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U.S. Department of Commerce
Wilbur L. Ross, Jr., Secretary

National Institute of Standards and Technology
Kent Rochford, Acting NIST Director and Under Secretary of Commerce for Standards and Technology

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1. GENERAL BACKGROUND INFORMATION

ACRONYMS AND ABBREVIATIONS USED IN THIS BULLETIN

ACTS	- Automated Computer Time Service		
BIPM	- Bureau International des Poids et Mesures		
GPS	- Global Positioning System		
IERS	- International Earth Rotation Service		
MC	- Master Clock		
MJD	- Modified Julian Date		
NIST	- National Institute of Standards and Technology	ns	- nanosecond
SI	- International System of Units	μs	- microsecond
TA	- Atomic Time	ms	- millisecond
TAI	- International Atomic Time	s	- second
USNO	- United States Naval Observatory	min	- minute
UT1	- Universal Time (Astronomical)		
UTC	- Coordinated Universal Time		

2. TIME SCALE INFORMATION

The values listed below are based on data from the IERS, the USNO, and NIST. The UTC(USNO,MC) - UTC(NIST) values are averaged measurements from all available common-view GPS satellites (see bibliography on page 5). UTC - UTC(NIST) data are on page 3.

0000 HOURS COORDINATED UNIVERSAL TIME			
Jun 2017	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
1	57905	380 ms	-4.2 ns
8	57912	372 ms	-3.3 ns
15	57919	369 ms	-1.8 ns
22	57926	364 ms	-0.1 ns
29	57933	360 ms	-1.2 ns

The master clock pulses used by the WWV, WWVH, and WWVB time-code transmissions are referenced to the UTC (NIST) time scale. Occasionally, 1 s is added to the UTC time scale. This second is called a leap second. Its purpose is to keep the UTC time scale within ±0.9 s of the UT1 astronomical time scale, which changes slightly due to variations in the Earth's period of rotation.

NOTE: No leap second will be added at the end of June 2017.

Positive leap seconds, beginning at 23 h 59 min 60 s UTC and ending at 0 h 0 min 0 s UTC, were inserted in the UTC time scale on 30 June 1972, 1981-1983, 1985, 1992-1994, 1997, 2012, 2015 and on 31 December 1972-1979, 1987, 1989, 1990,1995, 1998, 2005, 2008, 2016.

The use of leap seconds ensures that UT1 - UTC will always be held within ±0.9 s. The current value of UT1 - UTC is called the DUT1 correction. DUT1 corrections are broadcast by WWV, WWVH, WWVB, and ACTS and are printed below. These corrections may be added to the received UTC time signals in order to obtain UT1.

DUT1 = UT1 - UTC =

+0.3 s beginning 0000 UTC 29 June 2017
+0.4 s beginning 0000 UTC 30 March 2017
+0.5 s beginning 0000 UTC 26 January 2017
+0.6 s beginning 0000 UTC 01 January 2017
-0.4 s beginning 0000 UTC 17 November 2016
-0.3 s beginning 0000 UTC 01 September, 2016
-0.1 s beginning 0000 UTC 24 March 2016
+0.0 s beginning 0000 UTC 31 January 2016
+0.1 s beginning 0000 UTC 26 November 2015
+0.2 s beginning 0000 UTC 11 September 2015
+0.3 s beginning 0000 UTC 01 July 2015
-0.7 s beginning 0000 UTC 28 May 2015
-0.6 s beginning 0000 UTC 19 March 2015

The difference between UTC(NIST) and UTC has been within ±100 ns since July 6, 1994. The table below shows values of UTC - UTC(NIST) as supplied by the BIPM in their *Circular T* publication for the most recent 310-day period in which data are available. Data are given at ten-day intervals. Five-day interval data are available in *Circular T* .

