IIoT: Open Issues on Time Synchronization

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Background

Open issues:

🖎 Editor's note: Whether DS-TT and NW-TT support Boundary Clock also if 5GS is not acting as grandmaster is FFS

🖎 Editor's note: Support for external networks operating with IEEE 1588-2008 [107] is for further study.

Boundary clock when GM is external

📶 It has been proposed to support Boundary Clock even when the GM is external to the 5GS. However, as for current IEEE1588 specification, the 5GS clock would have to be locked to the external GM clock (unless specified by a specific Profile, such as IEEE802.1AS case), which is not acceptable.

📶 In fact,

- as stated in IEEE 1588-2019, clause 9.1: *"PTP Instances synchronize only to the PTP Instance selected using the best master clock algorithm."*

- While the external behaviour would not change if correction is only made on the correctionField of the transmitted sync and follow up messages (as for instance specified by IEEE802.1AS), as expressed in IEEE 1588-2019 clauses 9.5.9.4, 9.5.9.5 and 9.5.10, the requirement is to synchronize the "Local PTP Clock" based on an estimate of its Grandmaster Clock and use the same to update the originTimestamp (or preciseOriginTimestamp) of the sync (or FollowUp) messages unless specified by a specific Profile, see next slide

Boundary clock: extracts from IEEE 1588-2019

9.5.9.4 One-step PTP Ports

For a one-step egress PTP Port:

— The originTimestamp field of the Sync message shall be an estimate no worse than ± 1 s of the <syncEventEgressTimestamp> excluding any fractional nanoseconds, unless otherwise specified by the applicable PTP Profile.

— The originTimestamp field of the Sync message should be the <syncEventEgressTimestamp> excluding any fractional nanoseconds. The sum of the Sync message correctionField and originTimestamp field shall be the value of the <syncEventEgressTimestamp> including any fractional nanoseconds.

9.5.9.5 Two-step PTP Ports

For a two-step egress PTP Port:

— The originTimestamp field of the Sync message shall be 0 or an estimate no worse than ± 1 s of the <syncEventEgressTimestamp> unless otherwise specified by the applicable PTP Profile.

— The correctionField of the Sync message shall be set to 0.

— The PTP Port shall transmit both a Sync and a Follow_Up message.

— The PTP Port shall capture the sequenceId value of the Sync message as an input to the sequenceId field of the Follow_Up message. The mechanism for obtaining the value for the preciseOriginTimestamp and correctionField fields of the associated Follow_Up message shall be started.

9.5.10 Transmission of a Follow_Up message

Unless otherwise stated in this standard, a PTP Port shall issue a Follow_Up message only if required by 9.5.9.5. The Sync message whose transmission requires the transmission of a Follow_Up message is the associated Sync message.

The Follow_Up message should be transmitted as soon as possible after the transmission of the associated Sync message and shall be transmitted prior to the transmission of a subsequent Sync message to the same destination address.

The value of the sequenceId field of the Follow_Up message shall be the value of the sequenceId field of the associated Sync message.

The value of the preciseOriginTimestamp field of the Follow_Up message shall be an estimate no worse than ± 1 s of the <syncEventEgressTimestamp> of the associated Sync message excluding any fractional nanoseconds, unless otherwise specified by the applicable PTP Profile.

- Note: the +/-1s tolerance may lead to an interpretation that some flexibility is allowed. In reality, this was done to address the variety of applications using IEEE1588 (with different sync requirements); furthermore there is no way to make sure that over a long chain of clocks this tolerance is actually always met if only the correctionField is updated

- It can be noted that in IEEE1588-2008 the possibility to not making an update of the originTimestamp (or preciseOriginTimestamp) was not present (text between red lines was added in 2019, among other things to allow full compliance of IEEE802.1AS)

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Concerns regarding acting as a BC

- By requiring to set the originTimestamp to the syncEventEgressTimestamp , we are **requiring the 5GS clock to practically be locked to the external GM clock** (which is not acceptable)

- The behavior described is what is universally interpreted by the industry for the operation of a boundary clock. Specifying something different may not only deviate from the IEEE standards but also generate confusion to the users

- Way forward, Limit the use of 5GS as Boundary clock only to the following 2 cases:
  - 5GS as GM
  - Supporting profiles that allow a behavior similar to IEEE 802.1AS (no need to lock the 5GS to external GM) (this is only a theoretical option, since IEEE 802.1AS is the only profile as far as we know allowing this behavior, and this is already addressed in TS 23.501)

Support for IEEE 1588-2008 (1)

☞ Standards IEEE 1588-2019 and IEEE 1588-2008 are expected to co-exist for some time

☞ Some networks and PTP profiles still use IEEE 1588-2008

- Some profiles are based on IEEE 1588-2008: such as the power profile IEC 61850-9-3, and the SMPTE profile for professional broadcast applications. The ITU-T Telecom profiles (e.g. G.8275.1) are based on IEEE 1588-2008 (expected to add this year the possibility to also use IEEE 1588-2019)

- Particularly, the SMPTE profile is included in Release-17 as supported profile. However, so far it is based on IEEE 1588-2008 as indicated in the standard SMPTE ST 2059-2:2015:

1   Scope

This standard specifies a Precision Time Protocol profile specifically for the synchronization of audio/video equipment in a professional broadcast environment.

The profile is based on IEEE Std 1588-2008 and includes a self-contained description of parameters, their default values, and permitted ranges.

Support for IEEE 1588-2008 (2)

- Just removing support to IEEE1588 -2008 may prevent the use of 5GS in many important use cases

- We propose to add support in 5GS

- Way forward: send LS to (SMPTE and) other relevant SDOs to verify if their new updated versions of the profiles uses IEEE 1588-2019 and if it is acceptable that only IEEE 1588-2019 is supported by the 5GS