

GPS Time and Frequency Transfer Activities at NIST

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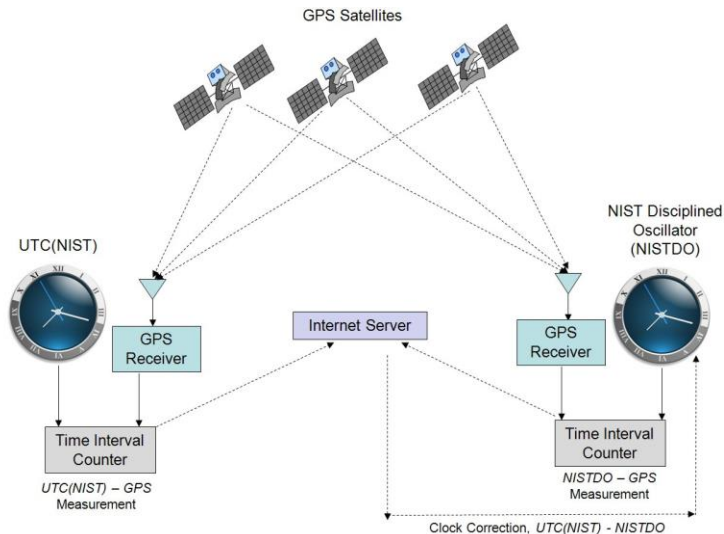


Code-Based Common-View

- Backup link for contributing NIST time scale to the computation of TAI and UTC
- Time and frequency comparison network in the Inter-American Metrology System (SIM)
- Synchronization of clocks in radio stations WWV/WWVB, and WWVH to UTC(NIST)
- Time Measurement and Analysis Service (TMAS)

Time Measurement and Analysis Service

- **Steer a remote clock to UTC(NIST) with the TMAS system**
- **The remote clock can be a NIST provided Rb clock or a customer's Cs clock**
- **Steering based on common-view difference every 10 minutes**
- **Averaged time offset < 1 ns, and time uncertainty < 15 ns after 1 day of averaging (k = 2)**



NIST Time Measurement and Analysis Service

Latitude	39° 59' min 43.725 s N	Date	2006-02-13	PRN	Time Est.	Seconds In View	Elev. Angle	PRN	Time Est.	Seconds In View	Elev. Angle
Longitude	105° 15' min 44.552 s W	Time	22:09:40	01	7	20891	10°	17	-6	22835	10°
Altitude (m)	1655.06	Filename	20060213.003	02	6	21888	12°	18	1	15618	45°
Samples	79777	Sawtooth	21	03	-6	24108	10°	19	3	24576	10°
Last Reading	3.02	Visible Sats	8	04	-9	19367	10°	20	7	23264	10°
Min Reading	-56.75	Sats In Use	8	05	-1	20938	13°	21	-7	17264	57°
Max Reading	14.55	Rx Temp.	30° C	06	4	14034	65°	22	-4	17739	10°
Range	71.30	Rx Status	Position Sent	07	12	22547	12°	23	-6	20569	10°
Mean Value	-1.25	Rx Code	8	08	10	22201	10°	24	-14	24567	10°
Midpoint	-21.10	Pos. Hold	ON	09	9	25277	10°	25	-8	21859	10°
Mean Diff	0.00			10	4	19568	24°	26	-3	16987	47°
STDEV Diff	3.18			11	14	27537	10°	27	-1	23670	12°

TIC Cal Time	2006-02-13:00:00:01	PRN	LO Phase	dBm	
Start Range	2370 - 6423	CH1	16	260834	-123
Stop Range	2152 - 6945	CH2	18	260846	-117
Start Res (ps)	25	CH3	15	246690	-122
Stop Res (ps)	26	CH4	6	246676	-120
TIC Delay (ns)	-0.41	CH5	10	246676	-121
TIC Time Base	5 MHz	CH6	29	246683	-118
		CH7	26	246683	-116
		CH8	21	246687	-115

