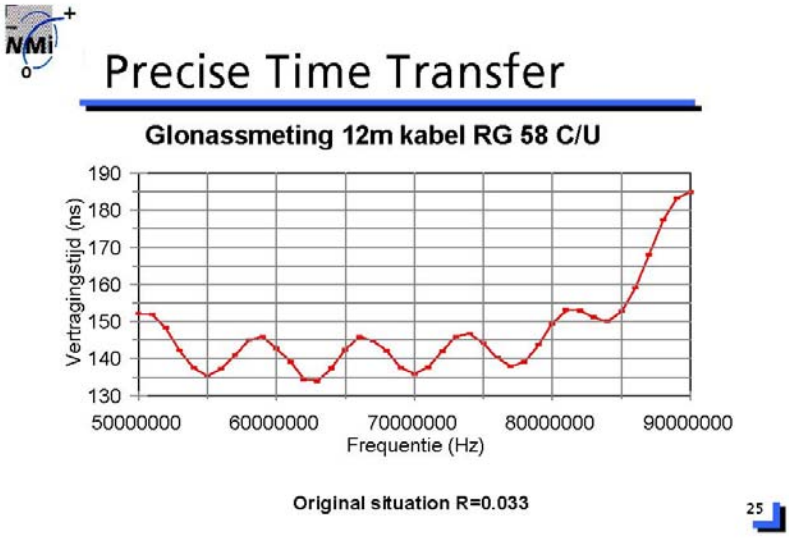

Fig.3

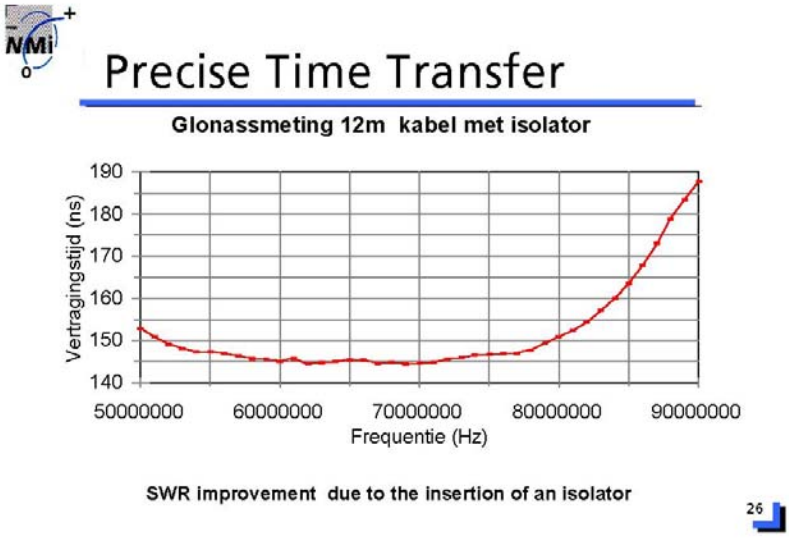

Fig. 4

Publications

1.
Azoubib, J., Kirchner, D., Lewandowski, W., Hetzel, P., Klepczynski, W.J., Matsakis, D., Parker, T., Ressler, H., Soering, A., de Jong, G., Baumont, F., Davis, J.A., Two-Way Satellite Time Transfer Using INTELSAT 706 On A regular Basis: Status and Data Evaluation, 30th Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting, 1 - 3 December 1998, Reston Va, USA, pp 393 - 404.

2.
de Jong, G., Precise Time transfer, Proceedings Asia-Pacific Workshop on Time and Frequency 2000 (ATF2000), CRL, Tokyo, 31 October- 2 November 2000, pp 13 - 22.