The Open Traceable Time Platform

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Open source hardware and software for dissemination of traceable time and frequency

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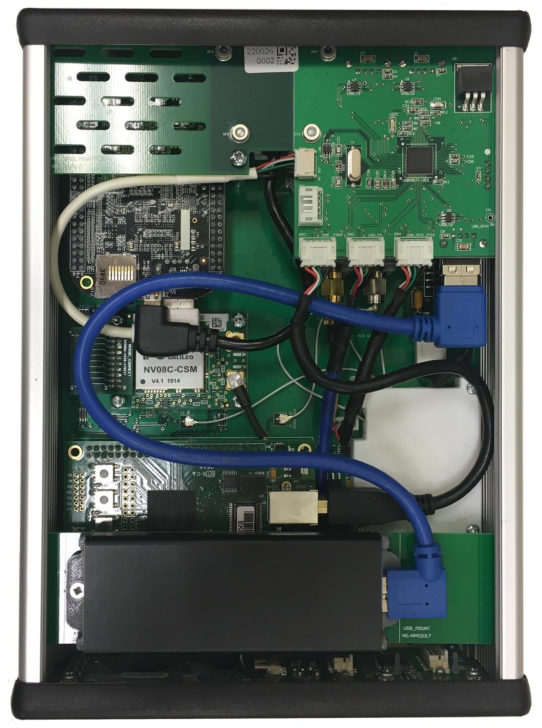
Aims

- All hardware designs and software to be openly available to promote co-operation.
- Reference design to use low-cost, self-contained hardware (<$US2000).
- Produces CGGTTS and RINEX time-transfer files.
- Easy customization.
- Easy extension to new GPS/GNSS receivers in view of the typical product lifetimes for the low-cost receivers being used.
- To support the development of services.
- To develop technical capabilities in participating NMIs.

Project history

Nov 2014 Project proposed to APMP
Mar 2015 Project funded
Aug 2015 Initial software commit to GitHub
Oct 2017 Prototype systems delivered

