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Test Report

Big Ben Software Time Server Test Report– PC time synchronisation products

FOR:	Big Ben Software Products Ltd. Contact: Steve Bullman <info@bigbensoftware.com>
DESCRIPTION:	Test report of Big Ben software performance as a time synchronisation tool for PCs running Microsoft Windows.
DATE OF RECEIPT:	2021-09-02
DATE(S) OF TEST:	Test 1: 2021-12-13 - 2021-12-20 Test 2: 2021-12-24 - 2021-12-31 Test 3: 2022-01-18 Test 4: 2022-01-24

Date of Issue: 18/03/2022

Signed: J A Davis

(Authorised Signatory)

Checked by: Peter Whibberley

Name: John Davis

on behalf of NPLML

ORIGINAL SCOPE
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Company name: Big Ben Software
Project name: GPS MSF Big Ben Time Server
Technical Lead name: Adam Peverell (Higher Research Scientist)
NPL reference number: 10588
Start date of support work: 2021-09-13
End date of support work: 2021-12-13
Number of days of NPL support: 20

Project Aim:
To test the GPS MSF Big Ben Time Server software in order to determine the precision and accuracy with which it conforms to the reference time scale at NPL, under test conditions employing commonly available hardware modules and a consumer-grade computer.

Equipment:

- 2 x commercially available GPS modules compatible with standard PC interface (USB) (purchased from online stores)
- 2 x commercially available MSF receiver modules compatible with standard PC interface (USB) (1 borrowed from client due to cost limitations, 1 set of electronic components for assembly)
- Adapters and cables
- Reissue PC/laptop from NPL IT department

Test Plan:

- Set up computer as an NTP time server
- Set the time with the Big Ben software
- Connect the selected hardware
- Measure the time offset between the test computer system time and our reference as observed on a lab PC running logging software, and connected as a client via NTP to NPL time server and the test computer.
- Expected accuracy of measurement system ~ 1 ms
- Expected accuracy of test system 100 ms – 1 s
- Test duration: 1 week for each hardware system (x 4)
- Report results of tests with statistical and graphical analysis.

Timeline:

Week 1-2: sourcing equipment
Week 3-4: test system setup
Week 5-10: test runs
Week 11-12: analysis/report preparation

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TEST DESCRIPTION

Purpose

The Big Ben time server software provides an 'offline' Windows PC time sychronisation tool. This tool takes timing data from a local GPS or MSF receiver connected to the PC and uses it to set the Windows system clock. The aim of this test project was to measure the timing accuracy of the resulting Windows system time as set by the Big Ben software. Several GPS receivers of a standard 'consumer'-grade type with USB connections were procured to provide a range of data for the tests.

Equipment

- Test Computer model: Dell Latitude 7480
- Test Computer specifications: i5-6300U 2.4 GHz 8 GB
- Test Computer Operating System: Microsoft Windows 10 Enterprise 1909 (Network Time synchronisation disabled)
- External Timing Receiver 1: GlobalSat BU-353-S4 USB GPS Receiver (SiRF Star IV/Black)
- External Timing Receiver 2: EverMore SA-320 GPS Receiver
- External Timing Receiver 3: Beitian USB Marine GPS Receiver BP-572U

Software

- Windows Terminal
- Windows Powershell
- Windows Command Line
- Windows Subsystem for Linux
- NTPdate

Notes

- Location: Indoor office beside window
- Reception: Restricted sky view but consistently 5+ satellites in use as reported by software

Method

For each test run, the receiver was connected via USB to the test computer, and the Big Ben software was initialised with the relevant settings to start synching the computer system time with the receiver. The test computer was also connected to the NPL network with a LAN connection to the NPL time stratum 1 NTP servers.

A script was run on the test computer to compare the local system time with the NPL time servers, by performing an offset calculation with the Network Time Protocol. NTP algorithms on a wired network reliably produce sub-millisecond accuracy for the measured offsets.