Contact: Time and Frequency Division in Boulder
 Laboratory: National Institute of Standards and Technology
 Reference: UTC(NIST)-CV3

SIM ID: 3 Ref Delay: 442.3 Rx Delay: 82.1 Mask: 10 FTP: Y

Buttons: Go, Stop, Antenna Survey, Coordinates, TIC Calibration, Quit

- **Monitor the customer's local time standard by continuously comparing it to the national time standard using GPS common-view**
- **Comparison result is available in every 10 minutes**
- **Time transfer Uncertainty < 15 ns, and frequency uncertainty < 5 x 10⁻¹⁴ after 1 day of averaging (k = 2)**

For details of the TMAS, contact Michael Lombardi: michael.lombardi@nist.gov



Code-Based One-Way

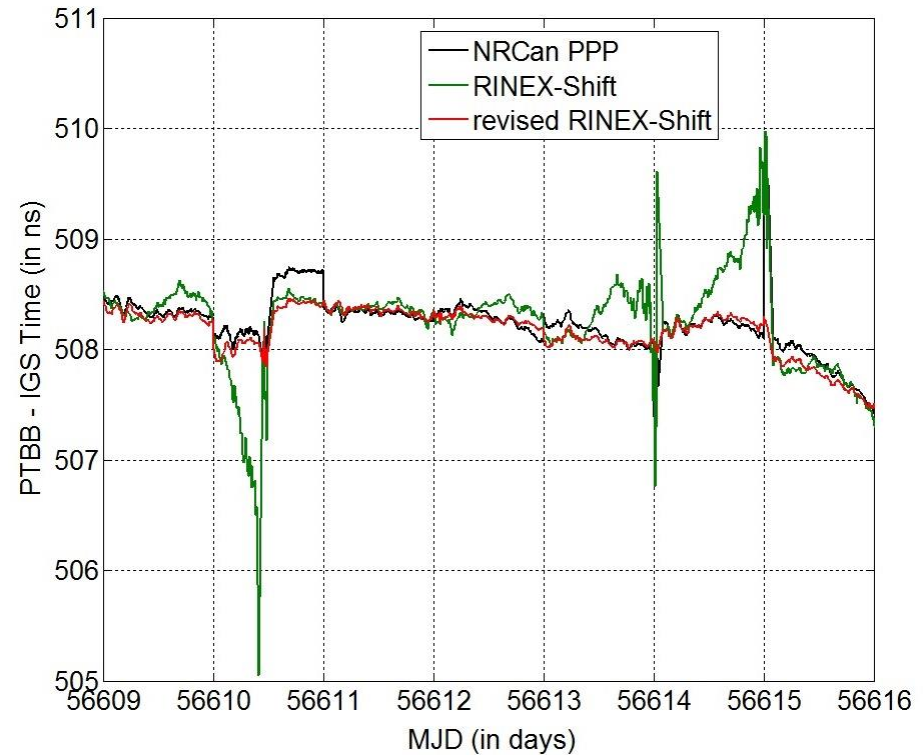
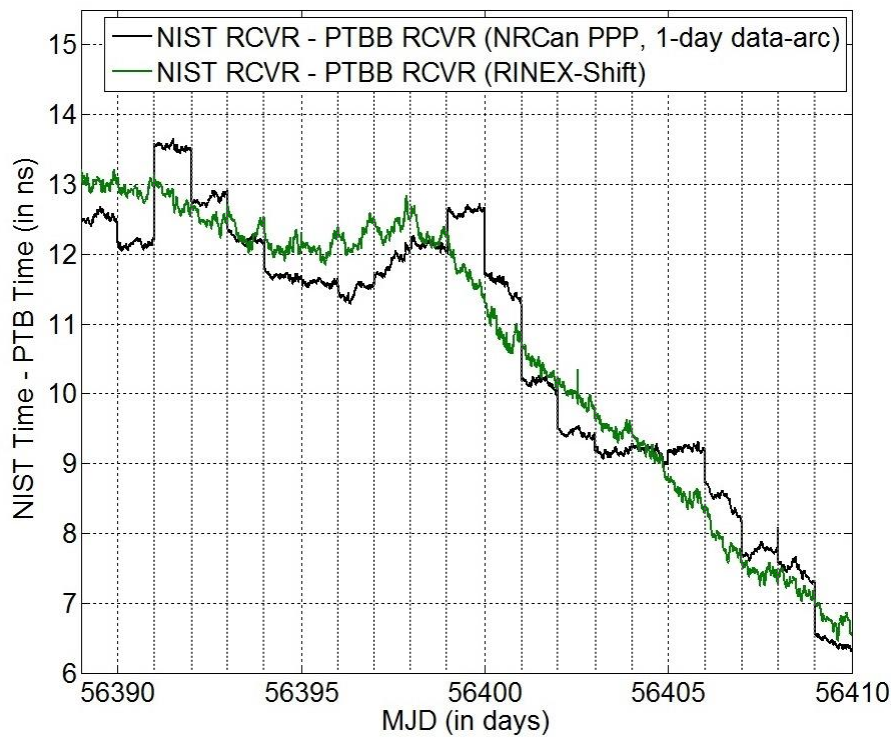
- Frequency Measurement and Analysis Service (FMAS)
- GPS Disciplined Oscillator and GPS One-Way Receiver Calibration Service
- NIST GPS Data Archive

