Technology Issues for 10 Gigabit Ethernet

IEEE 802.3

March 1999

Ben Yu

Technology Development Center

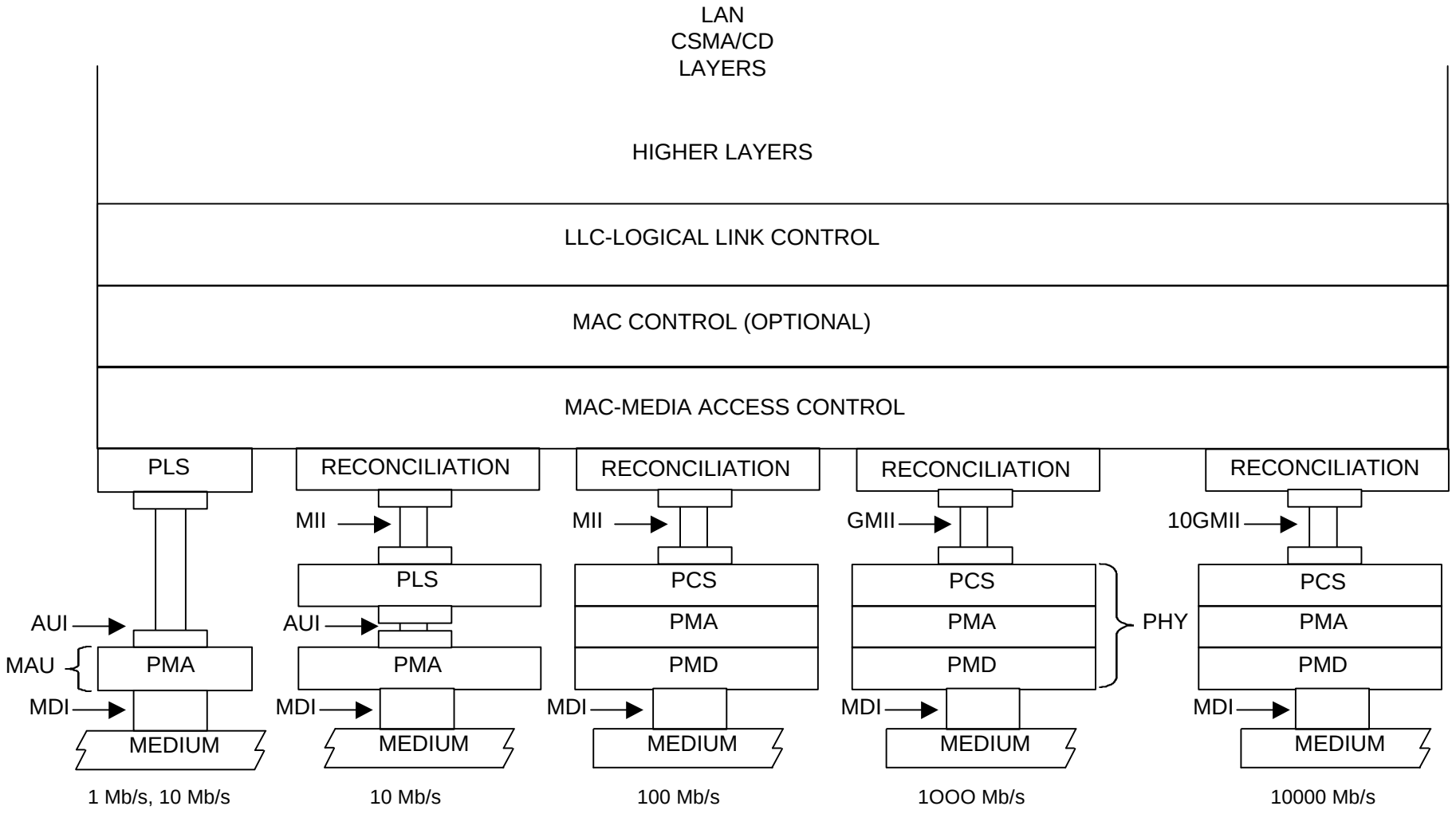
3Com Corporation

3Com

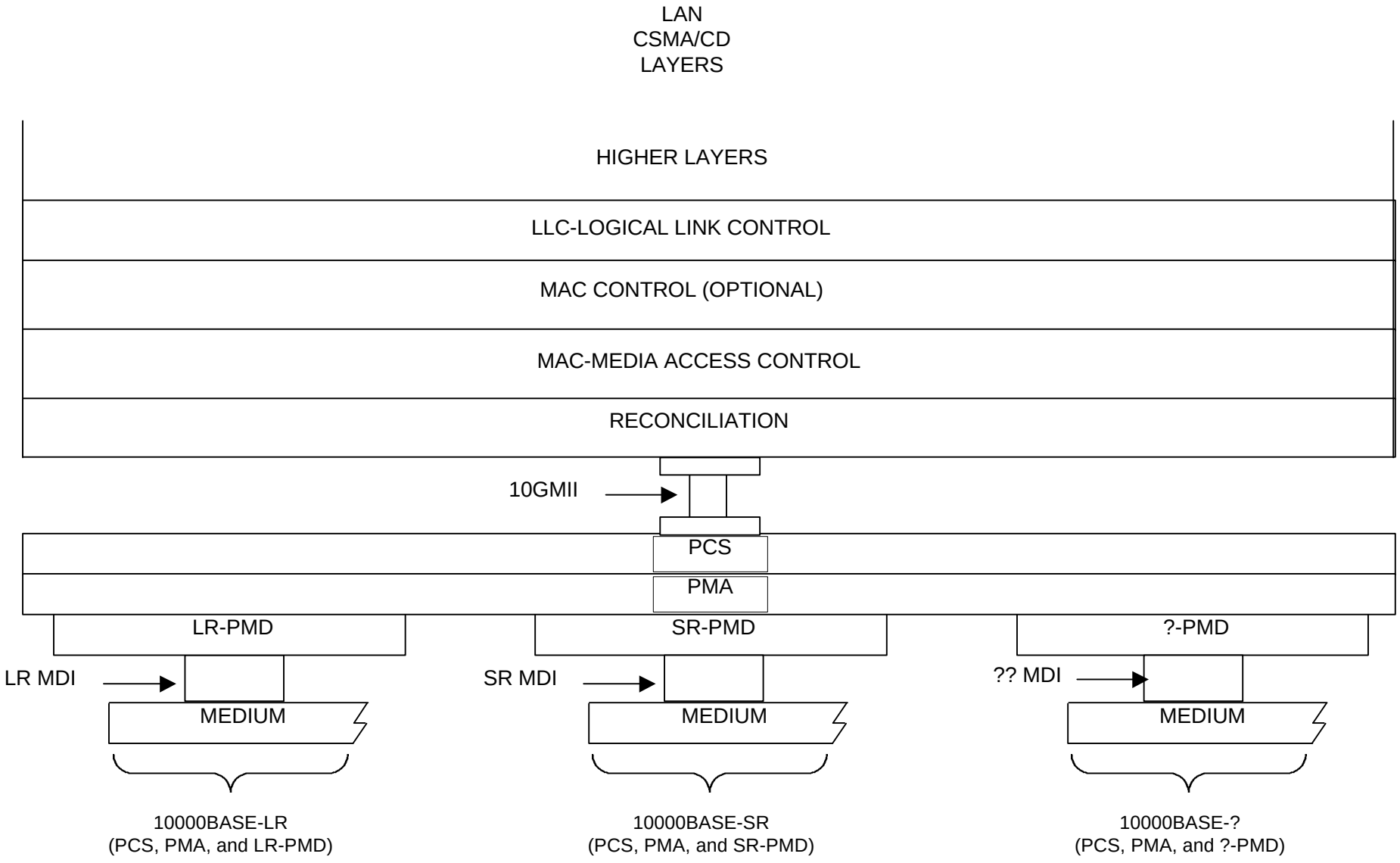
Distance Requirement

- Datacenter, server switch applications
  - up to 50 meters
- Building risers
  - up to 500 meters
- Campus LAN, building to building
  - 2 km to 10 or 20 km
- Access and MAN
  - 30 km or more

