

IGS partnership with the BIPM

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Time section



6th Meeting of representatives of time
laboratories contributing to TAI
BIPM, 31 March 2004

IGS/BIPM Pilot Project (1998- 2002)

- Goal: developing operational strategies to exploit geodetic GPS methods for improved time and frequency comparisons.
- IGS: dual frequency carrier-phase based geodetic techniques.
- BIPM: time and frequency transfer by single-frequency GPS C/A common views and TWSTFT.
- IGS+BIPM: global time and frequency comparisons at the sub-ns level by using GPS carrier phase and geodetic techniques.



Actions

- Hardware requirements (1-pps input in timing receivers)
- Software requirements (BIPM time transfer format CGGTTS) --> P. Defraigne
- Calibration of receivers (Ashtech Z12-T, ...) --> G. Petit
- Integration of time laboratories into the IGS network --> next slide



IGS stations located at BIPM time laboratories

<i>IGS Site</i>	<i>Time Lab</i>	<i>GPS Receiver</i>	<i>Freq. Std.</i>	<i>City</i>
AMC2	AMC *	AOA SNR-12 ACT	H-maser	Colorado Springs, CO, USA
BOR1	AOS	AOA TurboRogue	cesium	Borowiec, Poland
BRUS	ORB	Ashtech Z-XII3T	H-maser	Brussels, Belgium
KGN0	CRL *	Ashtech Z-XII3	cesium	Koganei, Japan
MDVO	IMVP	Trimble 4000SSE	H-maser	Mendeleevo, Russia
MIZU	NAO	AOA Benchmark	cesium	Mizusawa, Japan
NPLD	NPL *	Ashtech Z-XII3T	H-maser	Teddington, UK
NRC1	NRC *	AOA SNR-12 ACT	H-maser	Ottawa, Canada
NRC2	NRC *	AOA SNR-8100 ACT	H-maser	Ottawa, Canada
OBE2	DLR	AOA SNR-8000 ACT	rubidium	Oberpfaffenhofen, Germany
OPMT	OP	Ashtech Z-XII3T	H-maser	Paris, France
PENC	SGO	Trimble 4000SSE	rubidium	Penc, Hungary
PTBB	PTB *	AOA TurboRogue	H-maser	Braunschweig, Germany
SFER	ROA *	Trimble 4000SSI	cesium	San Fernando, Spain
SPT0	SP	JPS Legacy	cesium	Boras, Sweden
TLSE	CNES	AOA TurboRogue	cesium	Toulouse, France
TWTF	TL *	Ashtech Z-XII3T	cesium	Taoyuan, Taiwan
USNO	USNO *	AOA SNR-12 ACT	H-maser	Washington, DC, USA
WTZA	IFAG	Ashtech Z-XII3T	H-maser	Wetzell, Germany
WTZR	IFAG	AOA SNR-8000 ACT	H-maser	Wetzell, Germany

- participates in two-way satellite time transfer (TWSTT) operations

IEN incorporated recently



Use of GPS dual-frequency P code observations in TAI

- TAI P3 pilot experiment (April 2002)
- Calibrated Ashtech Z12T receivers
- Data since mid-2002
- 7 TAI P3 links compared to other techniques in TAI
 - TWSTFT, GPS C/A SC
- Long term time stability of order 1.0 ns (1σ)
- Start introducing TAI P3 links in TAI (July 2003)
 - DLR/PTB
 - IFAG/PTB
 - ORB/PTB



GPS P3 links

- Long term instability of GPS P3 links is of order 1.0 ns (1σ)
- Equivalent to the performance of TW links, at least twice better than GPS C/A links

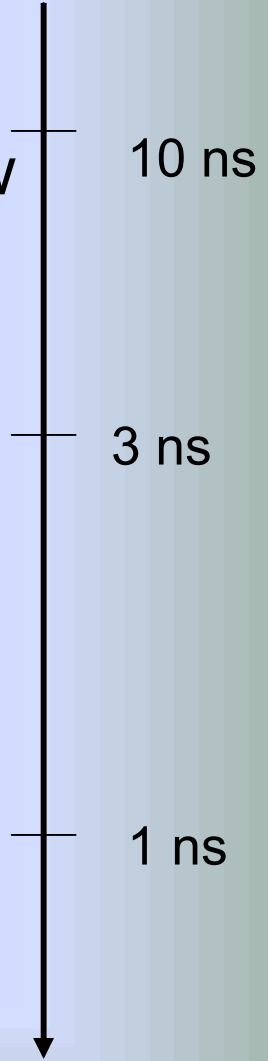


Laboratory	GPS P3 equipment	TW equipment	GPS C/A equipment
IEN	Ashtech Z12T	MITREX 2500A	3S Nav. GNSS-300T (MC)
BNM/SYRTE (OP)	Ashtech Z12T		NBS TTR5 (SC)
PTB	Ashtech Z12T	TimeTech/SATRE	AOA TTR5 (SC)
USNO	Ashtech Z12T	MITREX 2500	AOS SRC TTS-2 (MC)
NRC	Ashtech Z12T		(SC)
CRL	Ashtech Z12T	AOA/Atlantis	3S Nav. R-100 (MC) AOA TTR6 (SC)
NMIJ	Ashtech Z12T	AOA/Atlantis	AOA TTR6 (SC)
TL	Ashtech Z12T	AOA/Atlantis	AOA (SC)

