



Synchronization of SMPTE ST 2110 Signals: SMPTE ST 2059



matrox[®]
Digital Video Solutions



SONY



NTP vs. PTP

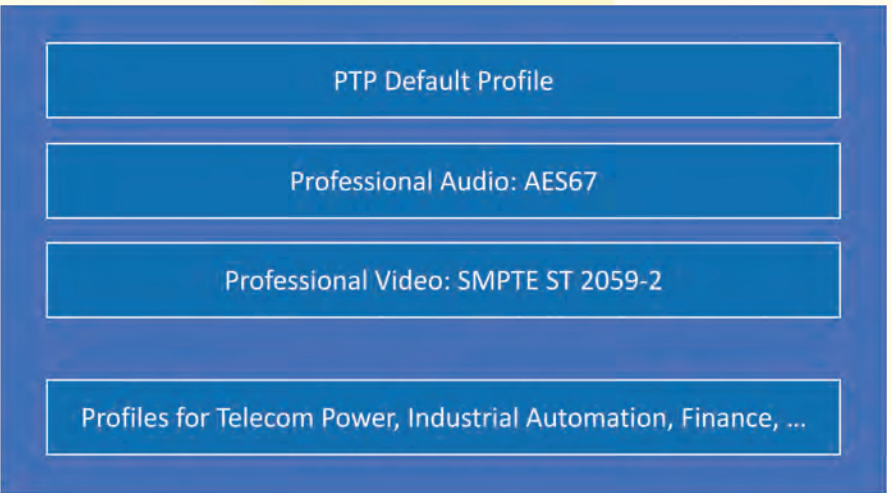
Network Time Protocol (NTP)	UDP/IP	IPv4 & 6	IETF	WAN
Precision Time Protocol (PTP)	UDP/IP	IPv4 & 6	IEEE	LAN

PTP Clock: Dynamic Range 2⁴⁸ seconds, Resolution 1ns

Seconds (48 bits)	Nanoseconds (32 bits)
-------------------	-----------------------

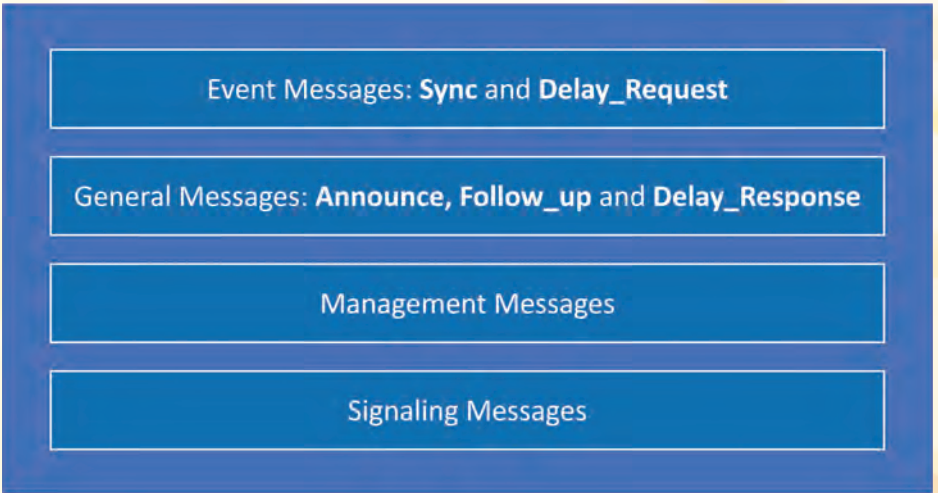
The Network Time Protocol (NTP) was the first standard for synchronizing clocks of devices in IP networks to within milliseconds of the Coordinated Universal Time (UTC). The IEEE developed the IEEE 1588™ Precision Time Protocol (PTP) to enable precise synchronization of clocks with accuracies far below 1 microsecond.

