Gigabit Ethernet

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Profess ciences

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MBone Instructions

- Handouts for the class are available on-line: http://www.cis.ohio-state.edu/~jain/cis788-97/index.html or http://www.netlab.ohio-state.edu/~jain/cis788-97/index.html or ftp://netlab.ohio-state.edu/pub/jain/cis788-97/
- The schedule keeps changing. Please always check current schedule at: http://www.cis.ohio-state.edu/~jain/cis788-97/schedule.html

Instructions (Cont)

- Please email your positive and negative feedback about the quality of the reception as well as the content with a subject field of "Feedback" to mbone@netlab.ohio-state.edu
- If you are not able to receive the program due to some technical difficulties, please email "Feedback" to mbone@netlab.ohio-state.edu
- Please email technical questions with the subject field "Question" to mbone@netlab.ohio-state.edu. We will try to answer selected questions live.

- Current design goals
- PHY Issues
- MAC Issues
- Schedule

Since the Gigabit Ethernet standard is still in a draft stage, some statements made here may change.

Gigabit Ethernet

- Being standardized by 802.3z
- Project approved by IEEE in June 1996
- 802.3 meets every three months ⇒ Too slow
  ⇒ Gigabit Ethernet Alliance (GEA) formed.
  It meets every two weeks.
- Decisions made at GEA are formalized at 802.3 High-Speed Study Group (HSSG)
- Based on Fiber Channel PHY
- Shared (half-duplex) and full-duplex version
- Gigabit 802.12 and 802.3 to have the same PHY

How Much is a Gbps?

- 622,000,000 bps = OC-12
- 800,000,000 bps (100 MBps Fiber Channel)
- 1,000,000,000 bps
- 1,073,741,800 bps = 2^{30} bps (2^{10} = 1024 = 1k)
- 1,244,000,000 bps = OC-24
- 800 Mbps ⇒ Fiber Channel PHY
  ⇒ Shorter time to market
- Decision: 1,000,000,000 bps ⇒ 1.25 GBaud PHY
- Not multiple speed ⇒ Sub-gigabit Ethernet rejected
- 1000Base-X

Physical Media

- Unshielded Twisted Pair (UTP-5): 4-pairs
- Shielded Twisted Pair (STP)
- Multimode Fiber: 50 μm and 62.5 μm
  - Use CD lasers
- Single-Mode Fiber
- Bit Error Rate better than 10^{-12}

How Far Should It Go?

- Full-Duplex:
  - Fiber Channel: 300 m on 62.5 μm at 800 Mbps ⇒ 230 m at 1000 Mbps
  - Decision: 500 m at 1000 Mbps ⇒ Minor changes to FC PHY
- Shared:
  - CSMA/CD without any changes ⇒ 20 m at 1 Gb/s (Too small)
  - Decision: 200 m shared ⇒ Minor changes to 802.3 MAC

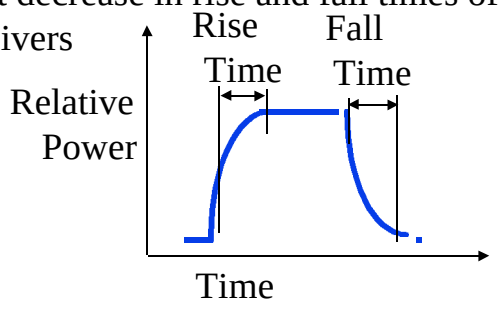
Gigabit Ethernet Objectives

- 1000 Mb/s MAC
- 802.3 Ethernet Frame format
- Meet all 802 requirements except possibly Hamming distance
- Preserve min and max frame size of 802.3
- Full and half-duplex operation
- Support star-wired topologies
- Use CSMA/CD with at least 1 repeater

- Support Fiber and, if possible, copper
- At least 500 m over multimode fiber
- At least 25 m over copper
  ⇒ Wiring-closet or data center backbone
  100 m desirable
- At least 2 km on single mode fiber
- Collision domain diameter of 200 m
- Accommodate 802.3x flow control
- Price: 2 or 3 times fast Ethernet ports and NICs

