1. The Introduction

This note describes the operation of the IEEE-1588 precision time protocol (PTP) as implemented on the Hyperion platform of instruments from Micron Optics. This enables timestamp synchronization over an Ethernet LAN, with a much higher precision than is achievable with other protocols such as NTP. The implementation on Hyperion is a software-based PTP that is able to achieve synchronization on the order of 10 microseconds.

2. Scope

These methods described in this document can be used to configure PTP settings for all instruments within the x55 product family, including si155, si255 and si255 EV models.

3. Configuration

To set up a Hyperion interrogator for PTP, the instruments first need to be connected to a network that has a PTP master clock. As long as this master clock is located on the same subnet as the interrogator, it will be found and used for time synchronization. A typical network topology is shown below.

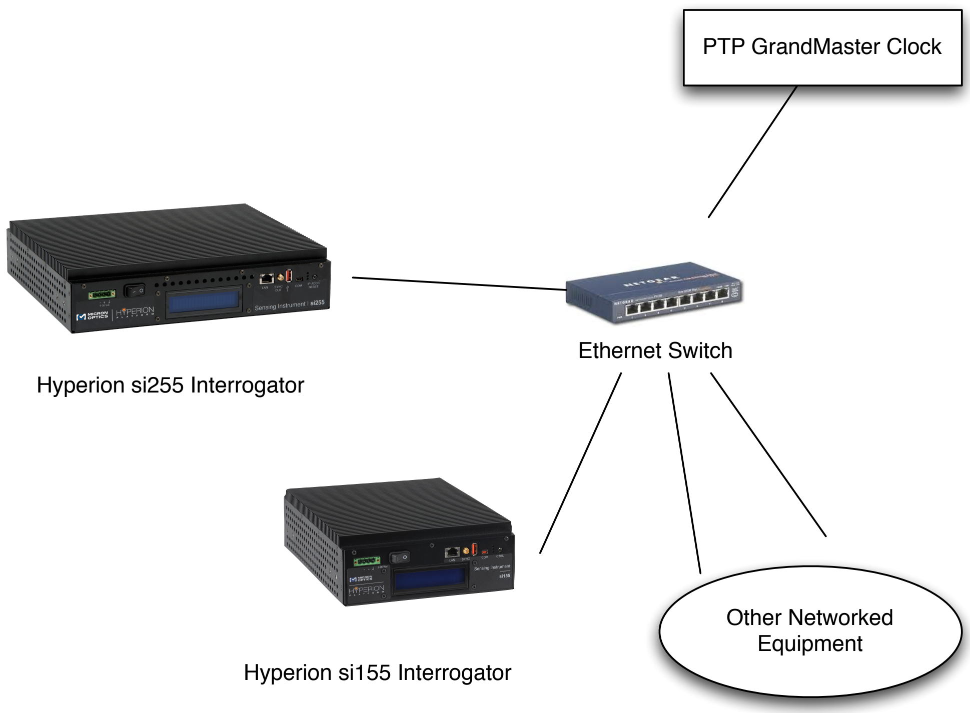

Figure 1. Components and connections required for PTP implementation with Hyperion interrogators. Note that while any Ethernet switch can work, a PTP compliant switch may give better results. All of our testing was done with a standard Ethernet switch.

4. PTP Commands

PTP can be enabled from a command console, either from within the Enlight software, the Labview simple console example, or the python console example. This can be enabled with the following commands (available on FW version 10.6.11 and above):
#SetNtpEnabled false
#SetPtpEnabled true

The first command is necessary because NTP is enabled by default, and must be disabled before PTP can be used as the time synchronization protocol. It can take a few minutes after enabling PTP before the optimum synchronization with the grandmaster clock is achieved. These steps are all that are required to begin using PTP.

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5. Results

We tested the PTP time synchronization capabilities using two Hyperion instruments connected on a network as shown above. Two identical fiber bragg gratings (FBG) were attached in parallel to a piezo transducer, so that a common strain could be applied simultaneously to both FBGs. The two FBGs were then connected to the two Hyperion instruments, respectively.

A custom Labview test program was used to measure the degree of synchronization between the two systems. This was done by acquiring signals from the two instruments and doing cross-correlation to line up the two time series to the nearest sample. The sample rate was 1 ms, so in order to get an estimation of the degree of synchronization with a precision on the order of microseconds, we calculated the centroid of the three highest points in the cross-correlation response. Since the sample clocks were not perfectly aligned, we saw variation in the relative sampling positions for the two instruments. One instrument sampled an additional data point compared to the other every 5 minutes, approximately.

