Clock Device for Packet Based Network Synchronization

TN160107TD

Over view

With the universal deployment of Ethernet, 'circuit switched networks' have been shifting to new 'packet switched networks'. Former voice telephony (PST: public switch telephone) is based on frequency synchronization. However, packet switched networks are inherently asynchronous; timing control technology is required to transfer voice, TDM (time division modulation) data through packed based network. Currently, there are two main solutions.

1) Synchronous Ethernet (SyncE: frequency synchronization type), 2) IEEE1588 (timing synchronization type).

Epson provides the oscillation devices that sustain the basic and indispensable technology for packed based network. High performance timing devices are especially important for lower PDV (packet delay variation) feature, and backup function during timing network outage. Thus Wander (MTIE,TDEV) ,Holdover specifications are important specifications.

This application note explains Epson's basic products deployment.

1. Timing Synchronization

Fig1 shows a typical mobile network. PRC (Primary Reference Clock) is the master clock of this system. For proper system operation, the timing information of PRC should be transmitted through the network to edge Macro-cell Base Station A and B, Small-cell Base Station A and B. Previous synchronization methods (SONET/SDH) can only transmit frequency information. However, packed based networks (Figure 1 EEC: Ethernet Equipment Clock) are inherently asynchronous. To synchronize through an asynchronous network, two solutions are proposed from ITU-T.

1) Synchronous Ethernet (SyncE)、2) IEEE1588. The next clause explains these two solutions.

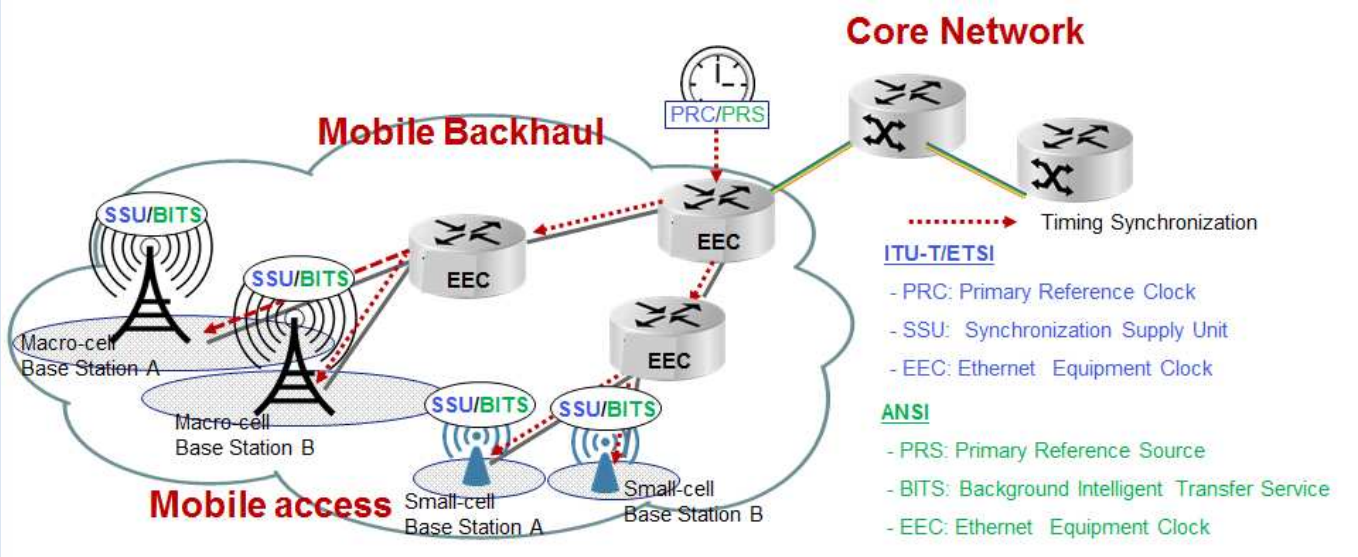

Figure 1: A typical mobile network

2. Ethernet vs SyncE vs IEEE1588

SyncE transmits frequency (through PHY layer), IEEE1588 transmits time (through protocol layer) .)