Carrier-Phase (1)

- Contribute NIST time scale to the computation of TAI and UTC, and compare remote clocks with the BIPM TAIPPP results
- Participate in the IGS tracking network
- Compare remote clock with the IGS clock products
- Analyze carrier-phase data for studies of receiver performance and remote clock comparison

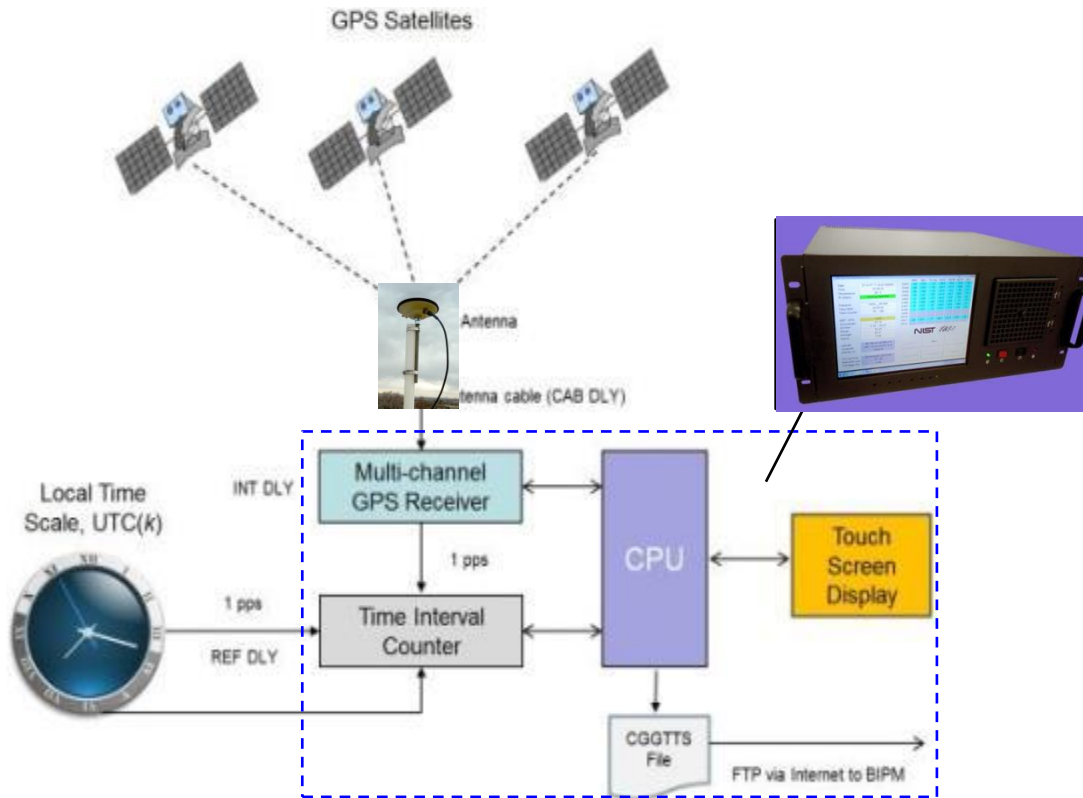
Carrier-Phase (2)

