2016 Group 1 GPS calibration trip

Summary

The 2016 visit to Group 1 laboratories started in March 2016.
The trip is decomposed into several phases, each separated with closures at the BIPM.

- Phase 1 (March-September 2016). BIPM-TL-NICT-NIM-BIPM with the traveling receivers BP1C and BP0U; In addition, a visit to NTSC was organized to check results of a previous Group 2 trip by NIM.
- Phase 2 (October-December 2016): BIPM-PTB-ROA-OP-BIPM with the traveling receivers BP1C and BP0U;
- Phase 3 (February-May 2017): BIPM-USNO-NIST-BIPM with the traveling receivers BP1C and BP0U;
- Phase 4 (To be continued)

Following work described in BIPM Technical Memorandum 243, calibration results for code C1 (L1C) have been added to the original Group 1 P1/P2 calibration. Starting with this report for the second Group 1 trip, results are provided for the GPS codes P1, P2 and C1.
This report provides intermediate results which are determined with respect to one BIPM receiver.
Final results for all three codes for all Group 1 receivers are determined in a separate document BIPM Technical Memorandum 266.

Trip 1001-2016: Report of phase 3

1. Description of equipment and operations

1.1 Traveling equipment

- Traveling systems:

Two systems are included in the BIPM traveling calibrator: BP1C and BP0U, see Table 1 and the report of operations 1001-2016-phase3-cv.pdf .

The long term stability of the two systems is described in the BIPM Technical Memorandum 204 .

- Other traveling equipment:

See Annex 1 of the Guidelines.

1.2 Visited equipment

See a summary in Table 1. The detailed information on the set-up and the measurements performed is in the report of operations 1001-2016-phase3-cv.pdf.
For reasons mentioned in section 3, two receivers (BP1J and BP1X) from the BIPM have been included as backup systems to check the closure.

Table 1. Summary information on phase 3 of the calibration trip 1001-2016

Institute	Status of equipment	Dates of measurement	BIPM code	RINEX name	Receiver type
BIPM	Traveling		BP1C	BP1C	Septentrio PolaRx3eTR
BIPM	Traveling		BP0U	BP0U	Dicom GTR50
BIPM	BIPM reference	57778-57782	BP0R	BP0R	Septentrio PolaRx2eTR
BIPM	BIPM backup	57778-57782	BP1J	BP1J	Septentrio PolaRx4
BIPM	BIPM backup	57778-57782	BP1X	BP1X	Dicom GTR51
USNO	G1 backup	57671-57678	USN6	USN6	Ashtech Z12T
USNO	G1 reference	57671-57678	USN7	USN7	Ashtech Z12T
NIST	G1 reference	57863-57867	NIST	NIST	Novatel OEM4-G2
NIST	G1 backup	57863-57867	NISS	NISS	Septentrio PolaRx3e TRPro
NIST	G1 backup	57863-57867	NIS3	NB01	Novatel OEM5
NIST	G1 backup	57863-57867	NIS4	NB02	Novatel OEM5
BIPM	BIPM reference	57896-57906	BP0R	BP0R	Septentrio PolaRx2eTR
BIPM	BIPM backup	57896-57906	BP1J	BP1J	Septentrio PolaRx4
BIPM	BIPM backup	57896-57906	BP1X	BP1X	Dicom GTR51

2. Data used

Rinex files have been obtained from all receivers participating to this trip.

3. Results of raw data processing

- The raw code differences have been generated by the DCLRINEX procedure (see Guidelines Annex 3). Each run for a pair of stations generates 3 files (summary .sum, data .dif, plot .pdf). Summary files and plots are available in 1001-2016-phase3-cv.pdf. All P1/P2 measurements are indicated with 2 digits numeric precision in order to minimize rounding errors in computing P3 values.
- In Phases 1 and 2 of this trip, we noted that the phase measurements of BP0R are sometimes corrupted and could not be fully trusted to compute the baseline that is needed to compute the code differences. To overcome this, we used two other receivers (BP1J and BP1X), which have previously been compared to BP0R, as additional references to check the baselines and the results obtained from BP0R.

- For each pair (traveling – visited) or (traveling – reference):
  - Plots of the data differences and of the statistical analysis (Tdev) are in the report of operations 1001-2016-phase3-cv.pdf;
  - The inferred RAWDIF(P1), RAWDIF(P2) and RAWDIF(C1) are taken as the median of the raw differences. The associated uncertainties are taken as the floor of the Tdev values, with a minimum of 0.1 ns.

