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Internet protocol aspects – Transport

**Timing characteristics of telecom boundary
clocks and telecom time slave clocks for use
with partial timing support from the network**

Recommendation ITU-T G.8273.4/Y.1368.4

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Recommendation ITU-T G.8273.4/Y.1368.4

Timing characteristics of telecom boundary clocks and telecom time slave clocks for use with partial timing support from the network

Summary

Recommendation ITU-T G.8273.4/Y.1368.4 specifies minimum requirements for time and phase synchronization equipment used in synchronization networks that operates in the assisted partial timing support (APTS) and partial timing support (PTS) architectures.

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Recommendation ITU-T G.8273.4/Y.1368.4

Timing characteristics of telecom boundary clocks and telecom time slave clocks for use with partial timing support from the network

1 Scope

This Recommendation specifies minimum requirements for time and phase synchronization equipment used in synchronization networks that operates in the assisted partial timing support (APTS) and partial timing support (PTS) architectures.

The APTS and PTS architectures are specified in [ITU-T G.8271], [ITU-T G.8271.2] and [ITU-T G.8275]. The applicable profile is established in [ITU-T G.8275.2], which specifies unicast PTS/APTS time or phase synchronization distribution for packet-based networks.

This Recommendation allows for proper network operation for phase/time synchronization distribution when a network equipment embedding an APTS or a PTS clock is timed from another telecom boundary clock (T-BC) or a telecom grandmaster (T-GM). This Recommendation specifies the minimum requirements for APTS and PTS clocks in network elements (NEs). These requirements apply under the normal environmental conditions specified for the equipment.

This Recommendation includes noise generation, noise tolerance, noise transfer, and transient response for APTS and PTS clocks.

Synchronous equipment clocks (per [ITU-T G.8262]) are optional in this Recommendation, and they are not used for APTS. For PTS, if a piece of equipment implements a synchronous equipment clock, as described in Appendix III and in Appendix IV, then the requirements in clause 8 still apply.

NOTE – For APTS, double failure (coincident failure of both global navigation satellite system (GNSS) and precision time protocol (PTP) input references) is not addressed in this Recommendation, except for short-term holdover scenarios (see clause 7.6.1) when the primary GNSS source is lost and a backup PTP source is temporarily unavailable. APTS double failure is for further study.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T G.703] Recommendation ITU-T G.703 (2016), *Physical/electrical characteristics of hierarchical digital interfaces*.
- [ITU-T G.781] Recommendation ITU-T G.781 (2020), *Synchronization layer functions for frequency synchronization based on the physical layer*.
- [ITU-T G.810] Recommendation ITU-T G.810 (1996), *Definitions and terminology for synchronization networks*.
- [ITU-T G.811] Recommendation ITU-T G.811 (1997), *Timing characteristics of primary reference clocks*.
- [ITU-T G.813] Recommendation ITU-T G.813 (2003), *Timing characteristics of SDH equipment slave clocks (SEC)*.

- [ITU-T G.8260] Recommendation ITU-T G.8260 (2020), *Definitions and terminology for synchronization in packet networks.*
- [ITU-T G.8262] Recommendation ITU-T G.8262/Y.1362 (2018), *Timing characteristics of a synchronous equipment slave clock.*
- [ITU-T G.8264] Recommendation ITU-T G.8264/Y.1364 (2017), *Distribution of timing information through packet networks.*
- [ITU-T G.8271] Recommendation ITU-T G.8271/Y.1366 (2020), *Time and phase synchronization aspects of telecommunication networks.*
- [ITU-T G.8271.2] Recommendation ITU-T G.8271.2/Y.1366.2 (2017), *Network limits for time synchronization in packet networks with partial timing support from the network.*
- [ITU-T G.8272] Recommendation ITU-T G.8272/Y.1367 (2018), *Timing characteristics of primary reference time clocks.*
- [ITU-T G.8273.2] Recommendation ITU-T G.8273.2/Y.1368.2 (2019), *Timing characteristics of telecom boundary clocks and telecom time slave clocks.*
- [ITU-T G.8275] Recommendation ITU-T G.8275/Y.1369 (2017), *Architecture and requirements for packet-based time and phase distribution.*
- [ITU-T G.8275.2] Recommendation ITU-T G.8275.2/Y.1369.2 (2020), *Precision time protocol telecom profile for phase/time synchronization with partial timing support from the network.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

Terms related to synchronization are defined in [ITU-T G.810] and [ITU-T G.8260].

