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Architectural consideration of timestamp for 802.3ba

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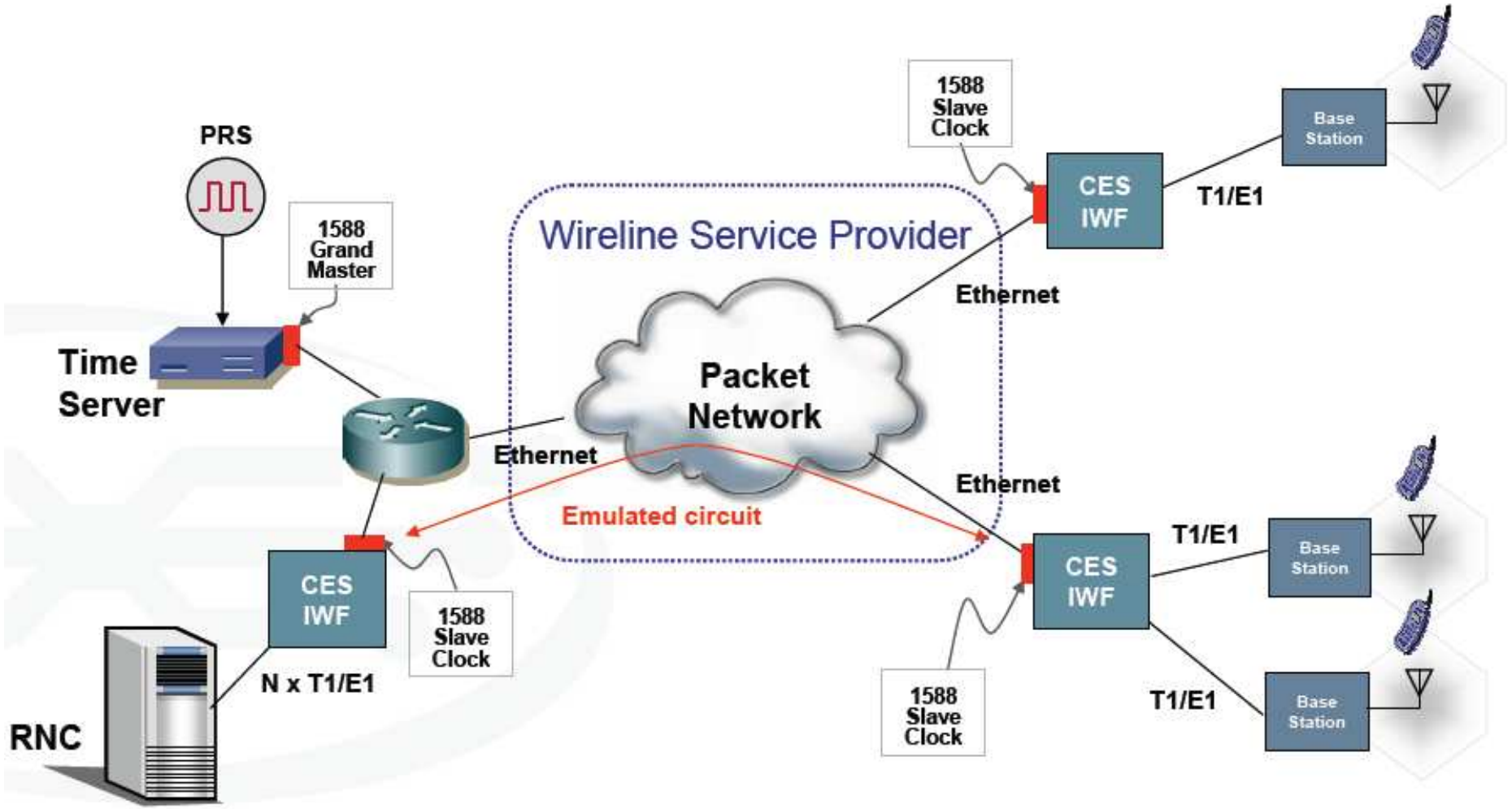
Packet Transport Networks

