# Evaluating CWDM 10GBASE-SX


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| | |
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| Steven Swanson | Corning |
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| Robert Bryan | MicroOptical Dev |
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| Siva Yegnanarayanan | Cognet uSystems |



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# PMD Solutions - 4X CWDM

- CWDM 10GBASE-SX - ***multi-mode only***
  - Installed multi-mode 100m
  - New MMF 550m
- CWDM 10GBASE-LX
  - Installed multi-mode 300m
  - New MMF 300m
  - Single-mode 10km

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# Why a CWDM 10GBASE-SX?

- Uses available low cost silicon technology
- Uses inexpensive multi-mode optics & lasers
- Meets 100 and 300 meter distance objective
- Meets economic criteria
- 1/3 the cost of CWDM 10GBASE-LX
- 1/3 the cost of 850nm 10G serial

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# Why a CWDM 10GBASE-SX?

- **Uses available low cost silicon technology**
- TIA CMOS technology
- PHY Interface CMOS technology
- 2.4GHz Silicon Detectors on-hand

LOW COST and LOW RISK

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# Why a CWDM 10GBASE-SX?

- **Uses inexpensive multi-mode optics & lasers**
- plastic optics
- low cost multi-mode sources
- fast and easy assembly

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# Why a CWDM 10GBASE-SX?

- **Meets 100 meter distance objective**
- CWDM 10GBASE-SX 100m
- CWDM 10GBASE-LX 300m at 3 X cost
- 850nm 10G Serial 30m at 3 X cost
- 1300nm 10G Serial 80m at 3 X cost

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# Why a CWDM 10GBASE-SX?

- **Meets 300 meter distance objective**
- CWDM 10GBASE-SX 550m
- CWDM 10GBASE-LX 300m at 3 X cost
- 850nm 10G Serial 300m at 3 X cost
- 1300nm 10G Serial 80m at 3 X cost

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# Why a CWDM 10GBASE-SX?

- **Meets economic criteria***
- "A target cost increase of 3X 1000 BASE - X...."
- CWDM 10GBASE-SX meets this criteria at 100K piece quantities

