News from the BIPM

Felicitas Arias

Time Department

Meeting of the CCTF WGTW , 6-7 September 2012

BIPM, Sèvres

Time transfer

- ✓ GPS/GLONASS/TW data daily reported – Only laboratories with non-adapted GPS receivers still send weekly files;
- ✓ All laboratories post data in specific ftp directories;
- ✓ Combined GPS/GLONASS and TWPPP links are routinely used in the calculation of UTC;
- ✓ Time Department Database (originally planned for GNSS equipment in laboratories contributing to UTC) is in the last steps of development

New prediction algorithm

After test and simulations for a long period (5 years), after publications and presentations[1,2,3] the new prediction algorithm for EAL has been validated and implemented.

From August 2011 a quadratic prediction is officially used to calculate UTC; the frequency drift is considered in the model for all kind of clocks.

The frequency drift affecting EAL is almost completely removed.

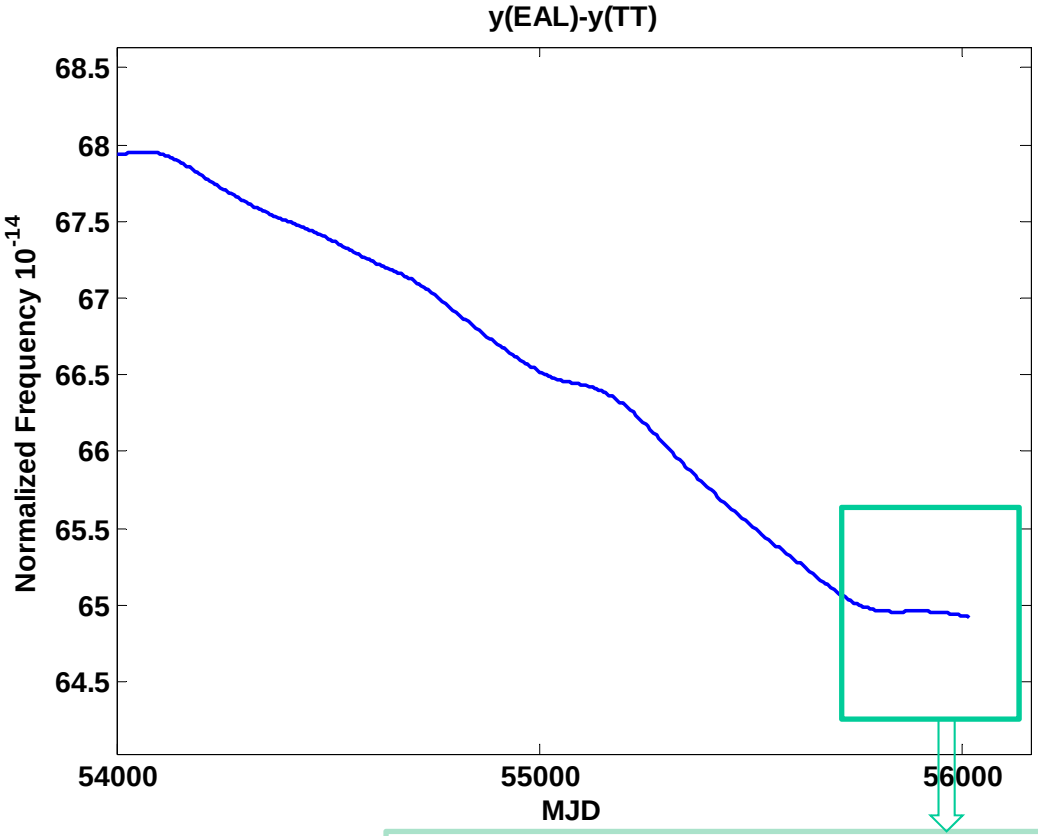
[1] G. Panfilo and E.F. Arias. "Studies and possible improvements on EAL algorithm". UFFC, Vol. 57, No.1, January 2010, pp. 154-160.

[2] G. Panfilo, A. Harmegnies, L. Tisserand. "A new prediction algorithm for the generation of International Atomic Time". Metrologia, 2012, 49, n°1, 49-56.

