GP/TM266

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Continuity of GPS "INTDLY" values of Group 1 geodetic receivers in successive Group 1 trips

Introduction

TM243 has described the procedure to choose reference values for "INTDLY" of Group 1 (hereafter G1) geodetic receivers participating in the initial G1 trip 1001-2014, covering P1/P2 as well as C1 values.

The Calibration Guidelines state:" *Because we do not have (so far) an absolute reference, we propose to consider that the ensemble of the "Group 1" systems is itself the reference. There are several possible implementations: e.g. for each new "Group 1" calibration trip, the delay values will be set so as to minimize, for the ensemble of participating "Group 1" systems, the variations of the values with respect to the previous calibration results.*"

This TM describes the procedure used to realize this goal.
Part A explains the general methodology. In Part B, the procedure is applied to derive the results of the second G1 trip (1001-2016) in continuity to the first trip (1001-2014).

Version history
V0 2016/12/16: Draft
V1 2017/01/17: Corrected minor typos. Added Median in Table 3, following Pascale Defraigne's suggestion, for future studies.
V1.2 2017/02/10: Results for NC5G and NC4C changed to account for measured CABDLY values.
V1.3 2017/06/22: Corrected minor typos. Inclusion of SIM results in section B.4 and new statistical study in B5. Annex 2 completed for SIM results.

A. Methodology

Let IDXXp(k) be the previous value of INTDLY for receiver k for code XX (P1,P2,C1…), obtained from previous calibration, and IDXXn(k) the desired new value of INTDLY, result of the new calibration.

The principle is to define IDXXn(k) as follows:
1. Obtain intermediate results IDXXi(k) for the new calibration using as a reference IDXXp(REF) where REF is a receiver at the BIPM which was part of the results of the previous calibration and is now used to compute a closure of the new calibration;
2. Compute the changes dIDXX(k) = (IDXXi(k)- IDXXp(k));
3. Compute an average change DIDXX(K) = <dIDXX(k)> on a set K of receivers that took part to both the previous and the new calibration;
4. Set IDXXn(k) = IDXXi(k) - DIDXX(K) for all receivers in the new calibration.

Several questions may be explored and some of them are examined in this document:
a) Should the set K represent the maximum possible set of G1 receivers (all of them)? A complete G1 trip involves, so far, three continents, 10 international travels, and numerous customs. It has been found more secure and practical to break it into several sub-trips with intermediate returns at the BIPM, which still adds to the total duration. If K should represent all G1, final results cannot be provided before the full completion of the trip which total duration is not anticipated to be below 6 months in any foreseeable future. It is likely that the full 2016 trip will last close to one year so that some labs could wait final results for one year. An alternative is to provide results for subsets K corresponding to each intermediate return to the BIPM, i.e. in 2016 successive results for APMP, EURAMET and SIM.
b) How should the average change DIDXX(K) be computed exactly? Should all available receivers have the same weight? Should it be a simple average or some other norm?
c) Should this procedure be applied independently for each code? An alternative for P1/P2 may be to add an additional constraint based on P3 (this would be redundant in case a simple average is used because P3 is a linear combination of P1 and P2).

d) Should receivers for which only TOTDLY is available be included if the set-up has not changed?
e) Should receivers which were not part to the previous calibration, but have been aligned to calibrated receivers, be included?

In practice, the most important question is (a) because it conditions the availability of new calibration results to the G1 labs. In principle, it is proposed to publish the results of a G1 trip for each subset K between two successive returns at the BIPM and to study the effect of this choice after the full completion of the trip. For the 2016 trip, however, the first two legs (APMP and EURAMET) have been joined in a subset to obtain the first release of results (V1 of this TM). Then this TM will be updated after each subset and after the completion of the trip.

B. Results of 1001-2016 from 1001-2014

Group 1 laboratories were chosen during 2014. They are

- For EURAMET: OP, PTB, ROA
- For APMP: NICT, NIM, TL
- For SIM: NIST, USNO
- For COOMET: SU

Final results of the 1001-2014 calibration are recalled in Annex 1 for P1, P2 and C1.

