High-speed Network Time-Transfer using Data-Filtering Method

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Extended Abstract: (Submission for main workshop)

In the Time and Frequency field, the Global Positioning System (GPS) Common-view method is widely used for time-transfers with a remote atomic clock. This method offers an accurate time, but it is difficult to setup and operate, especially in an Internet Data Center (IDC). Network Time Protocol (NTP) is widely used for time-transfers in network environments. Unfortunately, in a normal Internet environment, even over the same route, it is difficult for a simple NTP to receive an accurate time. There are three major problems. In this paper, we present effective solutions for these problems.

The first problem is caused by the behaviour of computers, for example, the interrupt requests to CPU during processing. The interrupt processing increases the uncertainty of the delay time measurement. Therefore, we have developed a hardware Simple-NTP (SNTP) board that can measure a one-way delay time. It is applicable to Giga-bit Ethernet (GbE) connections and has a theoretical time resolution of 4 ns. We will give details about the hardware SNTP board in another presentation. By installing hardware SNTP boards on both sides of a transfer path, we can immediately obtain the delay time of the path with a precision of within 10 ns.

The second problem is caused by cross-traffic. Our hardware SNTP board can measure a one-way delay time with ns-order accuracy. In this situation, cross-traffic affects the precision of the measured data. We have developed a precise method of estimating network time-transfer to reduce the effects of cross-traffic that uses data-filtering techniques. Using measured data, we estimated the performance of our method and found that it can offer almost the same accuracy as the GPS Common-view method. From the results of the comparison, a network time-transfer using data-filtering method is practical and offers accuracy to within the standard deviation, which is later than 2 μs.

The third problem is network conditions. NTP can measure the packet response time but it is greatly affected by physical network links. Network links are sometimes changed or suspended during long-term operations and the packet response time is often varies. Therefore, we set the offset time for both the up-link and the down-link and calculated the values for every measured piece of data using a linear-programming method. This technique overcomes the effects of the link changes, but it was difficult to estimate an accurate delay time when the link was suspended for long time.

Using a combination of these techniques, we can operate an atomic clock in a closed environment like an IDC. The operation is simple and it is an easy way to determine the time that is accurate enough for business use. Of cause, attention has to be paid to network links being suspended.

