

REPORT OF THE 16th MEETING OF THE CCTF WORKING GROUP ON TWSTFT

held in Borås, Sweden
on 2-3 October 2008

The 16th meeting of the Consultative Committee for Time and Frequency (CCTF) Working Group (WG) on Two-Way Satellite Time and Frequency Transfer (TWSTFT) was held on 2-3 October 2008 in Borås. The WG meeting was organized by SP and was chaired by Dirk Piester of PTB as deputy of the WG Chairman, Bill Klepczynski, who could unfortunately not attend the meeting. Other contributions to the meeting, and attendee list (*web doc 16-08*), are available on the BIPM open access website:

<http://www.bipm.org/wg/AllowedDocuments.jsp?wg=TWSTFT>

Documents related to the details of financial issues, and attendee list with e-mails (*web doc 16-39*), are available for Participating Stations on TWSTFT restricted access of:

<http://www.bipm.org/en/committees/cc/cctf/>

Agenda

- 1) Opening address – Jan Johansson, Head of the Department of Measurement Technology
- 2) Approving Agenda
- 3) Laboratories reports
- 4) Contractual matters – A. Bauch, PTB
- 5) Pacific Rim – status and future plan – presented by NICT
- 6) Improving TWSTFT standardization and data management: towards an improved version of the Recommendation ITU-R TF-1153 – A. Bauch, D. Piester, PTB
- 7) Study of TWSTFT triplets, joint USNO, BIPM and PTB activity – PTB
- 8) Possible experiments with Larger Bandwidth
- 9) Status of the implementation of the triangle calibration – Z. Jiang, W. Lewandowski, BIPM
- 10) Unifying the TW and GPS calibrations for UTC time transfer – F. Arias, Z. Jiang
- 11) Comparison of TWSTFT with other techniques at the BIPM
- 12) Web page for the time transfer equipment calibration at the BIPM – F. Arias, W. Lewandowski, BIPM
- 13) Report from TimeTech – W. Schaefer
- 14) Current and planned calibration exercises
- 15) Discussion
- 16) Lab tour

Summary of the meeting

1. Presentation of the organization of metrology at SP. (*Webpage document TWSTFT/16-10*).

3. Reports from Participating Stations (see full reports on *BIPM TWSTFT web-site*).

AOS. Temperature dependence: diurnal signatures on transatlantic links. Status of TA(PL) and UTC(AOS). Development of TTS-4. Contribution to Galileo GTSP and PTF (*web doc 16-11*).

INRiM. Participation in TW calibration exercise for Galileo/Fidelity. Temperature dependence studies: diurnal signatures on transatlantic links. There is no clear idea of the causes of these diurnals. Oscillations for transatlantic links is larger than for European links (*web doc 16-12*).

METAS. Expecting results of a recent new TW calibration which took part during the week 39. Temperature dependence studies: diurnal signatures and time jumps on transatlantic links. Triangle calibration data implemented. UTC(CH) is now a hardware clock. Perform an evaluation study to stabilize transatlantic links (*web doc 16-13*).

NICT. TW link in Asia by JCSAT – 1B: NICT, KRISS, TL, NTSC,.... Time management system for QZSS, with TWSTFT link to US through Hawaii. JCSAT – 1B out of service in 2010/4. Candidate satellites under study. EU-Asia by IS-4. New TW using dual PRNs (*web doc 16-14*).

NIST. 3.7m motorized antenna with Ku-band RF equipment. Two-channel SATRE MODEMs. Time transfer stability for one day <100 ps. Automated operations. John Lowe new group leader, should be on all TW e-mails. The main TW contact is Victor Zhang. Tom Parker continues as contractor, and should be on TW mailing list. Implemented BIPM TM 151. IS-3R is estimated to run out of fuel in the fall of next year. The satellite for replacing was not yet launched (*web doc 16-15*).

