Information on IEC/IEEE 60802 status and references to IEC/IEEE 60802 and 802.1AS by 3GPP Service Requirements for Cyber Physical Control Applications

Geoffrey M. Garner
Huawei (Consultant)
gmgarner@alum.mit.edu

Stefano Ruffini
Ericsson
stefano.ruffini@ericsson.com

IEEE 802.1 TSN TG
2020.01.22

Outline

- Introduction
- Current status of IEC/IEEE 60802
- References to Drafts of 802.1 documents by 3GPP TS 22.104
- Observations
- Proposal for Liaison to point out that the referenced documents are early drafts, and what work is still needed on them

Current Status of IEC/IEEE 60802 – 1

- The IEC/IEEE 60802 Profile Document is currently a draft (D1.1)
  - It is expected to change substantially in the next draft, and also likely when it is finally published
- In particular, the question of whether the end-to-end requirement for the Working Clock Domain (1 μs) for the desired HRM (100 hops) is consistent with the desired equipment requirements is still being studied
- The current desired equipment requirements include, but are not limited to
  - Maximum frequency offset at a time-aware relay instance and time-aware end instance of ±100 ppm
  - Maximum frequency drift rate at a time-aware relay instance and time-aware end instance of 3 ppm/s
- It is planned to perform simulations to determine the maximum dynamic time error (max|dTE|) for the HRM, given the respective equipment requirements

Current Status of IEC/IEEE 60802 – 2

- In addition, the contribution of the accumulation of constant time error (cTE) to total maximum absolute time error (max|TE|) must be considered and accounted for
- In worst-case, static time error accumulates linearly
  - Since static time error does not change with time, a particular connection that happens to have large static time error will have that large error for as long as the ports of the PTP Instances of that connection are enabled
  - While it has been argued in previous 802.1 meetings that the probability of all the components of cTE having their worst-case values is small (assuming uniform probability density functions for the components), this is based on the assumption that the individual components of cTE are independent (or, at least, uncorrelated)
    - **But this assumption of independence need not hold because the same semiconductor components might well be used in the various PTP Instances in the network, and these components could have the same or similar cTE (i.e., cTE at successive PTP Instances could be highly correlated)**
    - This could certainly happen if a single equipment vendor's equipment were used in the network, but also could occur with multiple equipment vendors if they happened to use the same components
- **The actual target performance (1 μs over 100 clocks) looks problematic:**
  - **Control of cTE within a few ns per equipment is not trivial. As an example ITU-T has specified various classes of clocks, with cTE ranging from 50ns to 15ns. One last clock is being specified targeting less than 5 ns cTE per clock, however this is considered as an extremely accurate clock requiring specialized hardware implementation**

References to 802.1 Documents by 3GPP TS 22.104

- 3GPP TS 22.104 specifies service requirements for cyber-physical control applications in vertical domains
- Its scope indicates that it provides “Stage 1 normative service requirements for 5G systems, in particular service requirements for cyber-physical control applications in vertical domains.” [1]
  - *Stage 1* indicates that the service description is from the user’s standpoint
  - The scope further indicates that “cyber-physical systems are to be understood as systems that include engineered, interacting networks of physical and computational components; control applications are to be understood as applications that control physical processes.” [1]
  - The scope also indicates that “Communication services supporting cyber-physical control applications need to be ultra-reliable and, in some cases, the end-to-end latency must be very low. Communication for cyber-physical control applications supports operation in various vertical domains, for instance industrial automation and energy automation.” [1]

References to 802.1 Documents by 3GPP TS 22.104 (Cont.)

- 3GPP TS 22.104 V17.2.0 (2019-12) [1] references the following 802.1 documents (copied from the reference list in [1]; reference numbers 20, 22, and 26 are the reference numbers in [1])
  - [20] IEEE, Use Cases IEC/IEEE 60802, 2018.
  - [22] "IEEE Standard for Local and metropolitan area networks--Timing and Synchronization for Time-Sensitive Applications," IEEE Std 802.1AS-Rev/D7.3, pp. 1-502, August 2018.
  - [26] IEC/IEEE 60802: "Time-Sensitive Networking Profile for Industrial Automation".
- Reference [20] is the IEC/IEEE 60802 use case document
  - This document is an unapproved contribution to the IEC/IEEE 60802 Joint Project, not an approved and published document; the latest draft that the authors are aware of (V1.2) is available at http://www.ieee802.org/1/files/public/docs2018/60802-industrial-use-cases-0918-v12.pdf
- Reference [22] is to an earlier draft (D7.3) of P802.1AS-Rev
  - At present, the latest draft of 802.1AS-Rev is D8.3, which is the version that was on the agenda for the January 8, 2020 RevCom teleconference
  - Once 802.1AS-Rev is approved by the IEEE Standards Association Standards Board (SASB), it can be referenced as IEEE Std 802.1AS-2020.

