



Clarification on PTP Timestamping in the presence of Alignment Markers

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Introduction

- Clarifications are needed in clause 90 to unambiguously define how Alignment Marker functions affect PTP timestamping
 1. Clarify Tx and Rx Path Data Delay
 2. Clearly specify how AM and Idle insertion/deletion affect PTP timestamps

New Complicated PHYs

- Newer PHYs (200GBASE-R PHY is shown) are more complicated with respect to timestamping
 - Timestamp events are captured at the xMII
 - AM insertion/removal occurs between the xMII and MDI
 - The data shift resulting from AM insertion/removal creates new considerations for accurate timestamp transmission
 - There are different allowable methods for creating the bandwidth needed for AM insertion

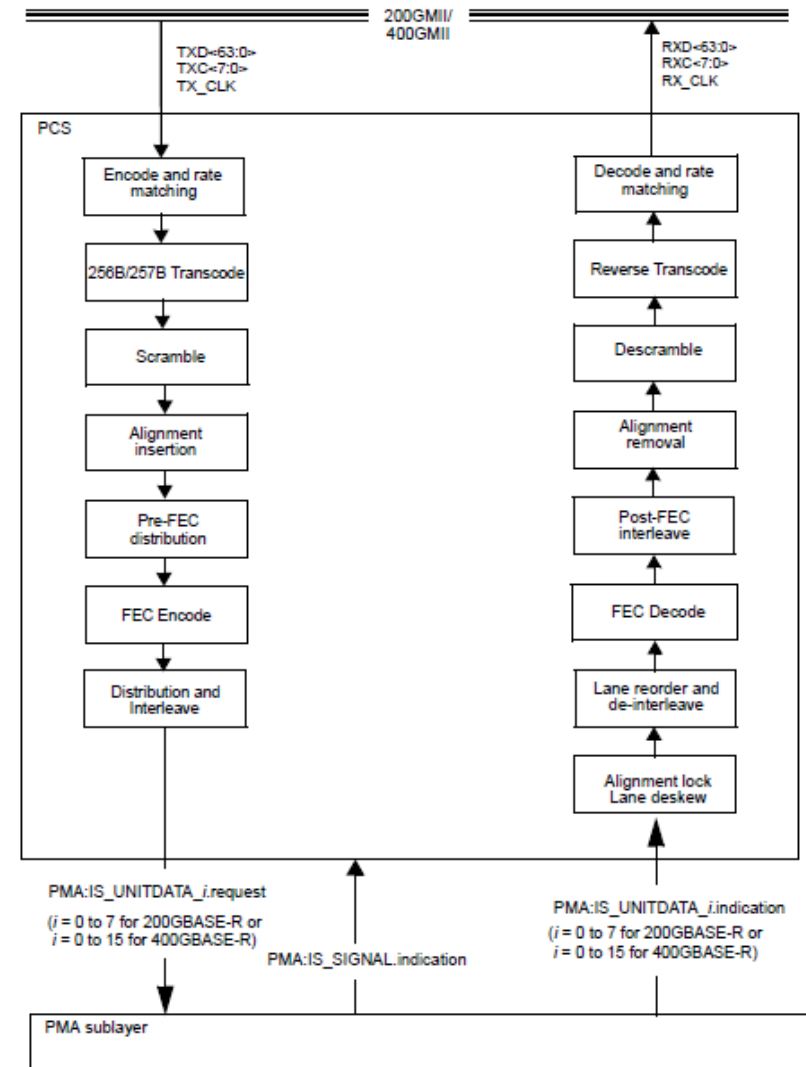


Figure 119–2—Functional block diagram

Tx and Rx Path Data Delay: Background

- Subclause 90.7 states
 - “The transmit path data delay is measured from the input of the **beginning of the SFD** at the xMII to its presentation by the PHY to the MDI. The receive path data delay is measured from the input of the **beginning of the SFD** at the MDI to its presentation by the PHY to the xMII.”

however...