[3] G. Panfilo, A. Harmegnies, L. Tisserand. Report to CCTF. A new prediction algorithm for EAL.

Results: y(EAL)-y(TT)

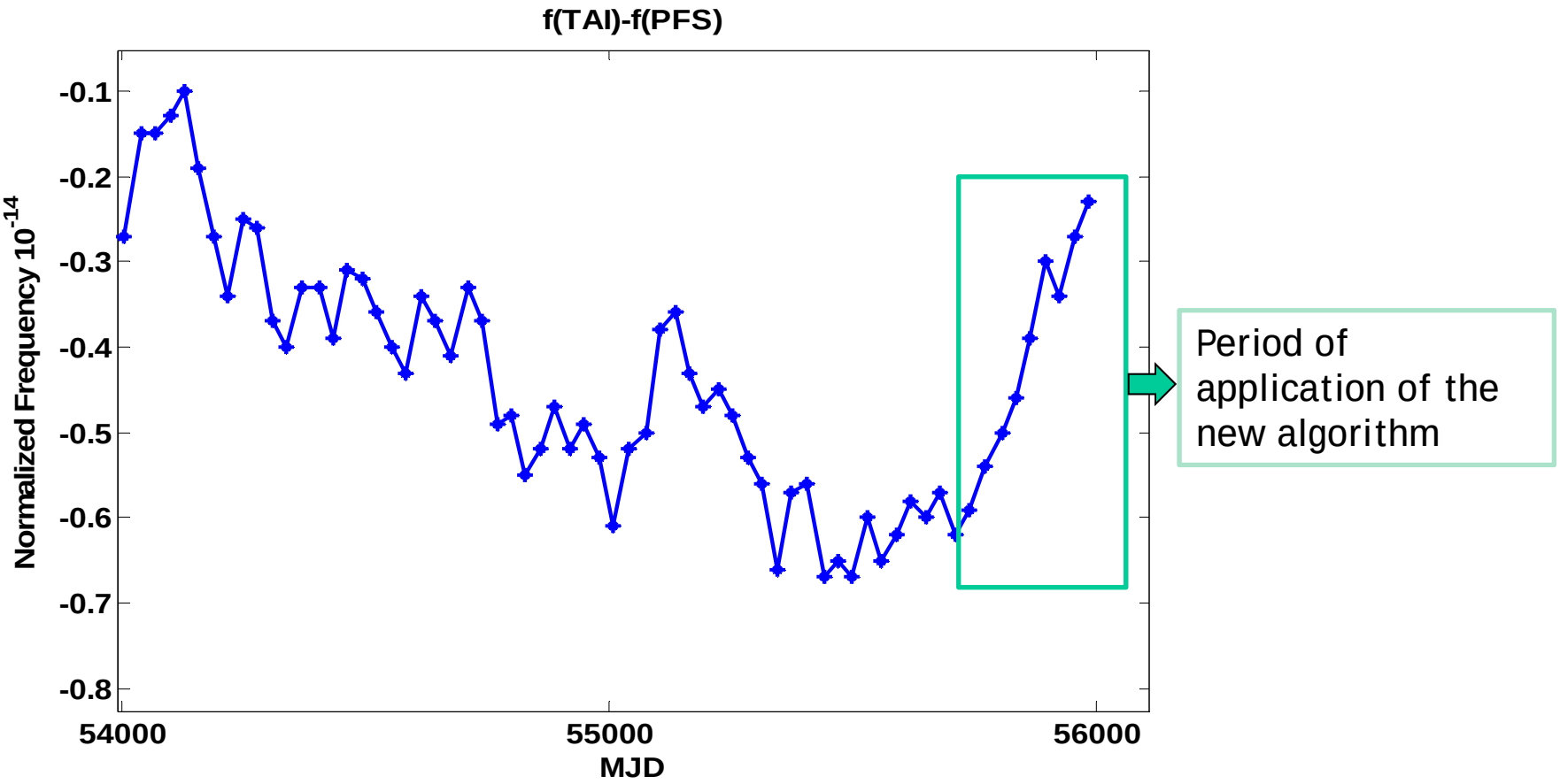
Starting from August 2011 the new algorithm is officially used in UTC calculation:



The frequency drift affecting EAL is almost completely removed

Period of application of the new algorithm

.....f(TAI)-f(PFS)



The value of the difference f(TAI)-f(PFS) should be close to zero. Starting from the application of the new prediction algorithm this value is approaching zero with some noise.