The RINEX-Shift algorithms for minimizing data boundary discontinuity



“An Improvement of RINEX-Shift Algorithm for Continuous GPS Carrier-Phase Time Transfer” to be presented during ION GNSS+ 2014 by Jian Yao and Judah Levine, Contact: jian.yao@boulder.nist.gov

NIST TAI-1 GPS Time Transfer Receiver

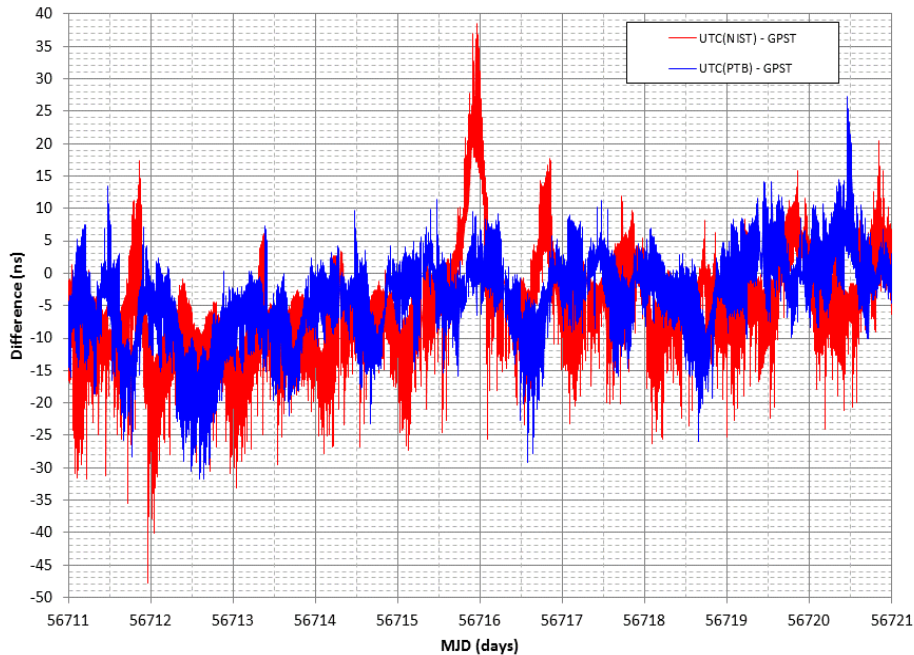


- Low cost, suitable for timing labs with limited resource
- Used for common-view/all-in-view time and frequency transfer
- Able to survey antenna coordinates
- Data in the CGGTTS format, ready for the BIPM TAI/UTC computation
- Time transfer uncertainty < 15ns ($k = 2$)