B.1. The APMP part of 1001-2016

The report of the APMP part of 1001-2016 is here. It includes three Group 1 laboratories and ten receivers, some of them were present in 1001-2014, or were directly aligned to receivers present in 1001-2014 (see Table B.1). The BIPM reference receiver (BP0R) is also common to both trips.
Table B.1 indicates under **IDXXp** the 1001-2014 results and under **dIDXX** the change in INTDLY (1001-2016 minus 1001-2014). The last line provides **DIDXX(APMP)** computed as the simple average of all **dIDXX** values. Note that DIDP3 is equal to 0.1 ns when computed with TLT1 and equal to 0.2 ns when computed without TLT1. In the following, TLT1 will not be considered as its values for P1, P2 and C1 are not available because TLT1 was aligned only in P3.

Table B.1. List of 1001-2014 INTDLY values and differences **dIDXX** (1001-2016 – 1001-2014) for APMP.

System	Note	P1		P2		C1		P3	
		IDP1p	dIDP1	IDP2p	dIDP2	IDC1p	dIDC1	IDP3p	dIDP3
BIPM									
BP0R	REF	222.6	0.0	224.8	0.0	225.8	0.0		0.0
TL									
TLT1	(1) TWTF	N/A	N/A	N/A	N/A	N/A	N/A	400.8	-0.3
NICT									
NC01	(2) NC02	217.4	+1.0	222.3	+0.4	???	???	209.8	+1.9
NIM									
IMEJ	(3)	0.0	+0.8	0.0	+1.3	-1.3	+0.8	0.0	-0.1
IMEU		-25.7	-1.7	-12.7	-1.4	-23.8	-1.9	-45.8	-2.0
BJNM		74.0	+1.4	81.7	+1.6	75.8	+1.4	62.1	+1.0
Average			+0.3		+0.4		+0.1		+0.1/+0.2

(1) Calibration transferred from TWTF to TLT1 by TL. Values are TOTDLY and only P3 is meaningful.
(2) Calibration transferred from NC02 to NC01 by NICT
(3) P1/P2 results of 1001-2014 are entered and used in the receiver (GTR50), thus appear as 0.0.

Computing IDXXn(k) = IDXXi(k) - DIDXX(APMP) for each code, one would obtain results based on minimizing the changes on APMP.

B.2. The EURAMET part of 1001-2016

The report of the EURAMET part of 1001-2016 is here. It includes three Group 1 laboratories and thirteen receivers, some of them were present in 1001-2014, or were directly aligned to receivers present in 1001-2014 (see Table B.2). The BIPM reference receiver (BP0R) is also common to both trips.
Table B.2 indicates under **IDXXp** the 1001-2014 results and under **dIDXX** the change in INTDLY (1001-2016 minus 1001-2014). The last line provides **DIDXX(EURAMET)** computed as the simple average of all **dIDXX** values.

Table B.2. List of 1001-2014 INTDLY values and differences **dIDXX** (1001-2016 – 1001-2014) for EURAMET.

System	Note	P1		P2		C1		P3	
		IDP1p	dIDP1	IDP2p	dIDP2	IDC1p	dIDC1	IDP3p	dIDP3
BIPM									
BP0R	REF	222.6	0.0	224.8	0.0	225.8	0.0		0.0
OP									
OPMT		310.2	-1.1	321.6	-0.3	311.0	-1.3	292.6	-2.4
PTB									
PT02		303.9	+0.7	319.3	+0.9	304.4	+0.8	280.1	+0.5
PT03		301.0	+0.6	323.5	+0.8	301.1	+0.7	266.2	+0.2
ROA									
RO_5	(1)	0.0	+0.0	0.0	+0.5	+1.7	-0.1	0.0	-0.7
RO_6	(2)	50.0	-0.3	48.4	+0.4	N/A		52.5	-1.4
Average			+0.0		+0.4		+0.0		-0.6

(1) P1/P2 results of 1001-2014 are entered and used in the receiver (GTR50), thus appear as 0.0.
(2) Firmware was upgraded on MJD 57582, resulting in changes of -4.8 ns in P1 and -3.6 ns in P2 (info from H. Esteban, ROA). This change is taken into account in the IDP1p and IDP2p values.

Computing IDXXn(k) = IDXXi(k) - DIDXX(EURAMET) for each code, one would obtain results based on minimizing the changes on EURAMET.

B.3. 1001-2016 results from merging APMP and EURAMET

From the results in the previous sections, we see that the final values will vary by fractions of a nanosecond (e.g. 0.0 to +0.3 ns in P1, -0.6 to +0.2 ns in P3) between minimizing the changes on APMP only, on EURAMET only, or on (APMP+EURAMET). Assembling all ten receivers for which continuity can be traced between 1001-2014 and 1001-2016 in a single ensemble in principle provides the most robust solution. In Table B.3.1, we summarize the individual changes and statistical estimators related to this choice.