Revision of the clock weighting algorithm

In the current weighting algorithm the weight attributed to a clock reflects its long-term stability. The clocks with deterministic signatures like frequency drift or aging are de-weighted and considered “bad” clocks.

The H-masers have a small weight due to frequency drift affecting the behaviour.

After the implementation of the new prediction algorithm the deterministic signatures are eliminated or minimized in the time scale.

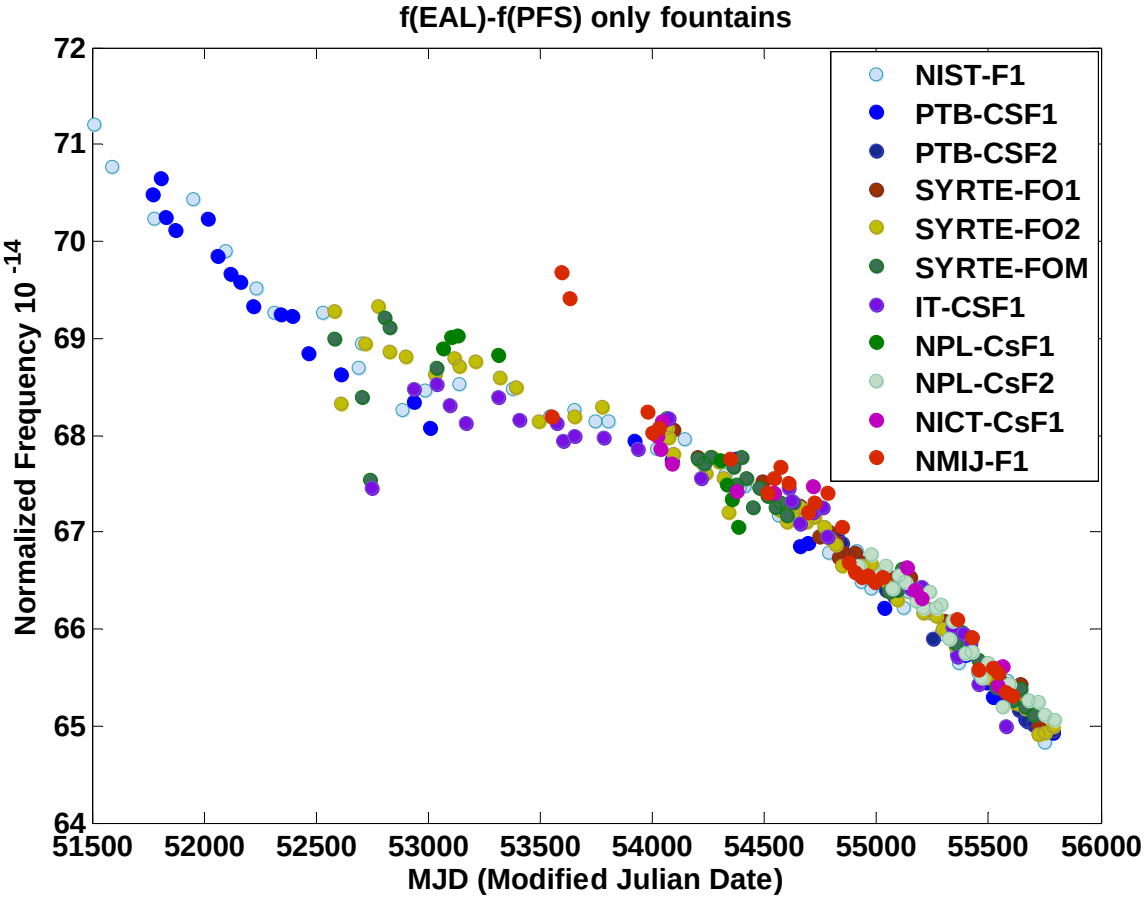
In the new ALGOS the weighting algorithm needs to be revised.

The main idea of the new weighting algorithm is that a good clock is not a stable clock but a predictable clock[1].

