10 Gbps Ethernet

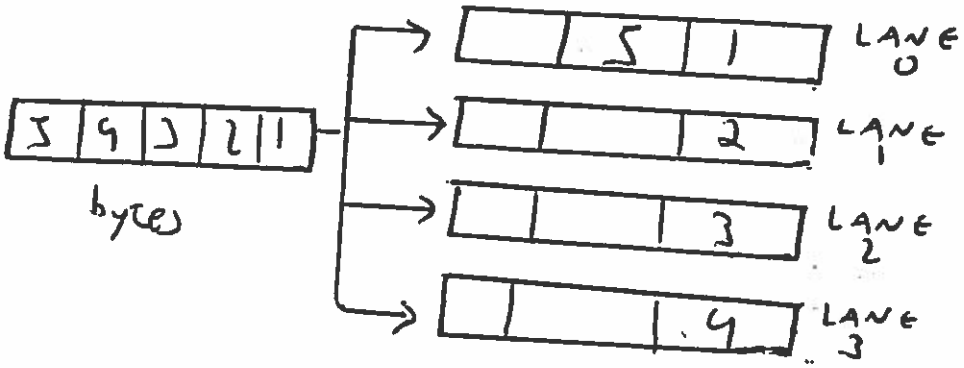
IEEE 802.ae Circa 2003/4

Will compete with ATM/SONET

Eight implementations & works with 4 types of transceivers (one 4λ WDM system and 3 serial systems with a variety of multimode and single mode fiber options). Can go 40+ km with single mode fiber.

Uses CRC code.

Full duplex, non CSMA/CD.



4 lanes

MAC operates in Parallel

IPG

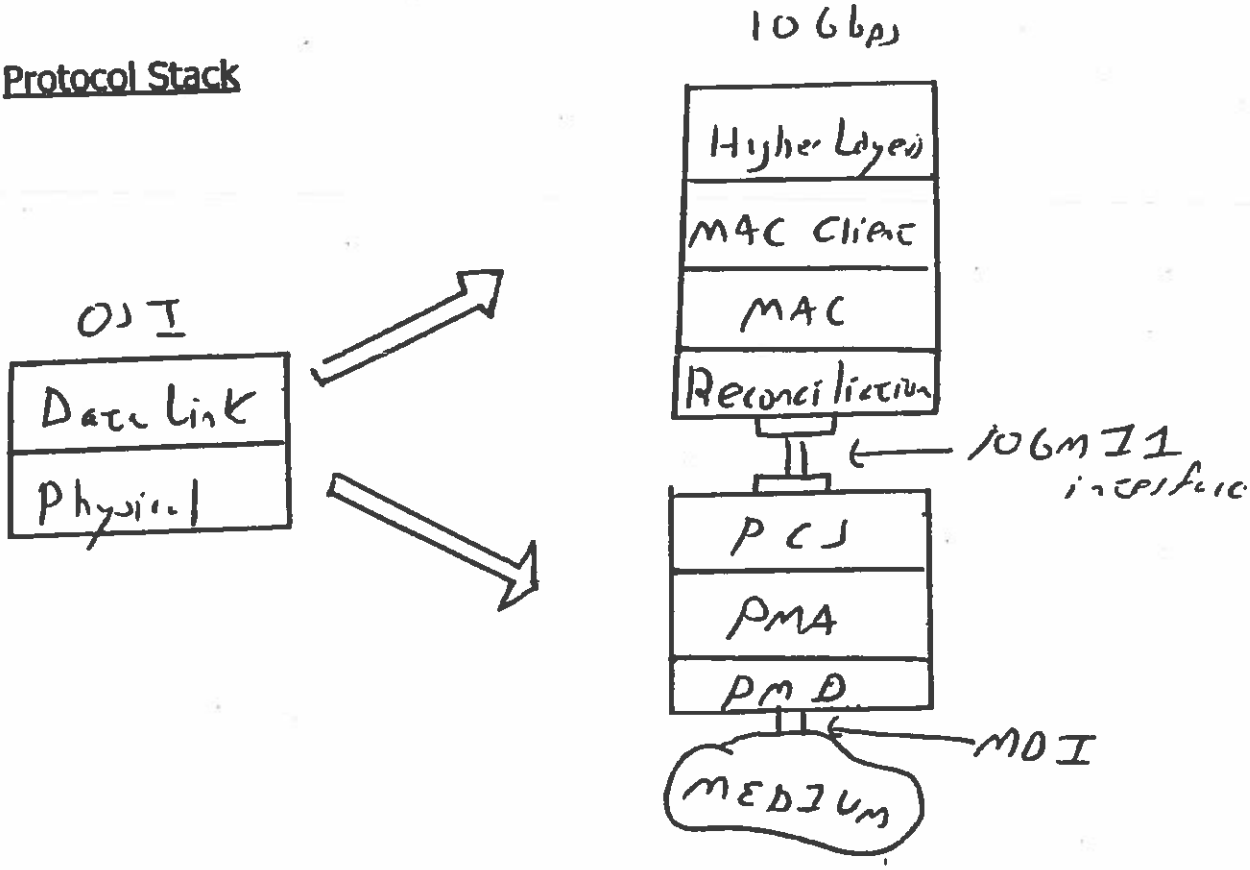
12 byte Inter Packet Gap (IPG), that is minimum amount of space between packets.

Difficult to predict ending byte lane of previous transmission. So would be hard to find starting byte of next transmission.

Solution: Starting byte always in lane 0. IPG is determined by pad (add additional 1-3 byes) , shrink (subtract 1-3 bytes) or combination averaging (average is 12 bytes with combination of padding and shrinking).

Padding produces extra overhead in some implementations.

