Recent work to define asymmetry correction

Michael Mayer
michael.mayer1@Huawei.com

Purpose of presentation

- Provide update of some work in ITU-T on automatic asymmetry correction
  - Initially proposed of OTN (in Q11)
  - General guidelines have been developed in Q13
  - 802.1AS also has some support
- At this meeting: Initiate general discussion on use such methods within Ethernet based profiles
  - Further architectural work is likely needed in ITU
  - Some control functions are likely needed
  - Since Q13 profiles are somewhat TSN-like (e.g. both Ethernet) looking at TSN may be a good start
  - Additionally, would TSN benefit from such mechanisms?

Recent inputs to ITU-T SG-15

ITU-T SG-15, June 2017:

- Renewed interest on asymmetry correction methods from IEEE1914 [1]
- Submissions to ITU-T (Q11) expressing interested in methods [2,3] with focus on OTN

Current status:

- Q11 and Q13 responded [4] to issue and reiterated current current methods that can be used which include fibre switching or other methods

[1] TD52/G *LS/i to Question 13/11 on asymmetry evaluation* [IEEE 1914 Next Generation Fronthaul Interface (NGFI) Working Group]

[2] C0087 *Asymmetric latency measurement* [IP Light]

[3] C0086 Delay measurement upgrade accuracy [IP Light]

[4] SG15-TD81/GEN, Link and network asymmetry compensation

See WP3 report of the June 2017 ITU-T SG-15 meeting

Recap: Asymmetry Problem

- What is it:
  - unequal length of paths in transmit and receive direction.
    - Primary causes: unequal fibre length, presence of DCM
    - Secondary causes: unequal system delay
- Why important:
  - LTE-A and 5G require accurate synchronization in time/phase to support certain transmission modes or features (CoMP, TDD, eICIC, etc.)
    - Recent interest to increase accuracy requirements
  - PTP (IEEE 1588) is viewed by carriers as important to address availability/vulnerability issues with GPS based time-distribution
    - Reflected in standards produced by IEEE802, P1914, IEEE1588 and others
    - Ethernet has been key to wireless backhaul (and now front haul).
- ITU-T Q13/15 recognizes asymmetry, but specific details are still not defined
    - Asymmetry due to different wavelengths
    - Automatic fibre swtiching

Note: 802.1AS has some aspects of asymmetry correction in Annex G

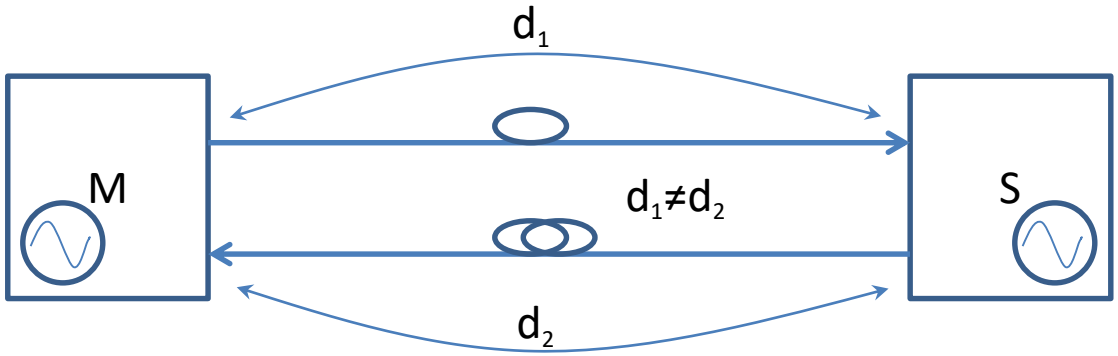
IEEE802.1 related work?

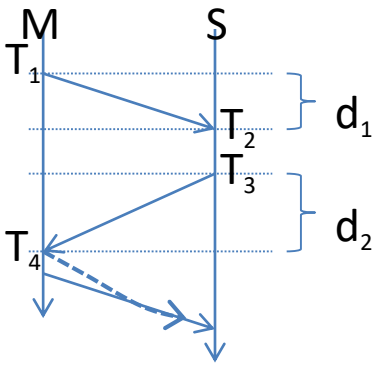
- Backhaul/fronthaul work is well established in IEEE802.1 TSN
  - All the components seem to exist:
    - IEEE802.1CM (front haul)
    - IEEE802.1AS (including IEEE1588)
    - IEEE802.1Q (i.e. 802.1Qbv)
    - Others?
- Ethernet switching is the implied focus of work in ITU-T Q13/15 for RAN timing
  - New work on automatic fibre switching being started for OTN front haul
  - Given existing TSN standards AND Ethernet focus in ITU, could automatic switching of PHY be supported in IEEE standards?
    - Annex G of 802.1AS covers the manual case.
    - Is there appetite for extending?
    - Useful to define a single method
  - (Alternatively we may need to ask: would an OTN defined switch mechanism work in an IEEE switched network?)
- IEEE802/TSN seems to be a good place to start discussions.
  - Further discussions in ITU-T would likely be needed