PHY Issues

- Fiber Channel PHY:
  100 MBps = 800 Mbps
  $\Rightarrow$ 1.063 GBaud using 8b10b
- Changes to get 500 m on 62.5-μm multimode fiber
  - Modest decrease in rise and fall times of the transceivers



- Symbol Codes for Specific Signals: Jam, End-of-packet, beginning of packet
- PHY-based flow Control: No.
  Use the XOFF flow control of 802.3x

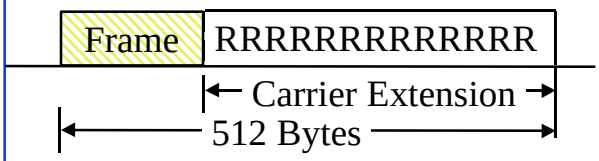
850 nm vs 1300 nm lasers

- 850 nm used in 10Base-F
  - Cannot go full distance with 62.5-µm fiber
  - 500 m with 50-µm fiber
  - 250 m with 62.5-µm fiber
- 1300 nm used in FDDI but more expensive
  - Higher eye safety limits
  - Better Reliability
  - Start with 550 m on 62.5-µm fiber
  - Could be improved to 2 km on 62.5-µm fiber
    ⇒ Needed for campus backbone

Media Access Control Issues

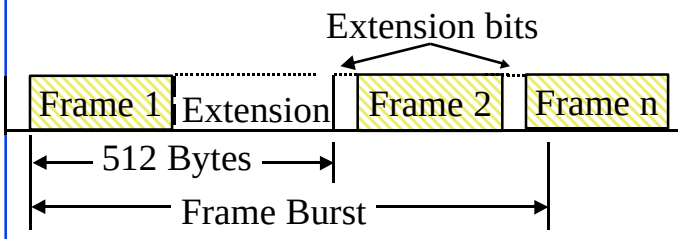
- Carrier Extension
- Frame Bursting
- Buffered Distributor

Carrier Extension



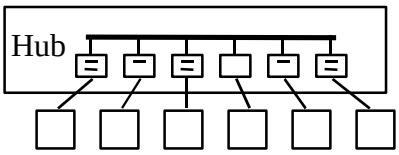
- 10 Mbps at 2.5 km ⇒ Slot time = 64 bytes
- 1 Gbps at 200 m ⇒ Slot time = 512 bytes
- Continue transmitting control symbols. Collision window includes the control symbols
- Control symbols are discarded at the destination
- Net throughput for small frames is only marginally better than 100 Mbps

Frame Bursting



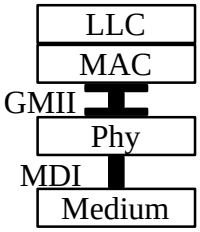
- Don't give up the channel after every frame
- After the slot time, continue transmitting additional frames (with minimum inter-frame gap)
- Interframe gaps are filled with extension bits
- No no new frame transmissions after 8192 bytes
- Three times more throughput for small frames

Buffered Distributor



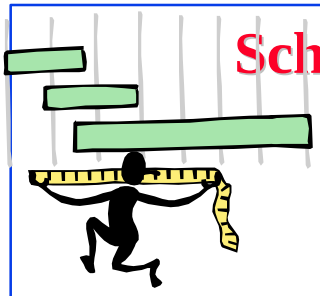
- All incoming frames are buffered in FIFOs
- CSMA/CD arbitration inside the box to transfer frames from an incoming FIFO to all outgoing FIFOs
- Previous slides were half-duplex. With buffered distributor all links are full-duplex with frame-based flow control
- Link length limited by physical considerations only

GMII



- Gigabit Media Independent Interface
- MII between MAC and PHY
- Allows any PHY to be used with a given MAC
  $\Rightarrow$ Allows fiber channel phy to be used with CSMA/CD MAC and TX
- Allows both full-duplex and half-duplex modes