NMIJ. JCSAT-1B station (1.8m, el. 46.5 deg, NEW). Temperature controlled box (outdoor unit). IS-4 (2.4m) (*web doc 16-16*).

NPL. Setnam Shemar is back since August 2008. NPL current equipment: 1.8m antenna. Satre #74. Station was recently calibrated for Galileo/Fidelity. NPL02 on new NPL building (*web doc 16-17*).

NTSC. Two Earth stations and two kind of modem: 1.8 and 2.4 m antennas. There are TW links with PTB, OP, VSL (*web doc 16-18*).

OCA. Two HP5071A. Three GPS receivers. One Earth station, 1.8 m VSAT monitoring of environmental conditions. Contribution to T2L2.

OP. Two 2.4m Ku band VSAT (OP01 & OP02). Operation of OP01 & OP02 during satellite changed. OP02 motorized. Satellite simulator operational from now. Contribution to T2L2 (*web doc 16-19*).

PTB. PTB01 (link to European and US), out of service since Feb 2008, PTB02 (link to USNO via X-band), PTB03 (link to Asia via IS-4 under NICT contract), PTB04 (link to European and US). Very limited space on the current roof. There are plans to move to another building. Watchdog system implemented. Work on inclusion of two Galileo PTFs into the EU/US TW network (*web doc 16-20*).

ROA. Two stations ROA01 and ROA02 used during satellite change. Both satellite used using a single modem. Monitoring software reporting issues every session. Week points: need to reboot the modem every two/three days. Report on frequency drift of links to PTB. (*web doc 16-21*).

SP. Report on satellite change and new feed in 2008: new CALR values according to BIPM TM 151, no change of CALR for PTB01, some new hardware. SP01/NIST01 TW link most stable (*web doc 16-22*).

TL. Three stations TL00 (test), TL01 (Asia), TL02 (Europe). TWSTFT links with North America will be soon operational (*web doc 16-23*).

TUG. Portable station. Right now no-UTC laboratory. TUG provides service of calibration: until now six calibration trips. Some concerns about availability of this service in the future (*web doc 16-24*).

USNO. Calibration updates: smaller/lighter equipment, old weight 68kg, new weight 22.7kg. Upcoming projects: TimeTech Satsim - install Satsim to monitor delay stability. Set up of TWSTFT station in Hawaii soon (*web doc 16-25*).

VSL. Maintain UTC(VSL) through TW, GPS/Glonass Changes in 2008: changed from Mitrex to Sartre, satellite simulator (some temperature fluctuations). New simulator will be built next year. Equipment under development for Galileo PTF (*web doc 16-26*).

4. Contractual matters – A. Bauch, PTB. Payment are ongoing smoothly. There is not clear who will pay for PTF TW calibrations in 2009. A. Bauch will keep in touch with laboratories on this issue. Cost per lab of about 7000 E for the recent calibration service (*web doc 16-27*).

5. Pacific Rim – status and future plan. Until 2009/3 NICT pays the link fee. From 2009/4, NICT would like to share the fee. Delay measurement in PTB station shall be installed. temperature dependence. For the coming four years IS-4 link seems to be available. Time transfer with PTB stopped about 1 month ago due to defects in outdoor equipment on PTB site, but resumed recently(*web doc 16-28*).

6. Improving TWTSFT standardization and data management: towards an improved version of the Recommendation ITU-R TF-1153 – A. Bauch, D. Piester, PTB. Standard format designed at the very beginning of operational TW was showing during last years several weak points. Especially BIPM was complaining. Several individual contributed to redesigning the format as V. Zhang, Z. Jiang, J. Achkar. We should agree on open issues

here or by correspondence. First changes are making format more readable. BIPM agrees on reporting data of type 1 only. Reporting additional data in more than one file ? Reporting results of a quadratic fit: TW, REFDELAY, CALR, and ESDVAR (*web doc 16-29, 30, 31*). A. Bauch will circulate a version 2.0 of the document within four weeks and call again for inputs / comments. A “final” version of the Draft should be accepted during the experimenters’ meeting during EFTF 2009 in Besançon.

