CCTF/01-38

15 th CCTF meeting, 20 & 21 June 2001

Report and Proposals of the CCTF WG on MRA

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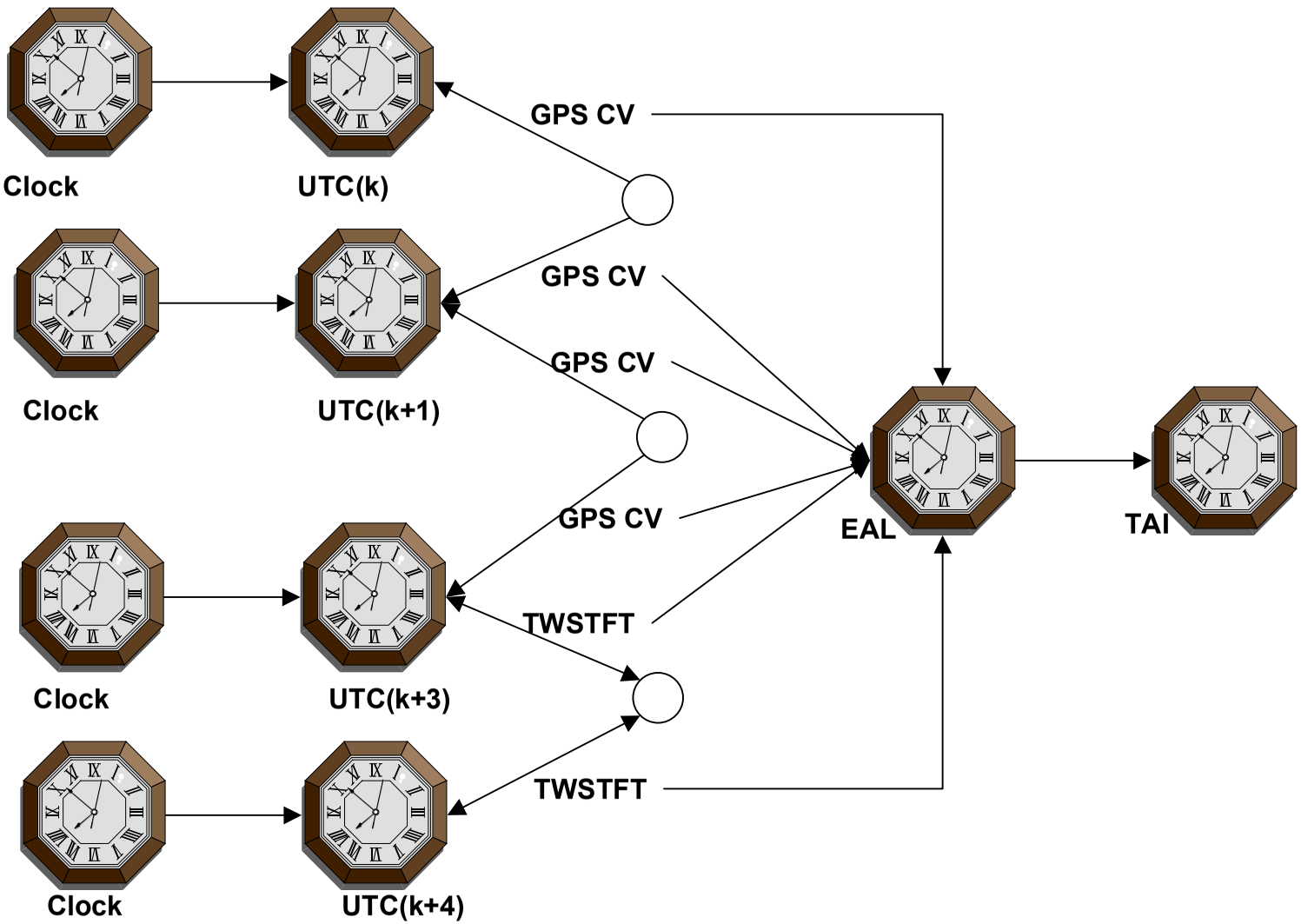

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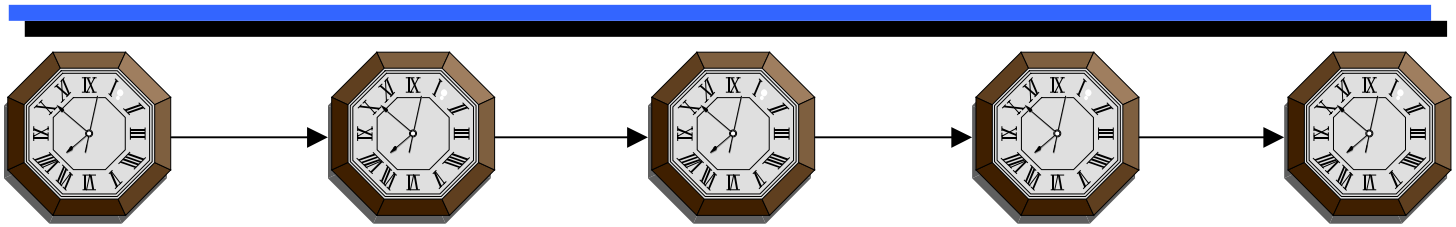

						Units
Time Scale	Clock		UTC(k)	EAL	TAI	UTC	hh:mm:ss
(epoch)	|		|	|	|	|	
Time Scale difference for standard dates	|---- UTC(k)-Clock-------| by lab k		|------UTC(k)-EAL-----| calculated by BIPM from clock data and UTC(k)-UTC(k+1) by Common View GPS or TWSTFT	|---------EAL-TAI----------| fixed, steering by BIPM from (EAL) TAI scale unit comparison to the SI second from Primary Time Standards (also called PFS)	|-----------TAI-UTC-----| fixed, 1 s steps by IERS from TAI-UT1	ns
	|--------------Rate TAI-Clock-_---|					
		|-----------------------------UTC- UTC(k)-----------------------------------|				

