S2-2107133

IEEE 1588 compatibility between editions and support for SMPTE profile

Ericsson

Background

- IEEE 1588 WG: LS response on Time Synchronization S2-2105362
  - Re interoperability between 1588 editions:
  - The IEEE 1588 working group created IEEE Std 1588-2019 such as to be backward compatible with IEEE 1588-2008. By that we mean that if you do not use the new optional features in the 2019 edition, then the old ones work the same as in 2008. However, care should be taken to make sure that the same optional features are implemented to allow equipment to interoperate. See IEEE 1588-2019 clause 19 on compatibility between the 2019 and 2008 editions.
  - IEEE 1588 WG deferred answer to other questions to SMPTE, so we propose to send an LS to SMPTE for feedback.

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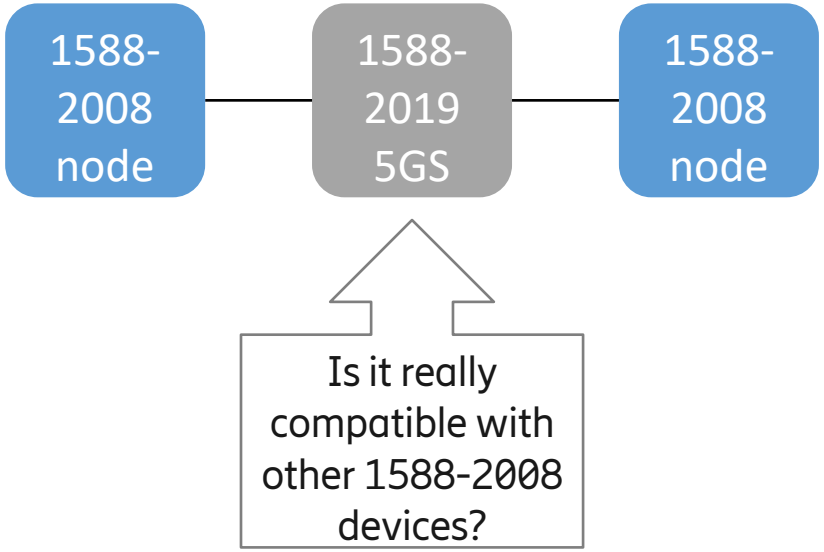
IEEE 1588-2008 parameters not available in 3GPP

- The goal is not to implement IEEE 1588-2008 within 5GS.
- 5GS only implements IEEE 1588-2019, but can be backward compatible & support interworking with IEEE 1588-2008.



The following parameters (IEEE 1588-2019 added in 3GPP) are not available in IEEE 1588-2008:

- defaultDS.sdoId
- defaultDS.instanceEnable
- defaultDS.externalPortConfigurationEnabled
- defaultDS.instanceType
- portDS.minorVersionNumber
- portDS.delayAsymmetry
- portDS.portEnable
- externalPortConfigurationPortDS.desiredState

(the highlighted parameters may have implications in a network with devices implementing different editions of the IEEE 1588 – see next slide)

Action for Parameters used in TS 23.501

- The way 3GPP initializes PTP instance in 5GS, and the way 3GPP enables external configuration in the 5GS, should not affect compatibility/interoperability (see images)
- Unless there is a common management in the network with both implementations: add a Note warning that the way to handle the management is different for different editions and needs to be properly handled if there is a common management

To initialize a PTP instance in 5GS, TSN AF or TSCTSF retrieve the "defaultDS.clockIdentity" of the PTP instance in NW-TT via UMIC. Upon detection of a DS-TT port, the TSN AF or TSCTSF initializes the PTP instance in the DS-TT by setting the "defaultDS.clockIdentity" via PMIC to the same value as retrieved from the NW-TT. The TSN AF or TSCTSF also enables the PTP instance by setting the defaultDS.instanceEnable = TRUE to DS-TT via PMIC and to NW-TT via UMIC. The TSN AF or TSCTSF can initialize any number of PTP instances up to the maximum number of supported PTP instances by the NW-TT and DS-TT(s), whichever is the lowest.

The PTP port states may be determined by NW-TT either via:

- Method a), BMCA procedure.
- Method b), local configuration.

When Method b) is used, the TSN AF or TSCTSF sets the defaultDS.externalPortConfigurationEnabled (per PTP instance) in UMIC to TRUE, and sets the value of externalPortConfigurationPortDS.desiredState (per PTP port) in UMIC to the desired state of the PTP port for each DS-TT and NW-TT port for the (g)PTP domain.