PTP Profiles



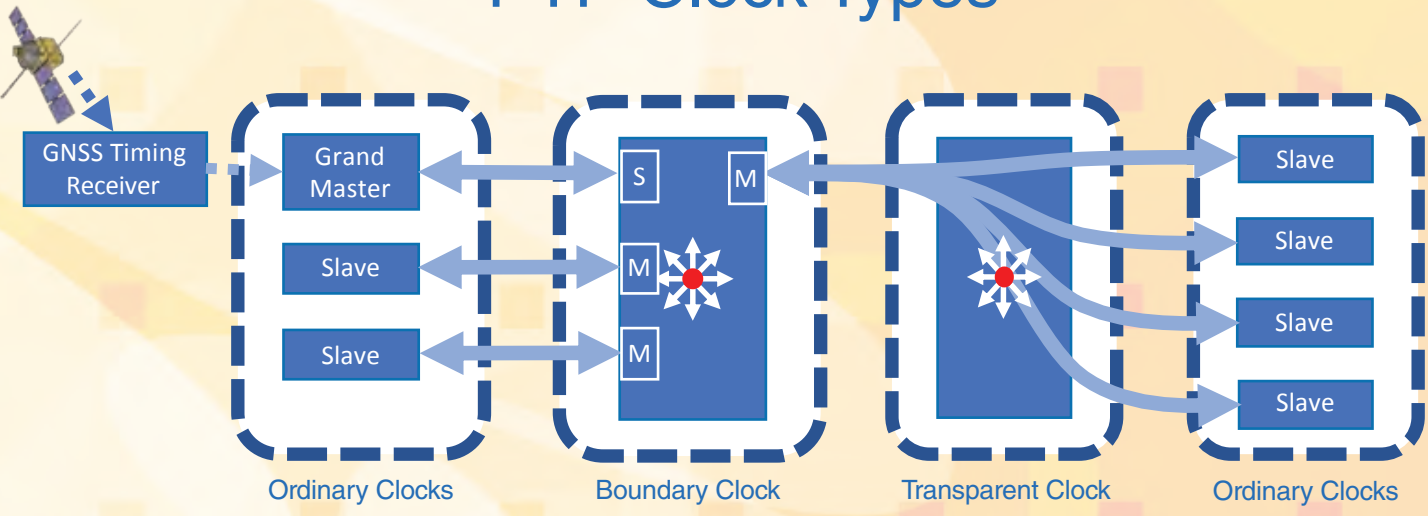
IEEE 1588-2008 defines profiles allowing PTP to be tailored to the requirements of a particular application. SMPTE ST 2059-2 defines a profile for use of PTP in professional broadcast applications.

PTP Message Types



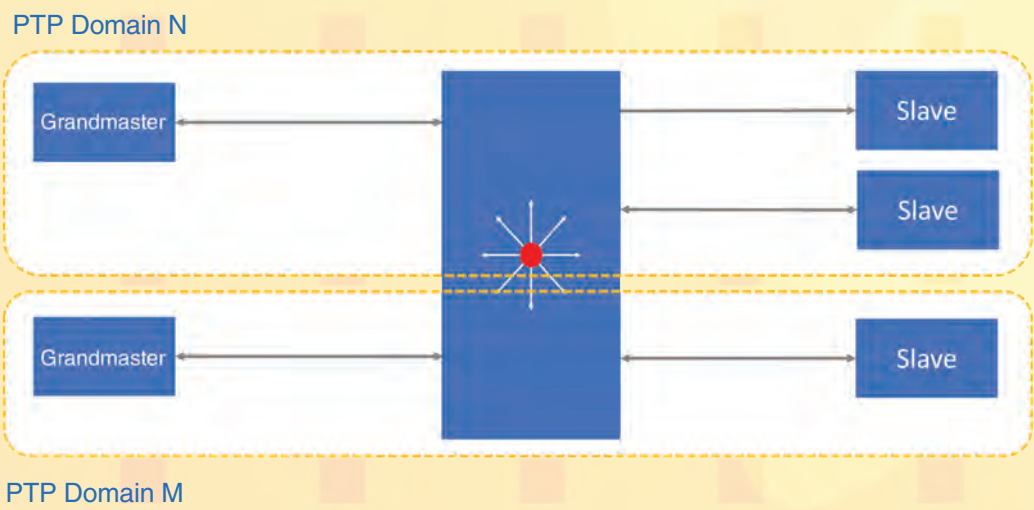
A bidirectional messaging system, defined by PTP, allows time to be distributed accurately over a network to other network devices for synchronization of their local clocks.