(See Table 1, Figure 2,3,4)

Table 1: Ethernet vs SyncE vs IEEE1588

type	Sync/Async		layer	Oscillator (on node)	Main specification
Ethernet	Asynchronous	——	——	+/-100pp	
SyncE	Synchronous	frequency	Physical	EEC compatible	Frequency stability
IEEE1588	Synchronous	frequency time	Protocol (PTP)	Stratum3 Compatible Stratum3E compatible	MTIE、TDEV、Holdover

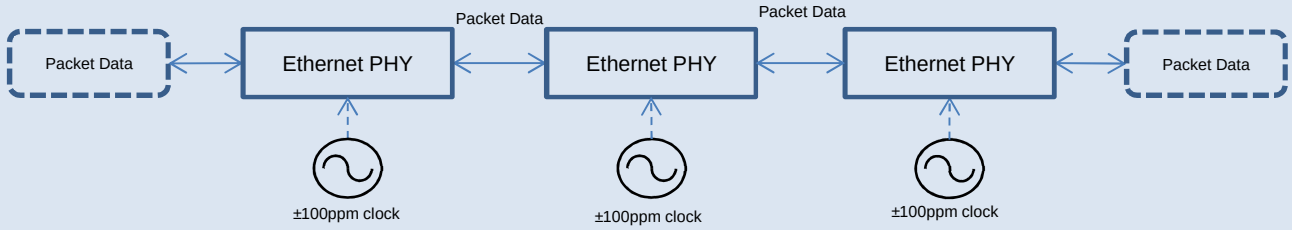

Figure 2 Ethernet

Ethernet (Figure 2) does not transmit timing information. Asynchronous network.

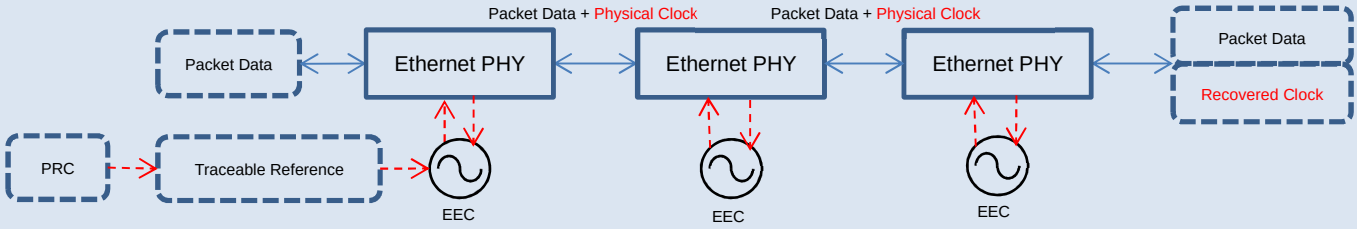

Figure 3 Synchronous Ethernet (SyncE)

PRC frequency signal can be transmitted to lower(right side) nodes through Ethernet PHY which have EEC(Ethernet Equipment Clock) with CDR function (CRD: clock data recovery). All Nodes should be equipped with EEC devices. SyncE can transmit frequency only, not time .PRC and final destination Node have the same frequency. (Frequency Synchronized).

(EEC : Ethernet Equipment Clock . The standard (ITU-T G.8261 Option1,2) compatible clock.