- *HSSG, 5 Criteria, Economic Feasibility, September York

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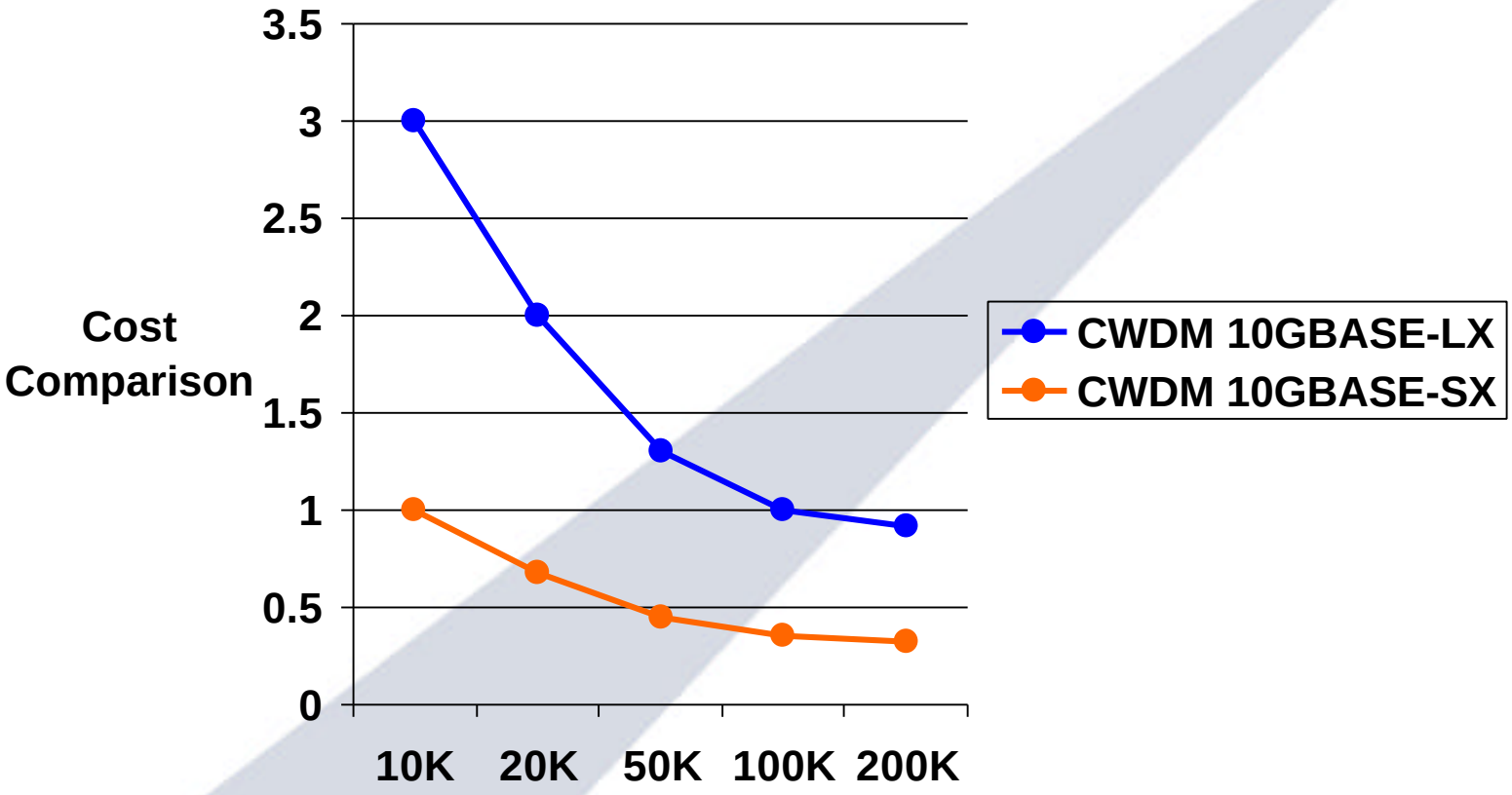
# Cost Comparison

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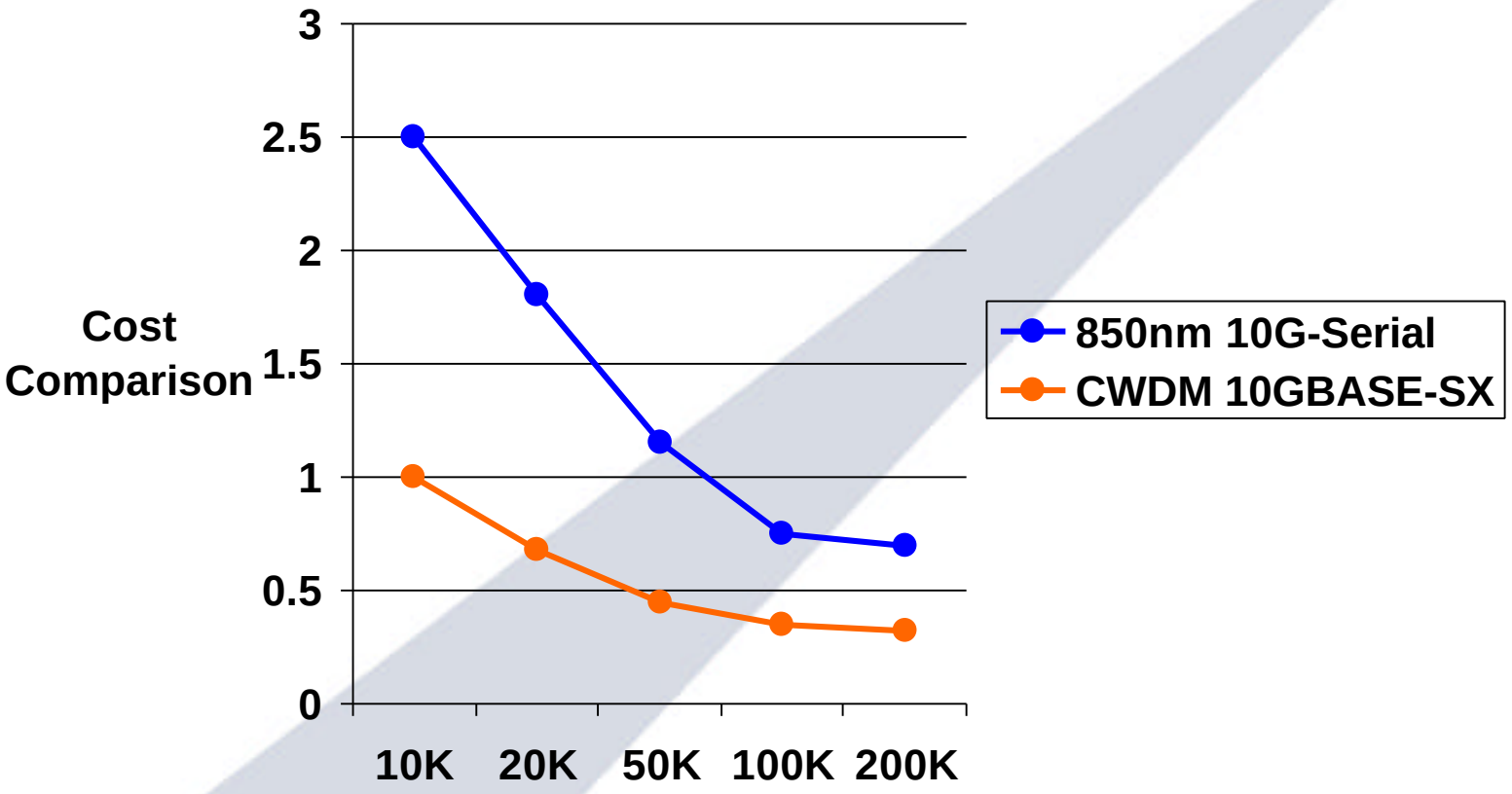
# Cost Comparison