Table B.3.1. List of differences **dIDXX** (1001-2016 – 1001-2014) and statistical values (all in ns).

System	dIDP1	dIDP2	dID(P1-P2)	dIDC1	dIDP3
BP0R	0.0	0.0	0.0	0.0	0.0
NC01	+1.0	+0.4	+0.6	N/A	+1.9
IMEJ	+0.8	+1.3	-0.5	+0.8	-0.1
IMEU	-1.7	-1.4	-0.3	-1.9	-2.0
BJNM	+1.4	+1.6	-0.2	+1.4	+1.0
OPMT	-1.1	-0.3	-0.8	-1.3	-2.4
PT02	+0.7	+0.9	-0.2	+0.8	+0.5
PT03	+0.6	+0.8	-0.2	+0.7	+0.2
RO_5	+0.0	+0.5	-0.5	-0.1	-0.7
RO_6	-0.3	+0.4	-0.7	N/A	-1.4
Mean	**+0.1**	**+0.4**	**-0.3**	**+0.1**	**-0.3**
Unc of mean	0.3	0.3	0.1	0.4	0.4
Std Dev	1.0	0.9	0.4	1.1	1.3
Median	**(0.0,0.6)**	**(0.4,0.5)**	**(-0.3,-0.2)**	**(0.0,0.7)**	**(-0.1,0.0)**

Computing IDXXn(k) = IDXXi(k) - DIDXX(APMP+EURAMET) for each code, using for DIDXX the **Mean** values of Table B.3.1, one obtains results for the APMP+EURAMET parts of the 1001-2016 campaign shown in Table B.3.2. Results for the Group 2 laboratory NTSC are also indicated for completeness.

Table B.3.2. Results of the APMP+EURAMET parts of the 1001-2016 Group 1 calibration (all values in ns).

System	Date	INTDLY P1	INTDLY P2	INTDLY C1
BP0R		222.5	224.4	225.7
BP1J	2016.9	53.0	52.6	54.4
TLT1 (1)	2016.2	415.0	424.1	414.9
TLT2	2016.2	-35.2	-36.2	-33.4
TLT3 (3)	2016.2	-5.7	-9.6	-6.9
NC01	2016.3	218.3	222.4	221.4
NC5G (3)	2016.3	5.9	12.7	-1.5
NC4C	2016.3	54.9	53.3	56.4
NC4S (2)	2016.3	276.8	276.3	278.2
IMEJ (3)	2016.5	0.7	0.9	-0.6
IMEU	2016.5	-27.5	-14.5	-25.8
BJNM	2016.5	75.3	82.9	77.1
NTP1	2016.6	55.7	55.1	57.4
NTP2	2016.6	55.5	54.2	57.3
NTP3	2016.6	53.1	52.2	54.6
RO_5 (3)	2016.8	-0.1	0.1	1.5
RO_6	2016.8	49.6	48.5	51.0
RO_7	2016.8	54.9	53.8	56.2
RO_8 (3)	2016.8	-0.3	0.2	-42.3
RO_9	2016.8	55.9	55.1	56.6
PT02	2016.8	304.5	319.8	305.1
PT03	2016.8	301.5	323.9	301.7
PT07 (3)	2016.8	-0.6	-0.5	-3.0
PT09	2016.8	56.0	55.2	57.3
PT10 (3)	2016.8	0.3	0.0	-4.0
OPMT	2016.9	309.0	320.9	309.6
OP71	2016.9	55.7	54.4	57.1
OPM9	2016.9	-33.7	-37.0	-31.7

(1) Results for TLT1 are Total Delay values (TOTDLY).
(2) Results for NC4S are System Delay values (SYSDLY).
(3) Results are changes with respect to values entered in the receiver

B.4. The SIM part of 1001-2016

The report of the SIM part of 1001-2016 is here. It includes two Group 1 laboratories and six receivers, some of them were present in 1001-2014, or were directly aligned to receivers present in 1001-2014 (see Table B.4). The BIPM reference receiver (BP0R) is also common to both trips.
Table B.4 indicates under **IDXXp** the 1001-2014 results and under **dIDXX** the change in INTDLY (provisional 1001-2016 minus 1001-2014). The last two lines provide **DIDXX(SIM)** computed as the simple average of **dIDXX** values. In the first of the two lines all **dIDXX** values are used while in the second one NIS3 is excluded from the average, as it appears that NIS3 results seem affected by a significant offset.