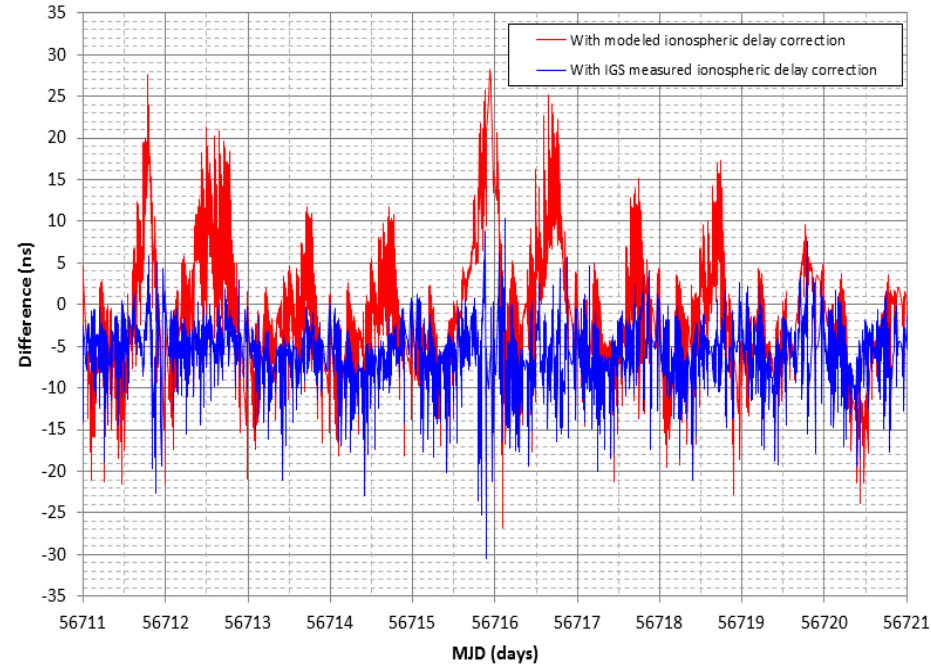
For details about the receiver, Contact Michael Lombardi: michael.lombardi@nist.gov

Solar Flare and GPS Time Transfer

REF - GPST Measurements with Modeled Ionosphere Delay Correction



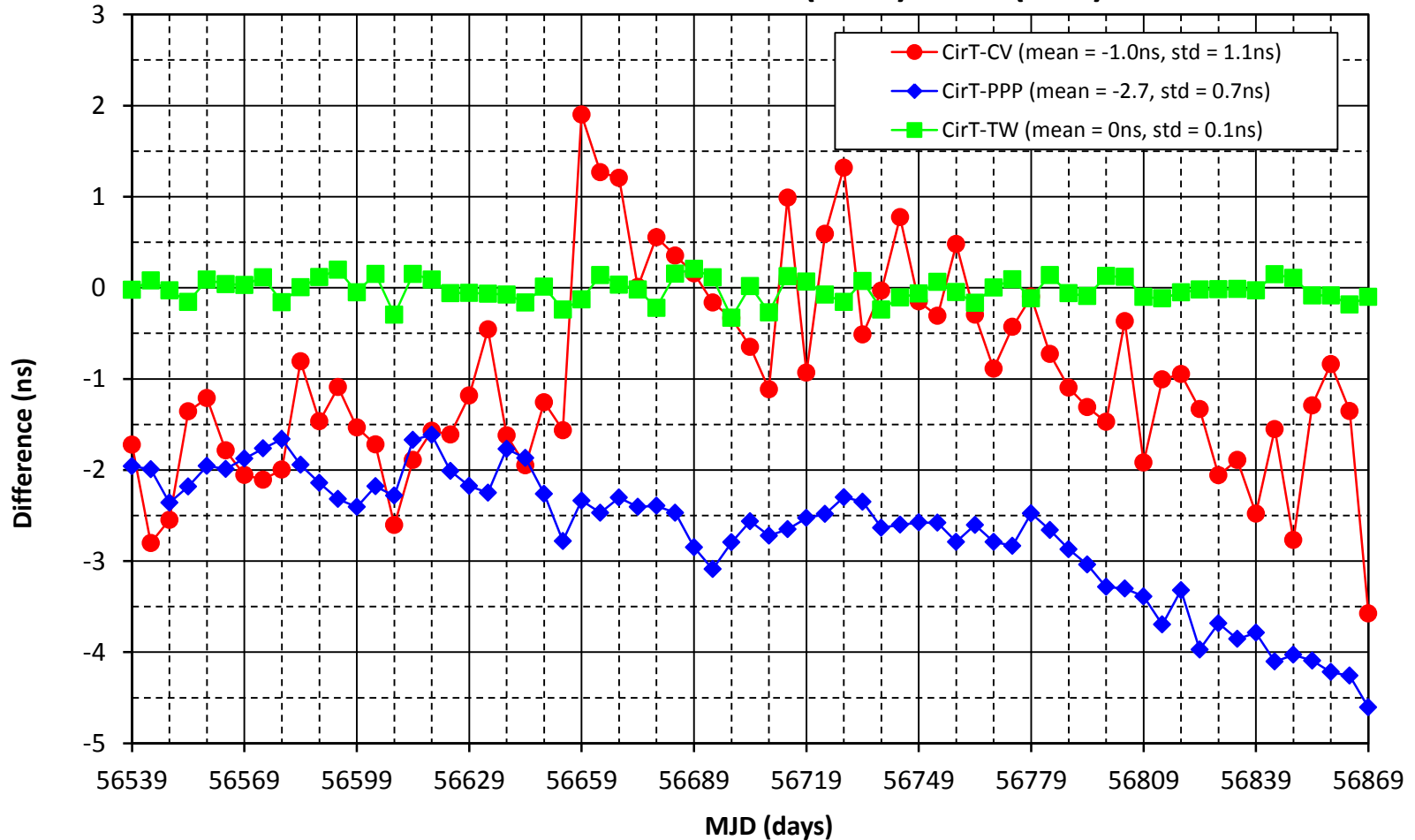
UTC(NIST) - UTC(PTB) Common-View Difference