- Subclause 7.3.4.1 of IEEE 1588v2 and subclause 11.3.9 of IEEE 802.1AS define the message timestamp point as follows:
 - “the message timestamp point for an event message shall be the **beginning of the first symbol after the Start of Frame (SOF) delimiter.**”

Tx and Rx Path Data Delay: The Problem

- When AMs are part of the PCS, the “beginning of the SFD” and the “beginning of the first symbol after SFD” could have path data delays that are different by a non-constant value, depending on whether or not AMs separate these two symbols

Tx and Rx Path Data Delay: Example

- Figure 82-5 defines the format of the control block that contains the implied /S/ start of packet delimiter
- As described in clause 81.2.2, the SFD occurs in the last 8 bits of this control block.
- Consequently, the “beginning of the SFD” and the “beginning of the first symbol after the Start of Frame (SOF) delimiter” are in different 66B blocks.
- The 66B block containing the /S/ and SFD can appear in any of the four different locations within the 256B/257B block code.
- Per clause 119.2.4.4, “The alignment marker group ... interrupts any data transfer that is already in progress.”
- Consequently, if the AM insertion occurs immediately following a 257B block in which the SFD is carried at the end of that block, the AM adds $\approx 5\text{ns}$ of latency (from the 4×257 AM block bits for 200GbE and 8×257 for 400GbE) between the “beginning of the SFD at the xMII to its presentation by the PHY to the MDI.”

Tx and Rx Path Data Delay: Proposal

- PROPOSED CHANGE TO SUBCLAUSE 90.7:
 - Using the same reference point for the 802.3 delay measurement as 1588 uses for the timestamp reference point would remove the current problem in a future-proof manner.
- The statement should be modified by adding the red text shown below:
 - “The transmit path data delay is measured from the input of the beginning of **the first symbol after** the SFD at the xMII to its presentation by the PHY to the MDI. The receive path data delay is measured from the input of the beginning of **the first symbol after** the SFD at the MDI to its presentation by the PHY to the xMII. **At the MDI, the beginning of the first symbol after the SFD is the first bit of the DA field, after the sync header bits.**”

Effect of AM and Idle insertion/removal on PTP Timestamping: The Problem

- Insertion/deletion of AMs and Idles can affect the time at which the PTP event message's timestamping point crosses the timestamping reference plane and consequently affect its timestamp
- A noteworthy number of legacy complex PHY implementations (with AM insertion/removal) are already in use
 - Not desirable to degrade the performance of these legacy PHYs

Effect of AM and Idle insertion/removal on PTP Timestamping: Considerations

- Figure 119-2 (see slide 3) shows a Tx functional flow of the gRS (where timestamps are inserted) followed by rate matching followed by AM insertion
 - Accommodating AM insertion is one of the potential reasons for rate matching
 - Rate matching is typically performed by Idle insertion/removal
- Strict adherence to the functional flow of Figure 119-2 implies that the timestamp event captured at the xMII will be shifted by the AM and Idle insertion/removal process, thus creating an inaccuracy for which (unlike FEC) there is no guarantee that the Rx processes will cancel it out in the same location of the received bit stream
- 802.3 has a long established principle of recognizing implementations as being compliant as long as the device output bit stream is the same as if the process described in the standard had been applied

Effect of AM and Idle insertion/removal on PTP Timestamping: Considerations (continued)

- The current standard allows both
 - Making room for AMs by deleting idles
 - Making room for AMs by other means without deleting idles
- To ensure accurate timestamps on a message-by-message basis
 - Departure (Tx) timestamp: some legacy implementations perform AM insertion and Idle insertion/removal before capturing the timestamp
 - Arrival (Rx) timestamp: some legacy implementations perform AM removal and Idle insertion/removal after capturing the timestamp
- **CONCLUSION:** Achieving accurate timestamp transfer in a manner that is compatible with all implementations requires using a message-by-message approach in which the timestamp at the xMII is modified to account for path data delay changes resulting from AM and Idle insertions/removals

Effect of AM and Idle insertion/removal on PTP Timestamping: Proposal

- PROPOSED CHANGE TO SUBCLAUSE 90.7:
- Add the following new paragraph after the current second paragraph:
 - “The AM insertion/removal functions for the 40GBASE-R and 100GBASE-R PCSs are shown in Figure 82-2 and the rate matching and AM insertion/removal functions for the 200GBASE-R and 400GBASE-R PCSs are shown in Figure 119-2. If the insertion or removal of AMs and/or Idles in these PCSs affects the transmit or receive data path delay, this effect must be accounted for in the timestamp. In this way, the timestamp operation is performed as if alignment markers are present at the xMII (i.e., as if AM insertion and Idle insertion/removal is performed ahead of the Tx xMII and AM deletion and Idle insertion/removal is performed after the Rx xMII).”

Summary

- Ambiguities in subclause 90.7 of 802.3 for PTP timestamping in the presence of alignment markers were described
 - These ambiguities can impact the achievable time synchronization accuracy
- Proposals to remove these ambiguities were provided