Initial Plans and Assumptions for 802.1ASdm

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IEEE 802.1 TSN TG
2020.11.02

Outline

- Introduction
- 802.1AS-2020 maintenance items
- New hot standby feature (main focus of 802.1ASdm)

Introduction - 1

- The main focus of 802.1ASdm is to add a new feature for hot standby
- 802.1ASdm also will address errors and omissions in the description of existing functionality
  - This allows various maintenance items for 802.1AS-2020 to be addressed in 802.1ASdm
- The 802.1ASdm project scope is (from the PAR):

  5.2.b **Scope of the project:** This amendment specifies protocols, procedures, and managed objects for hot standby without use of the Best Master Clock Algorithm (BMCA), for time-aware systems, including:

  - A function that transforms the synchronized times of two generalized Precision Time Protocol (gPTP) domains into one synchronized time for use by applications;
  - A function that directs the synchronized time of one gPTP domain into a different gPTP domain; and
  - Mechanisms that determine whether a gPTP domain has sufficient quality to be used for hot standby.

  This amendment also addresses errors and omissions in the description of existing functionality.

Introduction - 2

- The term “hot standby” is not actually defined in either the 802.1ASdm PAR nor in 802.1AS-2020 (though it is mentioned in the latter)
  - However, in the context of 802.1AS, it roughly refers to the use of redundant, i.e., standby gPTP network components (e.g., GM PTP Instance, PTP Relay Instance, PTP End Instance, etc.) that are in service along with the gPTP network components used for normal operation, such that the time synchronization requirements can be met during a fault/failure (i.e., time synchronization is maintained seamlessly)
    - Throughout this presentation, the terms *fault* and *failure* are used interchangeably (this is for convenience in this presentation; it is not a proposal)
  - The above is not proposed as a formal definition; it is limited to this presentation as a description of what we are talking about
- While the PAR does not define “hot standby,” the project scope does describe what the amendment will include
  - In particular, the project scope talks about the use of two domains
    - The synchronized times of two domains are transformed into a single synchronized time for use by applications
    - The synchronized time of one domain can be used in a different domain
  - Also, the project scope talks about mechanisms to determine whether the synchronized time of a domain has sufficient quality

Maintenance Items

- While this is not the main focus, it is discussed first in this presentation because it is a very simple item
- At present, there are 9 open maintenance items for 802.1AS-2020; their numbers (in the maintenance database) are
  - 263, 275 – 281, 283
- At present, 280 is assigned to 802.1ASdn, and the others are (or it is assumed they will be) assigned to 802.1ASdm
  - However, the 802.1ASdn editor has indicated that the 802.1ASdn PAR does not include text that allows the fixing of errors and omissions, and therefore this should instead be assigned to 802.1ASdm
- In addition, the 802.1ASdm editor plans to enter an additional 9 maintenance items for 802.1AS-2020
- All the maintenance items (the 9 already entered in the maintenance database and the additional 9 that will be entered) are to fix minor errors or editorial items
- All these items, or whichever ones are assigned to 802.1ASdm, will be included in the draft
- These maintenance items were either discovered by the 802.1ASdm editor or brought to the editor's attention by others; it is possible there will be additional maintenance items before 802.1ASdm is finished

Assumptions for Hot Standby Feature - 1

- When a fault occurs, time synchronization performance is maintained seamlessly
  - The specific performance objectives can be those in B.4 of 802.1AS-2020, or can be TSN profile specific
- It is required to mitigate only a single fault
  - This can be a fault on a link or on a time-aware system
  - It is assumed that the topology is sufficiently robust that at least any single fault can be mitigated; however, ensuring this is outside the scope of 802.1ASdm
  - It may be possible to mitigate more than one fault in specific cases; however, this is not a requirement
- The BMCA is not used; instead, the external port configuration feature is used
  - External port configuration is done by an external (to 802.1AS) entity
    - Therefore, the specification of this entity is out of scope of 802.1AS
  - When a single fault occurs, the external entity does not need to reconfigure the port states of the PTP Instances
    - Only local actions that are part of the hot standby feature, at one or more PTP Instances, are taken (this local actions occur through operation of the hot standby state machines)

Assumptions for Hot Standby Feature - 2

- Based on the above, only two gPTP domains are needed
  - Note also, that this part of the project scope
    - Allowing more than two domains would require a PAR modification
    - Allowing more than two domains would also require modification of the methodology submitted so far, which is currently documented in IEC/IEEE 60802/D1.2 Annex Z [1]
- After a failure, recovery (i.e., reconfiguration back to the original network configuration before the failure occurred) is non-revertive
  - Reverting to the unfailed configuration occurs either
    - Manually
    - Automatically as part of the operation of a network management system (this is outside the scope of 802.1AS, it will not be specified (but could be described informally in an informative annex if desired)
- Both gPTP domains involved when the hot standby feature is used have the same timescale
  - The timescale can be PTP or ARB, but is the same for both domains

