Comparisons between Time Transfer Techniques and Methods

-- The BIPM ftp site for monthly time link comparisons

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Time, Frequency and Gravimetry Section

Summary

- Time transfer data available at BIPM
- Comparisons of the Time transfer techniques
- Comparison results on the BIPM ftp site

Time link data available at BIPM

- 3 techniques : GPS,GLN and TW
- 29 labs over 68 have ≥ 2 techniques
- All labs have GPS with 25 GPS PPP
- 20 labs have GLN
- 20 labs have TW
- Time/frequency transfer Strategy is primary link : use either TW or GPS and when both available use TW

➔ Single-technique-single-link

Lab	GPS	GLN	TW
AOS	YES	YES	YES
AUS	YES		YES
CH	YES		YES
IT	YES	YES	YES
KIM	YES	YES	
KRIS	YES	YES	YES
KZ	YES	YES	
LDS	YES	YES	
MIKE	YES	YES	
NICT	YES		YES
NIM	YES		YES
NIS	YES	YES	
NIST	YES	YES	YES
NMIJ	YES		YES
NPL	YES		YES
NRL	YES	YES	YES
NPLI	YES	YES	
NTSC	YES		YES
OP	YES	YES	YES
PTB	YES	YES	YES
ROA	YES	YES	YES
SG	YES	YES	YES
SP	YES		YES
SU	YES	YES	
TL	YES		YES
UME	YES	YES	
USNO	YES	YES	YES
VSL	YES	YES	YES
ZA	YES	YES	.

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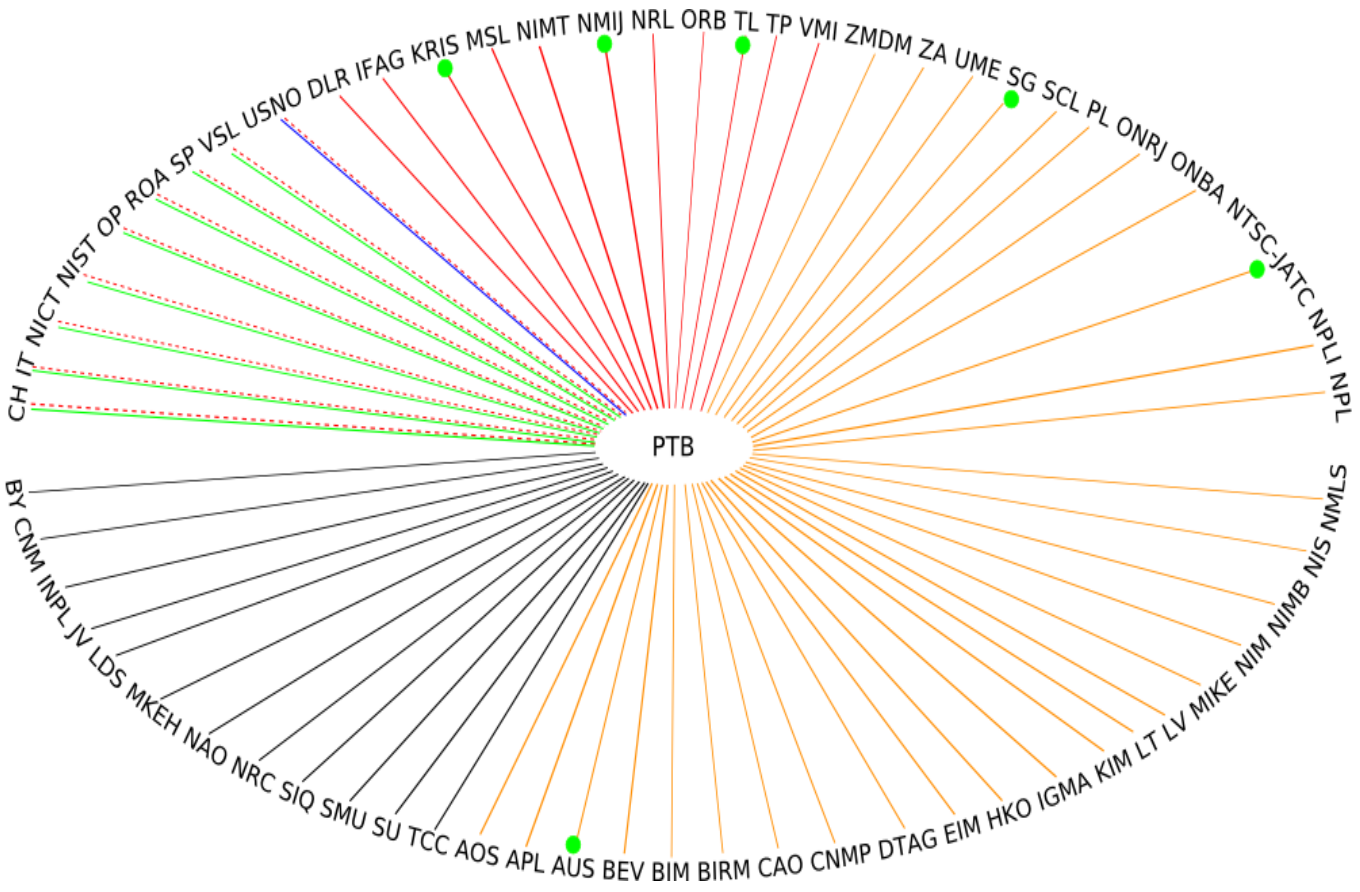
UTC/TAI Time Transfer Network