PTP Clock Types



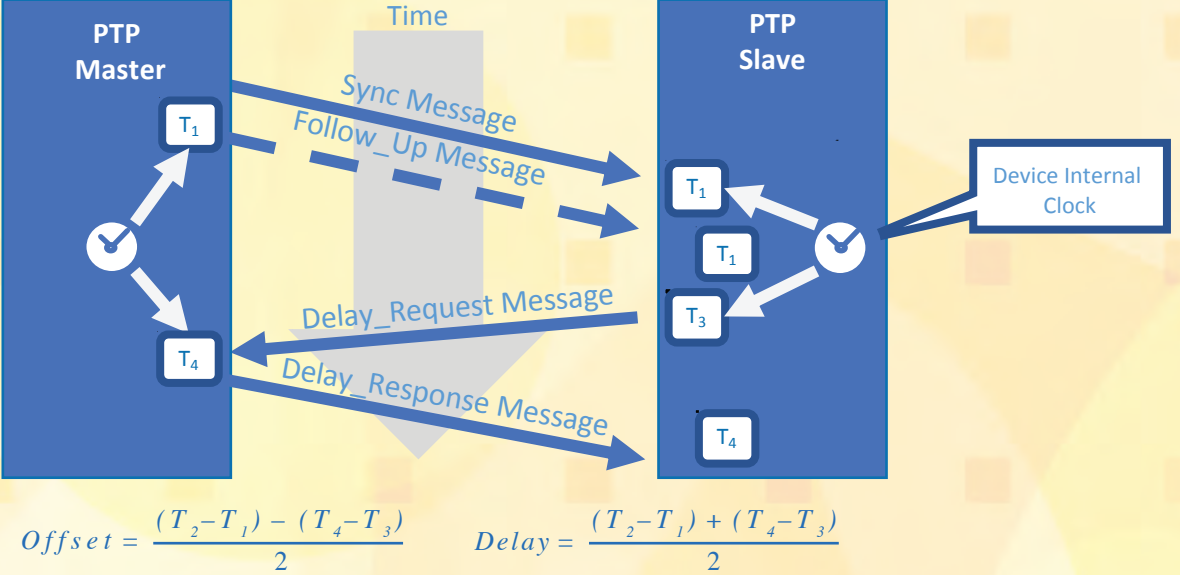
Every PTP aware device in a network represents a clock. PTP defines Ordinary clocks, Boundary clocks, and Transparent clocks. Ordinary clocks are end devices providing (Master) or requiring (Slave) time information. Boundary clocks re-distribute time information from a Grandmaster to all devices attached to them while Transparent clocks eliminate the effects of varying forwarding delays on the overall accuracy.

PTP Domain



In PTP, multiple PTP devices communicate with each other using a common PTP Domain.