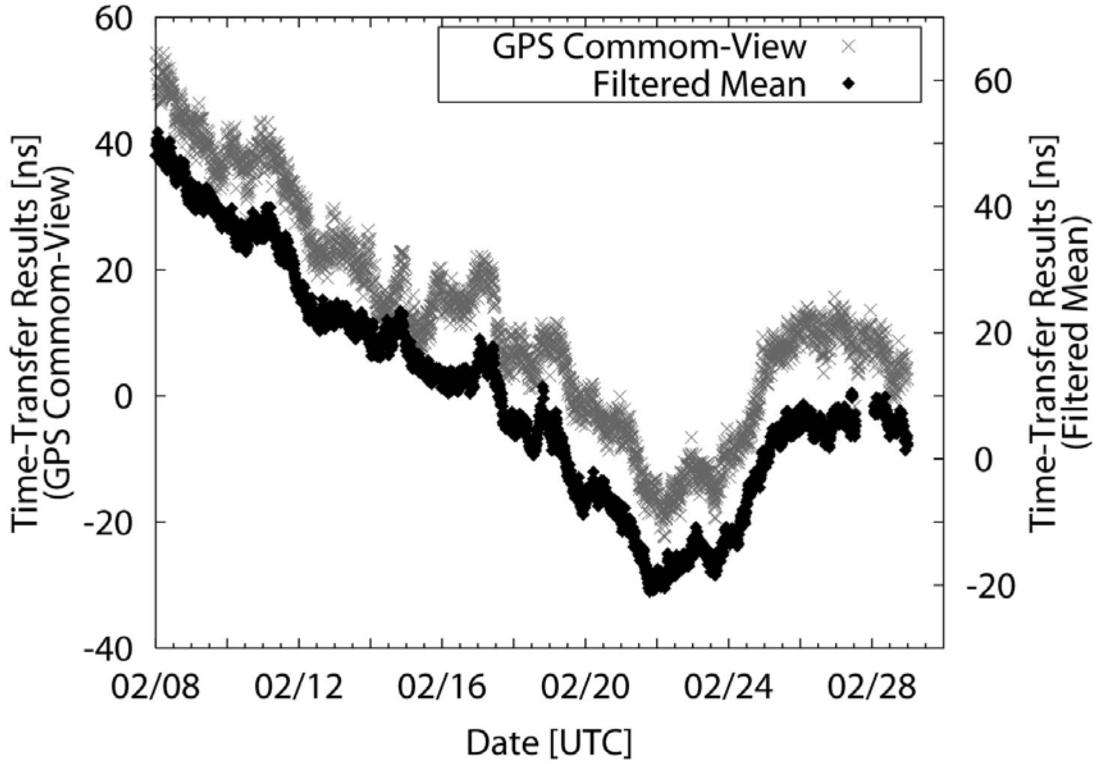

Fig. 1 Comparison results between GPS-CV and Data-Filtering

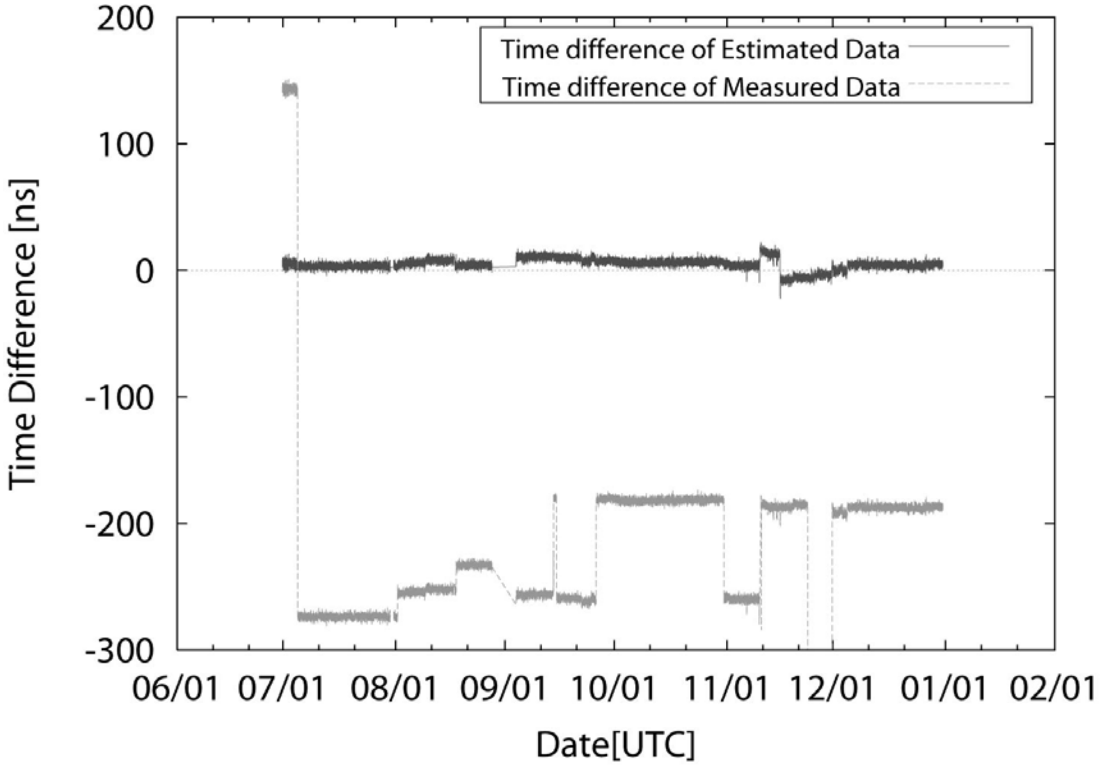

Fig. 2 Effects of the Network-link changes