CCTF WG on GNSS time transfer

2012-2015

Summary of the activities

Membership

Chairman: Dr Pascale Defraigne (ORB)

Secretary: Dr Gérard Petit (BIPM)

Members:

- One representative of the CCTF-WGATFT;
- Experts from laboratories contributing to UTC;
- Experts from the International GNSS Service (IGS);
- Experts from time/frequency sections of NMIs;
- Members of the BIPM Time Department,

Objectives

- State of the art in GNSS TFT + recommendations → CCTF;
- to gather and share among the TAI community about equipment, characterization of the hardware delays, data processing and scientific results;
- to maintain contacts with the receiver manufacturers in order to inform them about our needs;
- to stimulate the development of calibration procedures in agreement with new GNSS receiving systems;
- to establish contacts with the parallel scientific communities working on the definition of the receiver output standards;
- to study the clock results formats in agreement with the user needs.

Main Subjects Developed 2012-2015

- The possible evolution of CGGTTS format
- Stimulating the development of calibrations procedures
- Progresses in terms of time/frequency transfer performances

CGGTTS (1/2)

V2E : extended version of the format 2.0

- Published in *Metrologia* 2015 **52** G1

With a link to
http://metrologia.bipm.org/guides-stds-conventions/2015/G1.pdf

- New name : Common Generic GNSS Time Transfer Standard
- Includes :
  - GPS
  - GLONASS
  - Galileo
  - BeiDou
  - QZSS
- Single-frequency (L1 band) OR 2-frequency (the combination of the broadcast clocks → ONLY one combination)

CGGTTS (2/2)

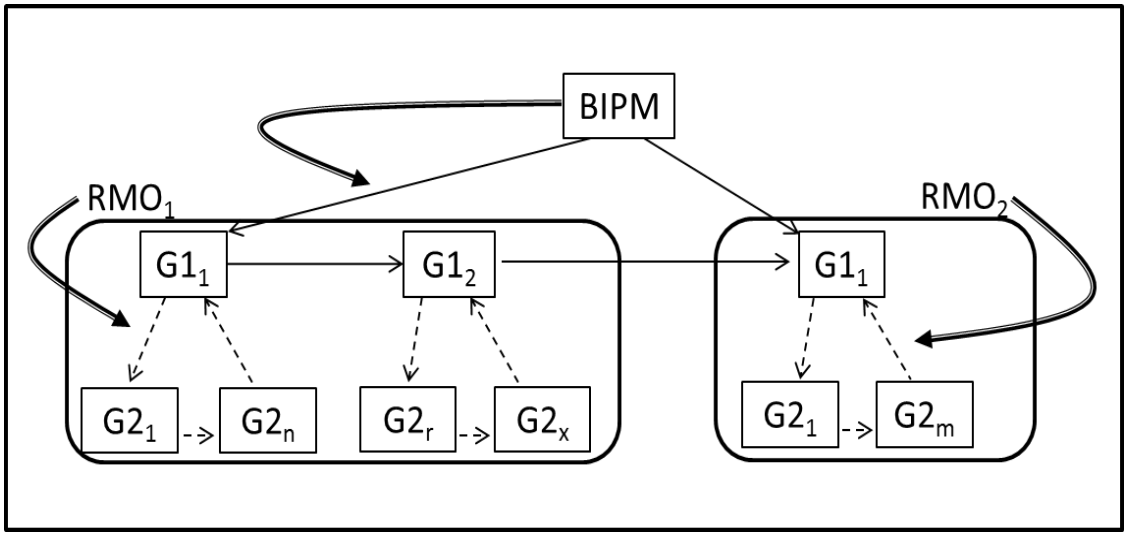
```
Case 2: ionospheric measurements available, single-frequency or dual-frequency results
CGGTTS     GENERIC DATA FORMAT VERSION = 2E
REV DATE = 2014-02-20
RCVR = RRRRRRRRR
CH = 12
IMS = IIIIIIIII
LAB = ABC
X = +4027881.79 m
Y =  +306998.67 m
Z = +4919499.36 m
FRAME = ITRF, PZ-90->ITRF Dx = 0.0 m, Dy = 0.0 m, Dz = 0.0 m, ds = 0.0, Rx = 0.0, Ry = 0.0, Rz = 0.000000
COMMENTS = NO COMMENTS
INT DLY =   53.9 ns (GLO C1),   49.8 ns (GLO C2)
CAB DLY =  237.0 ns
REF DLY =  149.6 ns
REF = UTC(ABC)
CKSUM = 3B
```