- Carrier Ethernet and its service - Fast growing Market
- Major growth in
  - Enterprise
  - Residential Access – GE-PON
  - **Wireless backhaul**
    - **41% of Ethernet market in 2010** (Ref: Heavy Reading)

Mobile backhaul Sync. over packet network

Source : IEEE-1588TMTelecommunications Applications (ref)



IEEE 1588 Precision Time Protocol Application Schematic

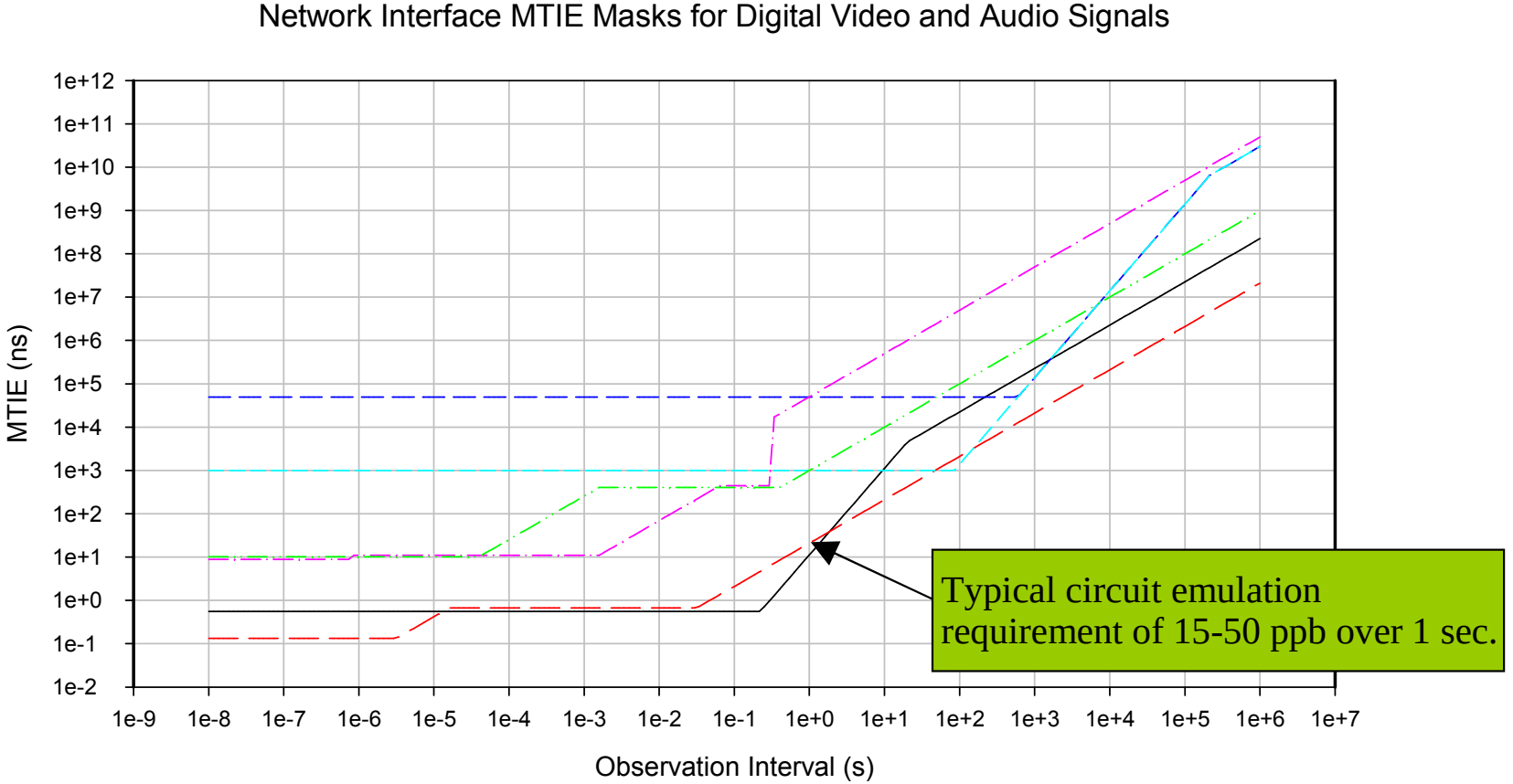
Mobile Backhaul Service Requirements

Source : MEF Carrier Ethernet for Mobile Operators

GSM	• Abis interface is TDM based and carried over E1/T1 links • Circuit emulation required for Ethernet transport