Table B.4.1. List of 1001-2014 INTDLY values and differences **dIDXX** (1001-2016 – 1001-2014) for SIM.

System	Note	P1		P2		C1		P3	
		IDP1p	dIDP1	IDP2p	dIDP2	IDC1p	dIDC1	IDP3p	dIDP3
BIPM									
BP0R	REF	222.6	0.0	224.8	0.0	225.8	0.0		0.0
USNO									
USN6		-6.5	+0.7	-9.6	+1.4	-6.5	+1.1	-1.8	-0.2
USN7		-6.1	+0.9	-9.1	+1.4	-4.9	+1.0	-1.4	+0.1
NIST									
NIST		-72.0	-0.6	-71.8	+0.1	-72.0	-0.2	-72.4	-1.5
NIS3		-8.6	+2.5	-20.6	+3.7	-8.6	+3.0	10.0	+0.7
NIS4		-9.8	-0.2	-21.3	+0.1	-9.8	+0.3	8.0	-0.8
Average			+0.5		+1.1		+0.9		-0.3
NIS3 excl.			+0.2		+0.6		+0.4		-0.5

Computing IDXXn(k) = IDXXi(k) - DIDXX(SIM) for each code, one obtains results based on minimizing the changes on SIM. Final results for SIM are listed in Table B.4.2 and are based on DIDXX(SIM) excluding the receiver NIS3, i.e. the values in the last line of Table B.4.1.

Table B.4.2. Results of the SIM part of the 1001-2016 Group 1 calibration (all values in ns).

System	Date	INTDLY P1	INTDLY P2	INTDLY C1
BP0R		222.4	224.2	225.4
USN6 (1)	2017.2	-6.0	-8.8	-5.8
USN7 (1)	2017.2	-5.4	-8.3	-4.3
NIST	2017.3	-72.8	-72.3	-72.6
NISS	2017.3	44.4	44.8	46.1
NIS3	2017.3	-6.3	-17.5	-6.1
NIS4	2017.3	-10.2	-21.8	-10.0

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

B.5. Statistical study of merging APMP, EURAMET and SIM

From the results in Tables B.1 (APMP), B.2 (EURAMET) and B.4.1 (SIM), we see that the final values will vary by fractions of a nanosecond (e.g. 0.0 to +0.5 ns in P1, -0.6 to +0.2 ns in P3) between minimizing the changes on APMP only, on EURAMET only, or on SIM only. Assembling all fourteen receivers for which continuity can be traced between 1001-2014 and 1001-2016 in a single ensemble in principle provides the most robust solution. In Table B.5, we summarize the individual changes and statistical estimators related to this choice. We see that the statistical results obtained from 14 receivers are similar to those obtained for 10 receivers in section B.3.

Table B.5. List of differences **dIDXX** (1001-2016 – 1001-2014) and statistical values (all in ns).

System	dIDP1	dIDP2	dID(P1-P2)	dIDC1	dIDP3
BP0R	0.0	0.0	0.0	0.0	0.0
NC01	+1.0	+0.4	+0.6	N/A	+1.9
IMEJ	+0.8	+1.3	-0.5	+0.8	-0.1
IMEU	-1.7	-1.4	-0.3	-1.9	-2.0
BJNM	+1.4	+1.6	-0.2	+1.4	+1.0
OPMT	-1.1	-0.3	-0.8	-1.3	-2.4
PT02	+0.7	+0.9	-0.2	+0.8	+0.5
PT03	+0.6	+0.8	-0.2	+0.7	+0.2

RO_5	+0.0	+0.5	-0.5	-0.1	-0.7
RO_6	-0.3	+0.4	-0.7	N/A	-1.4
USN6	0.7	1.4	-0.7	1.1	-0.2
USN7	0.9	1.4	-0.5	1	0.1
NIST	-0.6	0.1	-0.7	-0.2	-1.5
NIS4	-0.2	0.1	-0.3	0.3	-0.8
Mean	**+0.2**	**+0.5**	**-0.3**	**+0.2**	**-0.4**
Unc of mean	0.3	0.3	0.1	0.4	0.4
Std Dev	1.0	0.9	0.4	1.1	1.3
Median	**(0.0,0.6)**	**(0.4,0.5)**	**(-0.5,-0.3)**	**(0.3,0.7)**	**(-0.2,-0.1)**

B.6. The COOMET part of 1001-2016

[Part still to be done]

