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A STRATUM 1 NTP STAND ALONE TIME SERVER FOR STAR OCCULTATIONS

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Abstract. An asteroid passing in front of a star casts its shadow on the Earth for a period depending on its relative speed and size. It is therefore a phenomenon that provides valuable information on its physical characteristics. But it is also a potentially very short transient phenomenon, often less than a second. A sampling as fast as possible with a time base as precise as possible are two essential conditions for the quality of the measurements.

Keywords: Asteroid, occultation, NTP time server, Raspberry Pi, GPS

1 Introduction

The occultation of a star by an asteroid travelling along the line of sight is a phenomenon occurring on a very specific and unique projection line. Its observation therefore often implies to move on the ground where the only good conditions of access to a good time reference necessarily pass by the GPS and its 1PPS signal (one pulse per second). Another key parameter is a good knowledge of the acquisition delay of the experimental setup*.

2 Experimental setup

The equipment used is listed here:

- A PC with image or video acquisition software (SharpCap† recommended), which will also serve as a router for :
- A Raspberry Pi‡, connected to the PC with an RJ-45 crossover cable
- A Uputronics GPS/RTC card§ with GPS antenna, connected to the Raspberry, for 1PPS signal acquisition. The antenna to be connected to the ad hoc socket must be placed in such a way as to receive the GPS signal correctly.

3 Method

The Raspberry Pi and the NTP and GPS daemons installed on it¶ constitute a time server called "stratum 1", in other words the first level just behind the 1PPS signal from the GPS card connected to it. This time server is used to synchronize the internal clock of the PC according to a determined frequency (typically every 10 s). This is done through the graphical interface of the Meinberg NTP time monitor server‖. This setup does not require an Internet connection, so it is completely mobile for use anywhere.

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*See Le Cam, this book.
†`https://www.sharpcap.co.uk/sharpcap/downloads`
‡`https://www.raspberrypi.com/products/`
§`https://store.uputronics.com/index.php?route=product/product&product_id=81`
¶The reader is invited to refer to resources online: `https://xincto.me/2020/05/raspberry-ntp-stratum-1.html` for the detailed implementations of software resources on the Raspberry Pi.
‖`https://www.meinbergglobal.com/english/sw/ntp-server-monitor.htm`

4 Results

The Fig. 1 shows the real-time synchronisation of the PC clock by the Raspberry Pi (with IP 192.168.11.2 distributed by the PC as its router) which uses the PPS signal as a stratum 1 reference. The offset is here 0.149 ms. On the left of Fig. 2 are shown daily statistics of the offset. The plot shows the ones of June, 7th, 2022, for which the offset is in absolute value 263 μs at most, well below the ms regime when the process of synchronisation is stabilised. In comparison, the right of Fig. 2 shows the offsets obtained when connected to NTP servers. The one from the US (`time.nist.gov`) shows peaks of offset as high as 20 ms in absolute value, while the one from the Paris Observatory (`ntp.obspm.fr`) is more stable since closer on Internet to the PC. Both remain far from the device presented here in terms of time accuracy.

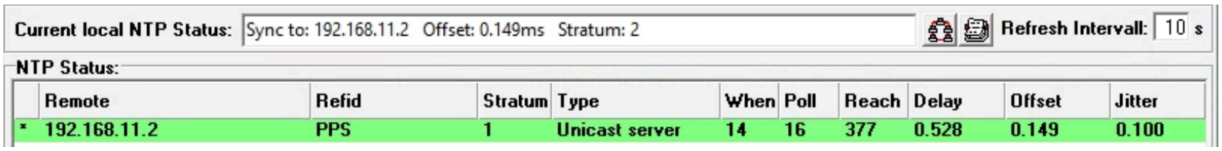

Fig. 1. Real-time synchronisation of the PC clock through Meinberg NTP. The green line indicates a correct lock on GPS.

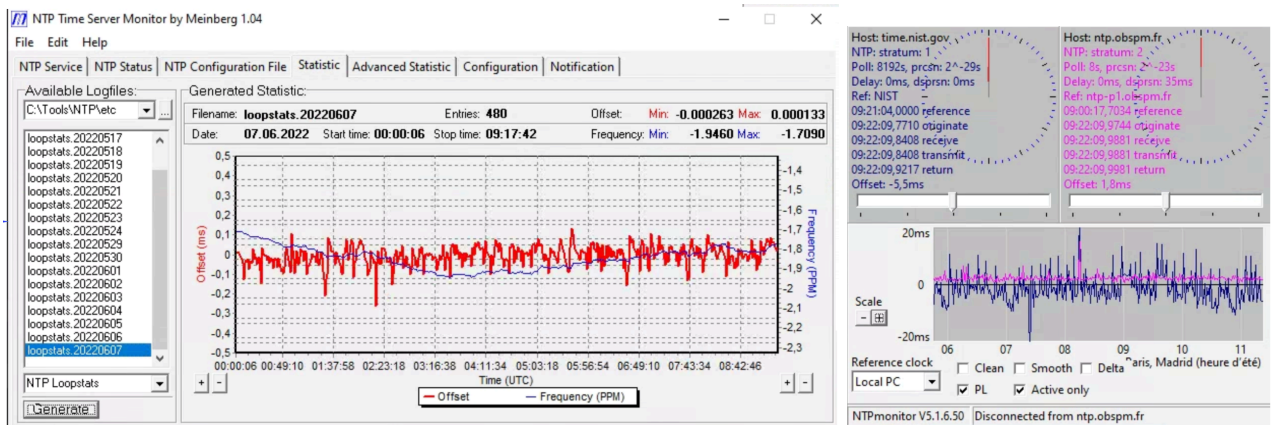

Fig. 2. Left: Daily statistics of the offset of June, 7th, 2022. **Right:** Comparison to NTP servers: from the US (blue, left), and Paris Observatory (pink, right). The latter appears more stable since closer on Internet to the PC.

5 Conclusions

A stratum 1 NTP stand alone time server has proven to be very efficient compared to resources available on the Internet and much more flexible in terms of portability.