IEEE 1588-2008 Precision Time Protocol (PTP) Software Overview

What it is and how it helps

Introduction

Timing synchronization has always been important in the wide area network. The foundation of the traditional WAN is synchronous; without transmit and receive clock matching, communications would be a mess. Even short of a total network failure, data corruption is almost certain; some higher layer protocols will ask for a retransmission, otherwise the data is lost. To overcome these issues, traditional WAN technologies have SSM (Sync Status Messages) to identify the highest quality clock available, assign that clock as master, and be ready to reassign a master should clock availability or relative qualities change.

Local Area Networks, specifically Ethernet, are asynchronous. The technology does not require clock synchronization. In addition, Ethernet was designed to operate in limited "local" areas and for the transport of data. Data transmission requires high accuracy, but not necessarily low latency and real time/deterministic delivery; Ethernet was not designed for voice calls.

Now the work assignment of Ethernet has expanded to voice traffic including mobile backhaul. Transmission speeds are increasing. The need for accurate, real time performance is driving a requirement for network clock synchronization in Ethernet networks. Also, time delay between clocks takes on a new importance as Ethernet is deployed more and more in WANs where packet delivery is not deterministic. There are two main solutions to meet these challenges: Synchronous Ethernet (SyncE), and Precision Time Protocol (PTP).

SyncE

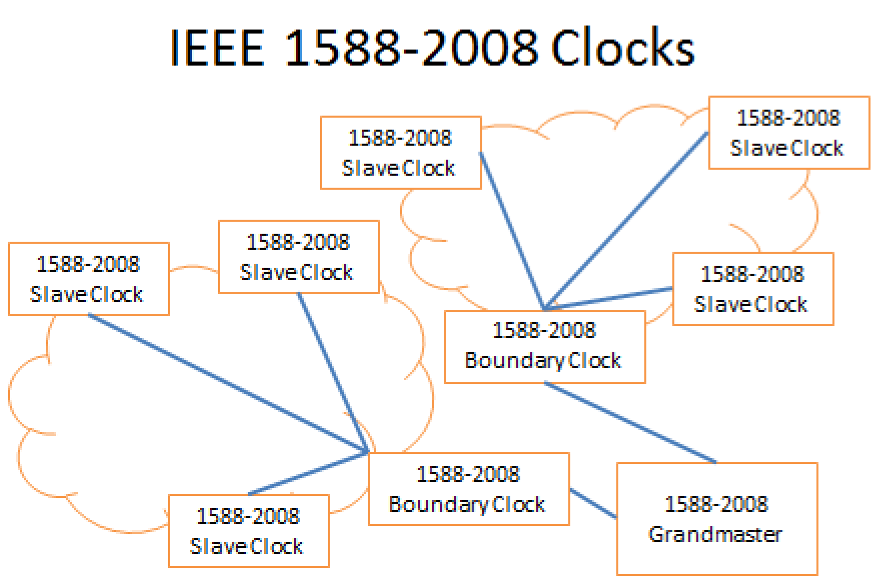
SyncE operates at layer one or the physical layer. It is implemented in hardware and provides an excellent option for the best frequency synchronization and clock stability. The major drawback is that it also requires that each piece of Ethernet equipment in the network have the SyncE capability. This may require network hardware upgrades and may force owners into single sourcing their equipment for practicality. It also may be awkward for application in access networks with multiple owners (carriers, service providers, enterprise owners, etc.). SyncE is an excellent technical solution with a high price tag and little backward compatibility within a target network.

PTP

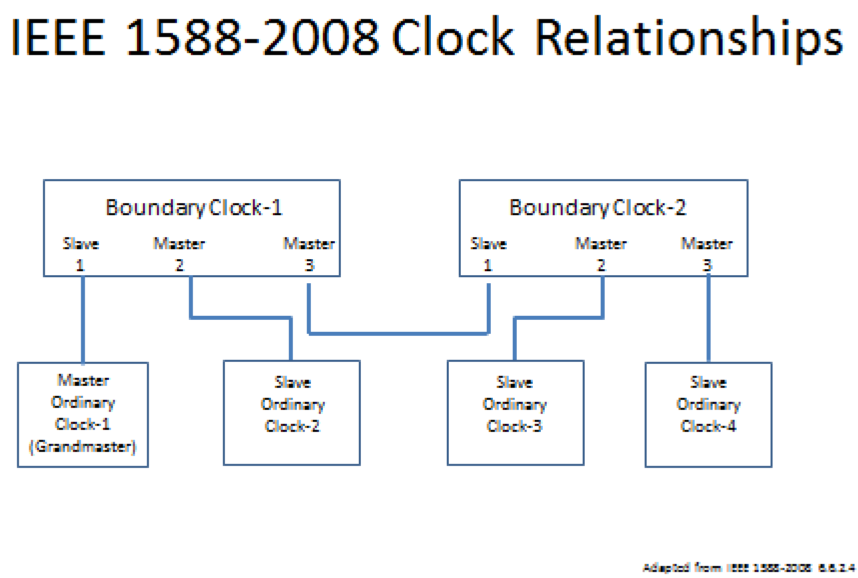
The PTP (Precision Time Protocol), specified by IEEE 1588-2008, manages clock synchronization of both frequency, and phase and time delay across asynchronous networks. IEEE 1588-2008 ensures both frequency and phase are aligned. Traditional WAN technologies have used Sync Status Messages to keep track of clock sources and their quality primarily to assign the best available clock source at any particular time. IEEE 1588-2008 PTP adds more active synchronization including frequency and phase and time delay adjustments. The rest of this paper discusses the details on how PTP works.