Further details to stimulate discussion

(Some background, all for information)

Problem: Asymmetry and PTP offset calculation





With the exchange of PTP messages, the slave can calculate its offset from the master:

$$T_2 = T_1 + d_1 + Offset_{SM} \qquad (1)$$

$$T_4 = T_3 + d_2 - Offset_{SM} \qquad (2)$$

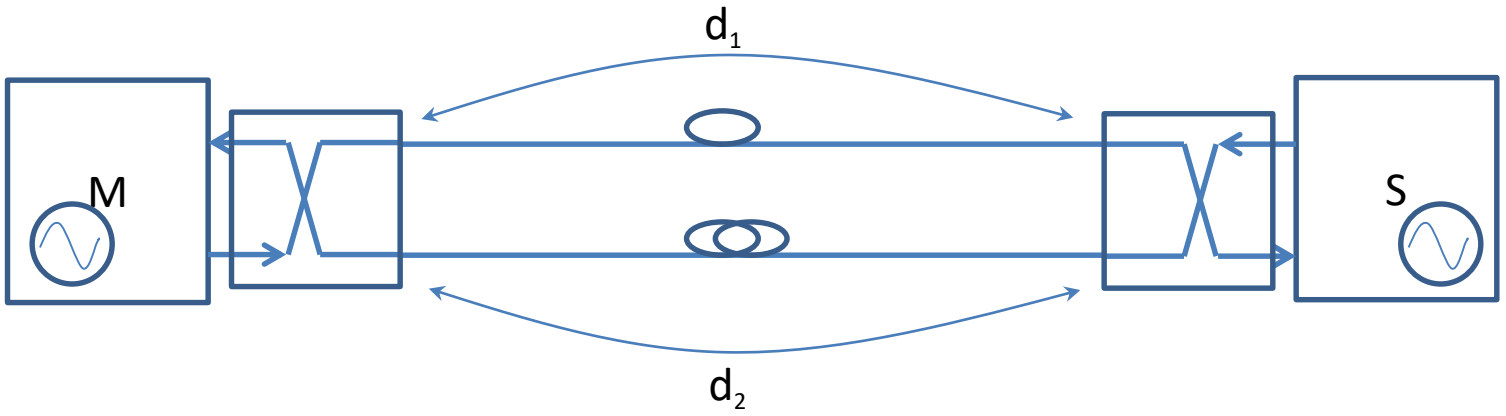
Combining (1) and (2):

