Status of 802.1ASbt (802.1AS-Rev) Features

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Introduction

- This presentation summarizes the status of the features listed in the P802.1ASbt PAR
  - Note that it has been agreed to develop a Revision to 802.1AS, rather than an Amendment
  - In accordance with this, a revision PAR has been prepared; once this PAR is approved, the 802.1ASbt PAR will be withdrawn
  - Starting with 802.1ASbt/D0.5, the draft was prepared in Revision format
- The purpose of this is to help the 802.1 TSN TG assess the progress of 802.1ASbt (802.1AS-rev)
- Reference: *Discussion of Assumptions for 802.1ASbt Features*, Geoffrey M. Garner, July 2012 (see http://www.ieee802.org/1/files/public/docs2012/as-garner-discussion-asbt-feature-assumptions-v02.pdf

Summary of Features

- The following table summarizes the features listed in the 802.1ASbt PAR, and gives the current status of each feature (in the table, “draft” means 802.1ASbt/D0.7)
- The table is just a summary; the slides that follow will have more detailed discussion of the status of items not yet added to draft
  - Items 1, 2, 4 – 7, 10
- No further discussion of items that are well in progress or dropped
  - Items 3, 8, 9

Feat-ure	Description	Current status
1	Support for link aggregation (IEEE 802.1AX, IEEE 802.1AXbk, and 802.1AXbq)	Not yet added to draft
2	Support for new media types, with corresponding media-dependent layers, e.g., IEEE Std 1901 and WiFi Direct	Not yet added to draft
3	Interoperability with one-step clocks on receive (but with no requirement to generate one-step Sync messages)	Dropped from 802.1ASbt / 802.1AS-rev (January, 2014 TSN TG meeting)

Summary of Features - 2

Feat-ure	Description	Current status
4	Support for redundant paths	Not yet added to draft; there have been various presentations
5	Enhancements to the determination of asCapable (e.g., longer cable lengths, new media types)	Not yet added to draft; discussion in maintenance item 140 (asCapable “hair trigger” issue) may be related
6	Incorporation of the interfaces specified in IEEE Std 802.3bf into the IEEE 802.3 full-duplex media-dependent layer model	Not yet added to draft
7	Improved performance (e.g., improved grandmaster changeover time, longer chains of time-aware systems).	Not yet added to draft
8	Carrying information on alternate time scales (e.g., local time for a respective time zone)	In progress in draft (approximately 80 – 90% complete)
9	Management support for automatic measurement of link delay asymmetry.	In progress in draft (approximately 50% complete)
10	Additional parameter sets for non-Audio/Video applications, e.g., industrial control	Not yet added to draft; some question on whether this is more appropriate for 802.1BA

Feature 1 – Support for Link Aggregation

- Link aggregation is mentioned in 11.2.5 of 802.1AS
- Indicates that link aggregation is not specified; however, if it is used:
  - Sync and Pdelay_Req messages must be part of the same conversation
  - There can be error in time synchronization if Pdelay_Resp uses a different physical link than Sync and Pdelay_Req
    - Error is equal to the absolute value of one-half the difference in the delays in the two directions
- To run the 802.1AS protocol over a link that consists of two or more aggregated physical links, we need a mechanism to ensure that Sync and Pdelay_Req are part of the same conversation, and that Pdelay_Resp uses same physical link as Sync and Pdelay_Req
- Brief examination of 802.1AX-Rev/D4.53 (by 802.1ASbt editor) indicates that per-service frame distribution is possible (see 8.2)
  - More careful examination of 802.1AX-Rev (by editor or someone else) is needed to determine what in 802.1AX-Rev must be referenced in 802.1AS-Rev, and what must be added to 802.1AS-Rev
- Presentation(s) needed on this, prior to modification of 802.1AS-Rev draft

Feature 2 – Support for New Media Types

- In accordance with the discussion in the November, 2011 IEEE 802.1 AVB TG meeting, WiFi direct will not be included
- In accordance with the discussion in the November, 2011 IEEE 802.1 AVB TG meeting, IEEE Std 1901 can be handled as a type of CSN
  - Add entry for IEEE Std 1901 in Table E.2
  - Add a subclause E.6.3 entitled “IEEE Std 1901 behavior”
  - Add appropriate reference(s) to clause 2
- The above items must be supplied to the Editor, but at least placeholders can be included in the initial draft
  - This seems relatively straightforward, but the information must be supplied