The modeled ionosphere delay correction is effective in dark (nighttime), but inadequate to handle the ionosphere delay change due to the daytime solar activity.

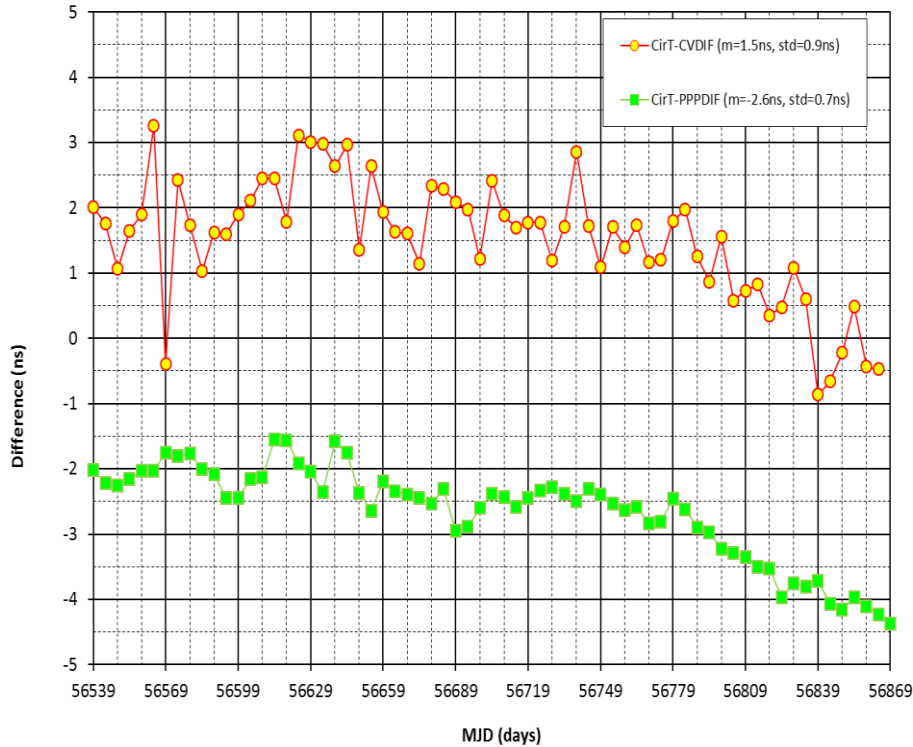
Primary Receiver Performance

Double Differences for UTC(NIST) - UTC(PTB)