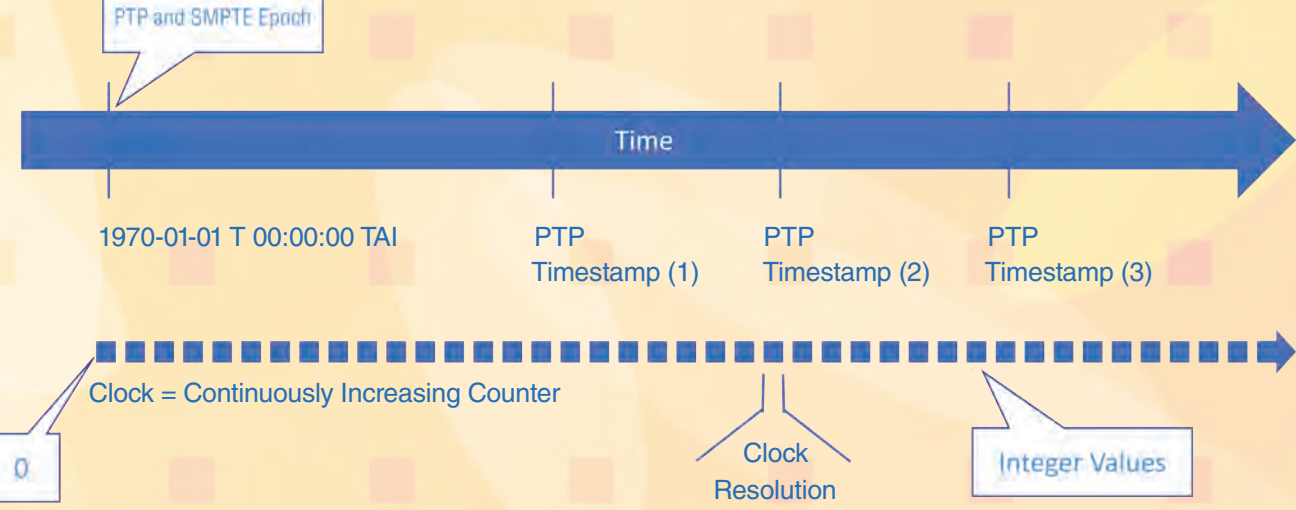
PTP Message Flow



$$Offset = \frac{(T_2 - T_1) - (T_4 - T_3)}{2} \quad Delay = \frac{(T_2 - T_1) + (T_4 - T_3)}{2}$$

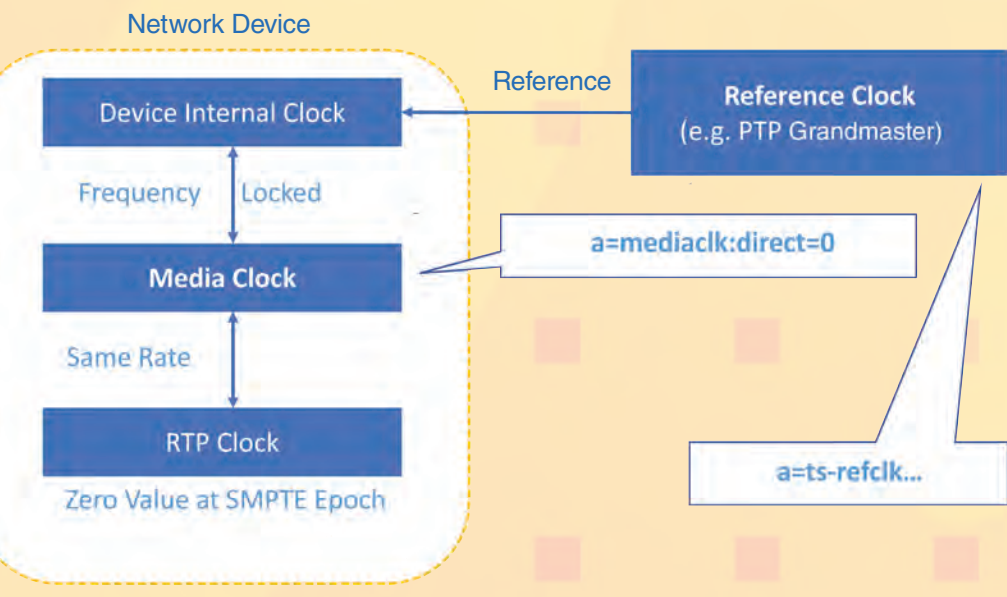
After establishing a two-way time transfer to its Master every Slave is able to calculate the offset of its local clock with respect to the Grandmaster.