- Summary tables.

For this report, the BIPM system BP0R is considered to be the reference. However two other systems (BP1J and BP1X) are used as backups to check the behavior of BP0R and are listed in Table 2.1.

Table 2.1 Raw differential results for all pairs (Traveling – Reference) (ns) for three reference receivers at the BIPM.

Labo	Date	Pair	RAWDIF(P1)	Unc	RAWDIF(P2)	Unc	RAWDIF(C1)	Unc
BIPM	57778-57782	BP1C-BP0R	-59.86	0.1	-55.96	0.1	-61.18	0.1
BIPM	57896-57906	BP1C-BP0R	-59.49	0.1	-56.11	0.1	-60.74	0.1
BIPM	57778-57782	BP0U-BP0R	-95.35	0.1	-90.99	0.1	-98.49	0.1
BIPM	57896-57906	BP0U-BP0R	-95.09	0.1	-91.31	0.1	-98.14	0.1
BIPM	57778-57782	BP1C-BP1J	25.41	0.1	31.46	0.1	25.88	0.1
BIPM	57896-57906	BP1C-BP1J	25.54	0.1	31.33	0.1	26.07	0.1
BIPM	57778-57782	BP0U-BP1J	-10.04	0.1	-3.46	0.1	-11.42	0.1
BIPM	57896-57906	BP0U-BP1J	-10.09	0.1	-3.82	0.1	-11.35	0.1
BIPM	57778-57782	BP1C-BP1X	31.53	0.1	34.74	0.1	37.48	0.1
BIPM	57896-57906	BP1C-BP1X	31.28	0.1	34.58	0.1	37.17	0.1
BIPM	57778-57782	BP0U-BP1X	-4.06	0.1	-0.28	0.1	0.04	0.1
BIPM	57896-57906	BP0U-BP1X	-4.38	0.1	-0.72	0.1	-0.31	0.1

Table 2.2 Raw differential results for all pairs (Traveling – Visited) (ns)

Labo	Date	Pair	RAWDIF(P1)	Unc	RAWDIF(P2)	Unc	RAWDIF(C1)	Unc
USNO	57839-57849	BP1C-USN6	-17.34	0.1	-8.95	0.1	-15.79	0.1
USNO	57839-57849	BP0U-USN6	-74.66	0.1	-66.05	0.1	-74.94	0.1
USNO	57839-57849	BP1C-USN7	-17.95	0.1	-9.48	0.1	-17.33	0.1
USNO	57839-57849	BP0U-USN7	-75.25	0.1	-66.59	0.1	-76.39	0.1
NIST	57863-57867	BP1C-NIST	-605.24	0.1	-600.25	0.2	-603.80	0.1
NIST	57863-57867	BP0U-NIST	-646.79	0.1	-641.44	0.2	-647.00	0.2
NIST	57863-57867	BP1C-NISS	903.64	0.1	908.64	0.1	903.64	0.1
NIST	57863-57867	BP0U-NISS	862.25	0.1	867.67	0.1	860.49	0.1
NIST	57863-57867	BP1C-NIS3	814.76	0.1	831.49	0.1	816.31	0.1
NIST	57863-57867	BP0U-NIS3	773.39	0.1	790.44	0.1	773.19	0.1
NIST	57863-57867	BP1C-NIS4	788.71	0.2	805.75	0.2	790.21	0.2
NIST	57863-57867	BP0U-NIS4	747.35	0.2	764.78	0.2	747.05	0.2

4. Calibration results

In the first step, one computes **ΔSYSDLY,** the differences of SYSDLY for all pairs (Traveling-

Reference) and (Traveling-Visited), from

$$\Delta SYSDLY_{A-B}(Code) = RAWDIF_{A-B}(Code) + REFDLY_A - REFDLY_B \quad (1)$$

where RAWDIF(Code) is read in Table 2 and where the values REFDLY are in the report of operations 1001-2016-phase3-cv.pdf.

The **ΔSYSDLY** values are reported in Table 3 for the pairs Traveling-Reference (section 4.1) and in Table 4 for the pairs Traveling-Visited (section 4.2).