[1] Levine J. “Introduction to time and frequency metrology”. Review of Scientific Instruments, Vol. 70, No. 6, pp.2567-2596, 1999.

Primary frequency standards in TAI

Primary frequency standards – 13 in the last five years (KRISS, INRIM, LNE-SYRTE, NICT, NIST, NMIJ, NPL, PTB), 11 are Cs fountains



TT(BIPM)

The BIPM computes in deferred time TT(BIPM), which is based on a weighted average of the evaluations of TAI frequency by the PFS.

TT(BIPM) is computed in deferred time and updated every year.

Predictions of TT(BIPM) are computed monthly.

TT(BIPM11) was published in January 2012

We consider TT(BIPM) the frequency reference to evaluate:

1. f(EAL) performance
2. f(TAI) performance
3. PFS performance

Secondary representations of the second (CCL-CCTF FS WG)

Clock	Value/Hz	Relative uncertainty
^{87}Rb	6 834 682 610.904324	3×10^{-15}
$^{199}Hg^{+}$ (ion)	1 064 751 609 899 145	3×10^{-15}
$^{88}Sr^{+}$ (ion)	444 779 044 095 484	7×10^{-15}
$^{171}Yb^{+}$ (ion)	688 358 979 309 308	9×10^{-15}
^{87}Sr (atoms)		
^{88}Sr (atoms)		
$^{40}Ca^{+}$ (ions)	411 042 129 776 393	4×10^{-14}
^{171}Yb (ion)	642 121 496 772 657	6×10^{-14}
^{171}Yb (neutral atom)	518 295 836 590 864	1.6×10^{-13}

Reported by LNE-SYRTE Jan 2012, accepted by the CCTF WG on PFS and published in *BIPM Circular T*

Rapid UTC

- UTCr started as a pilot experiment in January 2012.
- Operational since week 1208, regular publication on Wednesdays before 18 h UTC,
  - But steering to UTC not optimal in the first weeks and should be improved.
- Report to the CCTF in September 2012 and decision on the routine production of UTCr.
- UTC kept unchanged so far. Can only benefit from UTCr due to better anticipation and easier detection of problems.

Characteristics and publication of UTCr

- UTCr started as a pilot experiment in January 2012.
- Operational since week 1208, regular publication on Wednesdays before 18 h UTC, ftp://tai.bipm.org/UTCr/Results/
- Report to the CCTF in September 2012 and decision on the routine production of UTCr.
- UTC kept unchanged so far. Can only benefit from UTCr due to better anticipation and easier detection of problems.

UTCr_1235
2012 SEPTEMBER 05, 14h UTC

The results in this page are established by the BIPM Time Department in the frame of the pilot experiment on a rapid UTC, UTCr. The computed values [UTCr-UTC(k)] are reported.