68 UTC/TAI Labs and 67 primary links

Comparison of TW and GPS (GNSS)

Terms	TW	GPS
Calibration	~1ns	~ 5ns
Long-term stability	Yes	?
Transfer limit	baseline	global
Distance	dependent	~independent
Atmosphere effects	~free	corrections
Diurnals	yes	free
Data processing	simple/independ.	complex/depend.
Cost	expensive	less

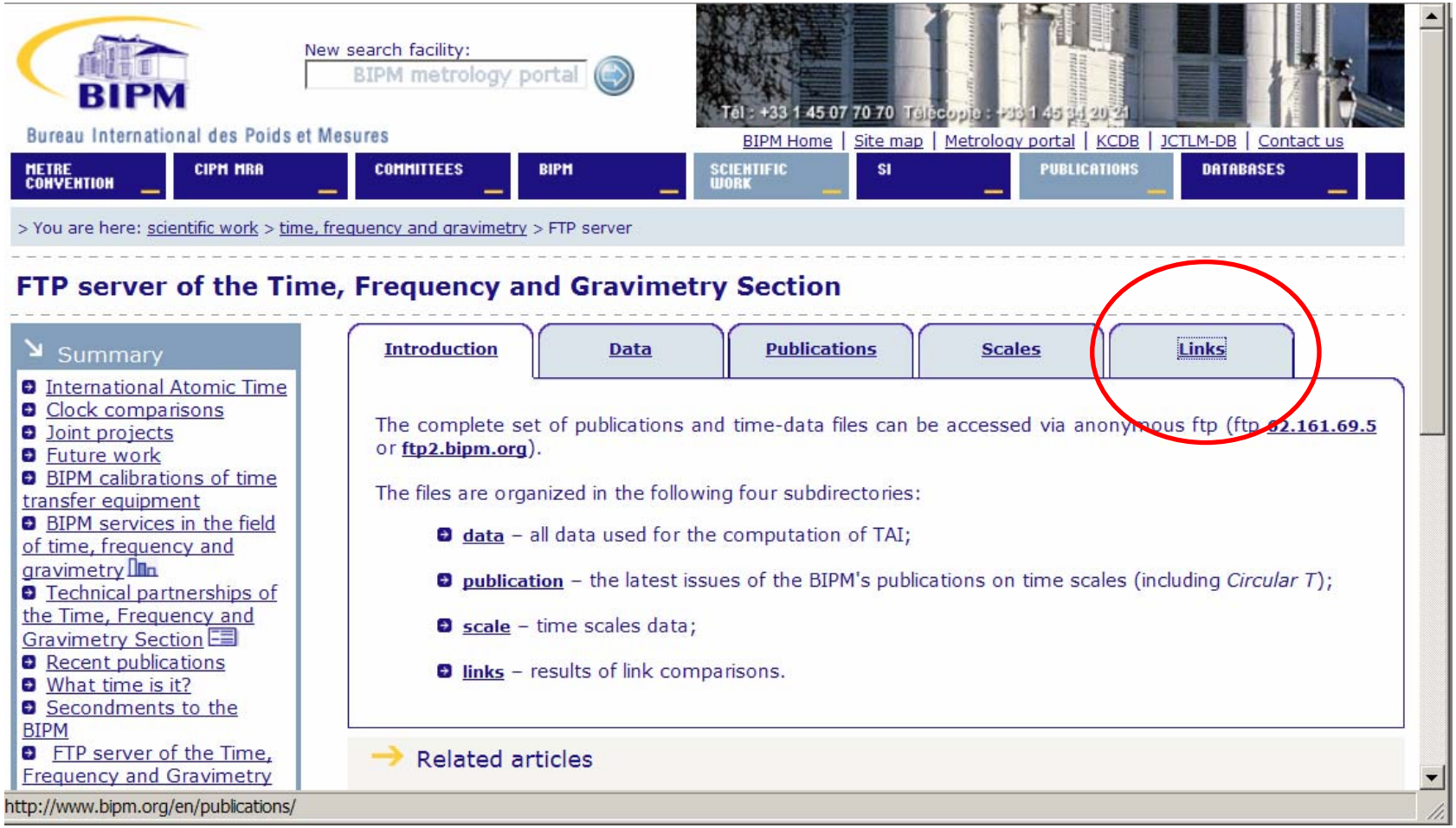
Making the time link Comparisons

- Goals: [1] Verify the quality; [2] Differential calibration; [3] Study new techniques;
- Between GPS: C/A-PPP and P3-PPP
- Between TW: KU vs. X bands; Satre vs. Nict modems
- Between GPS and TW: TW-GPS C/A; TW-GPS P3 and TW-GPS PPP
- Results monthly published through BIPM ftp site

Result of the time link **Comparisons** on **ftp**

1. address: ftp://tai.bipm.org/TimeLink/LkC/
2. Time link
3. Time link comparison

Result of the time link Comparisons



Get in the directory: LkC

Index of ftp://tai.bipm.org/TimeLink/LkC/

Up to higher level directory

Name	Size	Last Modified
0501		12/07/2005 00:00:00
0502		20/07/2005 00:00:00
… …		
0901		12/02/2009 16:31:00
0902		13/03/2009 14:57:00
0903		10/04/2009 12:41:00
0904		15/05/2009 14:49:00
… …		
LongTerm		10/04/2009 12:44:00
BIPM_LKC_CFS-PTTI2005.doc	285 KB	07/10/2005 00:00:00
ReadMe_LinkComparison_ftp_v7.doc	181 KB	29/05/2008 00:00:00

YYMM

Get in the directory: YYMM

Index of ftp://tai.bipm.org/TimeLink/LkC/0904/

Up to higher level directory

Name

- AOSPTB
- CHPTB
- DLRPTB
- … …
- KRIS NICT
- KRIS PTB
- NICTPTB
- … …
- NTSCNICT
- USNO PTB

Baseline

Index of ftp://tai.bipm.org/TimeLink/LkC/0904/USNOPTB/

Up to higher level directory

Name	Size	Last Modified	
Dlk		15/05/2009 14:49:00	difference of links
Lnk		15/05/2009 14:49:00	Links