0000 Hours Coordinated Universal Time		
DATE	**MJD**	**UTC-UTC(NIST), ns**
Jun. 25, 2017	**57929**	**1.0**
Jun. 15, 2017	**57919**	**0.0**
Jun. 5, 2017	**57909**	**-1.3**
May 26, 2017	**57899**	**-3.8**
May 16, 2017	**57889**	**-4.3**
May 6, 2017	**57879**	**-3.8**
Apr. 26, 2017	**57869**	**0.5**
Apr. 16, 2017	**57859**	**6.9**
Apr. 6, 2017	**57849**	**10**
Mar. 27, 2017	**57839**	**5.5**
Mar. 17, 2017	**37829**	**-4.9**
Mar. 7, 2017	**37819**	**-6.6**
Feb. 25, 2017	**57809**	**-5.1**
Feb. 15, 2017	**57799**	**-2.0**
Feb. 5, 2017	**57789**	**-0.6**
Jan. 26, 2017	**57779**	**-0.6**
Jan. 16, 2017	**57769**	**-1.2**
Jan. 6, 2017	**57759**	**-1.4**
Dec. 27, 2016	**57749**	**-1.2**
Dec. 17, 2016	**57739**	**-2.6**
Dec. 7, 2016	**57729**	**-1.3**
Nov. 27, 2016	**57719**	**0.9**
Nov. 17, 2016	**57709**	**1.6**
Nov. 7, 2016	**57699**	**1.2**
Oct. 28, 2016	**57689**	**1.8**
Oct. 18, 2016	**57679**	**4.5**
Oct. 8, 2016	**57669**	**5.5**
Sep. 28, 2016	**57659**	**4.1**
Sep. 18, 2016	**57649**	**1.3**
Sep. 8,2016	**57639**	**0.4**
Aug. 29, 2016	**57629**	**-1.6**
Aug. 19, 2016	**57619**	**-4.7**
Aug. 9, 2016	**57609**	**-4.2**
Jul. 30, 2016	**57599**	**-4.1**

3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	Jun 2017	MJD	Began UTC	Ended UTC	Freq.	Jun 2017	MJD	Began UTC	End UTC
WWVB	06-03-17 06-04-17	57907 57908	2015 0620	2057 0722	60 kHz 60 kHz	None			
WWV	None					None			
WWVH	None					None			

4. NOTES ON NIST TIME SCALES AND PRIMARY STANDARDS

Primary frequency standards developed and operated by NIST are used to provide accuracy (rate) input to the BIPM and to provide the best possible realization of the SI second. NIST-F1 and NIST F-2, cold-atom cesium fountain frequency standards, have served as the U.S. primary standards of time and frequency since 1999. The uncertainty of NIST-F2 is currently about 1 part in 10^{16}.

The AT1 scale is run in real-time by use of data from an ensemble of cesium standards and hydrogen masers. It is a free-running scale whose frequency is maintained as nearly constant as possible by choosing the optimum weight for each clock that contributes to the computation.

UTC(NIST) is generated as an offset from our real-time scale AT1. It is steered in frequency towards UTC by use of data published by the BIPM in its *Circular T*. Changes in the steering frequency will be made, if necessary, at 0000 UTC on the first day of the month, and occasionally at mid-month. A change in frequency is limited to no more than ±2 ns/day. The frequency of UTC(NIST) is kept as stable as possible at other times.

UTC is generated at the BIPM by use of a post-processed time-scale algorithm and is not available in real-time. The parameters that we use to generate UTC(NIST) in real-time are therefore based on an extrapolation of UTC from the most recent available data.

References:

Allan, D.W.; Hellwig, H.; and Glaze, D.J., "An accuracy algorithm for an atomic time scale," Metrologia, Vol.11, No.3, pp. 133-138 (1975).

Allan, D.W.; Davis, D.D.; Weiss, M.A.; Clements, A.; Guinot, B.; Granveaud, M.; Dorenwendt, K.; Fischer, B.; Hetzel, P.; Aoki, S.; Fujimoto, M.; Charron, L.; and Ashby, N., “Accuracy of international time and frequency comparisons via global positioning system satellites in common-view,” IEEE Transactions on Instrumentation and Measurement, Vol. IM-34, pp.118-125 (1985).

Heavner, T.P.; Jefferts, S.R.; Donley; E.A.; Shirley, J.H. and Parker, T.E., “NIST F1; recent improvements and accuracy evaluations,” Metrologia, Vol. 42, pp. 411-422 (2005).

