Time Synch
Requirements for L2
(802.3 specifically)

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Agenda/notes/cautions

• Agenda
  – Fundamental requirements
  – Preferences for 802.3

• Notes:
  – This represents a personal opinion, but based on work I’m committed to do in the 802.1 AVB Task Group

• Caution:
  – I am NOT an expert on PHY design, nor am I responsible for detailed chip architecture, but ...
  – I’ve done both in the not too distant past
802.1AS needs to measure how long it takes for an event to travel from a master clock ("grand master") to a slave clock ("ordinary clock")

The accuracy and resolution of that time measurement directly affects the accuracy and responsiveness of 802.1AS implementations.

A fundamental parameter is the delay time of an event through a network link (one cable hop)
Delay calculations

• Process requires t1, t2, t3 and t4 *and* that the propagation time in both directions is the same
  – or the offset between the two is known

• For known fixed extra delay “x” for t1->t2 direction:
  – d=((t2-t1-x)+(t4-t3))/2
• For symmetric paths, only “d” is needed
• For asymmetric paths, both “d” and “x” are needed:

\[ t_1^* = t_1 + d + x + (t_3 - t_2) \]

(note that “d” is the delay from ingress, while “x” is the offset from egress)
• Most applications of 802.1AS assume:
  – measurement granularity (resolution) of time is ±20ns
    • actually 0-40ns because truncation is assumed
  – local clocks are accurate with 100ppm
  – delay is symmetric within \((a)\) and does not change more than \((b)\)
    
    \((a\) and \(b\) are numbers that Geoff Garner knows, but I can’t find now)\)

• There are high value use models for test and measurement applications that require better performance
  – requests have been made for ±0.5ns granularity to support phased array radar test gear
    • to support network time synch of better than 5ns
Standards problem for 802.1AS

• 802.1AS for 802.3 specifies the “tn” measurement point as the start of frame at the cable interface
  – there is no place in any 802.3 standard which provides this information
  – the AVB TG needs this to be nicely integrated into an 802 architecture

• Note: this is a standards problem, not an implementation problem
  – we specifically do NOT want to define a new MII-thing or MDI-thing
  – any discussions like that will *definitely* slow down the process
A suggestion

• (Simple, but architectural change to 802.3)
• add an optional (but required for 802.1AS), MA_UNITDATA.confirm primitive that includes the time that a SOF actually hit the media
  – 802.11 already has a MA_UNITDATA.confirm
• add an optional (but required for 802.1AS) parameter to the MA_UNITDATA.indication that includes the time that the SOF arrived from the media
• include management objects for
  – the resolution (worst case measurement error) of any times in the confirm/indication
Implementation notes

• The time reference can be a layer management variable/function/service (heck, I don’t know what to call it) provided by management

• The time between an actual SOF measurement and the “wire interface” SOF can be a fixed value
  – just report an appropriate value in the “resolution” object, e.g., a 100BASE-T MAC might report “20ns”

• The measured SOF might be based on a value that is fixed only upon a new link establishment
  – e.g., a 1000BASE-T MAC might use different values for offset based on whether it is in master or slave state
Conclusion

• Please, no implementation-specific stuff in a new standard ... no new physical or “physical-like” interfaces
  –there is plenty of time for that later, when implementors figure out what they really need

• I *think* everything can be done with a change to the MAC service interface and *very* few management objects