BIPM 2013 Time Link Calibration Experiments

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The situation 1/2

Uncertainty
Type A / Type B / ns

\[ u_A \]

\[ u_B / \text{CA/GNSS 26\%} \]

\[ u_B / \text{CA/GNSS 16\%} \]

\[ u_B / \text{C/P/GNSS/TW 44\%} \]

\[ u_B / \text{TW 7\%} \]

Unbalance: \[ u_A \text{ vs. } u_B \]

Optic fibre etc.

year

GPS SA ON | Off 2000
MC/CV 2003
TW 2004
P3/AV 2005
TW/PPP 2009
TW+PPP 2012
O.F. ... 201X
The situation 1/2

60 % $u_A \leq 1 \text{ ns}$ vs. 93 % $u_B \geq 5 \text{ ns}$

The uncertainty in UTC is dominated by the $u_B$.

$\Rightarrow$ The major challenge: $u_B \leq 2 \text{ ns}$
Pilot Study launched in 2011

- To Strengthen Asia-Europe UTC link calibration: BIPM, PTB, OP, TL and NICT
- Goal: Unify GNSS+TW calibration with an Uncertainty $\leq 2\text{ns}$

- EFTF2011: BIPM Calibration Scheme for UTC Time Links
- Experiments already done at BIPM, OP and PTB
- Ongoing AOS, PL and tests on the 420 km Optical Fiber baseline
- Go to TL in Sept. during CCTF WG on TW
- NICT to be organised

- Similar works at ROA, PTB, OP and TL etc.
METODE: MEasurement of Total Delay
The BIPM calibration system

- Two Pre-cabled Black boxes: Fixed+Mobil with unknown delays
- only require: stable during calibration period (~3 months)
BIPM StdB setups

Setup at OP Paris

Setup at PL Warsaw
Attainable uncertainty of the StdB?

• Goal: \( u_B \leq 2\text{ns} \)

• To be verified with *independent* methods:
  
  – Classical differential receiver calibration (\( \pm 2\text{ns} \) for selected links)
  
  – TW time link calibration (\( \pm 1.x \text{ ns} \))
  
  – Measure a cable delay or short baseline and compare to a SR620 TIC (\( \pm 0.3\text{ns} \) on average)
  
  – Calibration result compared to a portable Cs standard (\( \pm 1\text{~}1.5\text{ns} \))
  
  – Optical fibre baseline 420 km realised by AGH-PL-AOS (\( \pm 0.2\text{ns} \))
Compare the CCD of StdB and TIC for a same delay

The 4 Offsets in the total delays measured by the calibrator StdB and a SR620 TIC

Add the two cables

Remove the two cables

<table>
<thead>
<tr>
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<th>54359</th>
<th>54362</th>
<th>54366</th>
<th>54369</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+15.1 ns</td>
<td>+52.5 ns</td>
<td>-15.1 ns</td>
<td>-52.5 ns</td>
<td>Normal setup</td>
<td>Normal setup</td>
</tr>
</tbody>
</table>

10 m short baselines at BIPM at TL
Portable Cs standard (TL)
Comparison of StdB and the Optical fibre transfers over 420 km baseline between UTC(AOS)-UTC(PL)

The 420 km fibre link: AOS-PL
Combined uncertainty 112 ps

The AGH optical fibre transceivers at AOS

4.09 ms: the time taken by the UTC(PL) goes and back of PL-AOS over 420x2 km
Summary  - from the experiment of BIPM-OP, Poster Wed. 15h

- The instability of the calibration system is fundamental
- The BIPM calibrator is capable to enable the task uB<2 ns
- The total uncertainty (experiments of OP): 1.1~1.8 ns
- More precisely designed validation tests are ongoing over the optical fibre baselines

- Coming soon BIPM Time Link calibration guideline

Thank you for your attention