We show the results below. Our largest source of error is clearly in our sub-sample estimation algorithm, which produces periodic errors that are largest at the points where the two samples have the largest misalignment (0.5 ms). Even with these errors, we see a worst-case synchronization error of less than 50 μs. If we filter this data further, we can see that the actual level of synchronization is much better than this.

In conclusion, the implementation of software PTP enables a very high level of synchronization between Hyperion instruments, and other PTP clients on the network.

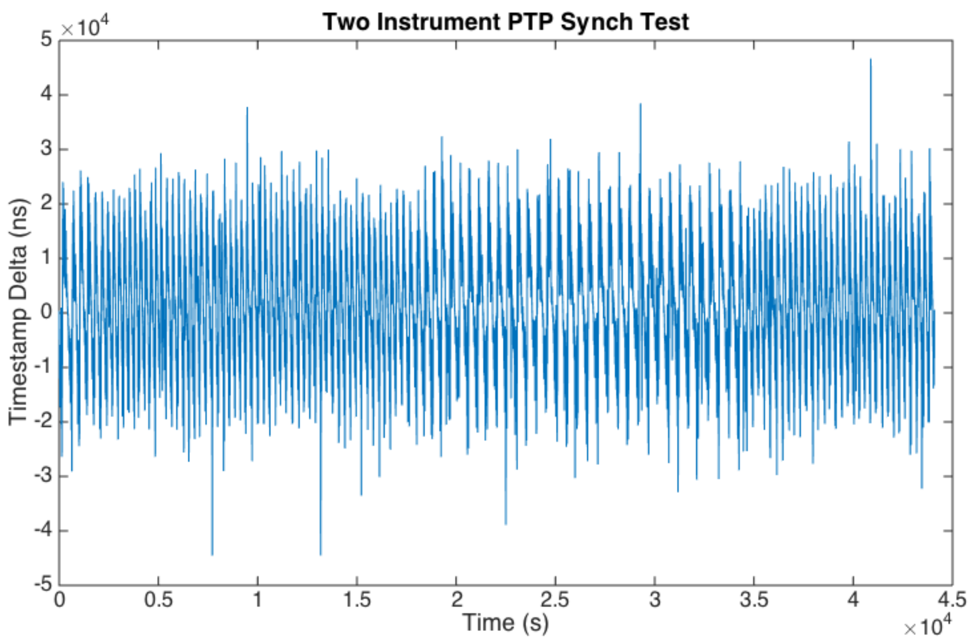

Figure 2. This is 12 hours of data showing the degree of synchronization between two Hyperion si155 insruments.

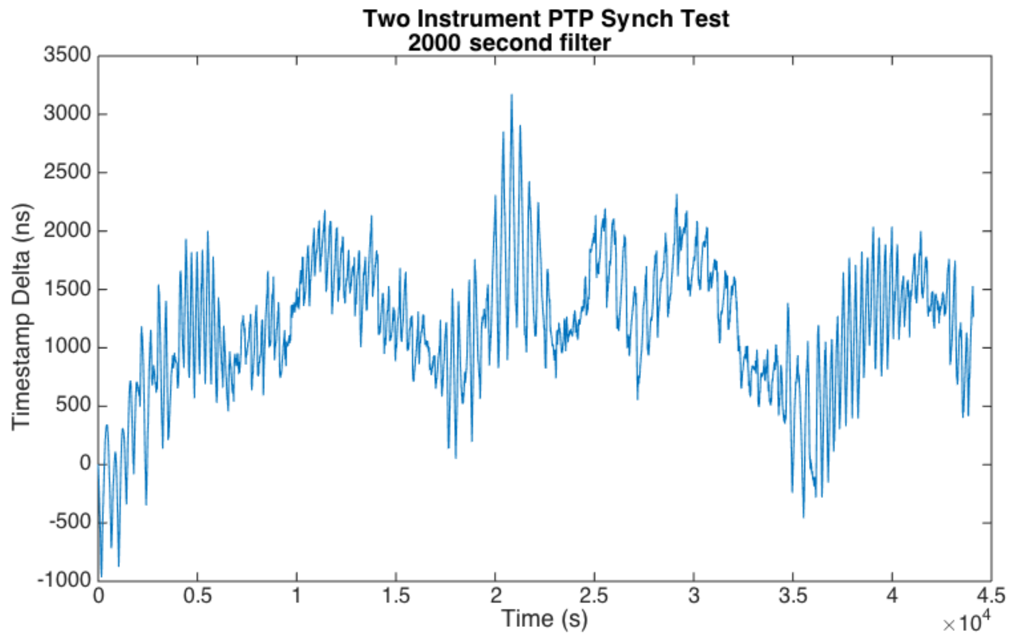

Figure 3. Same data as above, but with a 2000 second moving average filter. This filter averages out the cyclical fluctuations induced by the sampling misalignments that require additional calculation of the