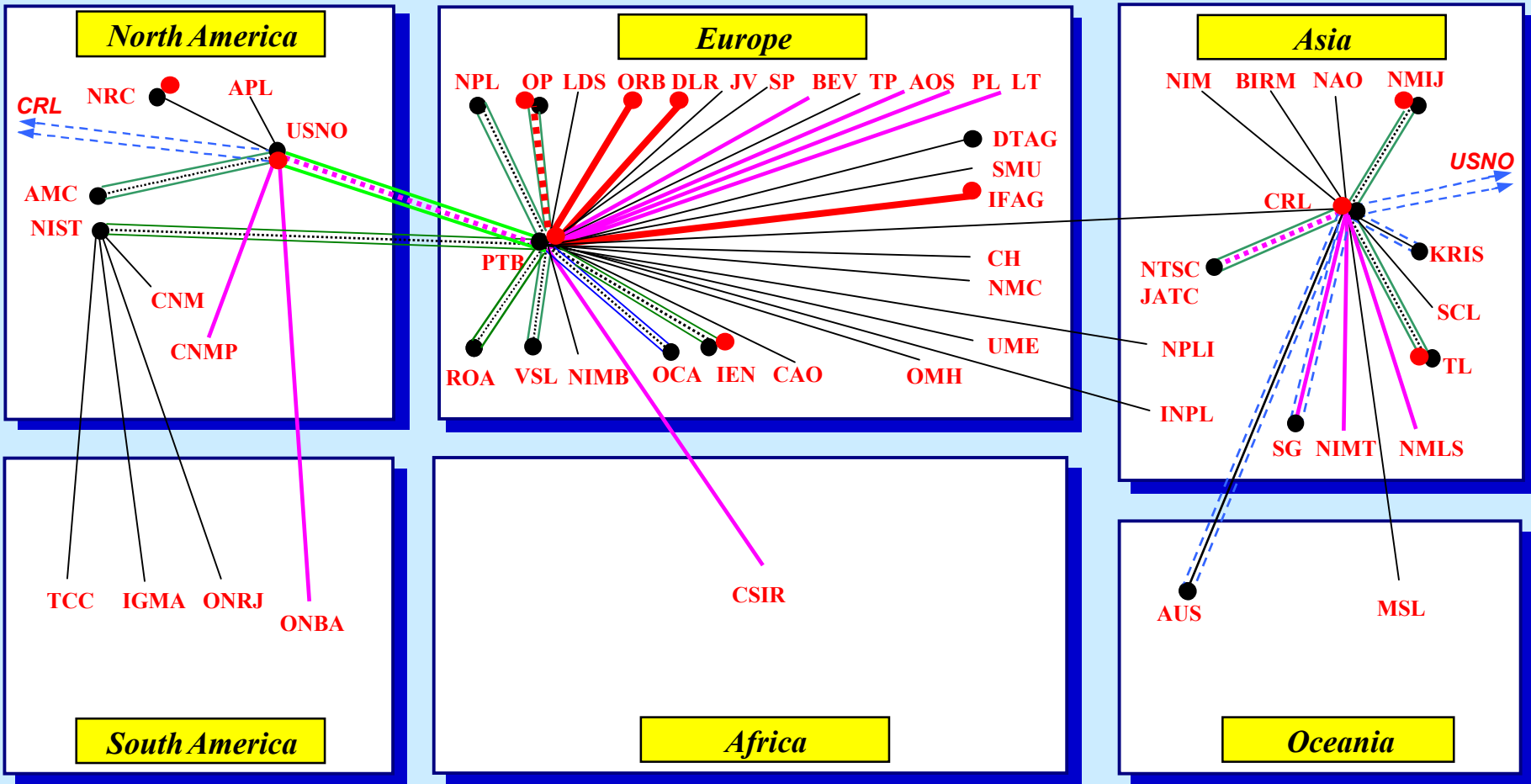
Link	Distance	Techniques
IEN-PTB	800 km	P3, TW, C/A SC
OP-PTB	700 km	P3, C/A SC
CRL-PTB	8300 km	P3, C/A SC
USNO-PTB	6300 km	P3, TW
NRC-USNO	700 km	P3, C/A SC
NMIJ-CRL	70 km	P3, TW, C/A SC
TL-CRL	2100 km	P3, TW, C/A SC



Clock comparison in TAI

- GPS C/A-code single-channel common-view
 - (3-10 ns uncertainty)
 - GPS C/A-code multi-channel common view
 - (ns uncertainty)
 - TWSTFT
 - GPSP3
- 





ORGANIZATION OF THE INTERNATIONAL TIME LINKS

February 2004

- TWSTFT
- TWSTFT back-up link
- TWSTFT link in preparation
- OCA/PTB link not used for computation of TAI
- Laboratory equipped with TWSTFT
- TWSTFT by Ku band with X band back-up
- Laboratory equipped with Dual Frequency reception

- GPS CV single-channel
- GPS CV single-channel back-up
- GPS CV multi-channel
- GPS CV multi-channel back-up
- GPS CV dual frequency link
- GPS CV dual frequency back-up link



IGS products in TAI

- Single-frequency GPS C/A links in TAI are corrected by using:
 - Precise IGS (rapid) orbits (all GPS links)
 - Ionospheric maps from CODE
- Schedule for (monthly) Circular T
 - standard dates are MJD ending by 4 / 9
 - deadline for data submission of month M is 5th (M+1)
 - process of calculation starts (hopefully) on 6th (M+1)
- Latency is essential for the choice of IGS products
 - IGS ionospheric maps on a short delay available



Access to other time scales

- To GPS time provided by Circular T
- [UTC - GPS time]
- [TAI - GPS time]
 - Every day at 0h UTC
- Same for GLONASS time
- In the future the access to Galileo time
- Access to IGS time





BIPM represented at:

- IGS Governing Board
- IGS WG on Clock Products

IGS represented at the CCTF



Comparison UTC, IGS Time Scale