UMTS R99	• ATM connections carried over E1/T1 IMA links • Circuit emulation or Pseudowires required for Ethernet transport
UMTS R5	• Suitable for Carrier Ethernet, depending on base station config
CDMA 2000	• EV-DO offers T1 or Ethernet interfaces at base stations
Mobile Core Network Evolution	• Towards IP/Ethernet • Split MSC architecture with IP/Ethernet interfaces • IP/Ethernet links between media gateways and MSC servers
Time synchronization accuracy	• frequency accuracy of 0.05 ppm for GSM, WCDMA, and CDMA2000 • ± 3 μs level for CDMA 2000 • ± 2.5 μs level for WCDMA

End-to-End MTIE requirements

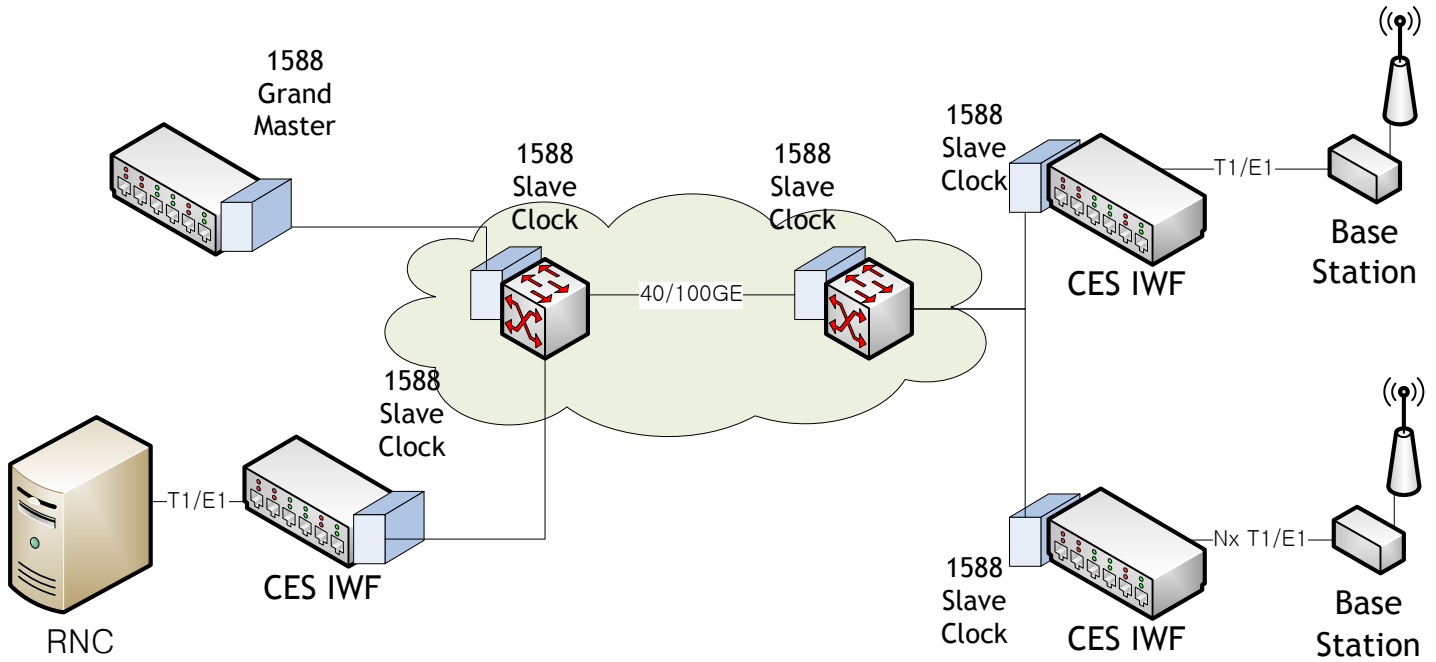
Source : IEEE 802.1AS (ref)