Measurement Uncertainty and Justification

There are several difficulties with providing an accurate assessment of uncertainties in these tests particularly when identifying the source of the uncertainties. The base measurement of time offset between the computer clock and the central server is conducted using the standard NTP protocol.

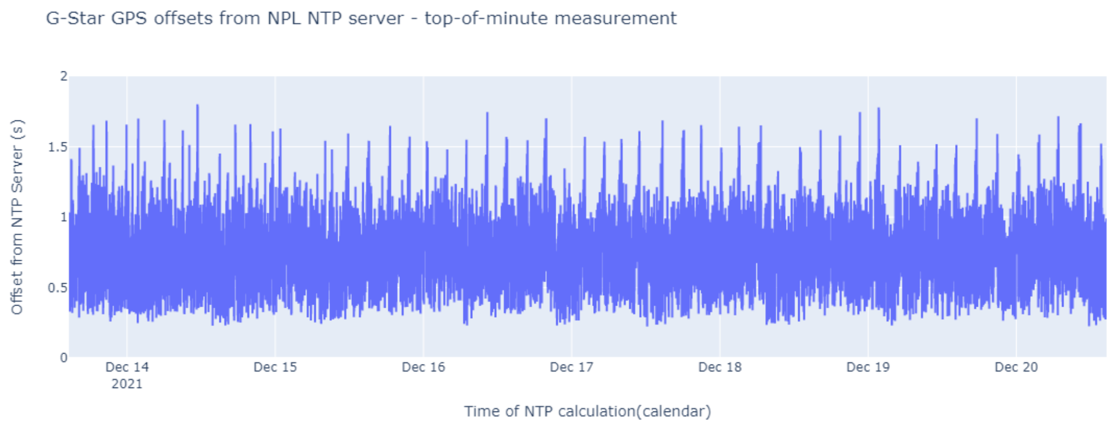
NTP measurements of time offsets within the NPL network against dedicated NPL time servers are regularly monitored and can be relied on for sub-millisecond accuracy. All measurements in this test report have thus been conservatively estimated at 1 ms. This means that the errors originating from the GPS modules and their interactions with the computer during synchronisation are much larger in magnitude than any errors in the offset calculations and are thus not displayed explicitly.

It is outside the scope of this project to evaluate the accuracy of the GPS receivers themselves, or to separate out the uncertainty due to different sources, as the uncertainties are necessarily a combination of the receiver, the communications interface (i.e. RS-232 to USB), the synchronisation software, and the operating system.

The measurements are meaningful despite these uncertainties in that a regularly synchronising time system that does not display long term drift has an accuracy represented by its mean offset, and a precision represented by the spread of the offset measurements (in the following tests we have reported standard deviation as a proxy for this). In the context of providing an absolute time for synchronisation, the expectations of the end user thus determine the acceptable uncertainty of the combined system of receiver and software.

An offset drift that remains uncorrected over human-noticeable timescales and with human-noticeable offsets (e.g. minutes or hours), is considered to be in practice not synchronising as it would not meet the minimum expected needs of a non-technical user i.e. to represent the correct time to within the accuracy that can be read by eye .

TEST 1 RESULTS – GlobalSat G-star module synched with Big Ben software
2021-12-13 – 2021-12-20

