Low Cost GPS Calibrator for G2-calibrations ?

-- towards a small size calibrator through Fedex service (V1f)

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* TL, NICT and NIM are the three G1 labs in APMP

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The ‘low cost’ ?

- Price of the calibrator (receiver, TIC, PC …)
- Operation fees: shipment, assurance, costumes …

→ Not to replace but to complement the ‘standard’ calibrator

Motivation 1/3

- ~26% of uB 20 ns, a calibration whatever is more urgent
- ~20% of uB 7~10 ns, similar as above
- ~33% C1 code time transfer
- They are all the UTC G2 labs

Shipment charges from BIPM to Lab(k) and back

Lab(k)	Cost / Euros
PTB / Europe	1231
NIM / China	1090
NMIJ / Japan	2548
NIST / USA	2401
VINIIFTRI / Russia	5196

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Motivation 2/3

Mandate of G1 (status Dec. 2013)

RMO	NMIs/DIs	N° of Labs	Associates	N° of GNSS receivers	
				NMIs/DIs	others
EURAMET	24		7	56	16
SIM	6		7	11	9
APMP	20	40	7	?	?
AFRIMETS	3		0	6	-
COOMET	4		0	3	1
GOLFMET	1		1	3	-
Total	51		21	103	35

- The new guidelines requires a calibration every 2 years

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Motivation 3/3

- **APMP has 3 G1 lab vs. 47 potential G2 → a G1-calibrator has 16 G2 :**
  - expensive: hardware, assurance, transport, costumes …
  - qualified G2-operators, conditions: damages of the G1 calibrator ?
  - uB~1.5-2 ns is in most case not necessary for the G2 labs

  → A G1 is less motivated to perform all the G2 calibrations
- **→ Low cost of code calibrator ?**
  - $2000~$3000
  - uB = 3~7 ns with small size of several kg
  - Black-box, easier operation-transport and costumes-free
  - A G1 lab may have several calibrator for parallel-repeated calib.

➔ To complement the standard calibrator

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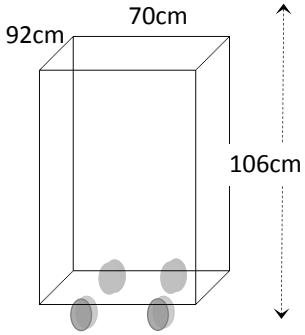
Different calibrators for different usages

C1 GPS Receiver
(NovAtel OEM)

Win10/Linux
compatible PC



BIPM METODE Calibrator

- 95 kg
- 50,000 Euros
- **0.8 ~ 1.5 ns for G1**

Low cost Calibrator

- Laptop Size
- 2,000~3,000$ (PC<100$, TIC<1000$, RCV<1000$ …)
- Target uB=3~7 ns (CirT uA(KZ)=1.5 ns)
- Commercialized (NMIJ,NIST,AOS…) ?
- Home made (TL, NIM, NICT …) ?