In the second step one computes **ΔSYSDLY** (Visited-Reference) for all visited systems.

$$\Delta SYSDLY_{V-R} = \Delta SYSDLY_{T-R} - \Delta SYSDLY_{T-V.} \quad (2)$$

One can then compute **ΔINTDLY** (Visited-Reference) for all visited systems.

$$\Delta INTDLY_{V-R} = \Delta SYSDLY_{V-R} - CABDLY_V + CABDLY_R \quad (3)$$

where the values CABDLY are taken from the report of operations 1001-2016-phase3-cv.pdf;
Tables 5 reports the $\mathbf{\Delta INTDLY_{V-R}}$ results for the pairs Visited-Reference (section 4.3).
Using assumed $\mathbf{INTDLY_R}$ values for the Reference system, Table 6 then reports $\mathbf{INTDLY_V}$ for all visited systems (section 4.4).

4.1 Traveling system with respect to the reference system

Table 3.1. Computed **ΔSYSDLY** values for the traveling systems with respect to BP0R used as a reference. The misclosures are also indicated. (all values in ns)

Pair	Date	$\mathbf{REFDLY_T}$	$\mathbf{REFDLY_R}$	Note	P1 (ns)		P2 (ns)		C1 (ns)	
					RAWDIF	**ΔSYSDLY**	RAWDIF	**ΔSYSDLY**	RAWDIF	**ΔSYSDLY**
BP1C-BP0R	57778-57782	256.5	268.9		-59.86	-72.26	-55.96	-68.36	-61.18	-73.58
BP1C-BP0R	57896-57906	256.4	269.0		-59.49	-72.09	-56.11	-68.71	-60.74	-73.34
		Misclos.				0.17		0.35		0.24
BP1C-BP0R		Mean				-72.18		-68.54		-73.46
BP0U-BP0R	57778-57782	52.6	268.9		-95.35	-311.65	-90.99	-307.29	-98.49	-314.79
BP0U-BP0R	57896-57906	52.6	269.0		-95.09	-311.49	-91.31	-307.71	-98.14	-314.54
		Misclos.				0.16		0.42		0.25
BP0U-BP0R		Mean				-311.57		-307.50		-314.67

Results for BP0R have been checked using BP1J and BP1X. Misclosures for BP1J and BP1X can be directly interpreted from the data in Table 3.2 and 3.3. However, the mean values of ΔSYSDLY obtained for (Traveling – BP1J) and (Traveling – BP1X) in Table 3.2 and 3.3 cannot be directly compared to those obtained for (Traveling – BP0R).

Table 3.2. Computed **ΔSYSDLY** values for the traveling systems with respect to BP1J used as a reference. The misclosures are also indicated. (all values in ns)

Pair	Date	$\mathbf{REFDLY_T}$	$\mathbf{REFDLY_R}$	Note	P1 (ns)		P2 (ns)		C1 (ns)	
					RAWDIF	**ΔSYSDLY**	RAWDIF	**ΔSYSDLY**	RAWDIF	**ΔSYSDLY**
BP1C-BP1J	57778-57782	256.5	179.9		25.41	102.01	31.46	108.06	25.88	102.48
BP1C-BP1J	57896-57906	256.4	180.1		25.54	101.84	31.33	107.63	26.07	102.37
		Misclos.				0.17		0.43		0.11
		Mean				101.93		107.85		102.43
BP0U-BP1J	57778-57782	52.6	179.9		-10.04	-137.34	-3.46	-130.76	-11.42	-138.72
BP0U-BP1J	57896-57906	52.6	180.1		-10.09	-137.59	-3.82	-131.32	-11.35	-138.85
		Misclos.				0.25		0.56		0.13
		Mean				-137.47		-131.04		-138.79

Table 3.3. Computed **ΔSYSDLY** values for the traveling systems with respect to BP1X used as a reference. The misclosures are also indicated. (all values in ns)

Pair	Date	$REFDLY_T$	$REFDLY_R$	Note	P1 (ns)		P2 (ns)		C1 (ns)	
					RAWDIF	**ΔSYSDLY**	RAWDIF	**ΔSYSDLY**	RAWDIF	**ΔSYSDLY**
BP1C-BP1X	57778-57782	256.5	42.6		31.53	245.43	34.74	248.64	37.48	251.38
BP1C-BP1X	57896-57906	256.4	42.6		31.28	245.08	34.58	248.38	37.17	250.97
		Misclos.				0.35		0.26		0.41
		Mean				245.26		248.51		251.18
BP0U-BP1X	57778-57782	52.6	42.6		-4.06	5.94	-0.28	9.72	0.04	10.04
BP0U-BP1X	57896-57906	52.6	42.6		-4.38	5.62	-0.72	9.28	-0.31	9.69
		Misclos.				0.32		0.44		0.35
		Mean				5.78		9.50		9.87