B.7. Comparison of results and discussion

As noted in section B.3 and B5, the final INTDLY values for each code will vary by fractions of a nanosecond depending on the ensemble of receivers on which it is chosen to minimize the changes between the previous and the current calibration exercises. Table B.7 summarizes the results obtained for 1001-2016 with respect to 1001-2014 for different choices of the ensemble of receivers taken as reference.
Obviously such a choice does not affect the results for links between G1 receivers in each subgroup. But it affects results for links between G1 receivers in different subgroups, or between G1 receivers and G2 receivers calibrated with respect to another subgroup. Nevertheless the variations associated to such choices remain well below 1 ns, even for the P3 combination, if using an ensemble of 4-5 receivers in three different laboratories as a reference. If using a single receiver as a reference, variations of order 1.0 ns RMS for each code and of order 1.3 ns RMS for P3 may be expected. This is to be compared to the standard uncertainties from calibration, which are presently of order 1.5 ns for links between Group 1 receivers and 2.5 ns for any link involving a Group 2.

It is thus expected that results for future Group1 trips may be provided for each sub-group at each intermediate closure at the BIPM, provided that an ensemble of order five receivers from some three laboratories is common to the current and previous trips.

Table B.7. List of differences **DIDXX** (1001-2016 – 1001-2014) computed with different ensembles (all in ns).

Ensemble	# rec	DIDP1	DIDP2	DIDC1	DIDP3
APMP	5	+0.3	+0.4	+0.1	+0.2
EURAMET	6	0.0	+0.4	0.0	-0.6
APMP+EURAMET	10	+0.1	+0.4	+0.1	-0.3
SIM	5	+0.2	+0.6	+0.4	-0.5
APMP+EURAMET+SIM	14	+0.2	+0.5	+0.2	-0.4
COOMET					

Final results for 1001-2016 are shown in Annex 2

References

TM243: Determination of reference GPS “INTDLY” values of Group 1 geodetic receivers in the initial Group 1 trip (Cal_Id = 1001-2014), Version 7 available at
ftp://ftp2.bipm.org/pub/tai/publication/gnss-calibration/group1/1001-2014/

BIPM guidelines for GNSS calibration, Version 3.2 available at
ftp://ftp2.bipm.org/pub/tai/publication/gnss-calibration/guidelines/

Annex 1: Results of 1001-2014

P1/P2 and C1 INTDLY values from the Initial Group 1 trip (Cal_Id=1001-2014) taken from Table 8 (P1/P2) and Table 9 (C1) of TM243. P1 and P2 are indicated with 2-digit numeric precision for internal consistency of P3. Values of REFDLY and CABDLY at the epoch of calibration and of TOTDLY(P3) are also indicated for reference (all values in ns).

System	Date	INTDLY P1	INTDLY P2	INTDLY C1	REFDLY	CABDLY	TOTDLY P3
BP0R		222.55	224.79	225.8			
TWTF (1)	2014.0	305.75	314.05	305.9	52.0	119.8	360.7
NC02	2014.2	219.71	225.87	222.8	429.7	248.5	29.0
SEPA	2014.2	217.44	222.33	220.4	406.1	213.4	17.2
IMEJ	2014.4	2.39	4.48	-1.3	0.0	0.0	-0.8
IMEU	2014.4	-25.67	-12.70	-23.8	115.5	250.3	89.1
BJNM	2014.4	74.00	81.72	75.8	315.3	125.0	-128.2
RO_4	2014.7	199.68	203.97	203.0	218.9	217.5	191.7
RO_5	2014.7	2.19	-0.40	1.7	0.3	0.0	5.9
RO_6	2014.7	54.81	51.97	56.1	218.3	66.7	-92.4
RO_7	2014.7	55.56	53.35	56.7	171.5	61.9	-50.6
NIST	2015.1	-72.03	-71.79	-72.0	80.0	275.5	123.1
NIS3	2015.1	-8.59	-20.60	-8.6	1545.8	298.5	-1237.3
NIS4	2015.1	-9.79	-21.29	-9.8	1516.5	298.0	-1210.5
USN6	2015.2	-6.53	-9.60	-6.5	0.0	0.0	-1.8
USN7	2015.2	-6.11	-9.13	-4.9	0.0	0.0	-1.4
OPMT	2015.4	310.21	321.60	311.0	100.1	156.5	349.0
OPM7	2015.4	270.69	273.87	272.1	128.1	0.0	137.7
OPM8	2015.4	270.76	273.95	272.2	124.6	0.0	141.2
PTBB	2015.4	303.89	319.28	304.4	74.0	301.7	507.8
PTBG	2015.4	300.97	323.47	301.1	46.3	251.4	471.3
SU19	2015.5	-28.98	-27.50	-27.3	194.5	48.2	-177.6