References to 802.1 Documents by 3GPP TS 22.104 (Cont.)

- Reference [26] is to the IEC/IEEE 60802 Profile Document
  - A date and draft number are not given; in any case, the latest draft is D1.1 (with last modified date in the 802.1 private area of 11 September 2019)
  - However, the TG ballot of D1.1 has closed
    - There were 584 comments submitted on the ballot
    - At present, many comments have been resolved; however, many comments are still to be resolved
    - It is expected that the next draft will change substantially compared to D1.1

Observations – 1

- As indicated earlier, the IEC/IEEE60802 Profile Document is currently not stable, and is expected to change substantially in the next draft and also when it is finally published
- The question of whether the end-to-end requirement for the Working Clock Domain (1 μs) for the desired HRM (100 hops) is consistent with the desired equipment requirements is still being studied
  - The current desired equipment requirements being studied include, but are not limited to:
    - Maximum frequency offset at a time-aware relay instance and time-aware end instance of ±100 ppm
    - Maximum frequency drift rate at a time-aware relay instance and time-aware end instance of 3 ppm/s
- The reference [26], to the IEC/IEEE 60802 Profile Document, therefore could be problematic

Observations – 2

- However, the reference to the IEC/IEEE 60802 Profile Document appears in only one place in TS 22.104, namely in the caption of Figure A.2.2.4-1, whose caption reads “Example of four cooperating machines with wireless connections (based on [26])”
  - Examination of this figure (note that the TS 22.104 document is publicly available at the link given in reference [1] of the current presentation) indicates that it is very similar to Figure 53 of the IEEE/IEC 60802 Use Cases Document (a link to this document is on slide 4), which is already referenced by TS 22.104 as reference [20]
  - Therefore, the normative reference to the IEC/IEEE 60802 Profile Document could be eliminated, and Figure A.2.2.4-1 could simply reference the Use Cases Document (reference [20] in TS 22.104)
- Finally, it seems that reference [22] of TS 22.104 should reference the approved 802.1AS-Rev, which will be IEEE Std 802.1AS-2020, rather than D7.3.

Proposal

- Send a liaison to 3GPP, pointing out the following:
  - Inform them that both the IEC/IEEE 60802 Use Cases Document and the IEC /IEEE 60802 Profile document are drafts, which can change. The latest draft of the Profile document is D1.1. The Task Group ballot for this draft has closed, and 420 comments were submitted for the ballot. At present, many comments have been resolved, but many comments still must be resolved. In any case, the next draft will be substantially different from D1.1. due to the comment resolutions, and there are expected to be further changes due to subsequent ballots.
  - Work related to the performance requirements and model(s) for time error accumulation is ongoing, and simulations are planned to determine the consistency of the equipment requirements, dynamic component of desired end-to-end requirements, and hypothetical reference model. Accumulation of cTE is another important aspect to analyze carefully.
  - Figure A.2.2.4-1 of TS 22.104, whose caption reads “Example of four cooperating machines with wireless connections” actually resembles Figure 53 of the IEC/IEEE 60802 Use Cases Document, and should reference this document (reference [20]) instead of the IEC/IEEE 60802 Profile Document (reference [26]). If this is done, reference [26] of TS 22.104 could be eliminated as it would no longer be referenced.
  - Reference [22] is to 802.1AS-Rev/D7.3. This is an older draft of 802.1AS-Rev. It should be replaced with the published version after approval by the IEEE Standards Association Standards Board, i.e., IEEE Std 802.1AS-2020.

References

[1] 3GPP TS 22.104 V17.2.0 (2019-12), *3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service requirements for cyber-physical control applications in vertical domains; Stage 1 (Release 17)*, 3GPP, December 20, 2019, publicly available at https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3528

Thank you