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

APTS	Assisted Partial Timing Support
BMCA	Best Master Clock Algorithm
cTE	constant Time Error
dTE	dynamic Time Error
EEC	Ethernet Equipment Clock
eLORAN	enhanced Long-Range Navigation
ESMC	Ethernet Synchronization Messaging Channel
GbE	Gigabit Ethernet
GNSS	Global Navigation Satellite System
I/O	Input/Output

IWF	Interworking Function
MTIE	Maximum Time Interval Error
NE	Network Element
PEC	Packet-based Equipment Clock
P-F	PTS to full timing support (FTS)
PPS	Pulse Per Second
PRC	Primary Reference Clock
PRS	Primary Reference Source
PRTC	Primary Reference Time Clock
PTP	Precision Time Protocol
PTS	Partial Timing Support
SDH	Synchronous Digital Hierarchy
SEC	Synchronous digital hierarchy (SDH) Equipment slave Clock
SSM	Synchronization Status Message
STM-N	Synchronous Transport Module – level N
SyncE	Synchronous Ethernet
T-BC	Telecom Boundary Clock
T-BC-A	Telecom Boundary Clock for Assisted partial timing support
T-BC-P	Telecom Boundary Clock for Partial timing support
TE	Time Error
T-GM	Telecom Grandmaster
ToD	Time of Day
T-TSC-A	Telecom Time Slave Clock for Assisted partial timing support
T-TSC-P	Telecom Time Slave Clock for Partial timing support

5 Conventions

None.

6 Physical layer frequency performance requirements

Synchronous equipment clock interfaces and synchronous equipment clock are optional. When used on the telecom time slave clock for partial timing support (T-TSC-P) or telecom boundary clock for partial timing support (T-BC-P), the synchronous equipment clock shall meet the performance requirements specified in [ITU-T G.8262], and shall generate and process Ethernet synchronization messaging channel (ESMC) messages as specified in [ITU-T G.8264].

Synchronous digital hierarchy (SDH) interfaces and SDH equipment slave clocks are optional. When used on the T-TSC-P or T-BC-P, the SDH equipment slave clocks shall meet the performance requirements specified in [ITU-T G.813], and shall generate and process synchronization status messages (SSMs) as specified in [ITU-T G.781].

7 Performance requirements for T-BC-A and T-TSC-A

7.1 Frequency accuracy

Under free-running conditions, the clock output frequency accuracy should not be greater than 4.6 ppm with respect to a reference traceable to a [ITU-T G.811] or [ITU-T G.8272] clock.

7.2 Time error noise generation

The time error (TE) noise generation of a telecom boundary clock for assisted partial timing support (T-BC-A) and telecom time slave clock for assisted partial timing support (T-TSC-A) represents the amount of noise (i.e., TE) produced at the output of the T-BC-A/T-TSC-A when locked to an ideal, wander-free time reference at the 1 pulse per second (1PPS) or PTP time input (see Figure A.1). This is equivalent to having an external local time reference at reference point A' as shown in Figure 1 of [ITU-T G.8271.2].

If an external local time reference is connected using a PTP timing signal instead of a 1PPS signal, the TE noise generation is for further study.

In the case of an integrated local time reference (e.g., a GNSS signal at the time input), there may not be an accessible 1PPS or PTP time input. In this case, the requirements of this clause are not applicable, except in the case of maximum TE noise generation, which is for further study.

The output of the T-BC-A is measured at both the 1PPS output and packet input/output (I/O) PTP master port; the output of the T-TSC-A is measured at the 1PPS output.

NOTE – The values in in this clause are valid for 1PPS interfaces and for 1 gigabit Ethernet (GbE), 10 GbE, 25 GbE, 40 GbE and 100 GbE interfaces. Values for other interfaces are for further study.

7.2.1 Maximum absolute time error ($\max|TE|$) noise generation

Under normal, locked operating conditions, the time output of the T-BC-A and the T-TSC-A should be accurate to within the maximum absolute TE ($\max|TE|$). This value includes all the noise components, i.e., the constant time error (cTE) and the dynamic time error (dTE).

The $\max|TE|$ limit is for further study.

In the case of an integrated local time reference, the $\max|TE|$ value is 100 ns greater than it would be for the case of an external local time reference. The total value is also for further study.

7.2.2 Constant time error generation

The permissible range of cTE noise generation is shown in Table 7-1.

Table 7-1 – T-BC-A/T-TSC-A permissible range of constant time error

T-BC-A/T-TSC-A class	Permissible range of cTE (ns)
A	± 50
B	± 20

NOTE 1 – The cTE definition and its method of estimation are given in [ITU-T G.8260]. For the purpose of testing the limits in Table 7-1, an estimate of cTE should be obtained by averaging the TE sequence over at least 10 000 s.

NOTE 2 – The cTE is measured at constant temperature (within ± 1 K).

7.2.3 Dynamic time error low-pass filtered noise generation

The dynamic TE low-pass filtered noise generation (dTE_L) is a maximum of 50 ns peak-to-peak.

NOTE – This should be measured under constant temperature (within ± 1 K) and using a first-order low-pass measurement filter with a bandwidth of 0.1 Hz for a minimum of 10 000 s.