Date 2012 0h UTC	AUG 27	AUG 28	AUG 29	AUG 30	AUG 31	SEP 1	SEP 2
MJD	56166	56167	56168	56169	56170	56171	56172
Laboratory k	[UTCr-UTC(k)]/ns						
AOS (Borowiec)	-6.2	-4.5	-5.8	-5.1	-4.9	-5.7	-4.3
BEV (Wien)	45.0	45.6	43.6	44.8	43.8	41.8	45.8
CH (Bern)	15.1	13.7	13.9	14.3	14.4	14.8	14.9
CNM (Queretaro)	-18.7	-13.2	-15.1	-16.9	-16.3	-17.7	-15.7
CNMP (Panama)	-25.5	-21.8	-26.6	-19.3	-20.8	-17.7	-19.2
DTAG (Frankfurt/M)	188.5	190.6	-	193.4	194.4	192.5	196.1
IFAG (Wettzell)	-627.0	-625.6	-624.7	-623.7	-622.9	-622.3	-621.9
IGNA (Buenos Aires)	8904.3	8916.5	8925.5	8935.7	8952.8	8964.5	8978.0
INTI (Buenos Aires)	-60.6	-63.8	-55.9	-49.7	-44.9	-39.1	-33.9
IPQ (Caparica)	-7.8	-6.1	-6.1	-7.3	-6.0	-11.6	-17.8
IT (Torino)	4.8	4.4	4.8	4.8	5.0	6.1	6.7
KRIS (Daejeon)	-1.8	-2.5	-2.4	-2.9	-2.2	-2.4	-2.3
LT (Vilnius)	116.3	117.5	117.3	113.2	120.9	129.3	126.9
NAO (Mizusawa)	153.7	157.3	157.6	158.7	156.0	156.3	159.8
NICT (Tokyo)	4.9	4.9	4.4	4.6	4.6	4.5	5.4
NIM (Beijing)	1.6	1.1	1.1	0.9	0.4	0.0	-0.1
NIMT (Pathumthani)	-12.0	-13.7	-13.9	-19.0	-17.1	-21.7	-21.7
NIS (Cairo)	-982.9	-983.4	-983.6	-986.0	-985.1	-987.2	-989.0
NIST (Boulder)	-2.2	-1.0	-2.5	-2.0	-2.4	-3.2	-2.7
NMIJ (Tsukuba)	-3.8	-3.6	-3.2	-2.8	-2.4	-2.3	-1.5
NMLS (Sepang)	-868.8	-862.1	-856.5	-849.4	-845.7	-844.4	-837.7
NPLI (New-Delhi)	182.5	183.0	183.1	184.8	185.3	185.3	185.2
NRC (Ottawa)	12.0	9.1	13.0	11.7	10.3	8.6	3.9
NRL (Washington DC)	-8.8	-8.3	-6.8	-6.0	-5.9	-5.1	-4.4
NTSC (Lintong)	1.0	0.5	0.3	-0.7	1.0	0.5	2.4
ONRJ (Rio de Janeiro)	-1.5	-0.6	-0.7	1.0	3.0	4.8	5.4
OP (Paris)	12.8	12.7	14.3	14.2	13.1	12.6	12.0
ORB (Bruxelles)	11.4	10.8	11.3	11.5	11.1	11.3	11.5
PL (Warszawa)	63.6	65.3	63.7	64.9	64.5	62.9	64.3
PTB (Braunschweig)	-1.8	-2.4	-2.7	-2.9	-3.2	-3.1	-2.6
ROA (San Fernando)	-7.8	-7.4	-6.9	-6.7	-6.7	-6.2	-5.1
SCL (Hong Kong)	-52.0	-52.9	-53.6	-53.5	-53.5	-57.8	-51.3
SG (Singapore)	-9.2	-9.6	-8.6	-4.6	-4.2	-1.7	0.3
SP (Boras)	-12.5	-13.1	-13.3	-13.4	-13.5	-13.6	-13.5
SU (Moskva)	-2.6	-0.4	-1.7	-1.2	-0.7	-2.0	-1.3
TL (Chung-Li)	5.8	5.2	4.6	4.4	3.9	3.8	4.0
UME (Gebze-Kocaeli)	272.9	277.4	277.2	276.0	277.1	277.5	277.7
USNO (Washington DC)	2.5	2.6	3.1	2.9	2.4	2.6	1.9
VSL (Delft)	-7.4	-5.8	-3.7	-2.5	-1.6	-0.5	-1.0

Meetings

- ✓ Royal Society Discussion « UTC for the 21st century », 3-4 November 2011
  - ✓ 12 invited lecturers, about 40 invited participants
  - ✓ time metrologists, astronomers, national administrations, ITU, IAU, BIPM, GNSS
- ✓ Radiocommunications Assembly, ITU, Geneva, January 2012
  - ✓ Modification of Recommendation ITU-R TF.460-6 on the definition of UTC, postponed for WRC 2015
- ✓ IAU General Assembly, Beijing, JD 7 “Space-time reference systems for future research” and Commission 31 (Time)
  - ✓ WG on pulsar timescale
  - ✓ WG on UTC (leap second for the ITU)

Publications

- ✓ *BIPM Annual Report on Time Activities for 2011*
  - ✓ Electronic version
  - ✓ http://www.bipm.org/en/scientific/tai/time_ar2011.html
- ✓ *BIPM Circular T* (monthly)
- ✓ UTCr (weekly)
- ✓ Journals, proceedings

Thanks for your attention!