PTP Clocks

There are three types of clocks in the IEEE 1588-2008 environment: ordinary clocks, boundary clocks and grandmaster clocks. All clocks start as ordinary clocks. Each clock acts as a master or a slave or might be both. A grandmaster can provide reference clocking to one or more boundary clocks. Boundary clocks provide a clock master to their respective timing domains, and can act as a source to a boundary clock in another timing domain. The diagram below shows an example of the clocks within an Ethernet network.



As you can see in the diagram below adapted from the actual standard, there are master-slave relationships as the grandmaster timing reference is passed through and between timing domains.



The PTP Process

IEEE 1588-2008 specifies a particular formula to determine which clock will become the Grandmaster; this is called the Best Master Clock or BMC algorithm. The algorithm initially selects the Best Master Clock available. As itt continues to run , it adjusts as needed to changes in the network clocks.

Clock properties in the network are assessed by short messages. The five message types are:

- Sync
- Follow up
- Delay Request
- Delay Response
- Management

IEEE 1588-2008 Precision Time Protocol synchronization process has **two stages**. In the **first stage**, the slave clock is synchronized with the master. First the master sends a sync message to the slave with the current time. Then the master sends a follow-up message to the slave with the actual transmission time of the sync message. The slave uses this additional information to calculate and apply the time offset. At this point, the master and slave are synchronized for frequency.

The **second stage** synchronizes the network (time) delay. The slave initiates this stage when it sends a delay request packet as it logs the exact transmission time of the packet. Upon receipt, the master responds with a delay response packet. Using both the original transmission time and the reception time stamp included in the delay response by the master, the slave calculates and applies the network time delay. At this point, the clocks are fully synchronized.

Sync status messages continue to be sent between the master and slave on a regular basis. Part of the algorithm applies adjustments as needed to handle the changes to network transmission.

IEEE 1588-2008 and WAN Sync Status Messages

Networks are often complex both in technologies and ownership. Ethernet can be carried over various physical layers. The payloads can be multiplexed and de-multiplexed many times. The paths crossed can easily include a half dozen or more owners. These various paths are likely to include WAN and Ethernet segments, and timing is critical to all of them.

The good news is that Sync Status Messages and IEEE 1588-2008 (as well as SyncE) information can be passed and shared, resulting in a wider scope of network synchronization. This capability is particularly useful in mobile backhaul that might end up going to a traditional land line in the far side of a SONET/SDH network.

NComm's IEEE 1588-2008 and SSM Source code

NComm provides complete source code solutions for IEEE 1588-2008 (Ethernet), SSM and communication between the two. All code is supplied as ANSI C, incorporates well defined APIs, and are pre-ported to Linux (2.4/2.6 versions) VxWorks, OSE and Nucleus Plus. Other operating systems are easy ports and instructions are included. All software is tested on real hardware, is guaranteed to achieve a standards compliant result when implemented according to instructions and is fast to bring up. Training is included.

Conclusion

Clock synchronization is a critical aspect for the implementation of real time voice services over packet networks. IEEE 1588-2008 provides a very good solution for high quality services, meeting aggressive Quality of Service agreements and excellent customer satisfaction. NComm's software offerings make this important capability easily available to equipment manufacturers of all sizes.

Please call (603-329-5221 x35) or email to (sales@ncomm.com) for more information.

About NComm

NComm, based in Hampstead, NH, provides turnkey embedded software solutions and hardware platforms that are used by equipment vendors to add Ethernet and WAN interfaces to their products. Developed by NComm's team of engineering and business professionals, our products are designed using the experience obtained by decades of experience in communications software and hardware design and bringing complex products to market.

NComm Trunk Management Software is the Ethernet and WAN de facto standard, embedded by equipment vendors from 3COM to ADC to Sonus Networks and is the most widely used and tested software for Ethernet and WAN OAM. NComm delivers the underpinning, drop-in software technology necessary to build interoperable, standards-compliant WAN access devices including framer configuration, alarming & fault management, PMON, line testing, and signaling. NComm's mission is to reduce their client's time-to-market through turnkey Ethernet OAM, T1, E1, T3, E3, SONET, SDH, APS, Primary Rate ISDN and Sync Status Message telecommunications source code

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