SCPTime®

Calibrating NTP

INTRODUCTION

Context

The Network Time Protocol (NTP) is one of the most widely used protocols for clock synchronization. NTP uses UDP over packet-switched networks to synchronize clocks between one or several time servers and clients.

Issue

The accuracy of NTP time synchronization depends on the validity of the assumption related to symmetric transmission delays between the client and the server. If this assumption does not hold, which is a common case in the current Internet, the NTP synchronization scheme results in significant errors.

Goal

We propose a method to improve the accuracy of NTP time synchronization by taking into account asymmetric transmission delays due to different bandwidth or routing on the forward and backward paths.

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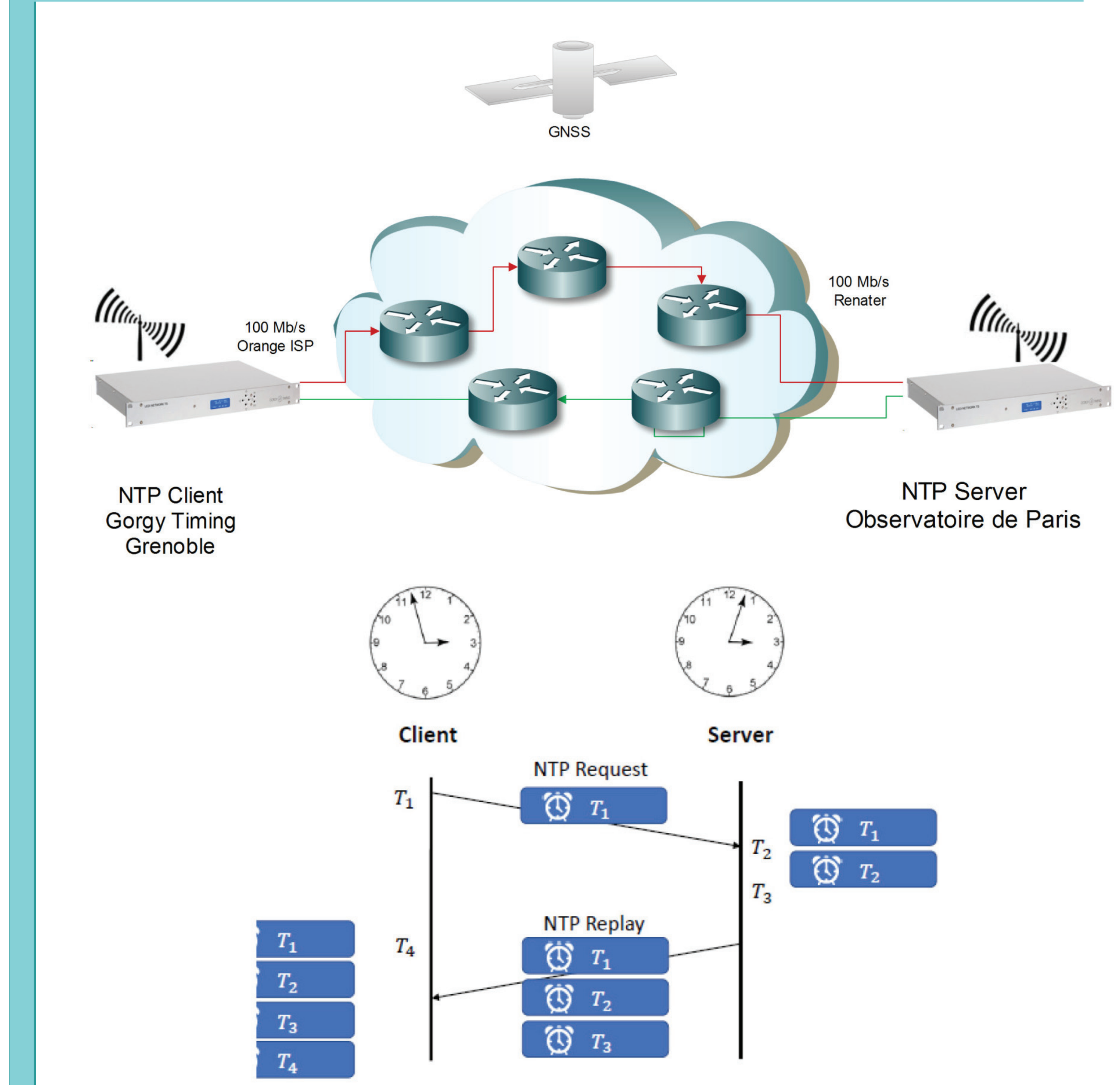
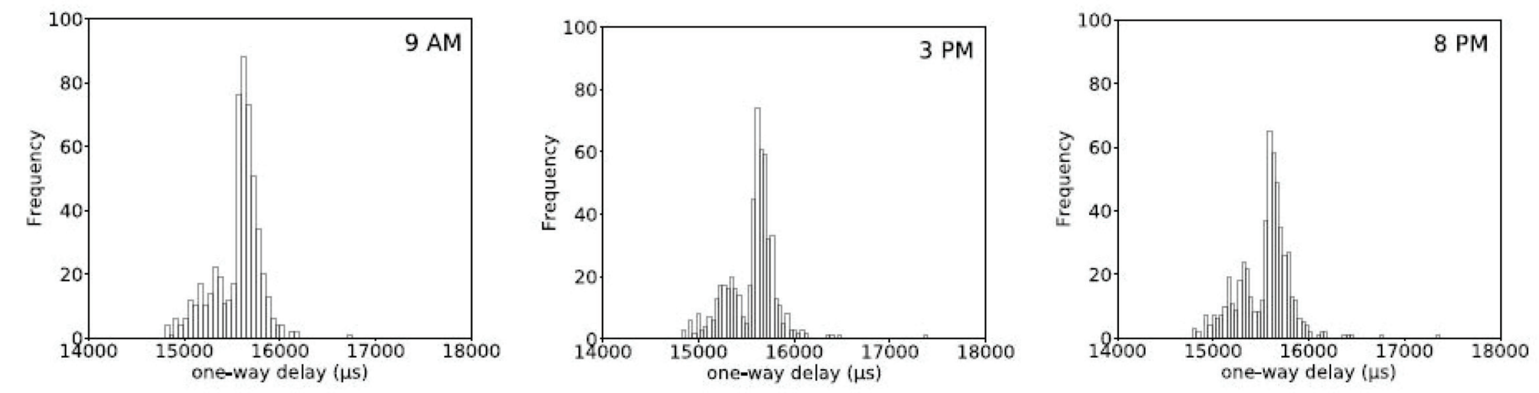
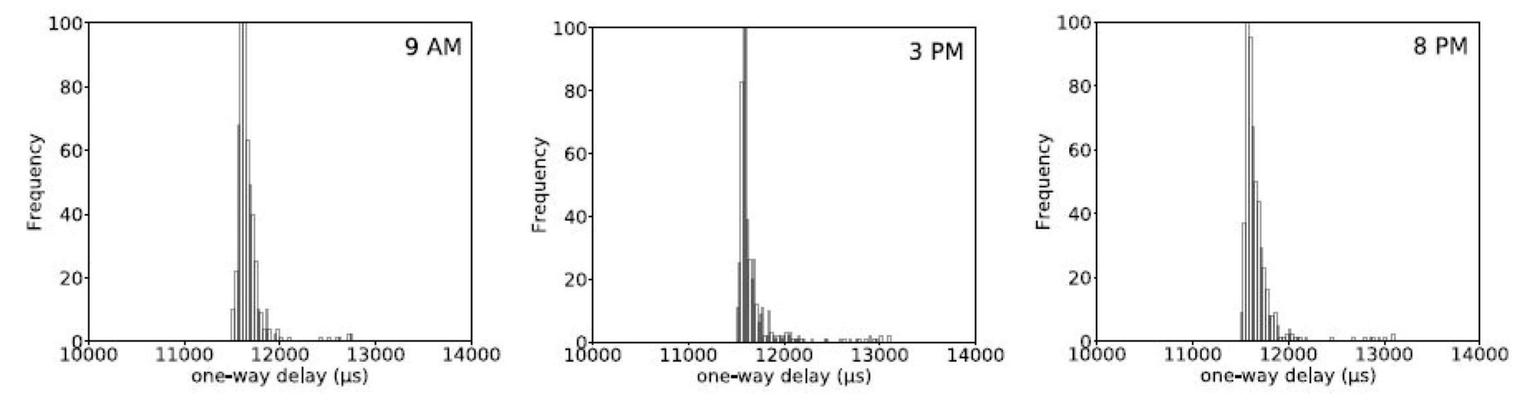
ONE-WAY DELAY ESTIMATION





Histograms of T_f



Histograms of T_b

PROPOSED METHOD

The method consists of calibrating NTP synchronization by:

- Measuring in a precise way the one-way transmission delay on the forward and backward path
- Finding the minimal delays
- Using the minimal delays in the estimation of the clock offset at the client to take into account path asymmetry
- Adapting to routing changes by maintaining several calibrated paths to multiple servers

CALIBRATING NTP

- Remove the GPS antenna and use NTP for synchronization
- NTP client sends n NTP requests and obtains n responses
- Find packets that experience the shortest transmission delays (called *lucky packets*):

$$j_f = \arg\min_j (t_2^j - t_1^j)$$

$$j_b = \arg\min_j (t_4^j - t_3^j), j = 1, \ldots, n$$

and use their timestamps for computing the time offset

- Use the estimates of minimum transmission times d_f^{min} and d_b^{min} for the time offset with the timestamps of packets j_f and j_b:

$$0 = \frac{(t_2^{jf} - d_f^{min} - t_1^{jf}) + (t_3^{jb} + d_b^{min} - t_4^{jb})}{2}$$