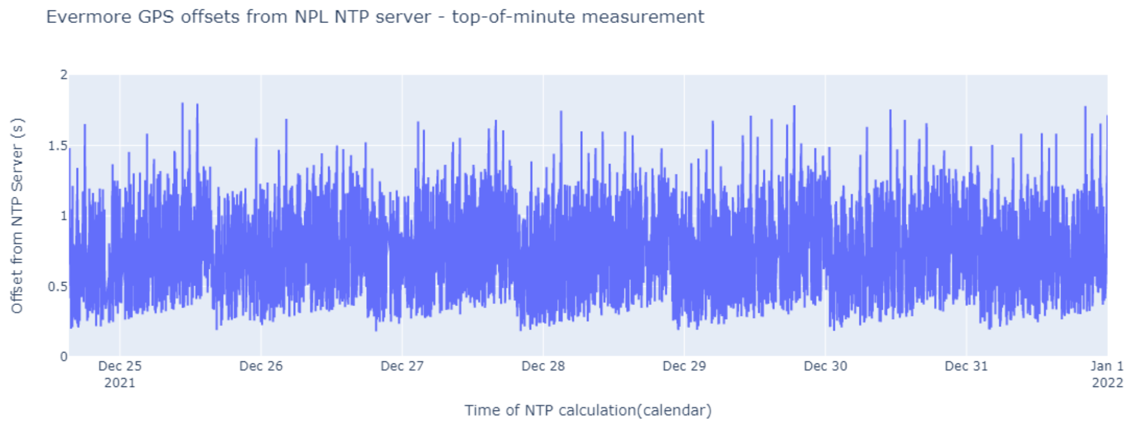


gstar mean offset: 0.75 s
gstar offset standard deviation: 0.26 s

Comments

The Big Ben software synched the GlobalSat module and the PC time over the course of a week with a mean offset of less than a second, and little comparable drift. At this scale of accuracy and precision, the accuracy of the NTP calculations is orders of magnitude better than the measured values, and should not significantly affect the results.

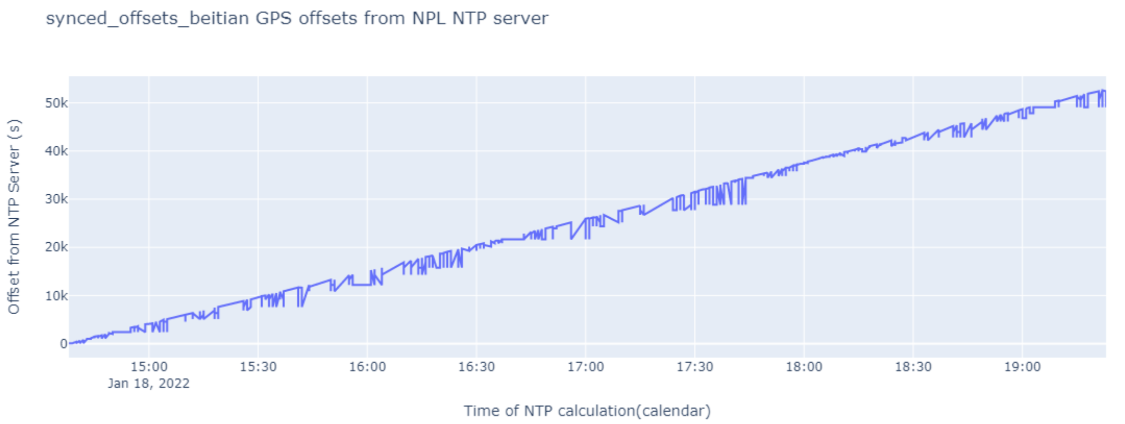
TEST 2 RESULTS – EverMore module synched with Big Ben software
2021-12-24 – 2021-12-31



evermore mean offset: 0.73 s
evermore offset standard deviation: 0.27 s

<u>Comments</u>
The Big Ben software synchronised the Evermore module and the PC time over the course of a week with a mean offset of less than a second, and little comparable drift. Compared with the GlobalSat test (see Test 1 Results) there is some sawtooth behaviour in the time offsets, however the accuracy and precision are similar overall. At this scale of accuracy and precision, the accuracy of the NTP calculation is assessed to be orders of magnitude less than the measured values, and should not significantly affect the results.