Protocol Stack



Protocol Stack



Media - Multimode Fiber

- Applications
  - Server switch applications
  - Horizontal and vertical risers
- Advantages
  - existing installed base in buildings
  - large core diameter -> low cost transceivers?
- Disadvantages
  - multiple propagation modes -> modal (& chromatic) dispersion limits bandwidth-distance product.

Media - Single-mode Fiber

- Applications
  - Campus LAN, building to building
  - Access and MAN
- SMF transmissions
  - Small core -> Single propagation mode and chromatic dispersion from finite laser spectral width.
  - Distance limitation
    - » 1.3 um: fiber attenuation limited
    - » 1.5 um: dispersion limited
  - Standard SMF

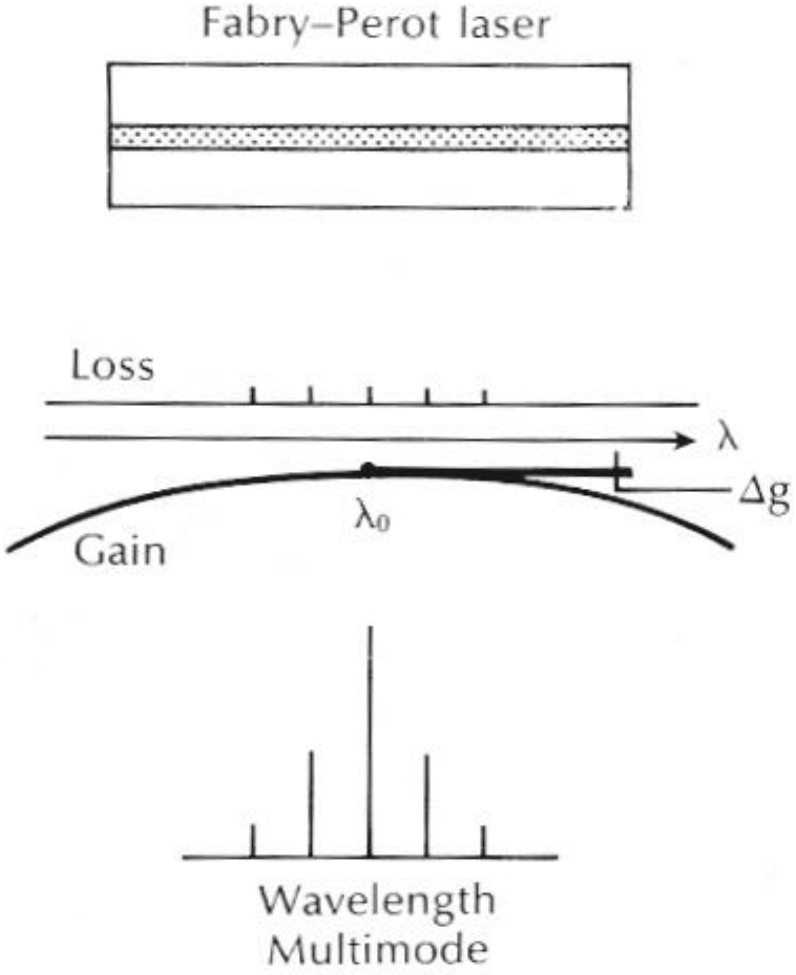
Media - Copper

- Applications
  - data center
  - server-switch connections
- Cost advantage?
- Distance Limitations
- Multilevel signal and DSP?
  - Noise sensitive
  - complex PMA