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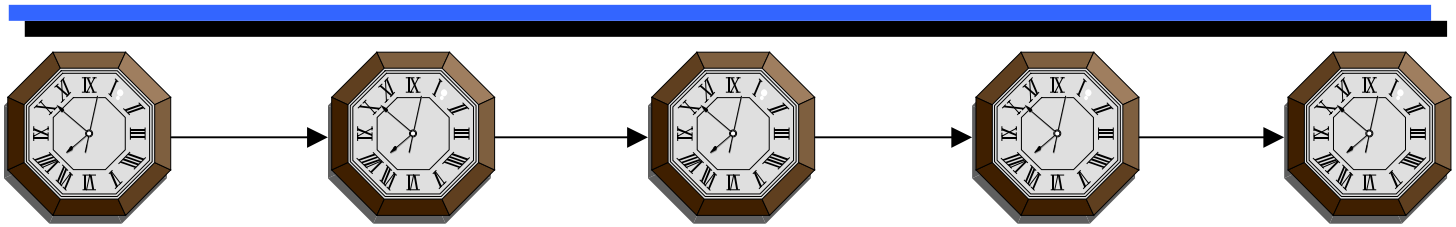

						Units
Frequency	Clock freq.	UTC(k) freq.	EAL freq.	TAI freq.	UTC freq.	Hz
(Nom. 1 Hz)	|	|	|	|	|	
Rate	Clock rate	UTC(k) rate	EAL rate	TAI rate	UTC rate	s/d
(Nom. 86400 s/d)	|	|	|	|	|	
Time Scale	Clock	UTC(k)	EAL	TAI	UTC	hh:mm:ss
(epoch)	|	|	|	|	|	

Time Scale diff. |---- UTC(k)-Clock-------|------UTC(k)-EAL-----|---------EAL-TAI----------|-----------TAI-UTC-----| ns

First time derivative gives rate difference:

Rate difference |---- UTC(k)-Clock-------|------UTC(k)-EAL-----|---------EAL-TAI----------|-----------TAI-UTC-----| ns/d, s/s, 10^{-15}

Inverse gives normalized frequency difference:

Frequency diff. |---- UTC(k)-Clock-------|------UTC(k)-EAL-----|----------EAL-TAI---------|-----------TAI-UTC-----| Hz/Hz, 10^{-15}

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Quantities used in Circular T and Annual Report of BIPM Time Section

1. *UTC-UTC(k)* and *TAI-UTC* , no uncertainties given
2. *TAI- TA(k)*, no uncertainties given
3. Difference between the normalized frequencies of EAL and TAI: *f(EAL)-f(TAI)*, uncertainty: numerical exact value, so uncertainty = 0
4. Fractional deviation *d* of the TAI scale interval from that of TT (the SI second on the geoid), total uncertainty *u* of *d* is given; instability of EAL (type A uncertainty) is given. TAI and UTC have the same property because of the numerical, exact, differences between TAI and EAL and TAI and UTC.
5. *[UTC-GPS time]* and *[TAI-GPS time]*, statistical type A and an estimate of type B uncertainty given
6. *[UTC-GLONASS time]* and *[TAI-GLONASS time]*, statistical type A and an estimate of type B uncertainty given

NOTE

PTB and LPTF show in 4 details of the links of their clocks to their UTC(k) $u_{l/lab}$ and of their link of UTC(k) to TAI (= equal to the link to EAL) $u_{l/TAI}$.
These values should be monitored and provided by all contributors to EAL and TAI!

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The CCTF has to define the quantity for a CIPM Key Comparison for the MRA.

UTC-UTC(k) is now reported back as a result of sending clock data and GPS link data or TWSTFT data to BIPM.

Proposal:

Define the TAI and UTC(k) calculations as a Key Comparison (KC) for CCTF.
(Name: CCTF-K2001.UTC)
As common **KC reference value** for the time scales UTC(k) to be chosen is **UTC**, for which the scale unit is known with respect to the SI second.

From the values UTC-UTC(NMI) the equivalence of the time scale UTC(NMI) is directly determined. From the first time derivative the equivalence of its scale unit (SI second) is determined and after correction with the deviation of the UTC and TAI scale interval the deviation from the SI second is accessed with a known deviation and uncertainty. Then also the equivalence of the frequency of UTC(NMI) is known.

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What is needed to access uncertainties?

1. **Clock link to UTC(NMI): delay value and its stability and uncertainty; can be done easily at NMIs.**
2. **Link of UTC(NMI) to TAI: delays and its stability and uncertainties in: cables, GPS receivers, antenna cables, antennas, antenna coordinates, delay difference in TWSTFT transmit and receive equipment and cables, ionosphere delay correction, transponder delay correction, etc.**
3. **Start with estimates and enhance after measurements.**
4. **Additionally Supplemental Comparisons can be organized specially for the purpose of absolute or relative calibration of GPS, Glonass and TWSTFT equipment (names: CCTF-S2001.GPSCAL etc).**
5. **Additional research should be done to develop improved calibration methods.**

Problems:
- non-NMI labs
- more than 1 NMI for T/F per country
- non-member countries

Actions:
- list of CMC items
- coordination between RMOs
- continuation of the WGMRA
- practical organization of calibration trips