Options used in 3GPP implementation of IEEE 1588-2019, which may affect compatibility: *Cumulative rate ratio*

19.4.12 Option for using cumulative rate ratios

The operation of this option with the specifications of the 2008 edition will result in synchronization errors if a PTP Instance conformant to this edition with this option enabled is in the PTP Communication Path of implementations conformant to the 2008 edition. These errors are due to incorrect computation of <meanLinkDelay> by PTP Instance using this option due to failure to receive the Cumulative_Rate_Ratio TLV from a 2008 implementation.

- 3GPP TS 23.501 uses "cumulative rateRatio" for IEEE 802.1AS: we assume there is no impact there
- "cumulative rateRatio" is used in the conversion and calculation of TSCAI parameters, clause 5.27.2.1, TS 23.501: add text to identify this parameter as optional, i.e., can operate with it if it is available.

About transparent clocks

- 1588-2019

19.4.5 Revision of the specifications of a Transparent Clock

Two major changes have been made in the specifications of Transparent Clocks. The optional data sets for Transparent Clocks in the 2008 edition have been replaced by attributes in the defaultDS and portDS data sets and the specifications are now explicitly per PTP Instance and therefore domain specific.

In the 2008 edition, the specifications were domain independent at least concerning the data sets (see the NOTE in 8.3.1 of the 2008 edition concerning the optional data sets). PTP Networks containing implementations conformant to the 2008 edition might not operate correctly in networks including PTP Instances of this edition if the following occur:

— The PTP Instances of this edition require a Transparent Clock to modify a PTP message field other than the correctionField (and any resulting updates of transport layer fields), and/or

— Options of this edition or of PTP Profiles have specifications that are explicitly per domain.

8.1.1.3 Transparent clocks

For each transparent clock, the following "transparent clock data sets" should be maintained locally as the basis for protocol decisions and for providing values for message fields:

— transparentClockDefaultDS data set (see 8.3.2)

— transparentClockPortDS data set (one data set for each port; see 8.3.3)

In LS to SMPTE ask: Does it mean that 3GPP needs to add these data sets to maintain locally in 5GS?
(see next slide)

About SMPTE profile based on IEEE 1588-2008 (claimed as supported in 3GPP)

- 3GPP does not specify support for PTP management mechanism (Chapter 15, optional), however SMPTE mandates it:

> **5.3 Management Mechanism**
>
> Management messages are used to access attributes and to generate certain events defined in this standard, and for sending the SM dataset.
>
> The management mechanism specified in Subclause 15.2 'PTP management mechanism' of IEEE Std 1588-2008 shall be used.

- Several parameters are set by SMPTE profile to a specified value (or range of values), and the rest must be set to the default value. The following parameters should be added and set accordingly:
  - defaultDS.slaveOnly
  - transparentClockDefaultDS.delayMechanism
  - transparentClockDefaultDS.primaryDomain

  (In LS to SMPTE ask: Is there a need for these deprecated parameters to be added to allow for a common management?)

- (IEEE 1588-2019): The optional data sets for Transparent Clocks in the 2008 edition have been replaced by attributes in the defaultDS and portDS data sets, but ONLY transparentClockDefaultDS.delayMechanism is covered by defaultDS.delayMechanism).

Additional concerns

- Potential issues concerning SMPTE vs IEEE 1588 2008/2019, may be related to:
  - packet rate: if packet rate is low, sync messages may exceed the 1 ms limit for difference with the Origin TimeStamp – the 5GS node does not update it – In LS to SMPTE: add this concern.
  - rules to send out sync messages - In LS to SMPTE: add this concern.

- In LS to SMPTE: has SMPTE introduced any additional option after 2008 edition (and not included in 2019) in the profile?

Regarding frequency accuracy

- According to SMPTE profile:

Synchronization is considered to have been achieved when network-based time accuracy between any two slave devices with respect to the master reference is within 1 microsecond. This standard is capable of providing a higher degree of accuracy depending on the network architecture.

5.7.1 Frequency accuracy

For application as the master reference for a plant synchronization system, the PTP grandmaster clock shall maintain a frequency deviating within 5 parts per million (ppm) from the SI second.

This accuracy may not be appropriate for all applications; requirements for precision and stability of oscillators for both Master and Slave devices are application dependent, and appropriate choices should be made during system design.

- This may require taking actions (e.g., estimate the frequency error of the incoming PTP messages) to limit the impact due to frequency deviation between the SMPTE master (that may be 5ppm compared with the SI second) and the 5GS timing (typically traceable to UTC).
- In LS to SMPTE ask: What portion of the time error budget can be allocated to the 5GS?

Summary of proposals

- CR addressing: note on some IEEE 1588-2019 parameters regarding common management, and adding that cumulative rateRatio can only be used is available.
- LS out to IEEE 1588 WG and SMPTE to:
  - Thank IEEE 1588 WG for their feedback
  - Requesting SMPTE for assistance and add some specific questions.