7. Study of TWSTFT triplets in Asia, Europe and USA – PTB, TL, USNO. The standard deviation of closure links for example for TL-NICT-NTSC is only of 174 ns over a period of four months. Network shows some advantages. In Europe standard deviation are ranging from 300 ps to 500 ps. Large non-zero closures in Europe have been identified as caused by: temporal instability of the local signal distribution, ... Closure only works if all links are at the exact same frequency (D. Matsakis). (*web doc 16-32, 33, 34*).

8. Possible experiments with Larger Bandwidth. New method exist. Results promising, but still experimental. Bill suggested larger bandwidth experimentation on satellite. Joseph added that especially for comparison of primary frequency standards.

9. Status of the implementation of the triangle calibration. RMS ranges from 0.2ns to 1.0 ns. Comparison TCC vs. TW-2005-calibration: difference from 0.9 ns to 1.4 ns. An individual TCC is not most optimal solution. TW labs implemented TCC-CALR values (*web doc 16-35*).

10. Unifying the TW and GPS calibrations for UTC time transfer. There are three independent calibrations GPS C/A, GPS P3, TW. Most often they agree well within uB. Monitoring calibrations is necessary. Unifying calibrations (TW/GPS) could bring significant improvement. Calibrating GPS equipment through TW is possible, cutting down uB for GPS to ≤ 3 ns. uB has not improved for GPS links (5-7ns). TW calibration/reproducibility: uB = 1ns. There was a concern about quickly aging quality of GPS link after TW calibration (*web doc 16-36*).

11. Comparison of TWSTFT with PPP at the BIPM. Advantages and weak points of two methods were described. Combination of two was presented. (*web doc 16-37*)

12. Web page for the time transfer equipment calibration at the BIPM. This is was a visit of BIPM website on calibration now under construction. Under names of various types of calibration the tables resuming past calibrations, and links to relevant publications are provided. Also BIPM link comparison site was presented.

13. Report from TimeTech. Carrier Phase is by anyway superior to Code (*web doc 16-38*).

14. Current and planned calibration exercises. During summer a calibration exercise was conducted by TUG among laboratories providing UTC for Galileo/GTSP/Fidelity. It was later extended to METAS and VSL. Results are expected shortly. AOS, OCA and SP are interested in TW calibration ASAP, willing to pay the 7000 E fee per lab. They may contact for this TUG on individual basis. But also D. Piester will contact TUG for future calibrations. NICT will work on calibration for Pacific Rim; showed interest in continuing GPS calibration piloted by BIPM. There was a concern about future calibrations. TUG might not be willing to continue. There is also a need for frequent (twice per year ?)

calibrations. Shall the group buy a portable station and operate it under BIPM piloting ? A need for quasi-concurrent GPS calibrations was stressed.

15. Discussion. The situation in Pacific-Rim needs a quick improvement: most of stations are operational but do not contribute to TAI. Pacific Rim TW Links should be calibrated ASAP.

Actions

a. Preparation of CCTF: Bill and Dirk will write WG report for CCTF. WG Chairmanship will contribute also to the elaboration of policy on future BIPM scientific activity in T & F.

b. TW calibration in Europe: Dirk will work with TUG on 2009 calibration trips. AOS, OCA and SP will contact TUG on individual basis for immediate calibration.

c. TW calibration in Pacific Rim: Yasuhiro KOYAMA of NICT will work on status and possible progress.

d. Pacific Rim TW use for TAI: BIPM staff will check the status.

Forthcoming meetings. Next meetings of Participating Stations will be held in November 2008 during the PTTI, and in April 2009 during the EFTF. The next full meeting of the Working Group will be held during autumn 2009 at the AOS, Poznań, Poland.

W. Lewandowski
Secretary of the CCTF WG on TWSTF