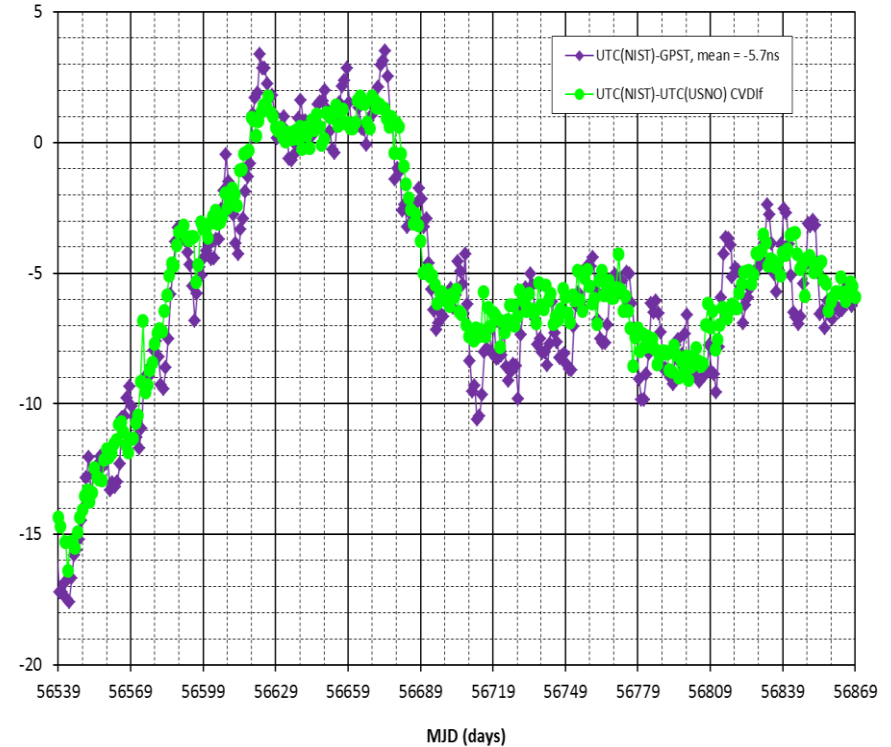


Primary Receiver Performance

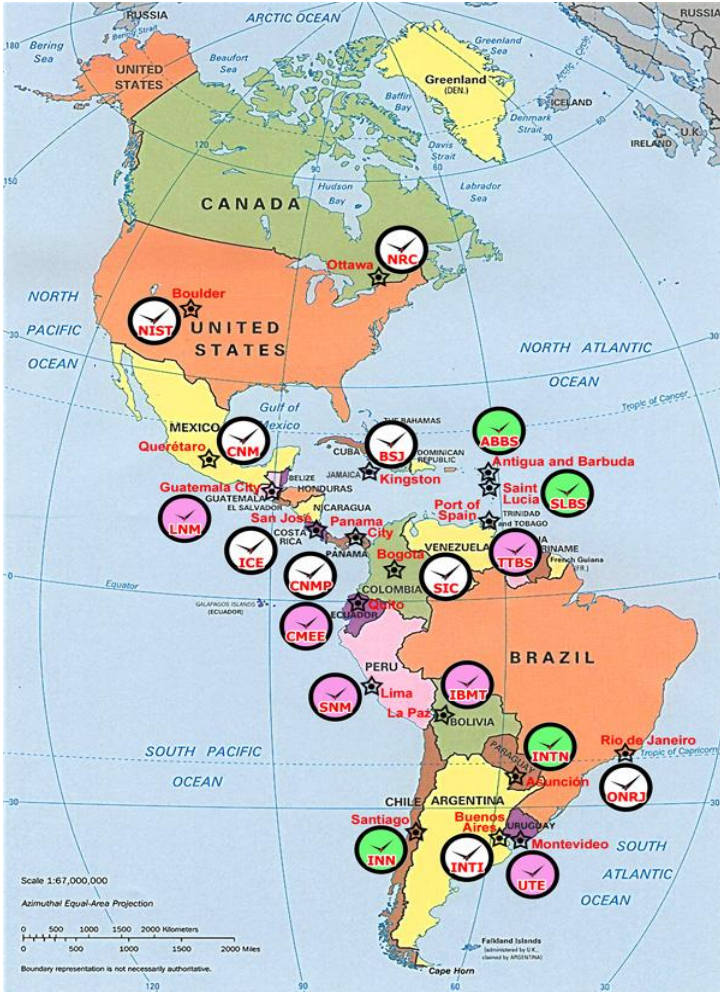
Double Difference for UTC(NIST) - UTC(USNO)



UTC(NIST) - GPS Time and UTC(NIST)-UTC(USNO) via Common-view



Time and Frequency Comparison Network in the Inter-American Metrology System



SIM Time Scale

(SIMT - SIMT(*k*) for the 1-hour period ending on 2014-08-21 at 20:20:00 UTC)

National Standard	National Flag	SIMT - SIMT(<i>k</i>), ns	SIMT Contribution	National Standard	National Flag	SIMT - SIMT(<i>k</i>), ns	SIMT Contribution
United States SIMT(NIST)		14.54	37.93 %	Uruguay SIMT(UTE)		—	0.00 %
Canada SIMT(NRC)		-42.34	22.77 %	Paraguay SIMT(INTN)		-16.55	0.00 %
Mexico SIMT(CNM)		-5.90	10.06 %	Trinidad SIMT(TTBS)		272.64	0.00 %
Brazil SIMT(ONRJ)		4.46	8.81 %	St. Lucia SIMT(SLBS)		20.04	0.00 %
Costa Rica SIMT(ICE)		-109.66	6.20 %	Chile SIMT(INN)		14.44	0.00 %
Peru SIMT(SNM)		35.69	4.79 %	Antigua SIMT(ABBS)		6.34	0.00 %