MTIE: Maximum Time Interval Error

Multi-hop timing precision budget

- Circuit emulation
  - End-to-end budget: 15-50 ppb in 1 sec → ±15-50 ns
  - Per-node budget: << 10 ns (?)
- Mobile backhaul
  - End-to-end budget: ~2 μs
  - Per-node budget: << 1000 ns (?)
- Audio Video Bridge (802.1AS, Ref. 4)
  - End-to-end (7 hop) budget: ~1 μs (± 500 ns w.r.t. grandmaster clock)
  - Per-node budget: 86 ns per Ethernet hop or 43 ns per Ethernet PHY



802.3ba Reference Delay

Table 150–1—Round-trip delay constraints (informative)

Sublayer	Maximum (bit time)	Maximum (pause_quanta)	Notes
MAC, RS, and MAC Control	8192	16	See 151.1.4.
40GBASE-R PCS	TBD	TBD	See 152.2.19
100GBASE-R PCS	TBD	TBD	See 152.2.19.
40GBASE-R PMA	TBD	TBD	See 153.
40GBASE-KR4 PMD	1024	2	Includes delay associated with backplane medium. See 154.4.
40GBASE-CR4 PMD	2560	5	Includes delay associated with cable medium. See 155.4.
40GBASE-SR4 PMD	1024	2	Includes 2 meters of fiber. See 156.2.1.
40GBASE-LR? PMD	TBD	TBD	Includes 2 meters of fiber. See 157.
100GBASE-CR10 PMD	2560	5	Includes delay associated with cable medium. See 155.4.
100GBASE-SR10 PMD	2048	4	Includes 2 meters of fiber. See 156.2.1.
100GBASE-LR4 PMD	1536	3	Includes 2 meters of fiber. See 158.2.1.
100GBASE-ER4 PMD	1536	3	Includes 2 meters of fiber. See 158.2.1.