This is done in Table 3.4 using comparisons (BP1J-BP0R) and (BP1X-BP0R) obtained in December 2015. As can be seen from Table 3.4, the various evaluations of ΔSYSDLY for (BP1C-BP0R) vary by no more than about 0.2 ns. They are considered close enough so that, in the following, the directly measured values (BP1C-BP0R) and (BP0U-BP0R) will be used to compute the results of the Group 1 trip.

Table 3.4. Computed **ΔSYSDLY** mean values for the traveling systems with respect to BP0R computed directly (Table 3.1) or through BP1J (Table 3.2) or BP1X (Table 3.3). Numerical discrepancies of 0.01 ns are due to rounding (all values in ns).

		ΔSYSDLY P1		**ΔSYSDLY P2**		**ΔSYSDLY C1**
BP1C-BP0R	Mean value	-72.18		-68.54		-73.46
BP1C-BP1J	Mean value	101.93		107.85		102.43
BP1J-BP0R	Dec 2015	-174.1		-176.4		-175.9
BP1C-BP0R	Sum of above	-72.18		-68.56		-73.48
BP1C-BP1X	Mean value	245.26		248.51		251.18
BP1X-BP0R	Dec 2015	-317.5		-317.1		-324.7
BP1C-BP0R	Sum of above	-72.25		-68.59		-73.53
BPOU-BP0R	Mean value	-311.57		-307.50		-314.67
BP0U-BP1J	Mean value	-137.47		-131.04		-138.79
BP1J-BP0R	Dec 2015	-174.1		-176.4		-175.9
BP0U-BP0R	Sum of above	-311.57		-307.44		-314.69
BP0U-BP1X	Mean value	5.78		9.50		9.87
BP1X-BP0R	Dec 2015	-317.5		-317.1		-324.7
BPOU-BP0R	Sum of above	-311.72		-307.60		-314.84

4.2 Traveling system with respect to the visited systems

Table 4. Traveling vs. Visited systems (all values in ns)

Pair	Date	$REFDLY_T$	$REFDLY_V$	Note	P1 (ns)		P2 (ns)		C1 (ns)	
					RAWDIF	ΔSYSDLY	RAWDIF	ΔSYSDLY	RAWDIF	ΔSYSDLY
BP1C-USN6	57839-57849	306.8	0.0	*	-17.34	289.46	-8.95	297.85	-15.79	291.01
BP0U-USN6	57839-57849	125.0	0.0	*	-74.66	50.34	-66.05	58.95	-74.94	50.06
BP1C-USN7	57839-57849	306.8	0.0	*	-17.95	288.85	-9.48	297.32	-17.33	289.47
BP0U-USN7	57839-57849	125.0	0.0	*	-75.25	49.75	-66.59	58.41	-76.39	48.61
BP1C-NIST	57863-57867	773.5	87.3		-605.24	80.93	-600.25	85.92	-603.80	82.37
BP0U-NIST	57863-57867	575.6	87.3		-646.79	-158.50	-641.44	-153.15	-647.00	-158.71
BP1C-NISS	57863-57867	773.5	1736.9		903.64	-59.73	908.64	-54.73	903.64	-59.73
BP0U-NISS	57863-57867	575.6	1736.9		862.25	-299.00	867.67	-293.58	860.49	-300.76
BP1C-NIS3	57863-57867	773.5	1597.0		814.76	-8.69	831.49	8.04	816.31	-7.14
BP0U-NIS3	57863-57867	575.6	1597.0		773.39	-247.94	790.44	-230.89	773.19	-248.14
BP1C-NIS4	57863-57867	773.5	1566.4		788.71	-4.21	805.75	12.83	790.21	-2.71
BP0U-NIS4	57863-57867	575.6	1566.4		747.35	-243.45	764.78	-226.02	747.05	-243.75

* USN6 and USN7 delay values incorporated in Rinex data.

4.3 Visited systems with respect to reference system

The Table 5 provides the values obtained by differencing Table 3.1 (BP0R reference) and Table 4. CABDLY values are taken from the report of operations 1001-2016-phase3-cv.pdf.

