Timestamp Provisioning in IEEE 802.3

Yuanqiu Luo Frank Effenberger

Huawei Technologies USA

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Outline

- Why
- Where
- How

Broad market of time synchronization

- Mobile backhaul
- Carrier class Ethernet
- Audio video applications
- Other markets

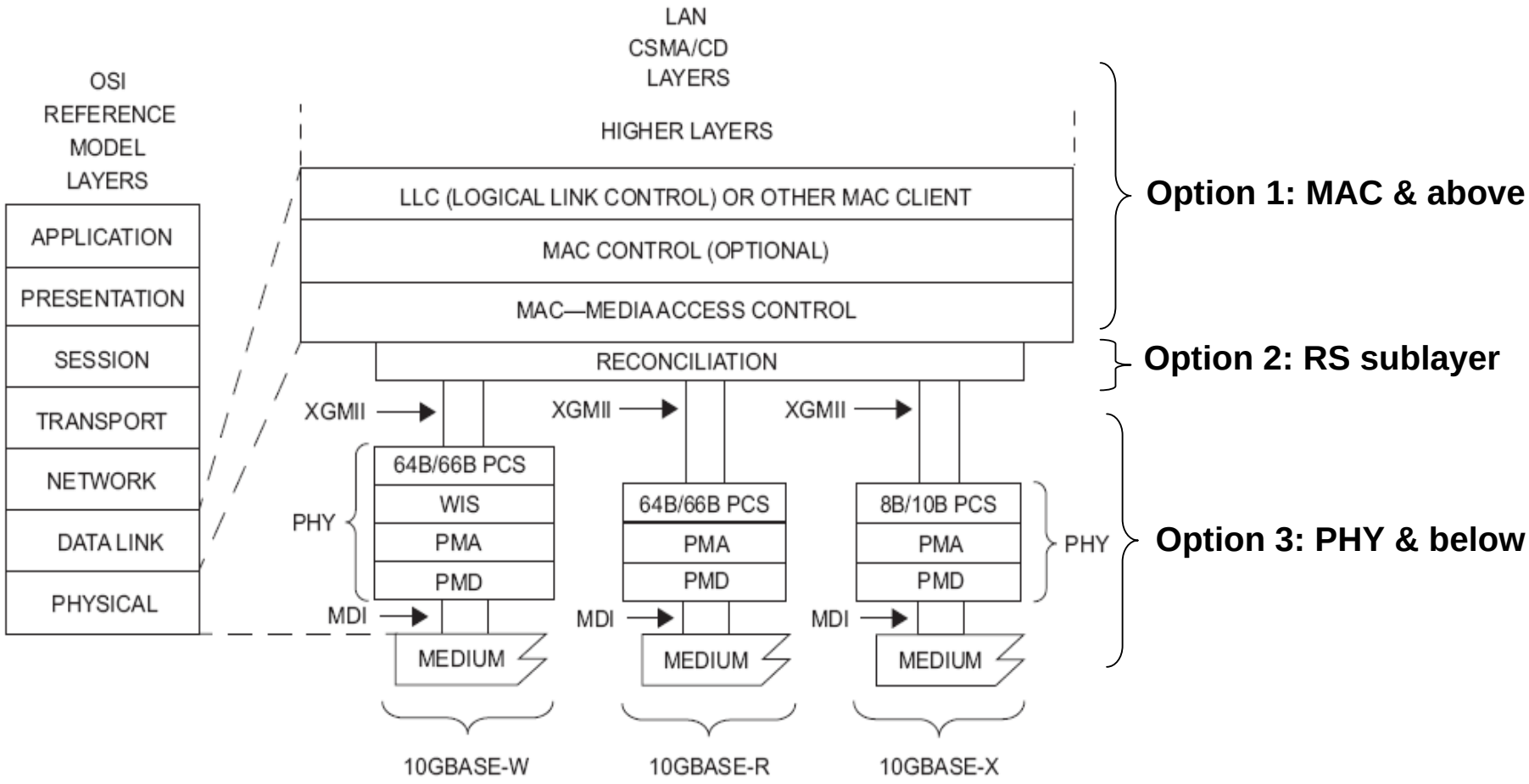
IEEE time synchronization standards

- IEEE Std 1588TM – 2008
  - Approved
  - A precision clock synchronization protocol for networked measurement and control systems
  - Accuracy depends on the ability of timestamping messages
- IEEE P802.1AS
  - Under development
  - Specifies the protocol and procedures used to ensure that the synchronization requirements are met for time sensitive applications across bridged networks
  - Needs notification of sending/receiving of frames