(1) Results for TWTF are expressed as INTDLY for consistency with the CGGTTS V2 format. **However they should NOT be used as true INTDLY values**: Only "Total delay" as defined in CGTTS V3 format (TOTDLY = INTDLY + CABDLY – REFDLY) has a physical meaning for TWTF. Note also that the REFDLY value in the CGGTTS files of TWTF (TL1Z) was changed to 46.3 ns on MJD 56763.

Annex 2: Results of 1001-2016

P1/P2 and C1 INTDLY values from the second Group 1 trip (Cal_Id=1001-2016) taken from Table 4 for APMP and EURAMET. Values of REFDLY and CABDLY at the epoch of calibration and of TOTDLY(P3) are also indicated for reference (all values in ns). NTSC receivers included for completeness.

System	Date	INTDLY P1	INTDLY P2	INTDLY C1	REFDLY	CABDLY	TOTDLY P3
BP0R		222.5	224.4	225.7			
BP1J	2016.9	53.0	52.6	54.4			
TLT1 (1)	2016.2	415.0	424.1	414.9	N/A	N/A	400.9
TLT2	2016.2	-35.2	-36.2	-33.4	24.5	140.3	82.1
TLT3 (3)	2016.2	-5.7	-9.6	-6.9	0.0	0.0	0.3
NC01	2016.3	218.3	222.4	221.4	407.6	213.4	17.8
NC5G (3)	2016.3	-31.1	-24.3	-38.5	-40.1	-37.0	-1.5
NC4C	2016.3	212.4	210.8	213.9	599.9	157.5	-385.0
NC4S (2)	2016.3	276.8	276.3	278.2	314.3	N/A	-36.7
IMEJ (3)	2016.5	0.7	0.9	-0.6	0.0	0.0	0.4
IMEU	2016.5	-27.5	-14.5	-25.8	112.8	66.7	-93.7
BJNM	2016.5	75.3	82.9	77.1	319.7	61.9	-194.2
NTP1	2016.6	55.7	55.1	57.4	373.8	209.0	-108.2
NTP2	2016.6	55.5	54.2	57.3	378.0	221.0	-99.5
NTP3	2016.6	53.1	52.2	54.6	192.6	198.0	59.9
RO_5 (3)	2016.8	-0.1	0.1	1.5	0.0	0.0	-0.4
RO_6	2016.8	49.6	48.5	51.0	234.4	66.7	-116.4
RO_7	2016.8	54.9	53.8	56.2	194.6	81.9	-56.1
RO_8 (3)	2016.8	-0.3	0.2	-42.3	0.0	0.0	-1.1
RO_9	2016.8	55.9	55.1	56.6	112.4	118.7	63.4
PT02	2016.8	304.5	319.8	305.1	73.9	301.7	508.7
PT03	2016.8	301.5	323.9	301.7	46.1	251.4	472.2
PT07 (3)	2016.8	-0.6	-0.5	-3.0	-0.8	0.0	0.0
PT09	2016.8	56.0	55.2	57.3	161.8	223.7	119.1
PT10 (3)	2016.8	0.3	0.0	-4.0	-0.2	0.0	1.0
OPMT	2016.9	309.0	320.9	309.6	155.9	156.5	291.2
OP71	2016.9	55.7	54.4	57.1	191.6	128.7	-5.2
OPM9	2016.9	-33.7	-37.0	-31.7	60.5	173.3	84.2
USN6 (1,3)	2017.2	-6.0	-8.8	-5.8	N/A	N/A	-1.7
USN7 (1,3)	2017.2	-5.4	-8.3	-4.3	N/A	N/A	-0.9
NIST	2017.3	-72.8	-72.3	-72.6	87.3	275.5	114.6
NISS	2017.3	44.4	44.8	46.1	1736.9	298.9	-1394.2
NIS3	2017.3	-6.3	-17.5	-6.1	1597.0	298.5	-1287.4
NIS4	2017.3	-10.2	-21.8	-10.0	1566.4	298.0	-1260.7

(1) Results are Total Delay values (TOTDLY).

(2) Results for NC4S are System Delay values (SYSDLY).

(3) Results are changes with respect to values entered in the receiver