Get in the directory of the baseline: USNO-PTB

File types:
Plot in Gif
data in Ascii

Link techniques:
GPS C/A
GPS P3
GPS PPP
TW KU band
TW X band
… …

Index of
ftp://tai.bipm.org/TimeLink/LkC/0904/USNOPTB/

Up to higher level directory

Name	Size	Last Modified
Dlk		15/05/2009 14:49:00
Lnk		15/05/2009 14:49:00

Link comparison

Link

USNOPTB.TGT35
USNOPTB.TGT35.Gif
USNOPTB.TMTA5
USNOPTB.TMTA5.Gif
USNOPTB.TPTA5
USNOPTB.TPTA5.Gif
USNOPTB.TTTX5
USNOPTB.TTTX5.Gif

USNOPTB.333A_.**Gif**
USNOPTB.333A_.**dat**
USNOPTB.MMMA_.Gif
USNOPTB.MMMA_.dat
USNOPTB.PPPA_.Gif
USNOPTB.PPPA_.dat
USNOPTB.TTTT_.Gif
USNOPTB.XXXT_.Gif

Before Oct. 2006 (0610), there are comparisons between All in View and Common View

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Examples: ASCII Link and link comparison data

USNO-PTB 0904 GPS PPP link:

```
GPS.GPI/Tai0904__US3-PT3/07-05       0.429_Vdk1.D7  6878/1_AV/at10:42_05/15/09
                   CLB__L2U__   0.134ns StdMjd Tau0=     427s LogAllVar TimeVar LogTime
54917.00000      -27.411      -27.223    0.188
54917.00347      -27.402      -27.192    0.210
54917.00694      -27.293      -27.163    0.130
54917.01042      -27.352      -27.134    0.218
54917.01389      -27.337      -27.107    0.230
… …
```

USNO-PTB 0904 link comparion between GPS PPP and TW Ku:

! 0904	Mjd	Link1	Link2	dLink	Jump1	Jump2	dLink_
1	54919.0326	-27.021	-26.276	-0.745	0.000	0.000	-0.745
2	54919.1160	-27.150	-26.370	-0.780	0.000	0.000	-0.780
3	54919.1993	-27.218	-26.314	-0.904	0.000	0.000	-0.904
4	54919.2826	-27.367	-26.736	-0.631	0.000	0.000	-0.631
5	54919.3660	-27.066	-26.508	-0.558	0.000	0.000	-0.558