Why timestamp frames in 802.3

- Both IEEE 1588 and IEEE 802.1AS need the timestamp facilities
  - IEEE 802.3 does not specify a timestamp interface for the notification of frame sending/receiving
  - Notification of “start of frame” being sent
  - Notification of “start of frame” being received
  - Notification of accuracy
  - It is desirable to specify related timestamp facilities in 802.3

Where to timestamp frames



MDI = MEDIUM DEPENDENT INTERFACE
PCS = PHYSICAL CODING SUBLAYER
PHY = PHYSICAL LAYER DEVICE
PMA = PHYSICAL MEDIUM ATTACHMENT
PMD = PHYSICAL MEDIUM DEPENDENT
WIS = WAN INTERFACE SUBLAYER
XGMII = 10 GIGABIT MEDIA INDEPENDENT INTERFACE

Figure 44–1—Architectural positioning of 10 Gigabit Ethernet

The timestamp point is expected to …

- Provide distinct pattern for frame recognition
- Support notification of frame sending and receiving
- Report accuracy of the aforementioned notification
- Specify a unified interface to higher layers
- Enable easy implementation of timestamp
- Meet requirement of timestamp precision

Option 1: MAC layer and above

- Latency of frame sending/receiving might not be deterministic
- The easiest implementation among 3 options
- Internal delay due to MAC and higher layer processing changes
- Accuracy downgrade as compared to the other 2 options

Option 2: Reconciliation sublayer

- Impact of MAC and higher layer processing delay would be eliminated
- Improved timestamp accuracy
- Moderate complexity of implementation

Option 3: PHY layer and below

- Eliminates internal processing delay impact
- Precise timestamp information
- High complexity of implementation

Three options

	Option 1: MAC & above	Option 2: RS	Option 3: PHY & below
Complexity	**Low**	**Medium**	**High**
Implementation difficulty	**Low**	**Medium**	**High**
Precision	**Low**	**Medium**	**High**

How to timestamp frames

- Each frame can be identified by its ID/pattern
- Records the time when a frame passes the selected timestamp point
- Frame ID/pattern is associated with the recorded time
- Timestamps it
- Provides the timestamp interface (including the timestamp and its accuracy) to upper layers

Which field(s) to carry frame ID / pattern

IEEE 802.3 Frame Format

Preamble	SFD	Destination	Source	Type/Length	Payload	FCS	IFG
7 bytes	1 bytes	6 bytes	6 bytes	2 bytes	n bytes	4 bytes	12 bytes

SFD: Start of Frame Delimiter FCS: Frame Check Sequence IFG: Interframe Gap

- The 8-byte synchronization pattern (7-byte Preamble and 1-byte SFD) can be utilized to carry frame ID
- Frame ID is unique within a synchronization interval of IEEE 1588 and IEEE 802.1AS
  - Frame ID size
  - Frame ID content
- It is desired to keep a frame delimiter like SFD
- Error control and detection are also desired

Frame ID

- Typical time synchronization intervals in IEEE 1588 and IEEE 802.1 are in the order of millisecond
  - Frame ID can be designed to roll over in seconds with increment of 1 (it is actually a frame sequence number)
  - The shortest Ethernet frame contains 84 bytes (7-byte preamble,1-byte SFD, 14-byte header, 46-byte payload, 4-byte FCS, 12-byte IFG)
  - At 100Gb/s, a 4-byte frame ID field rolls over every ~28 seconds
- CRC-8
  - Detects 2 errors
  - Corrects a single error
- SSD (Start of Sequence number Delimiter)
  - Different pattern from SFD
  - Different from the start of LLID delimiter (SLD) subfield in IEEE 802.3 Clause 65 (which is 0xd5)

Frame format

IEEE 802.3 Frame Format with Frame Sequence Number

Preamble	SSD	Seq#	CRC	Destination	Source	Type/Length	Payload	FCS	IFG
2 bytes	1 byte	4 bytes	1 byte	6 bytes	6 bytes	2 bytes	n bytes	4 bytes	12 bytes

SFD: Start of Sequence number Delimiter FCS: Frame Check Sequence IFG: Interframe Gap

Conclusion

- It is critical to provide timestamp interface in IEEE 802.3
- RS sublayer can fulfill timestamp facilities
  - Moderate complexity, implementation difficulty, and precision
- A mechanism of carrying frame ID is required
  - Uniquely identifies each frame in a synchronization interval
  - The reference point is RS sublayer

Thank you