Schedule



- November 1996: Proposal cutoff
- January 1997: First draft
- March 1997: Second draft
- July 1997: Working Group Ballot
- March 1998: Approval

Status

- On Schedule
- First draft reviewed in January 97
- Third draft was issued in July'97
- 1000Base-X: Gigabit Ethernet based on Fiber Channel Phy
- Phy modified for 1000 Mbps operation
- Phy modified for ISO 11801 standard for premises cabling ⇒ 550 m intra-building backbone runs
  ⇒ 1300-nm lasers on 62.5-µm multimode fiber
  850-nm lasers on 62.5-µm fiber ok for 300 m

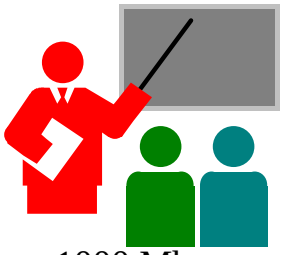
1000Base-X

- 1000Base-LX: 1300-nm laser transceivers
  - 2 to 550 m on 62.5-μm or 50-μm multimode, 2 to 3000 m on 10-μm single-mode
- 1000Base-SX: 850-nm laser transceivers
  - 2 to 300 m on 62.5-μm, 2 to 550 m on 50-μm. Both multimode.
- 1000Base-CX: Short-haul copper jumpers
  - 25 m 2-pair shielded twinax cable in a single room or rack.
    Uses 8b/10b coding ⇒ 1.25 Gbps line rate

1000Base-T

- 100 m on 4-pair Cat-5 UTP
  - Network diameter of 200 m
  - Requires new coding schemes
  - Under development.
  - New PAR approved in March 1997
  - 802.3ab task force

Summary



- Ethernet will run at 1000 Mbps
- Will compete with ATM for campus backbone and desktop
- Both shared and full-duplex links
- Fully compatible with current Ethernet

References

- For a detailed list of references, see http://www.cis.ohio-state.edu/~jain/refs/gbe_refs.htm
- "Media Access Control (MAC) Parameters, Physical Layer Repeater and Management Parameters for 1000 Mb/s Operation," IEEE Draft P802.3z/D3, June 20, 1997.

References (Cont)

- Email Reflector:
  stds-802-3-hssg@mail.ieee.org
  - To join send email to majordomo@mail.ieee.org
  - subscribe stds-802-3-hssg@mail.ieee.org <your email address>
- FTP Site:
  ftp://stdsbbs.ieee.org/pub/802_main/802.3/gigabit
- Gigabit Ethernet Consortium
  http://www.gigabit-ethernet.org

Gigabit Ethernet Products

- **Shipping**: Accclaim Communications, Cabletron, NBase
- **Announced**: 3Com, Alteon Networks, Foundry Networks, Packet Engines, XLNT Designs, Xylan, HP
- **Planning**: Bay Networks, Cisco, Compaq, Digital, FORE, Extreme Networks, IBM, Intel, Ipsilon, Madge Networks, Neo Networks, Plaintree, Prominet, Rapid City, Sun, YAGO Systems
- Ref: Network World, March 17, 1997

Current Schedule

7/17/97 Priority and Multicasting on LANs

7/22/97 No Class

7/24/97 Virtual LANs

7/29/97 Gigabit Ethernet

7/31/97 Quiz 2 (No MBone transmission)

8/5/97 Residential broadband: Cable Modems, xDSL

8/7/97 Multimedia: Compression Standards

8/12/97 Multimedia over IP: RSVP, RTP

8/14/97 Wireless LANs and WANs

8/19/97 Quiz 3 (No MBone transmission)

Credits

This MBone transmission was made possible by:

- Mark Fullmer, OSU/UTS
- Mike Iverson, OSU/UTS
- Mike Douglas, OSU/UTS
- Jayaraman Iyer, OSU/CIS
- Sohail Munir, OSU/CIS