Time Relationship



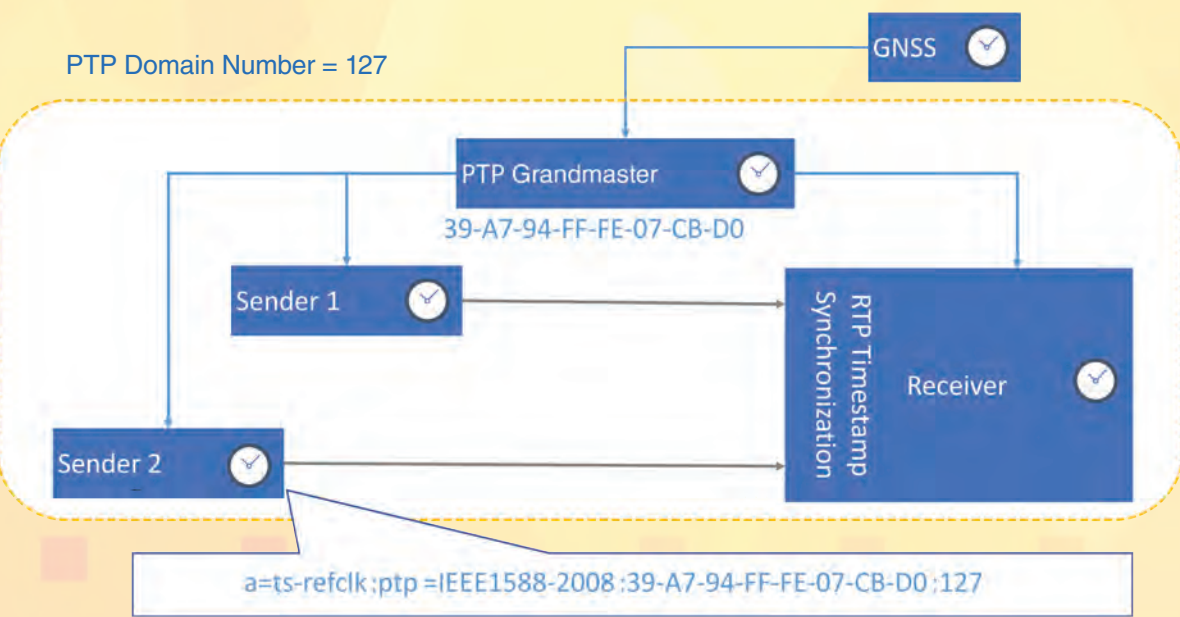
SMPTE ST 2059-1 defines the epoch as 1st of January 1970 at 0 hours, 0 minutes and 0 seconds TAI.

Direct-Referenced Media Clock



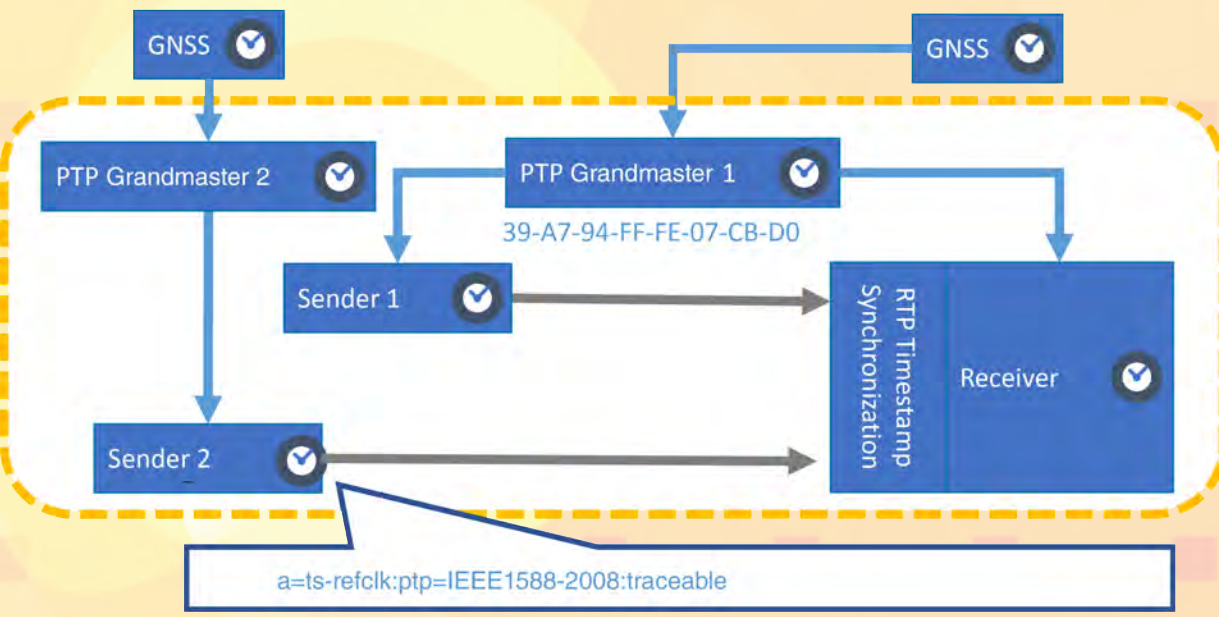
For proper synchronization within a session it is necessary to signal the reference clock source.

