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| **itu-old** | INTERNATIONAL TELECOMMUNICATION UNION | | | | | | | COM 15 – LS 378 – E |
| **TELECOMMUNICATION STANDARDIZATION SECTOR**  STUDY PERIOD 2013-2016 | | | | |  | | |
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| **Question(s):** | | 13/15 | | |  | | | |
| **Ref.: TD 605 (PLEN/15) Annex M** | | | | | | | | |
| **Source:** | | ITU-T Study Group 15 | | | | | | |
| **Title:** | | Reply to Liaison response on update on IEEE P802.1CM TSN for Fronthaul (reply to IEEE 802.1 – LS30) | | | | | | |
| **LIAISON STATEMENT** | | | | | | | | | |
| **For action to:** | | | | IEEE 802.1 (P802.1CM) | | | | | |
| **For comment to:** | | | |  | | | | | |
| **For information to:** | | | |  | | | | | |
| **Approval:** | | | | **ITU-T SG 15 (Geneva, 19-30 September 2016)** | | | | | |
| **Deadline:** | | | | 2 December 2016 | | | | | |
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| Please don’t change the structure of this table, just insert the necessary information. | | | | | | | | | |

Q13/15 thanks the IEEE 802.1 for your Liaison response to ITU-T SG15 LS-332, including updates on IEEE P802.1CM TSN for Fronthaul.

The group reviewed the Time synchronization requirements for four different categories, and the following can be said as an answer to your question on our view on the means to address these requirements.

As described in G.8271 (ref.1), time synchronization solutions could either be based on local reference (PRTC, Primary Reference Time Clock), or distribution from a remote master e.g. via PTP and an appropriate IEEE1588 profile. The remote master might be connected via intermediate nodes (supporting IEEE 1588) or via direct connections (e.g. direct fiber connection).

Note that PRTC are currently specified by ITU-T with accuracy of 100 ns.

Furthermore, an enhanced PRTC with target of 30 ns accuracy (G.8272.1, ref. 4) has been recently defined. However enhanced PRTCs are expected to be deployed only at central locations due to the complexity of the equipment, so that they might not be applicable in fronthaul scenarios.

ITU-T has specified a number of synchronization classes (see table 1 in G.8271, ref.1) addressing as a first step applications requiring 1.5 us accuracy with respect to an international recognized standard (class 4).

Q13 is currently looking at applications in the range of 100/200 ns accuracy requirements with respect to a common master. These applications may just need to limit their relative phase deviation and the common master could be the nearest boundary clock in the synchronization chain. Work is being done in G.8271.1 with planned definition of: network limits addressing these applications, enhanced synchronous Ethernet (G.8262.1 and revised G.8261) that could be used in the support of the time synchronization chain and if needed better performing time synchronization clock (new class of clock in G.8273.2, see ref.6).

As already mentioned a new better performing PRTC has been defined (G.8272.1) but this might not be applicable to the fronthaul use cases.

The following could be said for the various synchronization categories described in the liaison:

1. *Category A+ The maximum absolute Time Error ≤ 10 ns with respect to a common point in the synchronization chain (e.g., the common grandmaster clock or the nearest common boundary clock in case of PTP). Category A+ is, e.g., for Multiple-Input and Multiple-Output (MIMO) and transmit diversity radio access technologies.*

Phase alignment with this level of accuracy can be supported only in case of nodes connected to a common master (as mentioned earlier, a local PRTC, i.e., a local GNSS, for this type of application is expected to only provide an accuracy in the 100 ns range).

If the nodes are co-located, a local common synchronization master (as indicated in the text from IEEE802.1, the requirement is not for absolute time synchronization), can distribute timing e.g., via PTP or 1 PPS. It should be noted that due to the tight requirement any source of asymmetry (e.g. also in the link) must be carefully controlled in the range of a few ns.

Note: when distributing synchronization reference from a local common synchronization master, is important that when the end nodes are connected to different physical ports of the master, the time error between the ports is limited. In particular, with reference to G.8273.2, potential constant time error is possible when different physical interfaces are used, up to the limit specified for the G.8273.2 clock types (e.g. 20 ns for clock type B). That means that a G.8273.2 clock could be used for this application only if this source of error is controlled or if the same interface can be used to connect multiple end nodes (e.g. by splitting the 1 PPS output signal). It should be noted that in terms of dynamic noise generation, according to G.8273.2, the noise generation can in general be higher than 10 ns (e.g. 70 ns high frequency noise). However, any high frequency noise is expected that can be filtered by the end nodes so it should not matter, while low frequency noise is expected to be common on all interfaces, therefore it should not contribute to the maximum absolute Time Error.