327.6 ns @ 40G

81.92 ns @ 100G

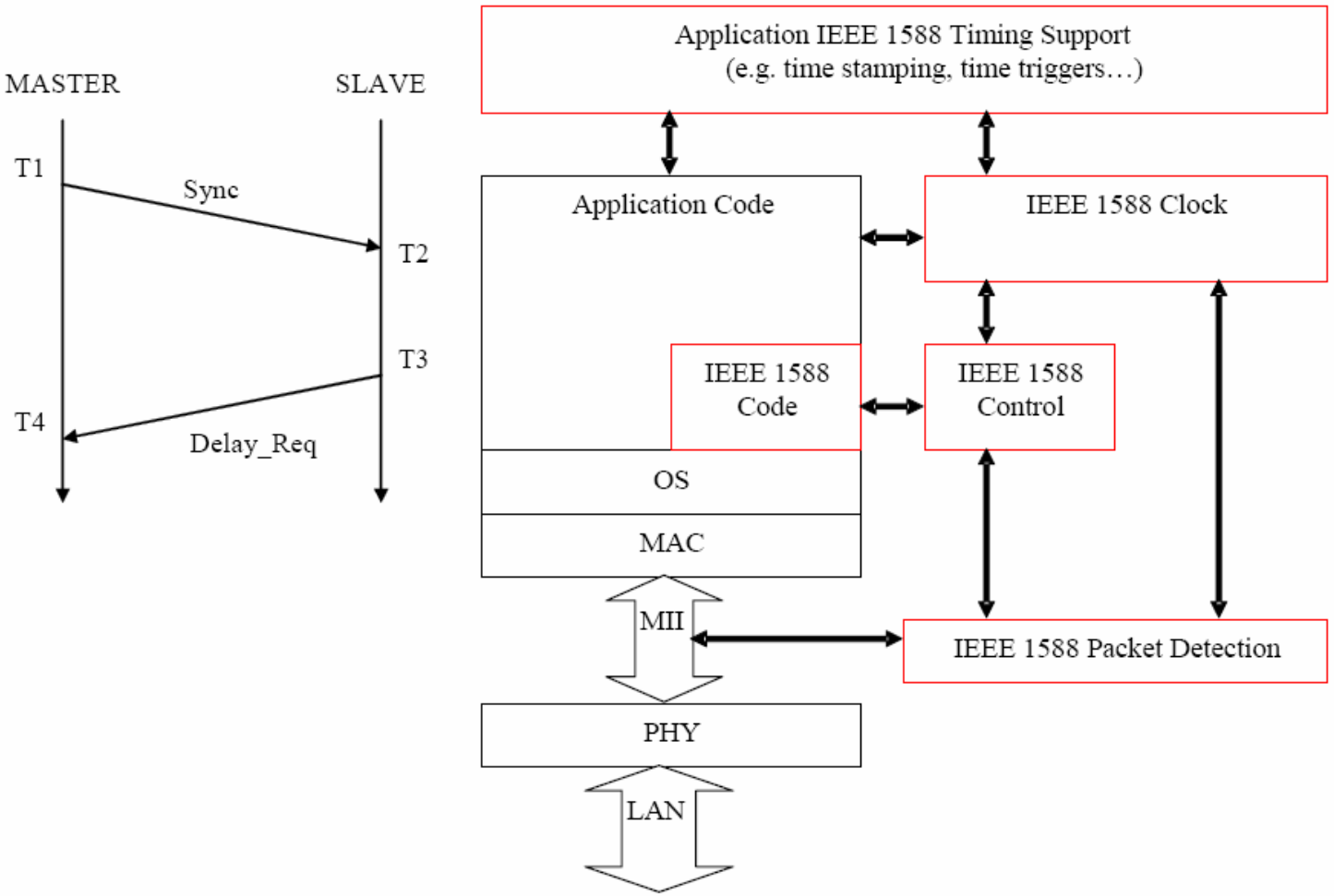
???

???