Jefferts, S.R.; Shirley, J.; Parker, T.E.; Heavner, T.P.; Meekhof, D.M.; Nelson, C., Levi, F.; Costanza, G.; De Marchi, A.; Drullinger, R.; Hollberg, L.; Lee, W.D.; and Walls, F.L., “Accuracy evaluation of NIST-F1,” Metrologia, Vol. 39, pp. 321-336 (2002).

Lewandowski, W. and Thomas, C., “GPS Time transfer,” Proceedings of the IEEE, Vol. 79, pp. 991-1000 (1991).

Parker, T.E.; Jefferts, S.R.; Heavner, T.P.; and Donley, E.A., “Operation of the NIST-F1 caesium fountain primary frequency standard with a maser ensemble, including the impact of frequency transfer noise,” Metrologia, Vol. 42, pp. 423-430 (2005).

Weiss, M.A.; Allan, D.W., “An NBS Calibration Procedure for Providing Time and Frequency at a Remote Site by Weighting and Smoothing of GPS Common View Data,” IEEE Transactions on Instrumentation and Measurement, Vol. IM-36, pp. 572-578 (1987).

5. UTC(NIST) – AT1 PARAMETERS

The table below lists parameters that are used to define UTC(NIST) with respect to our real-time scale AT1. To find the value of UTC(NIST) - AT1 at any time T (expressed as a Modified Julian Date, including a fraction if needed), the appropriate equation to use is the one for which the desired T is greater than or equal to the entry in the T_0 column and less than the entry in the last column. The values of x_{ls}, x, and y for that month are then used in the equation below to find the desired value. The parameters x and y represent the offsets in time and frequency, respectively, between UTC(NIST) and AT1; the parameter x_{ls} is the number of leap seconds applied to both UTC(NIST) and UTC, as specified by the IERS. Leap seconds are not applied to AT1.

UTC(NIST) - AT1 = $x_{ls} + x + y(T - T_0)$					
Month	x_{ls} (s)	x (ns)	y (ns/d)	T_0 (MJD)	Valid until 0000 on: (MJD)
Aug 17	-37	-447765.9	-37.25*	57966	57997
Jul 17	-37	-447058.15	-37.25	57947	57966*
Jul 17	-37	-446612.35	-37.15	57935	57947†
Jun 17	-37	-446278	-37.15	57926	57935
Jun 17	-37	-445643.05	-37.35	57909	57926†
Jun 17	-37	-445492.85	-37.55	57905	57909†
May 17	-37	-445230	-37.55	57898	57905
May 17	-37	-444745.75	-37.25	57885	57898†
May 17	-37	-444448.55	-37.15	57877	57885†
May 17	-37	-444338	-36.85	57874	57877†
Apr 17	-37	-444190.6	-36.85	57870	57874
Apr 17	-37	-443935.45	-36.45	57863	57870†
Apr 17	-37	-443418.15	-36.95	57849	57863†
Apr 17	-37	-443231.4	-37.35	57844	57849†
Mar 17	-37	-443156.7	-37.35	57842	57844
Mar 17	-37	-442621.2	-38.25	57828	57842†
Mar 17	-37	-442099.7	-37.25	57814	57828†
Mar 17	-37	-442062.85	-36.85	57813	57814†
Feb 17	-37	-441325.85	-36.85	57793	57813
Feb 17	-37	-441029.45	-37.05	57785	57793†
Jan 17	-37	-439880.9	-37.05	57754	57785
Dec 16	-36	-439547.45	-37.05	57745	57754
Dec 16	-36	-439287.05	-37.2	57738	57745†
Dec 16	-36	-438770.45	-36.90	57724	57738†
Dec 16	-36	-438733.45	-37.00	57723	57724†
Nov 16	-36	-438030.45	-37.00	57704	57723
Nov 16	-36	-437694.75	-37.30	57695	57704†
Nov 16	-36	-437620.95	-36.90	57693	57695†
Oct 16	-36	-436956.75	-36.90	57675	57693
Oct 16	-36	-436510.35	-37.20	57663	57675†
Oct 16	-36	-436472.9	-37.50	57662	57663†
Sep 16	-36	-435910.4	-37.50	57647	57662
Sep 16	-36	-435350.9	-37.30	57632	57647†
Aug 16	-36	-434936.7	-37.65	57621	57632

† Rate change in mid-month

***Provisional value**