Time Synch Requirements for L2 (802.3 specifically)

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Agenda/notes/cautions

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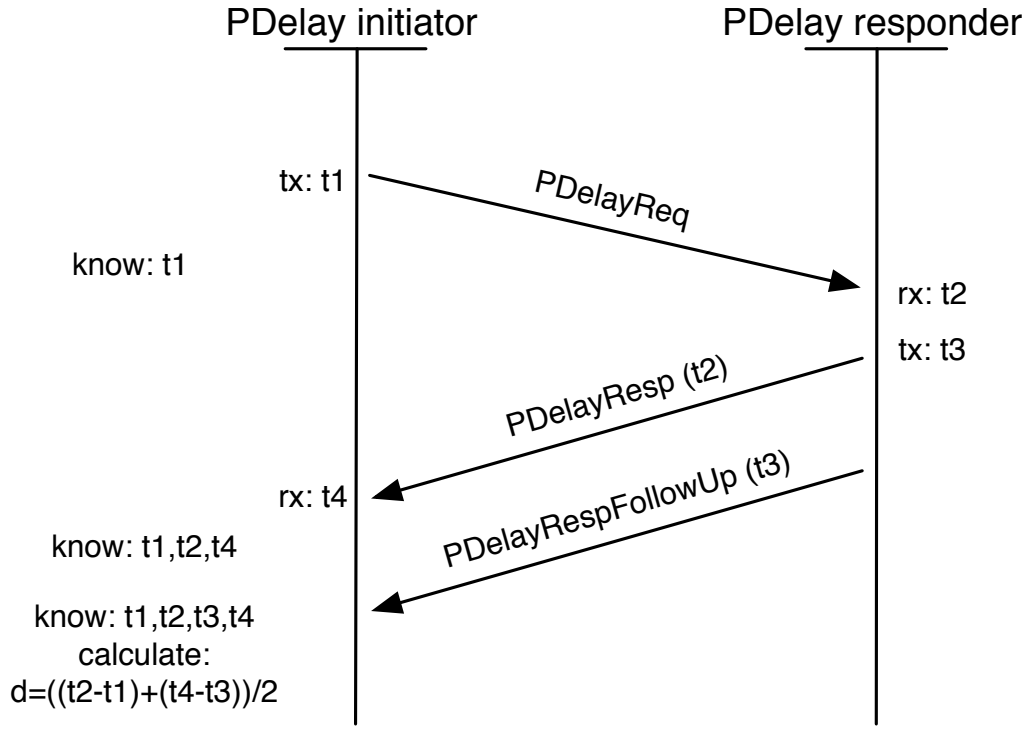
  - Fundamental requirements
  - Preferences for 802.3
- Notes:
  - This represents a personal opinion, but based on work I'm committed to do in the 802.1 AVB Task Group
- Caution:
  - I am NOT an expert on PHY design, nor am I responsible for detailed chip architecture, but ...
  - I've done both in the not too distant past

Fundamental requirements

- 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)

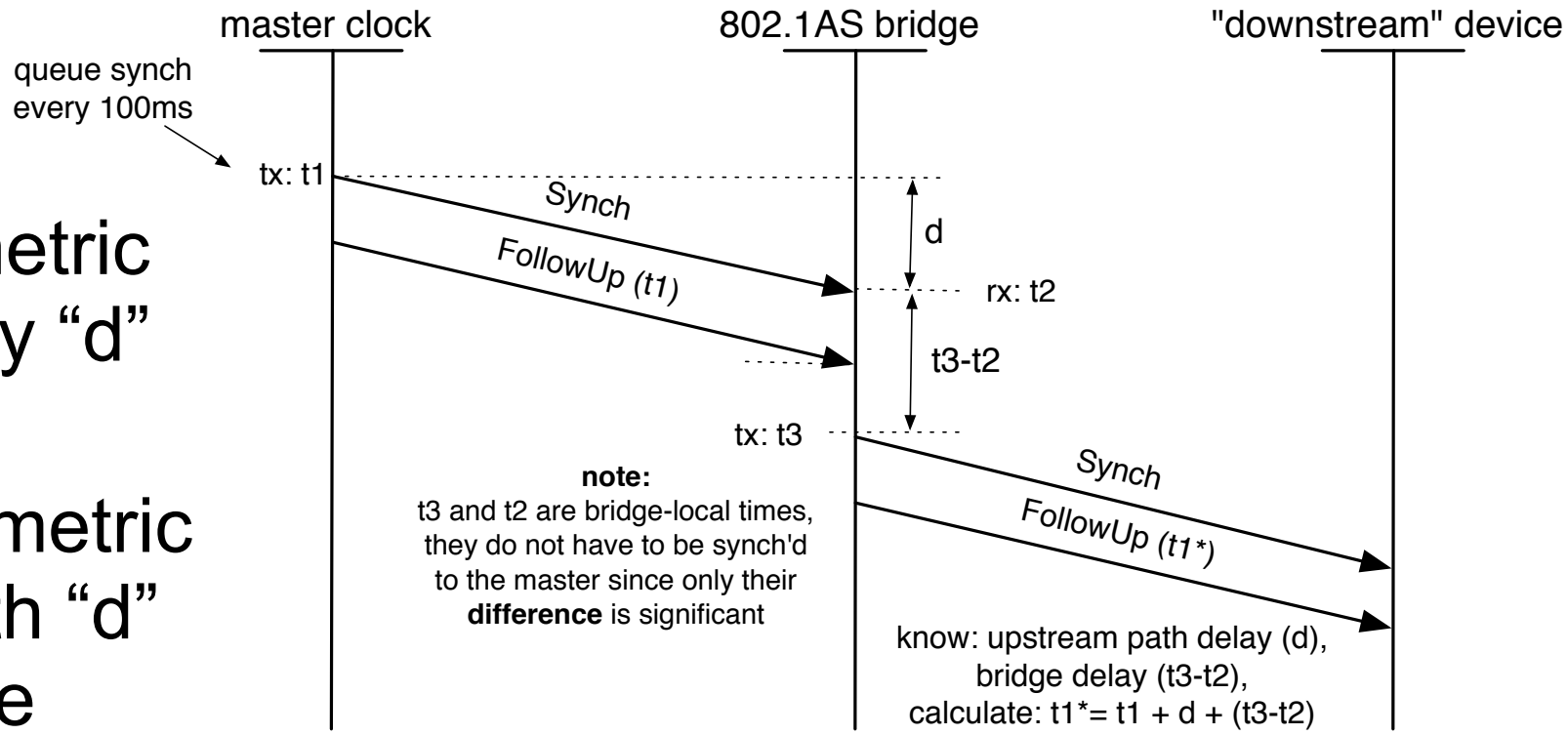
Delay calculations

- 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

Time offset calculation



- For symmetric paths, only “d” is needed
- For asymmetric paths, both “d” and “x” are needed:

  t1* = t1 + d + x +(t3-t2)

  (note that “d” is the delay from ingress, while “x” is the offset from egress)

Accuracy and resolution requirements

- 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