PMD Components - Lasers

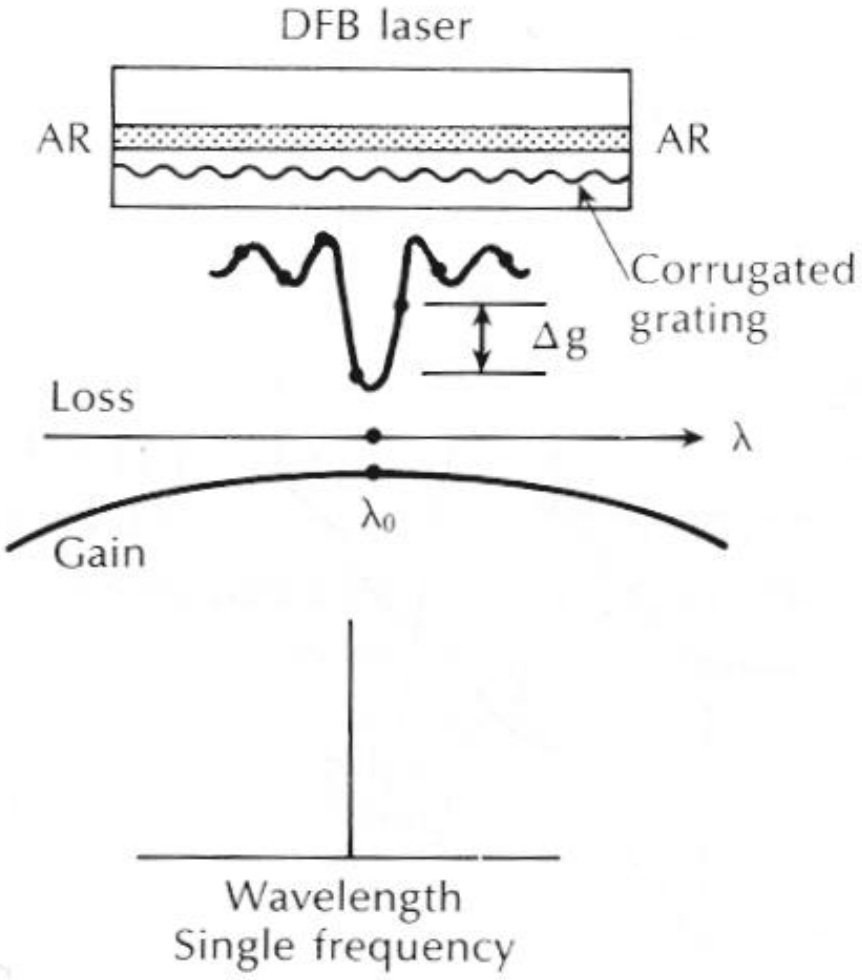
- Requirements
  - High modulation speed (> 10 G)
  - High output power
  - Low driving current/voltage
  - High linearity and narrow spectral width
  - stable output power unaffected by changes in ambient conditions
  - low-cost and reliable
    - » packaging and integration
    - » EMI