Current Proposals for Hot Standby - 1

- The latest proposal for hot standby is contained in IEC/IEEE 60802/D1.2, Annex Z (subclause Z.1) [1]
- This material was initially submitted by the author of [3] and [5]
  - Initially, it was thought it might be included in IEC/IEEE 60802; however, it was then realized that it might also be used by other TSN profiles
  - It therefore was decided to include it in an amendment to 802.1AS
  - In the interim, it was placed in Annex Z of [1], where it would remain until it could be copied into the initial draft of the respective 802.1AS amendment (i.e., the current amendment – 802.1ASdm)
  - Note that terminology and nomenclature used in the material that is specific to IEC/IEEE 60802 will need to be made more general
- In the slides that follow, this material is very briefly summarized; see IEC/IEEE 60802/D1.2 Annex Z [1] for more detail
- Some of the material (e.g., figures) is copied from [1]
- Note that this new hot standby material is media-independent

Current Proposals for Hot Standby - 2

- In the hot standby feature, the 802.1AS model for a PTP Instance (802.1AS-2020/Figure 10-1) is generalized by adding a 60802 System entity and allowing 2 PTP Instances (domains)
- One PTP Instance is designated primary, and the other secondary

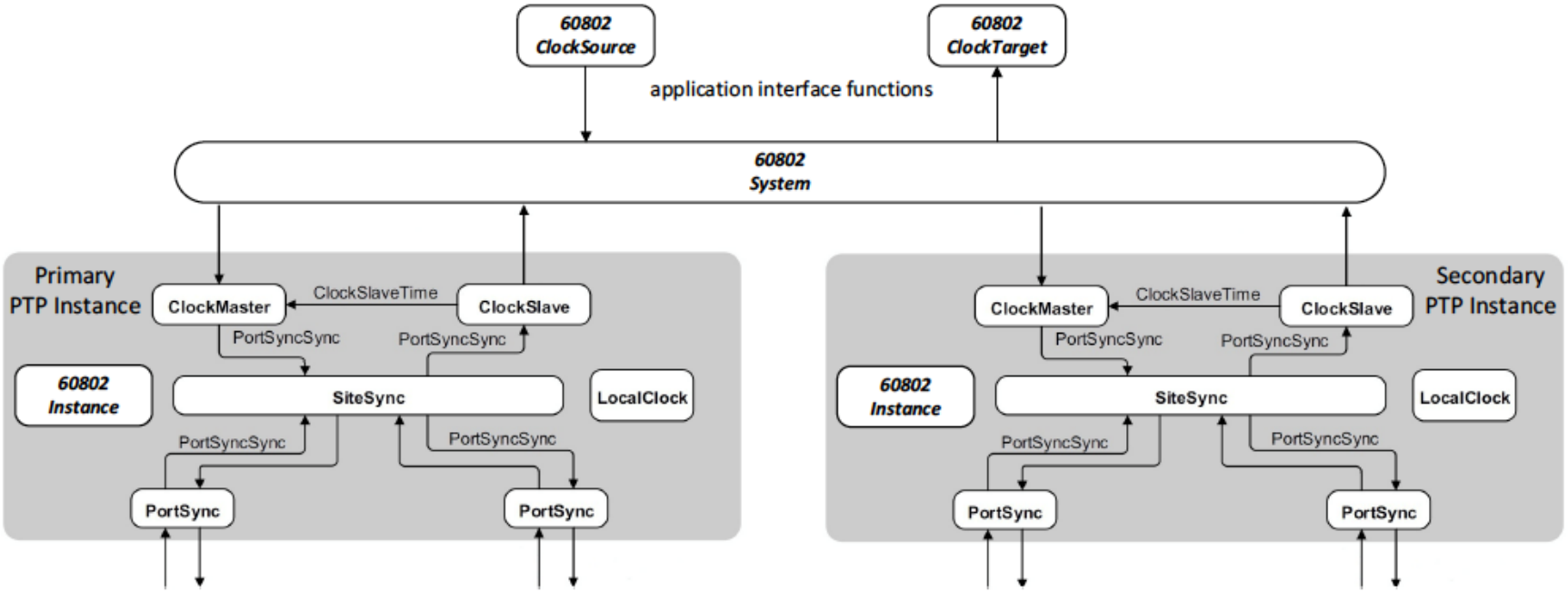

Figure Z.1 – Model of hot standby redundancy for time sync

Current Proposals for Hot Standby – 3

- Two new state machines are proposed in (as indicated earlier, the 60802 specific nomenclature must be made more general) [1]
  - 60802_Instance state machine – determines whether a PTP Instance is synchronized and providing a quality output (i.e., it has not failed, and is providing a synchronized time that is within the respective requirements)
    - Note: some aspects of this must still be clarified; e.g., the clock attributes of the current GM are known; however, the actual time error is, in general, not known
  - 60802_System state machine – determines whether one or both PTP Instances are synchronized and, based on this, determines which PTP Instance(s) to use for the source of synchronized time, in each domain, for
    - Time provided to end applications
    - Time used to timestamp incoming and outgoing Sync messages