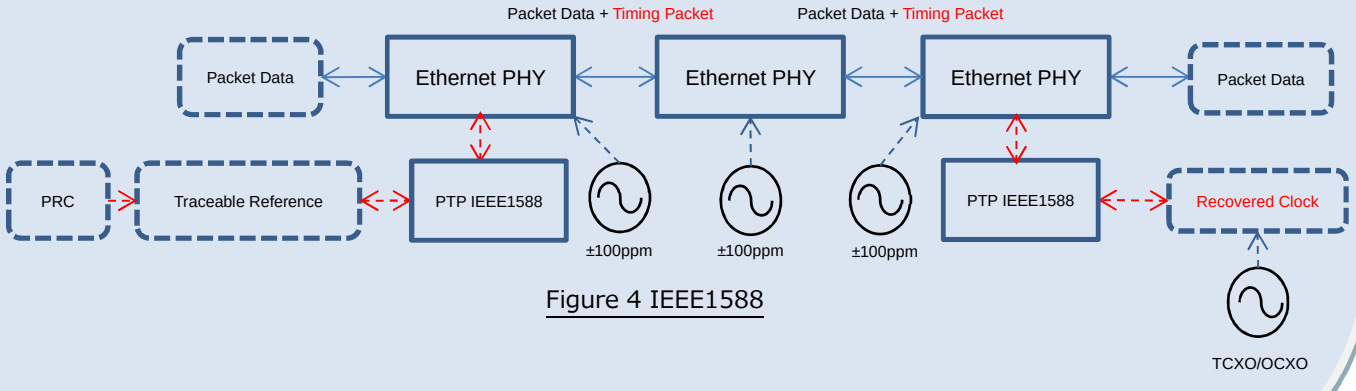

Figure 4 IEEE1588

IEEE1588 (Figure 4) transmits frequency and time information from PRTC to target Node by protocol layer (basically PTP（Precision Timing Protocol）.The target Node has the same time and frequency. This is timing synchronization. All Nodes may be equipped with normal Ethernet Clock. The final Node should be equipped with high stability oscillators (ex. TCXO, OCXO) to reduce PDV and provide redundant function (backup clock during timing signal interruption.).

3. Standards for solutions

Worldwide standards (ex. ITU-T etc.) are published for synchronization solutions. (see Table 2)

Table 2 Standards for synchronization solutions

solution	Layer		Network Standard	Equipment, Clock Standard
SONET/SDH	PHY (L1)	frequency	ITU-T G.825	ITU-T G.813 Option 2 *2 SEC: SONET/SDH Equipment slave Clock Telcordia GR-1244CORE Stratum3
SyncE	PHY (L1)	phase	ITU-T G.8261	ITU-T G.8262 Option 1,2 *2 EEC: Ethernet Equipment Clock Telcordia GR-1244CORE
PEC (Frequency)	Protocol (L2~3)	frequency	ITU-T G.8261	ITU-T G.8263 *3 Packet based Equipment Clock Telcordia GR-1244CORE
PEC (Phase/Time) *1	Protocol (L2~3)	Time	ITU-T G.8271	ITU-T G.8273 *3 Telecom Boundary Clock

Note

*1 IEEE1588 : PEC(Phase/Time)

*2 ITU-T has published standards.

*3 ITU-T has not finalized standards for PEC solutions.

From these standards, two main tiers of oscillator devices are used:
(Based on Telcordia Stratum)

<Telcordia GR-1244Core Stratum3 / G.812 Option 2 (SONET/SDH Equipment Clock) / G.8262 Option 2 >
- Frequency Accuracy +/-4.6ppm (20 years)
- Frequency Stability +/-300ppb (1day)
- Frequency Drift +/-40ppb (1day constant temp.)
- MTIE, TDEV, Holdover refer to each standards.

<Telcordia GR-1244Core Stratum3E / G.812 Typ3 >
- Frequency Accuracy +/-4.6ppm (20 years)
- Frequency Stability +/-10ppb (1day)
- Frequency Drift +/-1ppb (1day constant temp.)
- MTIE, TDEV, Holdover refer to each standards.

4. Epson product strategy

To meet these two levels of performance, Epson has several oscillator options:

Standard	Product	Products Series
Stratum3	TCXO	TG-5500 series, TG5032 series
Stratum3E	OCXO	OG2525 series, OG2522series, OG1409 series

Epson will provide these products application notes consequently.