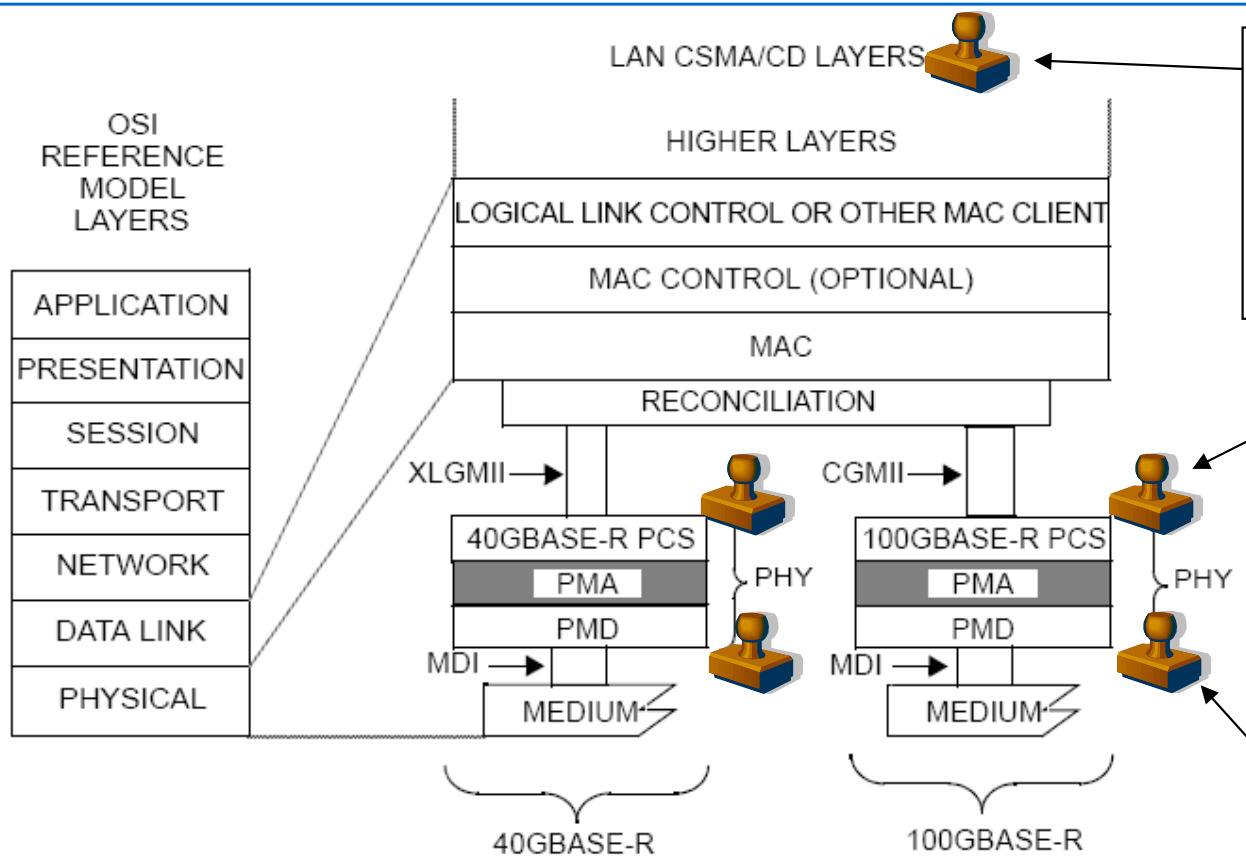
102.4 ns @ 40G

25.60 ns @ 100G

IEEE 1588 PTP Implementation model



802.3 Model (Eg. 802.3ba)



Option 1: Easy to implement, may not meet the time stamp precision requirement. Pause control is not supported.

Option 2: Complex to implement, may meet the time stamp precision requirement. Pause control is supported.

Option 3: Very difficult to implement, will meet the time stamp precision requirement. Pause control is supported.

CGMII = 100 Gb/s MEDIA INDEPENDENT INTERFACE
MDI = MEDIUM DEPENDENT INTERFACE
PCS = PHYSICAL CODING SUB-LAYER
PHY = PHYSICAL LAYER DEVICE
PMA = PHYSICAL MEDIUM ATTACHMENT
PMD = PHYSICAL MEDIUM DEPENDENT
XLGMII = 40 Gb/s MEDIA INDEPENDENT INTERFACE

ENCODING:
R = 64B/66B ENCODED

Figure 153–1—40GBASE-R and 100GBASE-R PMA relationship to the ISO/IEC Open Systems Interconnection (OSI) reference model and IEEE 802.3 CSMA/CD LAN model

Conclusions

- Time synchronization and time stamp function become critical due to the fast growing market in the area of mobile backhaul service, as well as multimedia server applications.
- 802.3 may require timestamp function provided to upper layer of MAC.
- 802.3 may require high precision timestamp function or signal generation below MAC layer.

LMI : Local Management Interface

References

- Ref 1 : Geoffrey M. Garner and Kees den Hollander, “Clock Synchronization in Audio/Video Bridging Networks using IEEE 1588 Version 2,” IEEE 1588 Conference, 2006 (http://ieee1588.nist.gov/2006%20IEEE1588%20Agenda/garner_vgs-gmg-kdh-1588conf-2006-r3.ppt)
- Ref 2 : Silvana Rodrigues and Antti Pietilainen, “IEEE-1588™ Telecommunications Applications,” http://ieee1588.nist.gov/tutorial-telcom.pdf
- Ref 3 : Don Pannell, Audio Video Bridging (AVB) Assumptions, http://www.ieee802.org/1/files/public/contrib/avb-pannell-assumptions-0408-v13.pdf
- Ref 4: Geoffrey M. Garner, “Assumptions for Sources of Time Synchronization Error in IEEE 802.1AS,” as-garner-assumptions-for-error-sources-time-synch-0507-v03.