Feature 4 – Support for Redundant Paths – 1

- This topic includes support for redundant paths and redundant GMs
- There have been many contributions that describe general approaches for this feature and what it might provide
  - Not all the approaches have been consistent
- Examples of what the feature might provide for
  - Redundant GMs all provide time simultaneously, with end-devices (and maybe BCs) free to use the time from the redundant sources as desired
    - E.g., primary and one or more hot standby GMs; ensembling of sources; etc.
  - Time transported over redundant paths simultaneously, with end-devices (and maybe BCs) free to use the time from the redundant sources as desired
    - E.g., multiple synchronization spanning trees from same GM root
  - Also had contribution describing the synchronization of the standby GMs by the primary, and synchronization of the primary by the standby that became GM, when the primary becomes GM again

Feature 4 – Support for Redundant Paths – 2

- Examples of approaches that have been suggested (this list is not necessarily complete)
  - How to identify/designate the redundant paths/GMs
    - Use different domain numbers (maybe partition the domain number field)
    - Use a separate identifier (some kind of path ID)
  - Where should computation of redundant paths and determination of redundant GMs be done
    - Inside gPTP (presumably using an alternate BMCA)
      - This would set port roles (1588 port states) to master, slave, passive, but would be associated with each redundant path
    - Outside gPTP (possibly by some centralized entity ("god box"))
      - Would be some interface to directly set port roles (states)
    - Could also determine redundant paths outside gPTP, but use an alternate BMCA to determine primary and backup GMs

Feature 4 – Support for Redundant Paths – 3

- Algorithms to distribute information and compute the primary and redundant GMs and the redundant paths
  - IS-IS and SPB (either in their entirety or reduced versions that were gPTP-specific have been mentioned)
  - It has been mentioned that there exist algorithms for determining maximally redundant paths
  - It has been mentioned that the default BMCA could be modified to determine, in addition to best clock, the second best, third best, etc.
- In summary, above items must be settled, i.e.
  - How should redundant paths/GMs be designated
  - Where should the computation of redundant paths/GMs be done
  - What algorithm(s) should be used to distribute the topology and clock attribute information and compute the redundant paths/GMs,

Feature 4 – Support for Redundant Paths – 4

- All the above pertains to determining the redundant paths and GMs
- Once they are determined, synchronization must be transported
- This problem is more straightforward, since once the redundant paths (from either the same or redundant GMs) are determined, synchronization can be transported using what is essentially an instance of gPTP
  - Whether we use domains or some other identifier for the redundant paths, we essentially have an instance of gPTP synchronization transport on each path
    - Each looks like a gPTP domain, whether or not we call it a domain
    - The differences between this use of domains and ordinary gPTP domains are completely in the redundant path determination, because information from multiple domains must be considered to determine the paths
      - But, as indicated above, this could be outside gPTP
- How the redundant synchronization information would be used at each time aware system (e.g., maintain separate synchronized times, combine (ensemble) the times, etc., would presumably be left to the application

Feature 4 – Support for Redundant Paths – 5

- In addition, the P1588 committee is working on including some handling of redundancy in next edition of IEEE Std 1588
  - At the moment, there is a proposal to use domain numbers to represent the redundant paths/GM
  - It was mentioned in the discussion that redundant path computation could be outside PTP, with an interface to directly set port states
  - These items have been discussed, but are not yet decided
- Presumably, 802.1AS-Rev should be consistent with whatever is decided for 1588
- We need to decide on what approach (or approaches, if we decide to allow more than one) we will use, before we consider the details of how this will all work
- Once we have decided on an approach (or approaches) the details need to be worked out
  - Need details/algorithms for those aspects that will be inside gPTP
  - Need interface(s) for information supplied, for those aspects that will be outside gPTP

Feature 4 – Support for Redundant Paths – 6

- **Contributions are needed**
  - **First, to lay out the overall structure(s)**
  - **Then, to supply details**

Feature 5 – Enhancements to Determine asCapable

- In 802.1AS-Cor-1, a value of 800 ns for neighborPropDelayThresh for 100BASE-TX and 1000BASE-T links, for full-duplex Ethernet, was added
- However, for fiber links, i.e., 100BASE-FX and 1000BASE-F, neighborPropDelayThresh is set to the maximum possible value
- For full-duplex IEEE 802.3 fiber links, need information (presentation) on the full range of desired cable lengths
- Need presentations to define the mechanism for other media, i.e., 802.11, 802.3EPON, MoCA, and any new media added by Feature 2; However, note that
  - For EPON, the default value of asCapable is TRUE (802.1AS/13.4)
  - For CSN, for the case of native path delay measurement, asCapable is set to TRUE
  - Therefore, may only need to address 802.11 and CSN for case without CSN network clock reference
- The addressing of maintenance item 140 (asCapable “hair trigger” issue may be relevant
- Contributions are needed