Table 5. Visited vs. BP0R Reference (all values in ns)

Pair	Date	$CABDLY_V$	$CABDLY_R$	Note	P1 (ns)		P2 (ns)		C1 (ns)	
					ΔSYSDLY	ΔINTDLY	ΔSYSDLY	ΔINTDLY	ΔSYSDLY	ΔINTDLY
USN6-BP0R via BP1C	2017.2	0.0	133.4	*	-361.64	-228.24	-366.39	-232.99	-364.47	-231.07
USN6-BP0R via BP0U	2017.2	0.0	133.4	*	-361.91	-228.51	-366.45	-233.05	-364.73	-231.33
USN7-BP0R via BP1C	2017.2	0.0	133.4	*	-361.03	-227.63	-365.86	-232.46	-362.93	-229.53
USN7-BP0R via BP0U	2017.2	0.0	133.4	*	-361.32	-227.92	-365.91	-232.51	-363.28	-229.88
NIST-BP0R via BP1C	2017.3	275.5	133.4		-153.11	-295.21	-154.46	-296.56	-155.83	-297.93
NIST-BP0R via BP0U	2017.3	275.5	133.4		-153.07	-295.17	-154.35	-296.45	-155.96	-298.06
NISS-BP0R via BP1C	2017.3	298.9	133.4		-12.45	-177.95	-13.81	-179.31	-13.73	-179.23
NISS-BP0R via BP0U	2017.3	298.9	133.4		-12.57	-178.07	-13.92	-179.42	-13.91	-179.41
NIS3-BP0R via BP1C	2017.3	298.5	133.4		-63.49	-228.59	-76.58	-241.68	-66.32	-231.42
NIS3-BP0R via BP0U	2017.3	298.5	133.4		-63.63	-228.73	-76.61	-241.71	-66.52	-231.63
NIS4-BP0R via BP1C	2017.3	298.0	133.4		-67.97	-232.57	-81.36	-245.97	-70.75	-235.35
NIS4-BP0R via BP0U	2017.3	298.0	133.4		-68.12	-232.72	-81.48	-246.08	-70.92	-235.52

* USN6 and USN7 delay values incorporated in Rinex data.

4.4 Provisional INTDLY values of visited systems

Table 6 lists provisional INTDLY values of the visited systems using 1001-2014 Group 1 values for BP0R (P1=222.6 ns; P2=224.8 ns; C1=225.8 ns), see in TM243_Group1-reference-values_V7.pdf. Final INTDLY values will be based on minimizing changes between 1001-2014 and 1001-2016, as described in BIPM Technical Memorandum 266, and will be reported in the global report of the trip 1001-2016 available here. Since two results can be computed from Table 5, using either BP1C or BP0U as traveling system, the values in Table 6 are the simple mean of the two results, and the difference between the two is indicated. We note that the difference Δ(BP1C-BP0U) is typically below 0.3 ns, which is considered reasonable and covered in the uncertainty budget.

Table 6. Provisional INTDLY values of Visited systems using 1001-2014 reference values for the reference systems BP0R (all values in ns).

Pair	Date	Note	P1	P2	C1
			$INTDLY_V$	$INTDLY_V$	$INTDLY_V$
USN6 vs. BP0R	2017.25	(1)	-5.77	-8.22	-5.40
Δ(BP1C-BP0U)			0.27	0.06	0.25
USN7 vs. BP0R	2017.25	(1)	-5.17	-7.68	-3.90
Δ(BP1C-BP0U)			0.29	0.05	0.34
NIST vs. BP0R	2017.31		-72.59	-71.70	-72.19
Δ(BP1C-BP0U)			-0.03	-0.11	0.12
NISS vs. BP0R	2017.31		44.59	45.44	46.48
Δ(BP1C-BP0U)			0.13	0.12	0.18
NIS3 vs. BP0R	2017.31		-6.06	-16.89	-5.72
Δ(BP1C-BP0U)			0.14	0.03	0.20
NIS4 vs. BP0R	2017.31		-10.04	-21.22	-9.63
Δ(BP1C-BP0U)			0.15	0.12	0.16

(1) For USN6 and USN7, results are changes with respect to values entered in the receiver

5 Uncertainty estimation

In this section, we determine the uncertainty of the differential calibration process i.e. we estimate all components that can affect the accuracy. We determine a value U_{CAL0} that is to be used as the accuracy of all P3/PPP links (Visited – Reference) at the epoch of calibration.

$$u_{CAL0} = \sqrt{u_a^2 + u_b^2}$$

with the statistical uncertainty u_a and the systematic uncertainty u_b. (all are 1-sigma).
The statistical uncertainty u_a originates from RAWDIF (see section 3) and is given by the statistical analysis of the raw code differences for (Traveling-Reference) and (Traveling-Visited).