Reference Clock (PTP)



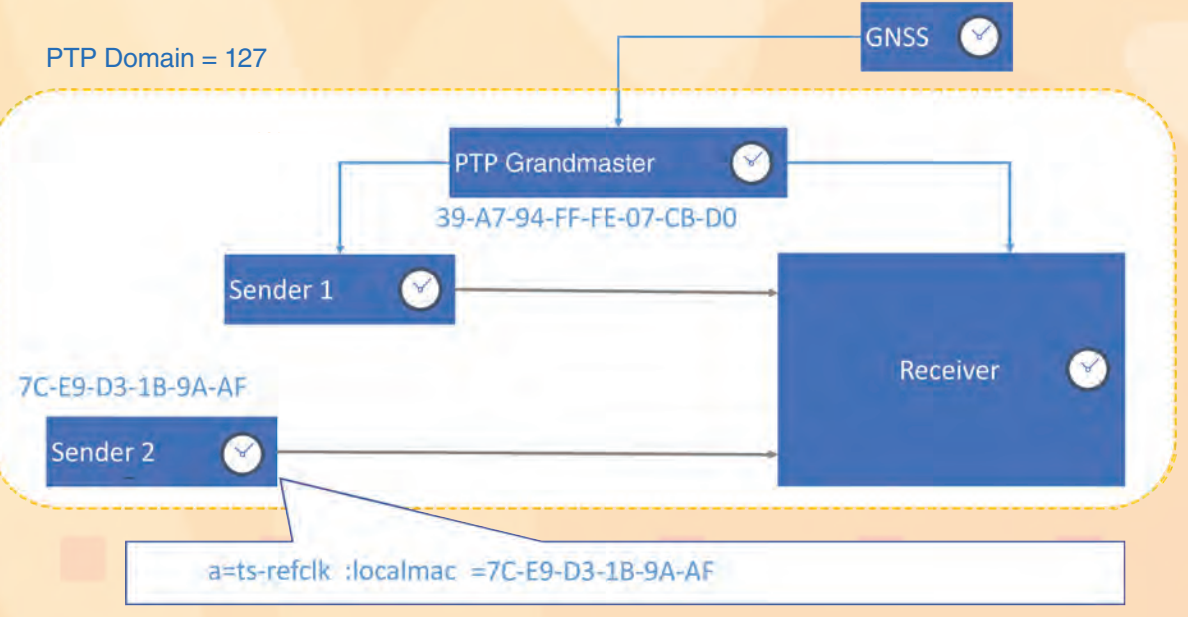
The Grandmaster is the source of the time or common reference clock for all Slaves in the PTP network. The "ts_refclk" SDP attribute describes a clock used as a time reference for clocks involved in timestamp generation. In this case, the PTP Grandmaster ID "39-A7-94-FF-FE-07-CB-D0" and PTP Domain "127" are specified.

Reference Clock (Traceable)



The SDP Statement can be simplified for the "ts_refclk" attribute, if all nodes are synchronized to external time sources which are traceable. Marking a clock as traceable allows additional information (such as the PTP Grandmaster ID and PTP Domain) to be omitted from the SDP, since any traceable clock available at the receiver is considered to be an appropriate reference clock.

Reference Clock (Local)



In the absence of a master based on an external time, a common reference clock is not available. Different devices are considered unsynchronized but streams from the same device will be synchronized with each other if a direct-referenced media clock is used.

In SMPTE ST 2110, inter-stream synchronization (such as audio/video synchronization, or proper presentation time for Closed Captions) relies on timestamp values in the RTP packet headers from senders based on a common reference clock. The common reference clock can be distributed to all participating senders and receivers over an IP network by use of the IEEE 1588-2008 Precision Time Protocol (PTP), and specifically for ST 2110, the PTP system must obey the SMPTE ST 2059-2 PTP Profile developed for use in professional broadcast applications. Details on the ST 2110 System Timing Model are specified in ST 2110-10.