Argentina SIMT(INTI)		-9.63	3.53 %	Ecuador SIMT(CMEE)		122.24	0.00 %
Colombia SIMT(INM)		-115.01	3.31 %	Bolivia SIMT(IBMET)		35.34	0.00 %
Panama SIMT(CNMP)		-14.72	2.57 %	St. Kitts SIMT(SKNBS)		—	0.00 %
Guatemala SIMT(LNM)		—	0.00 %	Guyana SIMT(GNBS)		—	0.00 %
Jamaica SIMT(BSJ)		—	0.00 %	Belize SIMT(BBS)		—	0.00 %

Click on a SIMT - SIMT(*k*) value to view today's graph. New values are computed at 30 minutes after the hour. This table was updated at 21:23:11 UTC and refreshes every 30 minutes.



NIST GPS Time and Frequency Transfer Service

- Frequency Measurement and Analysis Service (FMAS)
(*Service ID#76100S*)
- Time Measurement and Analysis Service (TMAS)
(*Service ID#76101S*)
- ~~Global Time Service (*Service ID#76110S*)~~
- Characterization of Global Positioning System (GPS) Satellite Receivers (*Service ID#76120S*)

http://ts.nist.gov/ts/htdocs/230/233/calibrations/time_freq/broadcast.htm

GPS Data Archive [GPS - UTC(NIST) all-in-view]

<http://tf.nist.gov/service/gpstrace.htm>