$$Offset_{SM} = (T_2 - T_4 - T_1 + T_3)/2 + (d_2 - d_1)/2$$

Error due to asymmetry

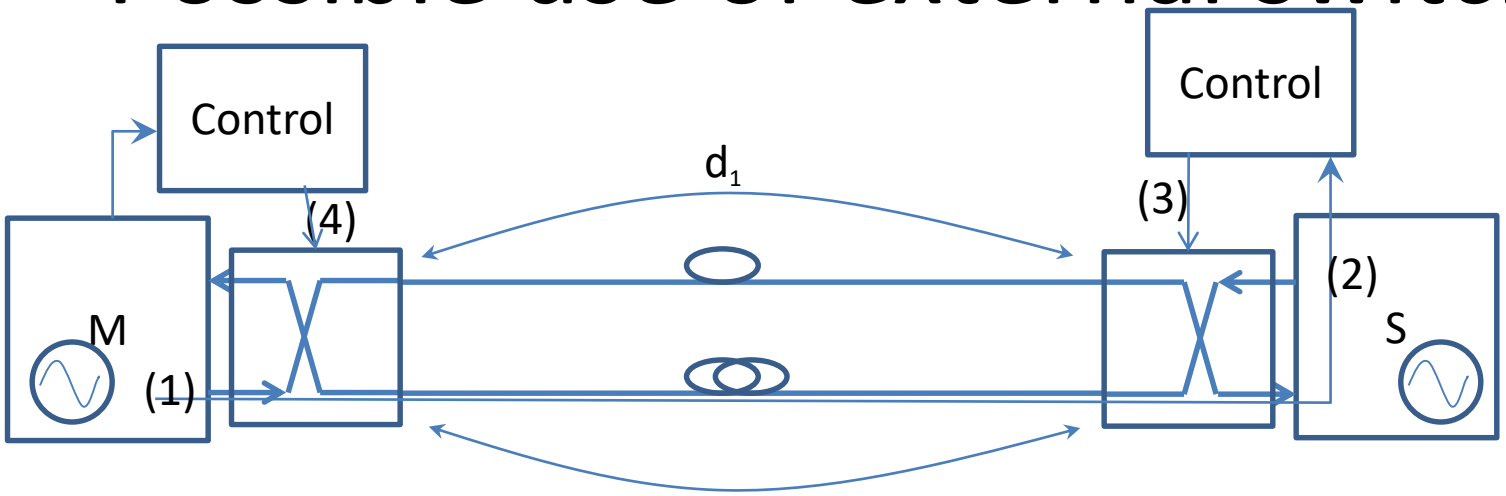
For fibre, Error: ~ 2 nS/m of asymmetry

Often spoken solution: Fiber swapping



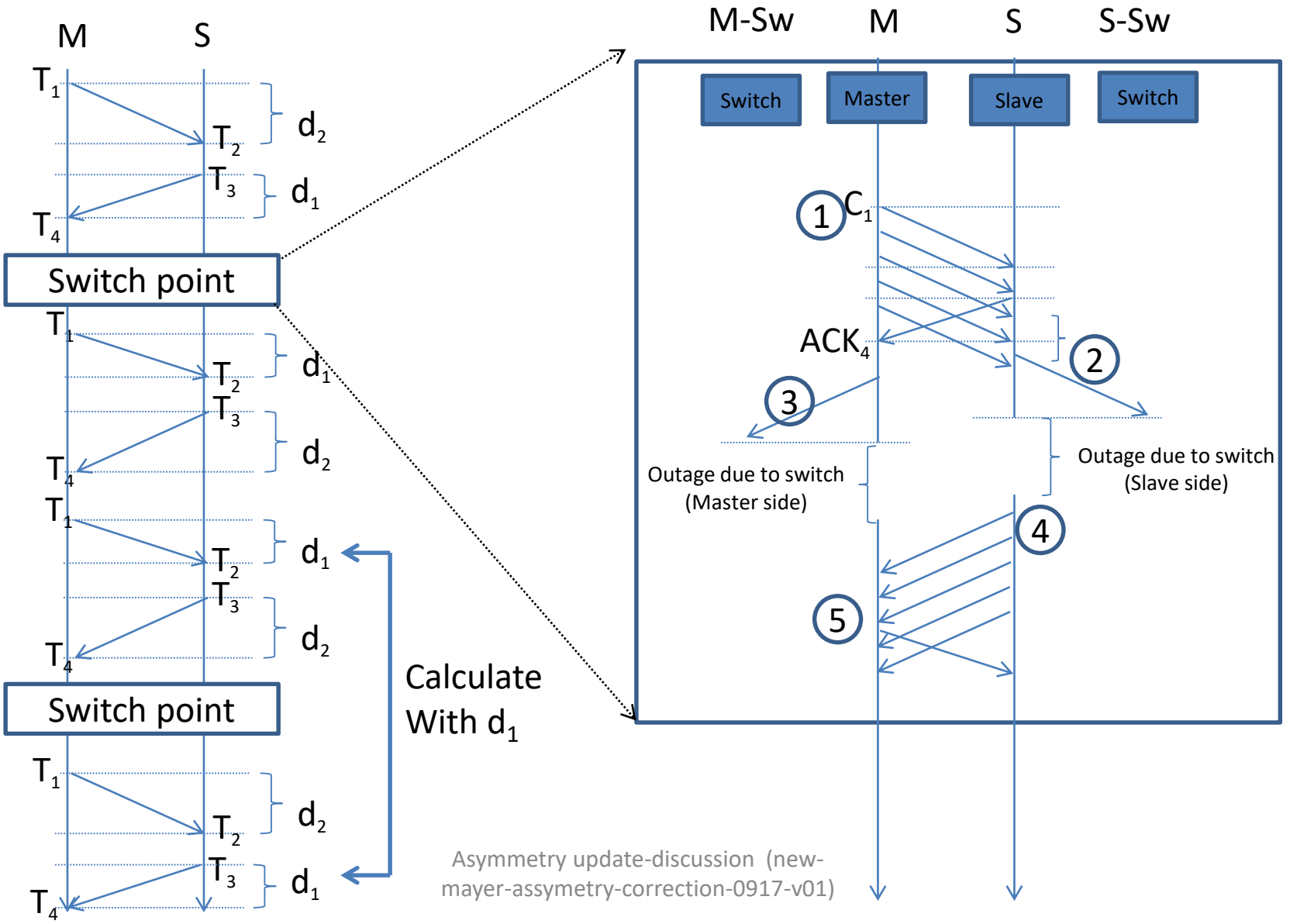
- Given the position of IEEE802 based standards for backhaul, is there advantage in developing and standardizing an IEEE protocol to control an optical switch to perform this function?
- Can't necessarily assume a signalling channel exists due to switch action.
  - Protocol needed.
  - Fibre switching will corrupt other traffic, some coordination may be required.