PMD - Lasers



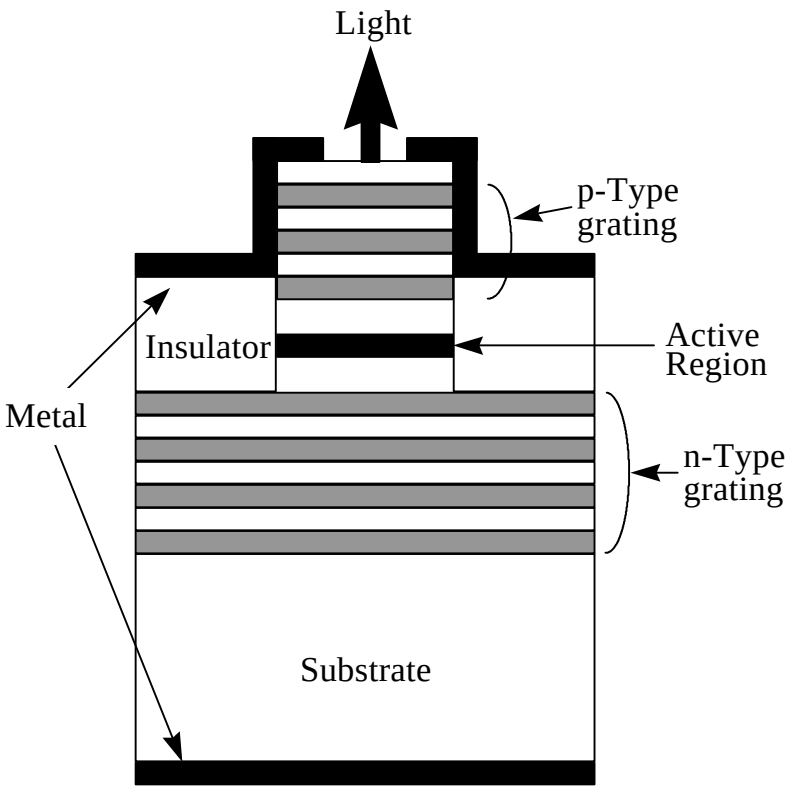
- Fabry-Perot Lasers
  - simple structure and low cost
  - 1.3 um; SMF/MMF
  - multi-mode laser
  - distance limited by dispersion and mode-partition noise

PMD - Lasers



- **Distributed-feedback (DFB) Laser**
  - 1.3/1.55 um; SMF/MMF
  - Distributed resonators suppresses multi-modes
  - Low threshold current
  - High BW-distance product
  - Direct/external modulation
  - Thermal cooling & isolator?
  - Distance limited by loss for 1.3 um and dispersion for 1.55 um (SMF)

PMD - Lasers



- **Vertical Cavity Lasers (VCSELs)**
  - 0.85 um/1.3 um; SMF/ MMF
  - single or multi laser modes
  - low packaging cost
  - distance limit? (single channel or CWDM)

PMD Components - Modulator

- **Used for extended reach**
- **Requirements**
  - High modulation speed
  - High linearity
  - Low driving voltage
  - Packaging size
  - low cost
- **Technologies**
  - $LiNbO_3$
  - Electro-Absorption
  - Hybrid integration with DFB lasers

PMD Components - Detector

- **Requirements**
  - High receiver sensitivity
  - High bandwidth
  - Low noise
- **Technologies**
  - PIN
  - APD

PMA

- Mux/Demux circuitry
- Clock data recovery
- Byte alignment (Optional)
- Serial interface to PMD
  - » laser driver and PIN preamp
- PMA service interface to PCS
  - » TBI?

PMA Process Technologies

- **Bipolar**
  - Mature technology
  - limited BW
- **GaAs**
  - Mature technology
  - High BW
  - Higher power dissipation
- **SiGe**
  - New emerging technology
  - High BW
  - Lower power dissipation

PCS Sublayer

- Functions
  - Encoding (decoding) of data from (to) MAC via Reconciliation sublayer
  - Need for 10 GMII
    - » support for WDM
  - Support half-duplex?
  - Auto-negotiation?
    - » 1000/10000?

Considerations for a 10 GbE Standard

- Lessons learned from .3z and .3ab efforts
- Focused initial standard development to
  - encourages concerted industry effort
  - ensures appropriate functional partitioning for future additions/scaling/cost reduction
  - guarantee timely availability of a useful standard
    - » simple, robust implementations that are standard compliant
    - » fit real user needs (timing, cost, etc.)
- Maintaining 802.3's reputation

Starting Point for 10GE Discussions

- Full-duplex only
- MAC/PCS/PMA standard interfaces
- 10 Gbps (data)
- Encoding (8B/10B)
- Single wavelength in 1300 nm window
- Standard single-mode fiber
- up to 30 km