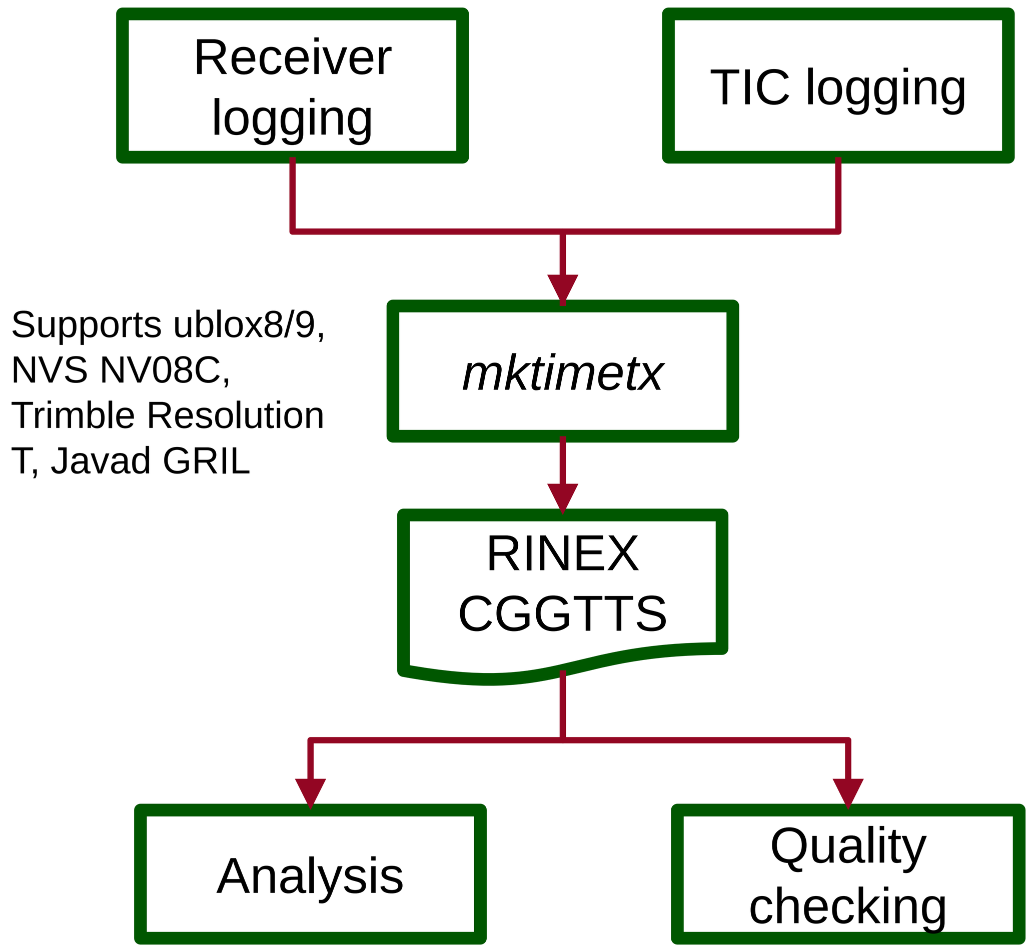
Hardware



GPS time-transfer receiver	NVS Technologies NV08C-CSM, 32 channels, GPS/GLONASS L1
Reference oscillator	Jackson Labs LTE-lite GPSDO
Multi-channel time-interval counter	Opal Kelly XEM6001 FPGA
Processing	BeagleBone Black single-board computer
Storage	Solid state disk

Software

GNSS time-transfer



Time-transfer software

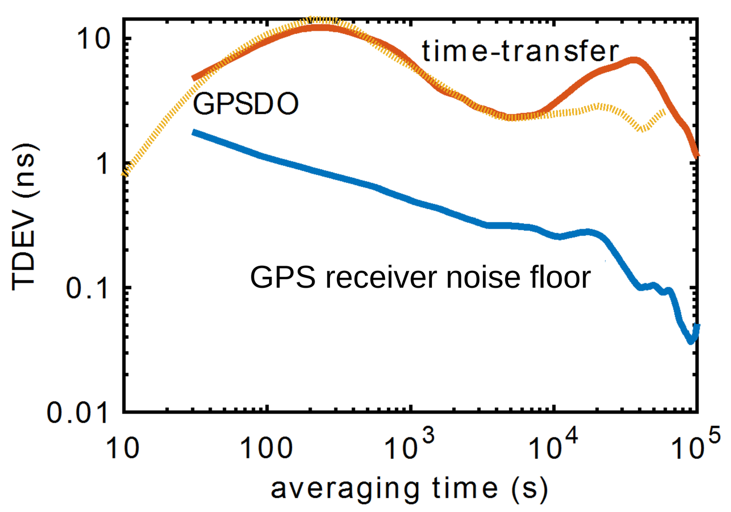
- mktimetx
- receiver and counter logging and configuration
- data quality checking
- CGGTTS comparison
- IGS data product downloading
- RINEX editing

System software

- process supervision
- FPGA management
- LCD interface
- daemon for multi-channel TIC access
- monitoring and alarm system