Possible use of external switch

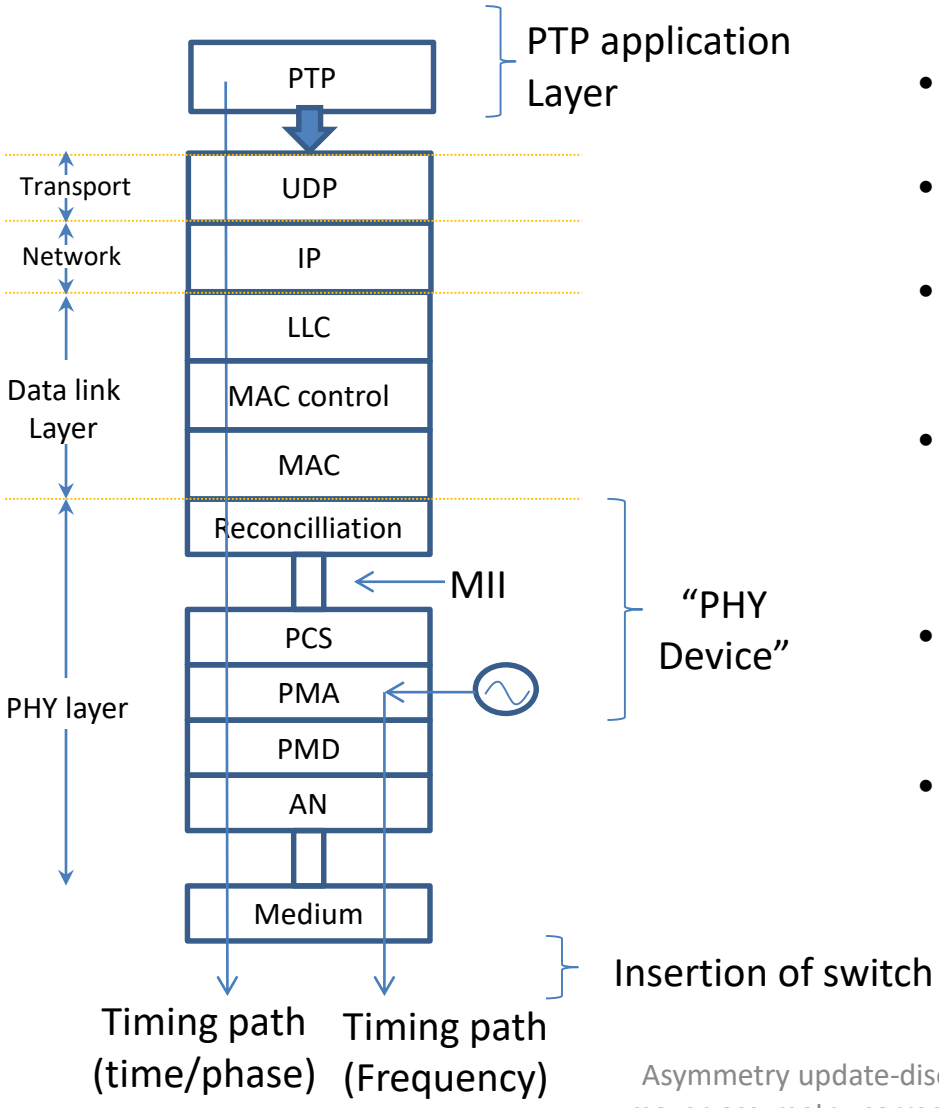


- Control (Transmit)
  - Master needs to send message to slave switch (1) and send “sacrificial” packets (packets will be dropped during switch!)
  - Master then needs to wait for ack then switch master switch (4)
- Control (receive)
  - Needs to detect control packets (2)
  - Ack or decline
  - Then switch slave switch (3)

Possible extension to show detail?

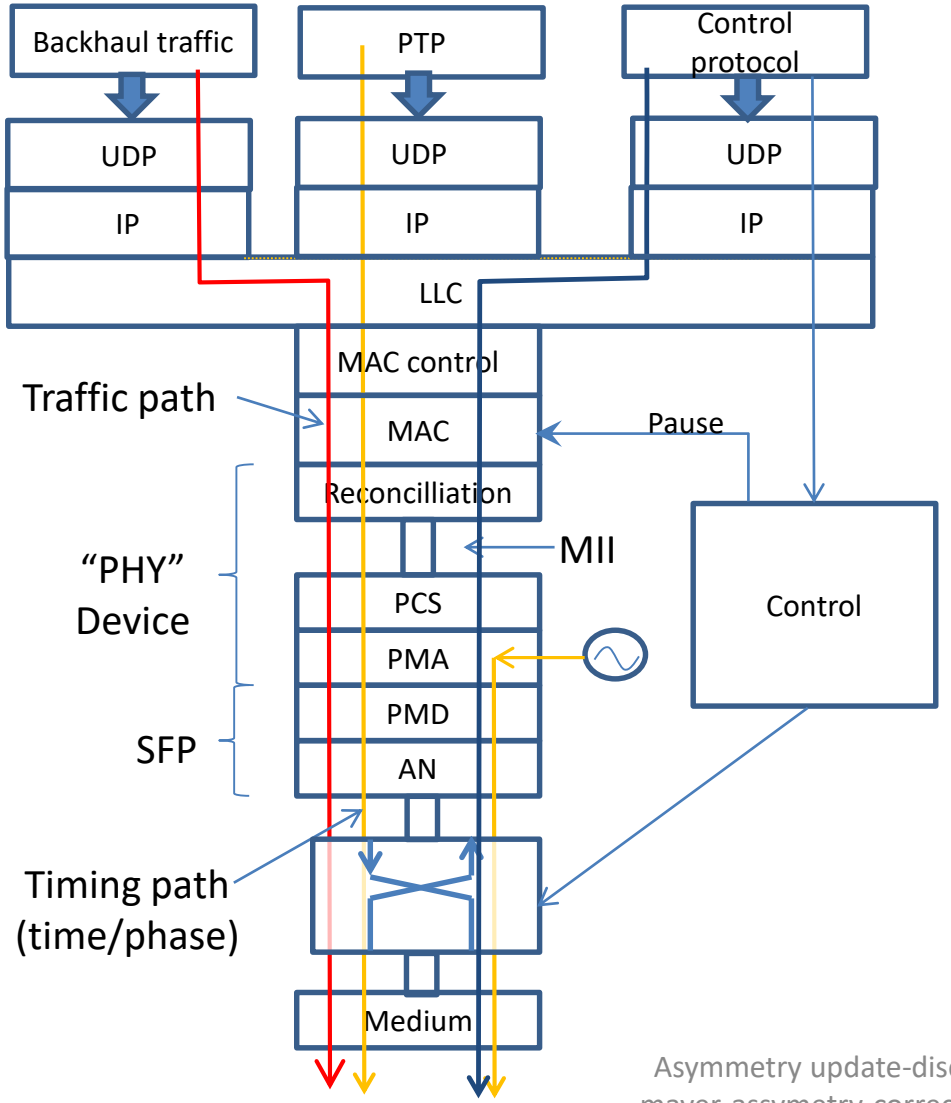


Full stack: PTP to fibre



- PTP operates as an application mapped using UDP/IP to provide time
- Frequency may be via the PMA as shown (e.g. Sync Ethernet)
- Data traffic not shown, but impact on non-timing data (e.g. backhaul) needs to be considered
- Location of optical switch and control needs to consider the transit time thought the stack and minimize impact at the PTP layer
- Hardware time-stamping often used to increase accuracy (Not shown here)
- Most of this is in the domain of IEEE802/TSN

Switch control: full stack perspective



- In order to combine traffic flows, a bridge function is needed
  - Bridge needs to route traffic to control function
- For standardization, need to reflect the model in terms of the "baggy pants" (BP)
  - Note, the BP is port-to-port.
  - The model on the left of this slide is only to start discussions. Some aspects may not be drawn correctly.
- Aspects of 802.1 and 802.3
  - EFM/CFM?