Feature 6 – Incorporation of IEEE 802.3bf Interface

- This feature is relatively well defined
- Replace MDTimestampReceive primitive (11.2.9) with appropriate 802.3bf primitives
- Modify MDSyncSendSM, MDSyncReceiveSM, MDPdelayReq, and MDPdelayResp state machines to use the 802.3bf primitives and mechanisms
- May be able to re-use aspects of early v1 drafts (D2.0 and earlier)
  - These used older interface model that had some similarity to 802.3bf model
- Editor should supply a presentation outlining additions/changes to add this feature (and any issues that arise)

Feature 7 - Improved Performance

- E.g., improved GM changeover time, longer chains
- The improved GM changeover time is discussed in the "Support for Redundant Paths" feature (feature 4 above), because it is facilitated by having redundant GMs
- 802.1AS-2011 enables achievement of ±500 ns over 7 hops
  - Any 2 time-aware systems separated by 7 or fewer hops differ by at most 1 μs
- With this feature, the same or better performance would be achieved over a larger number or the same number, respectively, of hops
  - In addition, the achievable jitter/wander performance might be improved
  - Some requirements are given in [4] and [5] of the slide 1 reference
- However, before adding any new features to 802.1ASbt, the achievable performance with the current 802.1AS needs to be determined, i.e.,
  - What is the maximum time error, jitter, and wander for a sufficiently large number of hops
  - The "sufficiently large number of hops" pertains to the entire network; 64 and 128 hops have been mentioned in the references cited above

Feature 7 - Improved Performance

- Initially, new simulations should be performed to determine the performance over a large number of hops (simulate at least 128, probably more for completeness)
- Note that previous 802.1AS simulations gave only the component of time error due to timestamp granularity, local noise phase noise, local node frequency offset measurement error, and local node frequency stability
- We also need components that account for
  - Uncompensated timestamp error, uncompensated PHY latency, and uncompensated link asymmetry
  - Error between ClockSource and ClockMaster
  - Error between ClockSlave and ClockTarget
  - Time change when GM changes or when network reconfigures
  - The above means that a budgeting exercise is necessary
- Once the above is done, if it is decided that better performance is needed, must decided how to achieve this (i.e., how to reduce the various impairments)
- Work and contributions are necessary

Feature 10 – Additional Parameter Sets for Non-A/V Applications

- Need to decide if these parameters should be in 802.1AS-rev, or in a Revision or Amendment of 802.1BA
- If the former, would we have multiple sets of default values, for the respective applications?
- In either case, we would eventually need presentations that describe the respective parameter sets for the respective applications
  - Industrial control
  - Automotive
  - Others??
- If this should be included in 802.1AS-Rev, contributions are needed
- If TSN TG decides not to include this in 802.1AS-Rev, this feature will be marked as dropped (in assumptions in Annex Z)

Assessment of Remaining Work

Feat-ure	Description	Current status/Amount of remaining work
1	Support for link aggregation (IEEE 802.1AX, IEEE 802.1AXbk, and 802.1AXbq)	Not yet added to draft; small to moderate amount of work, depending on how much study of 802.1AX is needed, and what must be referenced in 802.AS-Rev and where
2	Support for new media types, with corresponding media-dependent layers, e.g., IEEE Std 1901 and WiFi Direct	Not yet added to draft; likely small amount of work
3	Interoperability with one-step clocks on receive (but with no requirement to generate one-step Sync messages)	Dropped from 802.1ASbt / 802.1AS-rev (January, 2014 TSN TG meeting); no new work needed
4	Support for redundant paths	Not yet added to draft; large amount of work needed
5	Enhancements to the determination of asCapable (e.g., longer cable lengths, new media types)	Not yet added to draft; remaining work may be small, depending on what is needed
6	Incorporation of the interfaces specified in IEEE Std 802.3bf into the IEEE 802.3 full-duplex media-dependent layer model	Not yet added to draft; moderate amount of work in Clause 11

Assessment of Remaining Work

Feat-ure	Description	Current status
7	Improved performance (e.g., improved grandmaster changeover time, longer chains of time-aware systems).	Not yet added to draft; moderate to large amount of work needed (how large depends on how much simulation and analysis is needed)
8	Carrying information on alternate time scales (e.g., local time for a respective time zone)	In progress in draft (approximately 80 – 90% complete)
9	Management support for automatic measurement of link delay asymmetry.	In progress in draft (approximately 50% complete)
10	Additional parameter sets for non-Audio/Video applications, e.g., industrial control	Not yet added to draft; some question on whether this is more appropriate for 802.1BA; work needed only if there are additions to 802.1AS-Rev