The systematic uncertainty is given by $u_B = \sqrt{\sum_n u_{b,n}^2}$

where all possible terms to be considered in the sum are listed in Table 7 and some detail on their estimation is provided at the end of this section. Values appear separately for each code and for the difference of the two codes (P1, P2 and P1-P2) so as to compute a value u_{CAL} applicable to P3 links. We choose to compute U_{CAL} using for u_b the uncertainty u_{bSYS} of $\Delta SYSDLY_{V-R}$ from equation (2)[1] Table 7 presents all components of the uncertainty budget along with the uncertainty u_{bSYS} of $\Delta SYSDLY_{V-R}$ from equation (2) and the resulting uncertainty value U_{CAL}.

Table 7. Uncertainty contributions. For all components of u_b, the P3 values are computed as P1 + 1.545x(P1-P2)

Unc.	Value C1/P1 (ns)	Value P2 (ns)	Value P1-P2 (ns)	Value P3 (ns)	Description
u_a (T-V)	0.1	0.1			RAWDIF (traveling-visited)
u_a (T-R)	0.1	0.1			RAWDIF (traveling-reference)
u_a	0.15	0.15		0.4	
Traveling system instability					
$u_{b,1}$	0.3	0.3	0.2		Misclosure + compare 2 travelings
Systematic components related to RAWDIF					
$u_{b,11}$	0.05	0.05	0.05		Position error at reference
$u_{b,12}$	0.05	0.05	0.05		Position error at visited
$u_{b,13}$	0.2	0.2	0.3		Environment at reference
$u_{b,14}$	0.2	0.2	0.3		Environment at visited
Link of the Traveling system to the local UTC(k)					
$u_{b,21}$	0.5	0.5	0		$REFDLY_T$ (at ref lab)
$u_{b,22}$	0.5	0.5	0		$REFDLY_T$ (at visited lab)
$u_{b,TOT}$	0.8	0.8	0.5	1.0	
Link of the Reference system to its local UTC(k)					
$u_{b,31}$	0.5	0.5	0		$REFDLY_R$ (at ref lab)
Link of the Visited system to its local UTC(k)					
$u_{b,32}$	0.5	0.5	0		$REFDLY_V$ (at visited lab)
$u_{b,SYS}$	1.1	1.1	0.5	1.3	Components of equation (2)
u_{CAL}	1.1			1.3	Composed of u_a and $u_{b,SYS}$

[1] It is somewhat arbitrary to choose SYSDLY to estimate the link accuracy. This reflects the fact that the REFDLY is subject to change e.g. with change of reference clock or distribution and that its uncertainty should better be taken into account.

The components in Table 7 are separated in several categories:

- $u_{b,1}$ accounts for possible variations of the delays of the traveling systems during the trip. This is evaluated on the one hand by the observed misclosure (~ 0.3 ns average for each code, 0.2 ns for P1-P2, see Table 3.1), on the other hand by the observed discrepancies between the results of the two traveling receivers (< 0.3 ns average for each code, < 0.2 ns average for P1-P2, see Table 6). The chosen values represent an average of both evaluations.
- $u_{b,11}$ and $u_{b,12}$ account for errors in the differential position (Travel – Local). In general they are estimated to be 1.5 cm (50 ps) because the standard uncertainty of the differential positioning obtained with the data used for calibration is typically at or below this level.
- $u_{b,13}$ and $u_{b,14}$ account for environmental effects, including multipaths. This is difficult to estimate and a conservative estimate of 0.2 ns is conventionally used, following discussions in the CCTF Working Group on GNSS.
- $u_{b,21}$ and $u_{b,22}$ account for the measurement between the reference point of the traveling system and the local UTC(k). They include at least one measurement with a TIC and are taken to be 0.5 ns.
- $u_{b,31}$ and $u_{b,32}$ account similarly for the measurement between the reference point of the local system and the local UTC(k). They include at least one measurement with a TIC and are taken to be 0.5 ns.

Version history
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