Switch control aspects

- Basic assumption: some control required and should be coordinated with PTP
- Action of each controller need to be coordinated
  - Both ends need switching
  - Must assume that far end may not have communication during fibre switch. (e.g. no external channel available)
- Ideally, signaling could take place within packet layer
  - Switch control to control (software element) OK, but actual switching not OK.
  - Architecturally, switch is below any packet processing and can't be accessed
- Software (e.g. PTP) needs to see an interface to the switch
  - Do we want to have a single process that is consistent between various profiles? (Assume yes, but open for discussion)
  - Define a generic API?
- IEEE802.1 AS already has some asymmetry support. Could this form a base?
  - If so, this could be reflected in input to Q13
  - Q13 is currently developing SyncOAM

Switch control options

In-line (e.g. SFP)

- Coordination of switching with traffic and PTP messages is required
- Impact of switch will cause momentary outage.
- Control not necessarily possible within stack

External

- Coordination of switching with traffic and PTP messages is required
- Impact of switch will cause momentary outage.
- Control could utilize external interface

PTP service in IEEE802.1

- TimeSync client
- Is there a need to look at how this would operate with IEEE802.1Qbv?

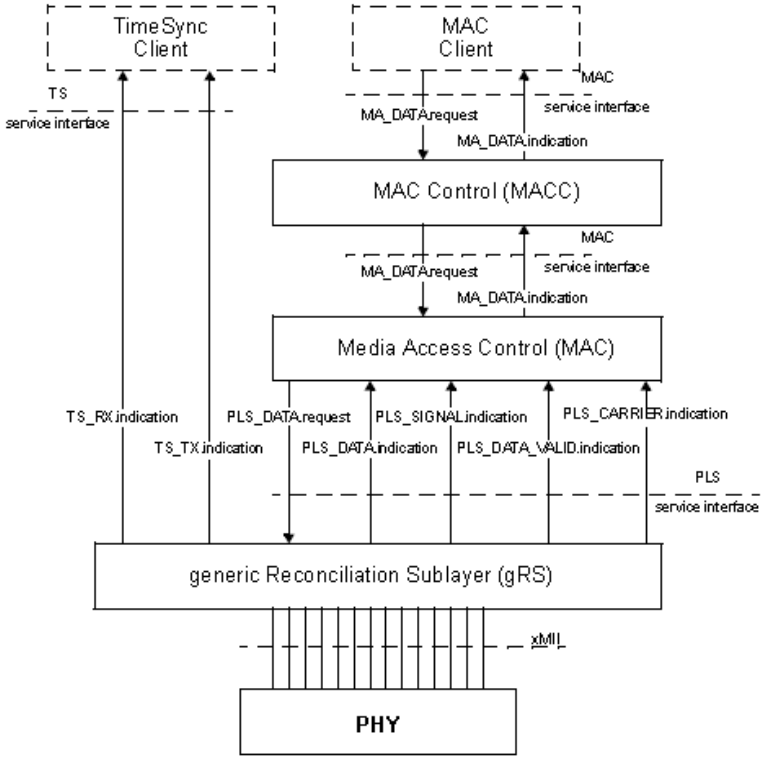


Figure 90–1—Relationship of the TimeSync Client, TSSI and gRS sublayer relative to MAC and MAC Client and associated interfaces

Summary

- Initial summary(for discussion)
  - Control of asymmetry is seen as an important aspect to increase accuracy of time-distribution critical for 5G and future services
  - IEEE defined protocols are dominant in time-distribution
    - IEEE802.1AS and ITU-T profiles both use IEEE1588
  - Future work will likely take place in ITU-T
    - Is there desire to define mechanisms that are consistent with both IEEE and ITU profiles?
    - Will this be useful for IEEE802.1AS?