If the nodes are not co-located, a direct connection from a remote common master (e.g. via fiber) is required. In fact, this is the set up normally used in fronthaul networks in order to meet this level of requirement (e.g., when using CPRI an internal 2-way protocol is used to compensate for the distance). As mentioned earlier, accurate control of any asymmetry is required (e.g. as related to use of different wavelengths in the transmission.

1. *Category A The maximum absolute Time Error ≤ 45 ns with respect to a common point in the synchronization chain (e.g., the common grandmaster clock or the nearest common boundary clock in case of PTP). Category A is for intra-band contiguous carrier aggregation radio access technology.*

This case can be considered similar to the previous one as the requirement can be considered still very tight: either direct synchronization distribution in case of remote master or a local common master when the end nodes are co-located, could be considered to meet Category A.

Also in this case a local PRTC is not suitable (due to the achievable performance).

1. *Category B The maximum absolute Time Error ≤ 110 ns, with respect to a common point in the synchronization chain (e.g., the common grandmaster clock or the nearest common boundary clock in case of PTP). Category B is for intra-band non-contiguous and inter-band carrier aggregation radio access technologies.*

As above, this category can be fulfilled via point-to-point synchronization distribution. When the end nodes are co-located, a common master could be suitable.

This level of accuracy, however, could also be achieved when the nodes are connected to a remote common master and the timing is distributed over a small network (e.g. chain of boundary clocks). The actual dimension of the network is still being studied. However, based on existing specification (G.8273.2) and expectation on the enhanced SyncE networks, some initial consideration could be made: T-BC of class A contributes by 20 ns static noise. Assuming 3 of these are cascaded, 50 ns remains for dynamic noise and for link asymmetries, that looks as a feasible target.

Note that common master could also be considered as an intermediate node in the overall chain as already discussed. See figure 1 in this contribution.

Use of a local PRTC at the end node is also an option in this case (appropriate antenna installation and cabling are important aspects to be taken into account in order to meet the synchronization requirements, see G.8272, ref. 7, for further information on factors influencing the performance of a GNSS-based PRTC).

1. *Category C The maximum absolute Time Error ≤ 1.36 μs, where the timing accuracy of the slave clock in the RE is relative to any grandmaster clock whose Time Error 100 ns. Meeting Category C requirement is mandatory. Category C is for time division duplex radio access technology.*

This case can be considered analogous to the scenarios addressed by G.8271.1 HRMs (e.g. over 10 or 20 PTP clocks), G.8275.1 profile (full timing support) and G.8273.2 clocks. So that these could be used. Note: in the requirement described in the liaison there is no the budget for rearrangements and the budget for the End application (that in this case is only the final radio antenna) is in the order of 40 ns. In fact, 100 ns from the grandmaster plus 40 ns leads to the 1.5 us standard requirement.

Use of a local PRTC is possible in this case.

As an additional consideration applicable to all synchronization categories, it is noted that allocation for network rearrangements (e.g. due to failures in the SyncE or PTP network) or holdover was not included in the noise budgeting.

Q13 also takes the opportunity to kindly ask IEEE 802.1 to provide a copy of the P802.1CM draft.

We look forward to continuing our good working relationship with the IEEE 802.1.

References:

1. ITU-T Recc. G.8271, Time and phase synchronization aspects of packet networks, <http://www.itu.int/rec/T-REC-G.8271-201607-I>
2. ITU-T Recc. G.8271.1, Network limits for time synchronization in packet networks, <http://www.itu.int/rec/T-REC-G.8271.1-201308-I>
3. ITU-T Recc. G.8272, Timing characteristics of primary reference time clocks, <http://www.itu.int/rec/T-REC-G.8272-201501-I>
4. ITU-T Recc. G.8272.1, Timing characteristics of enhanced primary reference time clocks
5. ITU-T Recc. G8275.1, Precision time protocol telecom profile for phase/time synchronization with full timing support from the network, <http://www.itu.int/rec/T-REC-G.8275.1-201606-I>
6. ITU-T G.8273.2, Timing characteristics of telecom boundary clocks and telecom time slave clocks

*Attachment: TD 613/P Rev1 (G.8272.1); TD 614 Rev1 (G.8273.2)*

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