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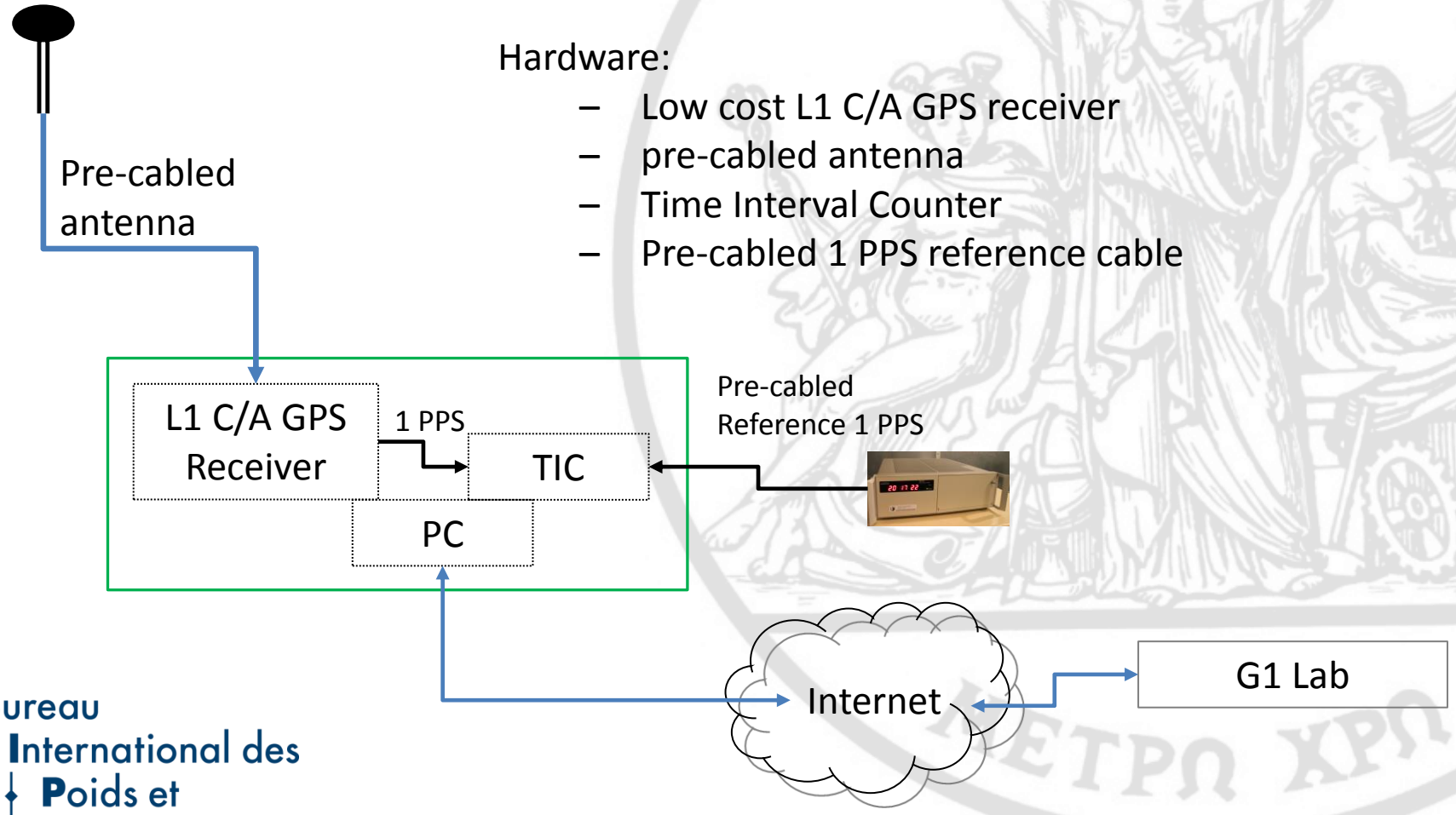
General:

1. Controlled by Remote (G1) Lab
2. Compensate Latch-REF 1 PPS (get from TIC) into CGGTTS to get REFGPS
3. Calibrate/align Total delay with G1-PTB UTC time link using C1 All in View using the BIPM giving antenna position, the same height ! (TM229)

Hardware:

- Low cost L1 C/A GPS receiver
- pre-cabled antenna
- Time Interval Counter
- Pre-cabled 1 PPS reference cable



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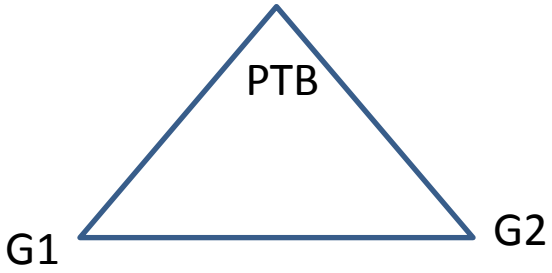
C1-Link Calibration, uB 3~7ns (METODE)



If the G1 calibrator is calibrated by GPS vs. the UTC network pivot PTB, we have the time link calibration correction :

$$\mathbf{DCD} = Link(G2 - PTB) - Link(G1_{Tr} - PTB)$$
$$= \mathbf{LinkCAL}_{G2\text{-}PTB} = \mathbf{RcvCAL}_{G2\ (PTB=0)}$$

➔ A '**one for all**' calibration:
Using C1 link to calibrate all the time links of C1, P3, PPP, GPS/GLN and TW

Conclusion

- Low cost calibrator
  - to complement but replace the ‘standard’ calibrator
  - affordable for all the G1 labs
  - smaller in size & lighter in weight … an express package?
  - assurance, transport, costumes, maintains …
  - Black-Box, easy setup: Open, Connect power and the pre-cabled antenna, 1 PPS reference …
  - Remote control by G1 lab
- N-calibrator parallel calibration is possible ➔ shorten the whole calibration duration
- if **One** calibrator uB 3~7 ns ➔ **Two** calibrator uB 2~5 ns

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Challenges

- Uncertainty (3~5 ns) ?
- Cost ?
- Costumes-free ?

Keep in mind:

- Who are the users?

- Different calibrators for different usages.

Thank you

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