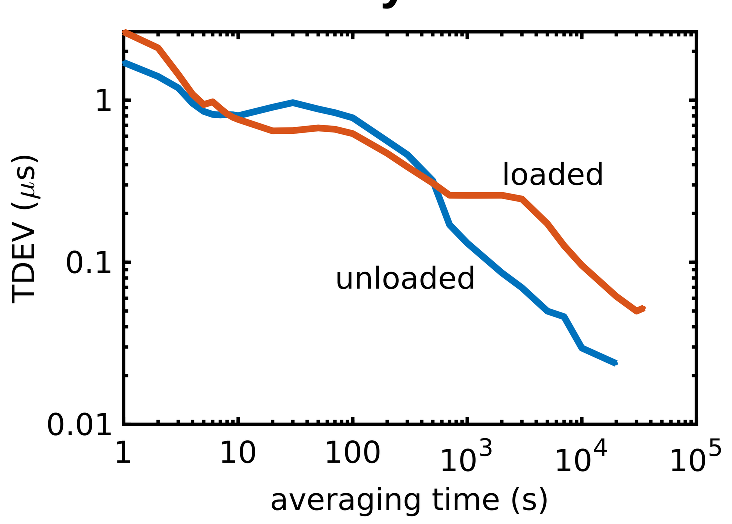
Time stability

GPS common-view time-transfer

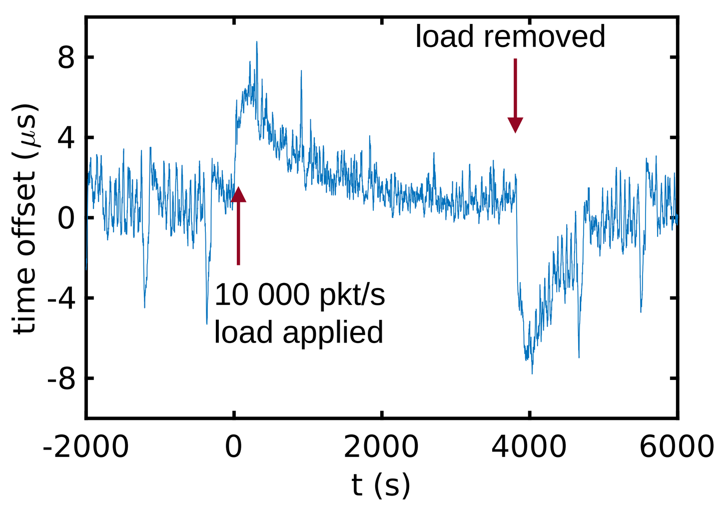


Time-transfer over a 2000 km baseline using broadcast ephemeris and Klobuchar ionosphere. The receiver noise floor is determined via a common clock and antenna comparison with a Septentrio PolaRx4TRPRO.

SBC system time



Response to NTP load



Time of day applications

Uncertainty budget

Component	U_i (μs)	k_i	u_i (μs)
GPSDO TDEV	0.02	1	0.02
GPSDO internal delay	0.002	1	0.002
software clock TDEV	5	1	5
interrupt latency	5	1.73	3
time-stamping latency	1	1.73	0.6
system loading	5	1.73	3
	combined uncertainty		6.5
	expanded uncertainty		13

Calibration of receiver internal delay

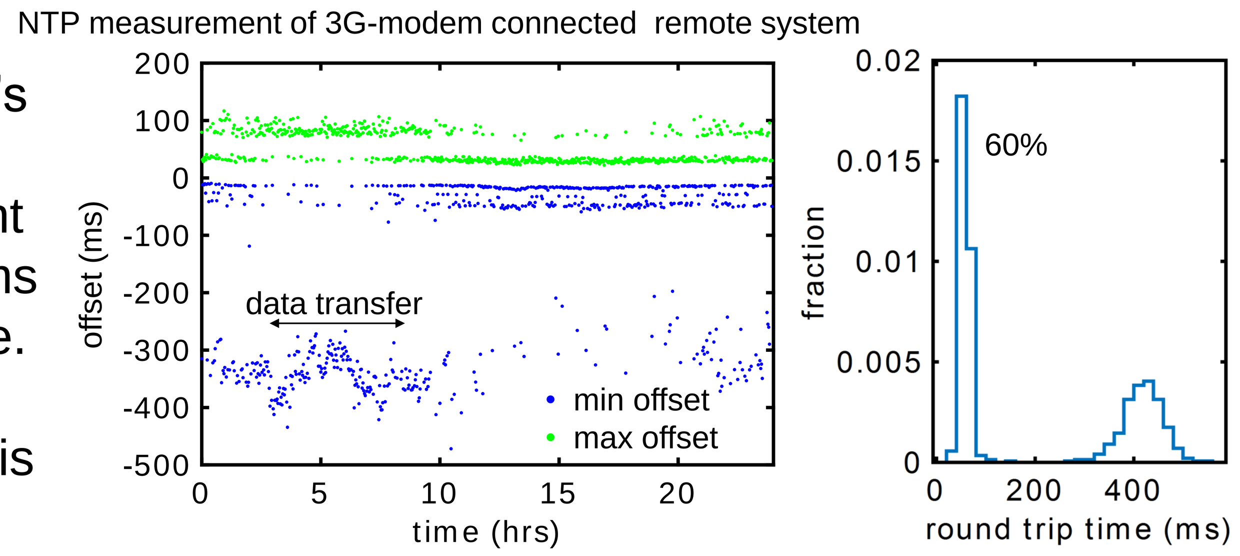
Delays are calibrated via a common-clock comparison with a calibrated receiver.

The measured delays of four systems have a std. dev. of about 2 ns.

NTP auditing

Monitor time on a client's device eg point-to-point legal speed enforcement systems, trading systems in a securities exchange.

The largest uncertainty is the network delay.



Current availability

All software is publicly available for download from GitHub
github.com/openttp
The reference hardware design is also available in schematic form from GitHub. PCB designs are available on request.

Future developments

- Multi-GNSS support (in progress)
- Improved TIC resolution
- Raspberry Pi version
- Currently testing the ublox ZED-F9P/T as a possible future receiver: 178 channels, multi-GNSS, dual frequency

Acknowledgment
This work was supported as a Technical Committee Initiative of the APMP Technical Committee for Time and Frequency