or SYS DLY = or TOT DLY =

CAL_ID = 1nnn-yyyy

SAT	CL	MJD	STTIME	TRKL	ELV	AZTH	REFSV	SRSV	REFSYS	SRSYS	DSG	IOE	MDTR	SMDT	MDIO	SMDI	MSIO	SMSI	ISG	FR	HC	FRC	CK
			hhmmss	s	.1dg	.1dg	.1ns	.1ps/s	.1ns	.1ps/s	.1ns		.1ns	.1ps/s	.1ns	.1ps/s	.1ns	.1ps/s	.1ns				
R24	FF	57000	000600	780	347	394	+1186342	+0	163	+0	40	2	141	+22	23	-1	23	-1	29	+2	0	L3P	5C
R05	FF	57000	000600	780	70	2325	+22617	+6	165	-3	53	2	646	+606	131	-9	131	-9	37	+1	0	L3P	8C
R17	FF	57000	000600	780	539	1217	-1407831	-36	154	-54	20	2	100	-8	24	+0	24	0	13	+4	0	L3P	7A
R16	FF	57000	000600	780	370	3022	+308130	-18	246	-28	29	2	134	-22	63	+4	63	4	21	-1	0	L3P	80

Calibration guidelines (1/2)



1. BIPM will organize the calibration of some stations (called “group 1” here after) in each RMO,
2. the RMOs, together with these “group 1” laboratories, will organize calibration campaigns for the other laboratories (called “group 2”) of their region.
3. In addition, the BIPM will conduct “Group 2” trips as necessary to accommodate special cases, using either one BIPM system or a “Group 1” system as a reference.

Calibration guidelines (2/2)

The Group 1 laboratories per RMO have been designated:

- **EURAMET**: OP, PTB, ROA
- **SIM**: NIST, USNO
- **APMP**: NICT, NIM, TL
- **COOMET**: SU
- no G1 laboratories in **AFRIMETS** and **GULFMET**.

A first G1 trip was organized by the BIPM in 2014, the results are available at

ftp://tai.bipm.org/TFG/GNSS-Calibration-Results/1001-2014/.

CALEX format

Single file reporting all the calibration results

```
1.3                                                             CALEX VERSION
CGTTS header                                                    CALEX TYPE
############################################################    COMMENT
CGTTS header = provides all information needed for the          COMMENT
header of the CGTTS format (INT DLY, CAB DLY, REF DLY)          COMMENT
SYS DLY = INT DLY + CAB DLY may be used in CGTTS V3             COMMENT
TOT DLY = SYS DLY - REF DLY may be used in CGTTS V3             COMMENT
TOT DLY can be directly removed from the PPP solutions          COMMENT
Other CALEX TYPEs to be defined                                 COMMENT
############################################################    COMMENT
                                                                END OF HEADER
                                                                START OF STATION CAL
USNO           USN3           US03                              LABO / RINEX / BIPM
RT920012203              ASHTECH Z-XII3T                        REC # / TYPE
KW5-0258                 AOAD/M_T     NONE                      ANT # / TYPE
GPS                      1008-2014                              GNSS / CAL_ID
 2004    10    01     0     0    00                            VALID FROM
 REF = UTC(USNO)                                                LAB REFERENCE
 2 TOTDLY P1=   287.9 P2=   304.1                               # / DLY / TYPE=VAL
                                                                END OF STATION CAL

...
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Precise Point Positioning

- Look for continuous PPP solutions (comparison of optical clocks)
  - Long batches/moving windows/ …
  - Solving Integer ambiguities : need for specific clock products → need for continuation of the collaboration with the geodetic community
- Need synchronized measurements of code an phase in the receiver → need for continuation of the collaboration with the receiver manufacturers