Protocol Stack



PCS, PMA & PMD uses parallel lanes for lower processing rate.

Reconciliation: Command translator that maps terminology and commands in MAC into electrical format appropriate for physical layer.

PCS: Physical Coding Sublayer

PMA: Physical Medium Attachment (at transmitter serialize code groups into bit stream, at receiver synchronization for data decoding).

PMD: Physical Medium Dependent (includes amplification, modulation, wave shaping).

MDI: Medium Dependent Interface (i.e. connector).

Sources: Prof. Raj Jain web page at Ohio State
http://www.cse.ohio-state.edu/~jain/cis788-99/ftp/10gbe/index.html and S.J. Vaughn-Nichols, "Will 10-Gigabit Ethernet Have a Bright Future", IEEE Computer, June 2002, pp. 22-24.

40-100 Gbps Ethernet

Approved 2010 (Convened July 2006).

Ethernet popular because of low cost, highly reliable and provides interoperable network service and broad vendor selection.

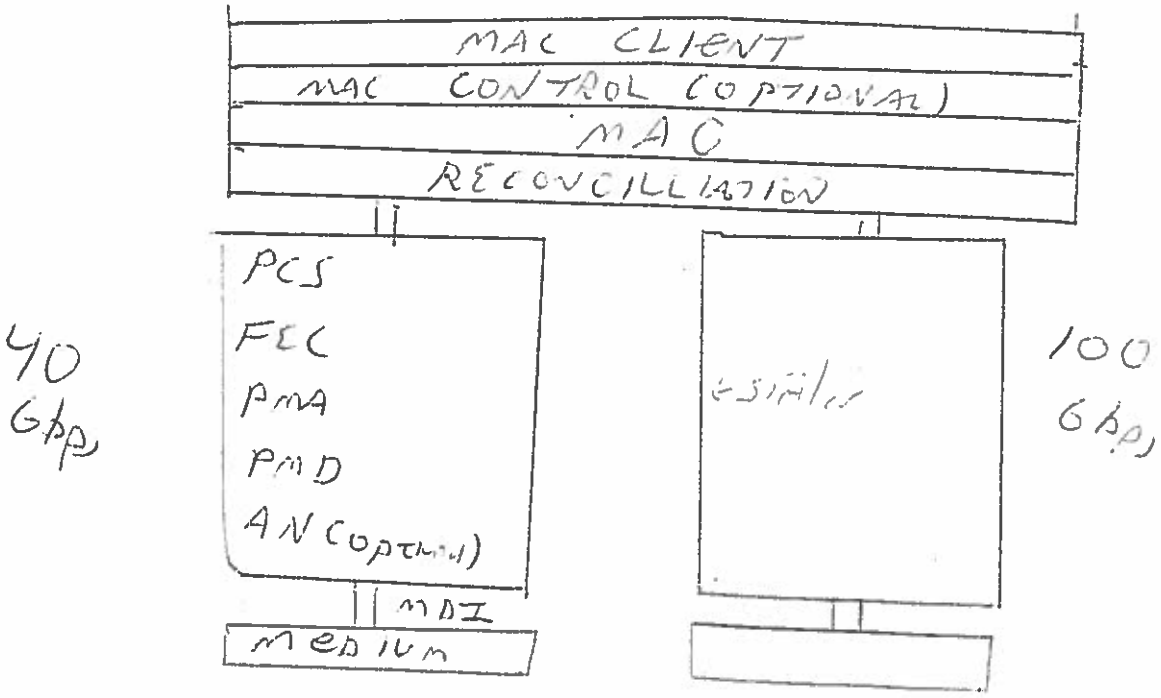
Drivers for 400 and 100 Gbps Ethernet: Need for increasing data rates in data centers, storage networks, in and from local area networks and in carrier networks.

Goals:

- Full duplex only.
- Preserve frame format and MAC.
- Preserve current min/max frame size
- Support for Optical Transport Nets (OTN)
- Support MAC data rates: 40 Gbps and 100 Gbps

Transmission Media:

40 Gbps		100 Gbps	
>= 10 km	Single Mode Fiber	>= 40km	Single Mode Fiber
>=100 m	Multi-Mode Fiber	>=10 km	Single Mode Fiber
>= 10m	Copper Cable	>=100 m	Multi-Mode Fiber
>= 1 m	Backplane	>=10 m	Copper Cable



Physical Coding Sublayer (PCS):

64B/66B coding used. 66 bit block distributed round robin on PCS lanes.

100 Gbps -> 20 PCS lanes:
Supports 1,2,4,5,10, 20 channels or wavelengths.
40 Gbps -> 4 PCS lanes:
Supports 1,2 4 channels or wavelengths.

Notes:

- Once PCS lanes created, can be multiplexed into any supportable interface width.
- No matter how multiplexed all bits in same lane follow same physical path.
- Receiver: (a) demultiplexes bits to reassemble PCS lanes. (b) realigns PCS lanes to compensate for skew.
- Each PCS lane has unique "lane marker" which is periodically inserted. Bandwidth for lane markers created by periodically deleting Inter Packet Gap (IPG).

Advantages of this approach:

- All encoding, scrambling and deskew functions implemented on CMOS devices residing on host.
- Minimal processing of bits other than multiplexing on an optical module.

Logical interface between MAC and PCS (known as GM11 (100 Gbps) and XLGM11 (40 GBps). 64 bit wide transit and receive path. Clocked at 1/64 th of data rate:

625 MHz for 40 Gbps and 1.5625 GHz for 100 Gbps.

See www.ethernetalliance.org From documents "40 Gbit Ethernet and 100 Gbit Ethernet Technology Overview" and "Overview of Requirements and Applications for 40 Gigabit and 100 Gigabit Ethernet".