PMA/PMD for WWDM PHY

10GBASE-LX4

IEEE Draft P802.3ae/D3.2

Clause 53 Presentation
Outline

• Introduction
• Wave Division Multiplexing Overview
• Clause 53 WWDM PHY
• Conclusion
Introduction

• 10Gigabit Ethernet offers a serial PHY and a parallel PHY with multiple wavelengths.
• Clause 53 of IEEE Draft P802.3ae/D3.2 defines PMD sublayer and baseband medium for WWDM PHY, type 10GBASE-LX4.
Introduction

• 4 optical wavelengths, each at 3.125GBaud
• Each wavelength contains 8B/10B encoded data as described in Clause 48
• Compatible with XAUI/XGXS
• Able to run over both single and multimode fiber (SMF, MMF) up to 10km and 300m respectively
What’s Next

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WDM Overview

• WDM (wave division multiplexing)
  – You can also have Dense, Coarse WDM
  – C/D depends on number of wavelengths
• Refers to the (de)multiplexing of multiple wavelengths over a single fiber
• One laser for each wavelength
• Why send one multi-gig stream over a fiber when you can send multiple?
WWDM Basics

• In General, a WDM system has the following main parts: Transmitter, Receiver, (De)Multiplexer, Amplifier, and Channel.
Transmitters

- Distributed feedback (DFB) lasers
  - 1310nm and 1550nm range
- Strict monitoring
  - Use feedback to control laser output
  - Temperature control
- High output power
- One laser for each wavelength
Amplifiers

- Power amplifiers
  - High gain before transmission
- Line amplifier
  - Restore signal to initial state
- Receiver amplifier
  - Recover signal from noise
Channel

• Long lengths of fiber
  – Attenuation
  – Chromatic dispersion (single mode fibers)
  – Broadening of pulses cause inter-symbol interference
  – This can cause major problems
Dispersion

- Dispersion is a function of the fiber
- Zero dispersion at 1300 nm
- Dispersion compensation fiber
- Dispersion shifted fiber
- Non-zero dispersion shifted fiber
  - Eliminate Four Wave Mixing
Multiplexing/Demultiplexing

- Prisms
- Diffraction Gratings
- Arrayed waveguide grating
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Implementation Example

- **TXC**: 4/32
- **TXD**: 32
- **RXC**: 4/32
- **RXD**: 32
- **8B/10B Encode**: MAC
- **XGMII**: Clause 48 PCS
- **8B/10B Decode**: Electrical to Optical and MUX
- **Optical to Electrical and DeMUX**: SMF or MMF
Implementation Example

XGXS
MAC
TXC
TXD
RXC
RXD

8B/10B Encode

8B/10B Decode

4x2

4x2

XGXS
XAUI

Re-Timer (may not be necessary)

Electrical to Optical and MUX

Optical to Electrical and DeMUX

SMF or MMF
PMD functions

- PMD Transmit function
  - Convert 4 electronic bit streams, tx_bit[0:3], requested by PMD service interface into four separate optical signal streams.
  - Four optical streams are converted, through WDM, to a single stream delivered to the MDI.
PMD functions

• PMD Receive function
  – Demultiplex the received optical signal into four separate optical streams.
  – Convert optical streams to electrical signals, rx_bit[3:0]
PMD functions

• Signal detect function
  – Reports to PMD service interface, the presence of optical signals on all four lanes.
  – Received signal needs to be greater than –30 dBm, greater than the receiver sensitivity, and compliant with 10GBASE-WWDM signal input.
## Wavelength assignments

<table>
<thead>
<tr>
<th>Lane</th>
<th>Wavelength Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane 0</td>
<td>1269.0 – 1282.4 nm</td>
</tr>
<tr>
<td>Lane 1</td>
<td>1293.5 – 1306.9 nm</td>
</tr>
<tr>
<td>Lane 2</td>
<td>1318.0 – 1331.4 nm</td>
</tr>
<tr>
<td>Lane 3</td>
<td>1342.5 – 1355.9 nm</td>
</tr>
</tbody>
</table>
### Operating ranges

<table>
<thead>
<tr>
<th>Fiber Type</th>
<th>MHz*km</th>
<th>Minimum range (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.5 µm MMF</td>
<td>500</td>
<td>300</td>
</tr>
<tr>
<td>50 µm MMF</td>
<td>400</td>
<td>240</td>
</tr>
<tr>
<td>50 µm MMF</td>
<td>500</td>
<td>300</td>
</tr>
<tr>
<td>SMF</td>
<td>n/a</td>
<td>10,000</td>
</tr>
</tbody>
</table>
Conclusions

• For LAN WDM PHY
  – XAUI to XAUI implementation
  – Well-known coding scheme (8B/10B)
  – 4 lanes at 3.125 Gbps
  – 300m of MMF, 10km of SMF
  – Leaves room for future expansion
    • More wavelengths
    • Higher speeds
To Learn More

- For more information regarding 10 Gigabit Ethernet, or the 10 Gigabit Ethernet Consortium, feel free to contact me via email: Eric Lynskey elynskey@iol.unh.edu

Or visit our website:

UNH IOL 10 Gigabit Ethernet Consortium