TEST 3 RESULTS – Beitian module synched with Big Ben Software
2022-01-18

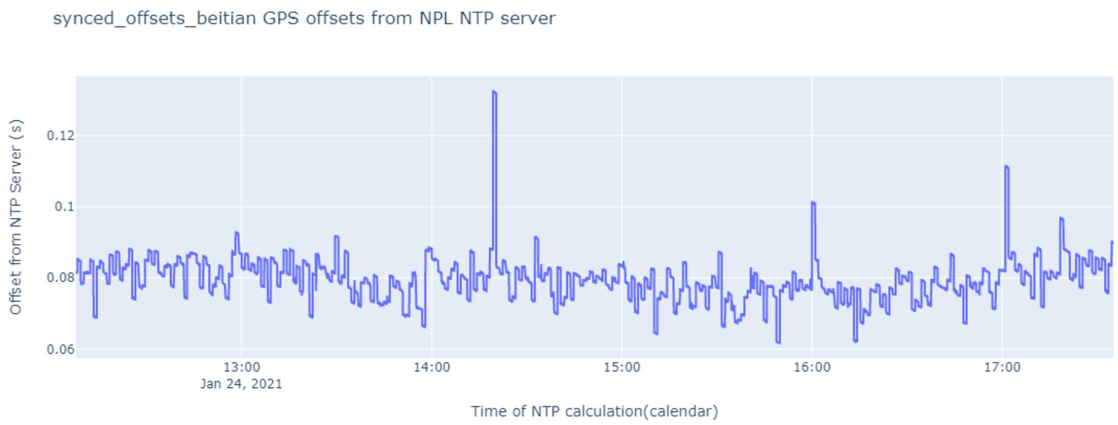


Checked by: Peter Whibberley

Comments

The Big Ben software synchronised the Beitian module and the PC time, and when first started the time was approximately correct, however as can be seen from the graph, in only a few hours the synched computer time drifted drastically away from the actual time as measured from the NTP servers. This discrepancy was observed over multiple tests at different times with that particular reciever, despite the receiver itself apparently working correctly (see Test 4 Results), and the NTP measurement method being reliable for all other tests. This test was not run for a full week as the time error was so big and the test had to be repeated to ensure it was a repeatable result.

TEST 4 RESULTS – Beitian module synched with Powershell script
2022-01-24



beitian mean offset: 0.079 s
beitian offset standard deviation: 0.006 s

Comments

This test was done as a way to confirm/explain the results of Test 3, as the results of that test showed a relatively large drift in the timing offset between the computer system time, as set by the Big Ben Software, and the NTP server used as a reference. The goal was to try to eliminate within reason the possibility that the large timing error observed was due to the test methods or the hardware used.

In order to confirm the reliability of the GPS module, a short Windows powershell script was created to read the time output of the GPS module directly. The serial data sent from the module was read from the Windows COM port in question, the NMEA sentences were parsed, and the time detected was used to set the system clock on the computer. At that stage the same measurement method was used as for the other tests, with an NTP offset calculation. The results show that the Beitian receiver was quite accurate based on the raw output, and so it seems reasonable to conclude that the receiver itself was performing as expected, and the measurement method was reliable.

FINAL COMMENTS

- The MSF receiver test was abandoned as the data was not reliable. Some inconsistency was observed between the time on the receiver module display and the time reported by the software. As this was a pre-used unit provided by the customer no conclusions have been drawn as to the source of the error, as it was conceivably due to receiver malfunction. Purchasing an equivalent new MSF receiver was outside the budget of the project.

- The Big Ben software showed consistent offsets from the NPL time server for the Evermore and GlobalSat G-star GPS receivers of less than a second, and standard deviation of less than 0.3 s. For normally distributed data this would correspond to 95% of the data points having an offset between 0.1 s and 1.3 s, and although there are some obvious non-random effects evident in the data it is still a useful measure.

- The Big Ben software showed inconsistencies in the reported and synched timing data compared with the NMEA data directly read from the serial output of the Beitian GPS receiver. It was a newly purchased unit, and according to our tests was outputting timing data with less than 100 ms mean offset from the NTP server, and a standard deviation less than 10 ms (see Test 4 Results). The large drift value observed in the Big Ben synched times (see Test 3 Results) thus appears to be some incompatibility between the Big Ben software and the Beitian receiver.