… …

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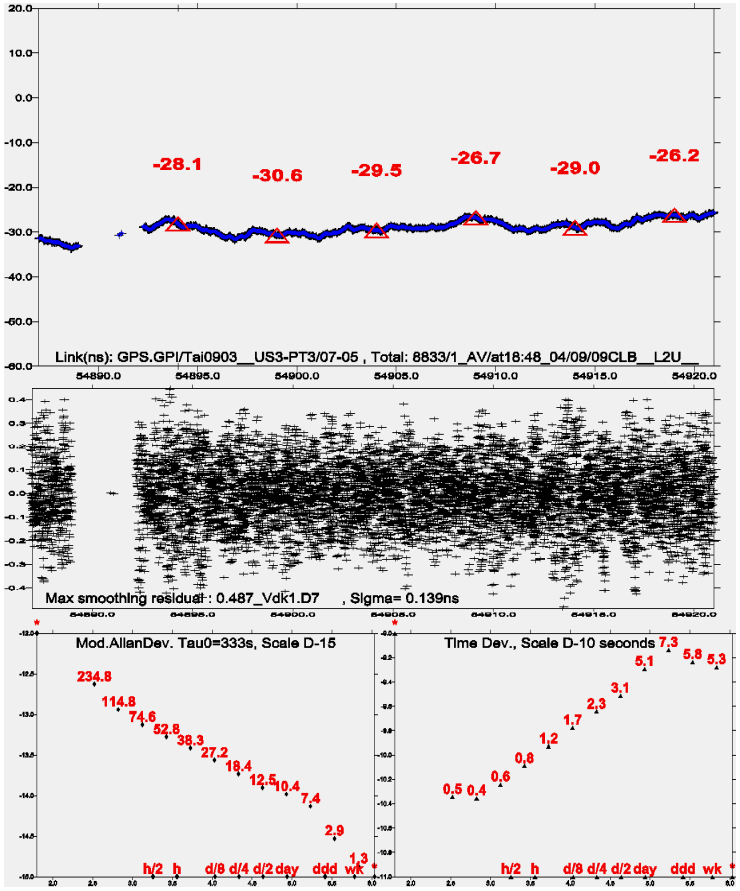
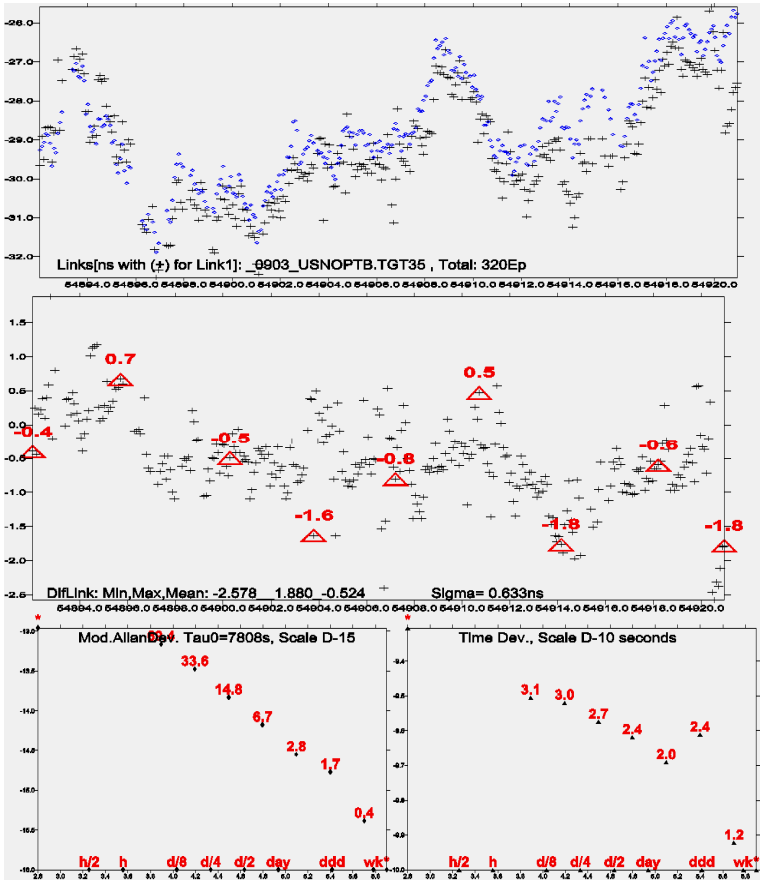
Examples: Plots of Link and link comparison

USNO-PTB 0903 GPS PPP **Link**:



USNO-PTB 0903 **Link comparions** between GPS PPP and TW Ku:



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Welcome to the BIPM LkC site:

ftp://tai.bipm.org/TimeLink/LkC

Thanks

Advantages of TW and GPS

- **TW**
  - Calibration and reproducibility ≈ 1ns
  - Long term stability
  - Atmosphere delay free symmetric trajectories
  - uA: 0.2~0.5 ns when diurnals off

- **GPS**
  - World-wide transfer without geometric limit
  - Hardware-manpower less cost
  - uA: ≈ 0.3 ns when PPP

disAdvantages of TW and GPS

- **TW**
  - Diurnals (dominant error source)
  - Baseline fixed (geometric limit)
  - Hardware-manpower cost
- **GPS**
  - Less accurate calibration vs. TW
  - Receiver-Navigation-system instability ?
  - Complex data treatment-Software