Current Proposals for Hot Standby – 4

- Providing time to/from a PTP Instance is described in subclauses of Z.1.13 of [1]
  - If the primary PTP Instance is GM, the 60802_System transfers time from the 60802_ClockSource to the ClockMaster of the primary PTP Instance
  - If the 60802_System of the secondary GM is in the REDUNDANT state, the 60802_System transfers time from the ClockSlave of the primary PTP Instance to the ClockMaster of the secondary PTP Instance
  - If neither PTP Instance of a time-aware system is a GM and the 60802_System state is REDUNDANT, the time of the primary ClockSlave is transferred to the 60802_ClockTarget
    - More generally, a combination of the primary and secondary times could be used, as indicated in the project scope, though the details of this would likely be implementation specific (the possibility of this would be indicated generically)
  - If neither PTP Instance of a time-aware system is a GM and the 60802_System state is FAULT, the time of the ClockSlave of the PTP Instance that is synchronized is transferred to the 60802_ClockTarget
  - If the 60802_System state is HOLDOVER (i.e., both PTP Instances are not synchronized), the time of the primary PTP Instance is transferred to the 60802_ClockTarget
    - Possibly a term other than HOLDOVER should be used, as one typically distinguishes holdover within limits, holdover not within limits, and free-run

Current Proposals for Hot Standby – 5

- Transferring of phase and frequency within a PTP Relay Instance
- If the 60802_System state is REDUNDANT, then phase and frequency are transferred in each PTP Relay Instance as specified in 802.1AS-2020
  - The received originTimestamp (or preciseOriginTimestamp in the 2-step case), correctionField, and cumulative GM rateRatio of each gPTP domain is used in the respective PTP Instance
- If the 60802_System state is FAULT, then the received originTimestamp, correctionField, and cumulative GM rateRatio of the PTP Instance that has not failed is used on the master ports of the PTP Instance that has failed
  - This is equivalent to the "split" functionality described in [3] and [5], and shown in the examples in [2] (though [2] does not use the terminology "split")
- Reference [5] also describes the ability for the hot standby state machines to change the state of a passive port (if there is a passive port) to slave if the current slave port loses synchronization
  - Specifically, this could be done by the 60802_Instance state machine
  - With this capability, failure of a link attached to a PTP Instance slave port, where the PTP Instance has at least one passive port, can be mitigated completely in the domain of that PTP Instance
    - Mitigation of failures of other links (i.e., links not meeting the above condition), or of the PTP Instance that is the GM of the primary domain, requires two domains

Possible Items for Initial Draft of 802.1ASdm - 1

- Include all maintenance items assigned to 802.1ASdm
- Add either a new major clause for hot standby, or a new subclause of clause 10 (media-independent layer specification) for hot standby
  - Include the Annex Z hot standby material from IEC/IEEE 60802/D1.2 in the new clause/subclause
  - Make any necessary modifications to the terminology so it is more generic (i.e., not 60802 specific)
  - Include description of the split functionality in this new clause/subclause

Items Where Work or Decisions are Still Needed

- Definition of the NOT_QUALITY state, associated functions, and incorporation into the 60802_instance state machine
  - Need a transition from SYNCED state to NOT_QUALITY state in the event the time no longer conforms to the quality requirements
- Ability for the state machine(s) to change the state of a port from passive to slave when the current slave port loses synchronization (and a passive port is present)
- The interfaces between the 60802 ClockSource/60802 ClockTarget and the 60802 System, and between the 60802 System and the ClockMaster/ClockSlave need to be clarified
  - The latter interfaces are those of Clause 9
  - The former are new (or, should these also be those of clause 9?)
  - Note that this is not a practical issue or a conformance issue; it is mostly a functional/modeling issue
- The examples of Figures 7-5 and 7-6 of 802.1AS-2020 are for hot standby; should these be put in the context of the new feature and, if so, moved to the clause/subclause where the new feature is specified

Thank you

References - 1

[1] IEC/IEEE 60802/D1.2, Annex Z (Subclause Z.1).

[2] Feng Chen, *Segment Protection*, IEEE 802.1 presentation, March 2014 (available at https://www.ieee802.org/1/files/public/docs2014/as-chen-segment-protection-0314-v01.pdf).

[3] Rodney Cummings, *802.1AS Hot Standby Amendment: Scope Discussion*, Revision 1, IEEE 802.1 presentation, January 2020 (available at https://www.ieee802.org/1/files/public/docs2020/new-cummings-as-hot-standby-scope-0120-v02.pdf).

[4] Mike Potts, *IEEE 802.1AS Addendum for "Hot Standby" with multiple domain definition*, IEEE 802.1 presentation, 18 February 2020 (available at https://www.ieee802.org/1/files/public/docs2020/dm-potts-as-hot-standby-multiple-domains-0220-v01.pdf).

References - 2

[5] Rodney Cummings, *802.1AS Hot Standby Amendment: 4 Domains*, Revision 3, IEEE 802.1 presentation, March 2020 (available at https://www.ieee802.org/1/files/public/docs2020/new-cummings-as-hot-standby-scope-0120-v02.pdf).