Reference: Economic Feasibility of 10Gbe, Nov. Kauai

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# CWDM 10GBASE-SX 10Gig-Serial Cost Comparison

- CWDM 10GBASE-SX is inherently less expensive than 10Gig-Serial
- **Four** silicon detectors are much less expensive than **one** InGaAs
- CMOS is less expensive than higher speed alternatives

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# Early Availability

- CWDM 10GBASE-SX Q4 2000*
- CWDM 10GBASE-LX Q4 2000*
- Early availability at attractive pricing helps to provide the important early adoption of 10G products

- *Pre-standard silicon, standards-based silicon Q2 2001

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# Technical Feasibility

| | | |
|---|---|---|
| ➢ Mux/Demux | Plastic molded optic | Now |
| ➢ Detectors | Silicon | Now |
| ➢ Sources | Oxide VCSELs | Now* |
| ➢ Filters | Wafer grown | Now |
| ➢ TIAs | Silicon | Dev** |
| ➢ PHY intface | Silicon | Dev |
| ➢ Standard assembly techniques | | Now |

- *specific wavelengths under development
- **2.5Gbits TIA available today

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# 10GBASE-SX Remaining Issues

- General Availability
- Cost
- Open Fiber Control

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# Table 38-6 Operating Range

| **Fiber Type** | **Modal bandwidth @ 850 nm (min. overfilled launch) (MHz*km)** | **Minimum range** (meters) |
|---|---|---|
| 62.5 µm MMF | 160 | 2-100 |
| 50.0 µm MMF | 500 | 2-300 |
| 50.0 µm MMF (new) | 2200* | 2-550 |

* pending launch analysis

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# Table 38-7 Transmit

| Description | 62.5 mm MMF<br>50 mm MMF<br>50 mm MMF (new) | Unit |
|---|---|---|
| Transmitter Type | Shortwave Laser | |
| Signaling speed per channel (range) | 2.578 ± 100 ppm* | GBd |
| Wavelength (range), four channels | 805 to 895 | nm |
| Channel center wavelengths | 812.5, 837.5, 862.5, 887.5<br>± 6.3 nm | nm |
| Channel separation | 25.0 | nm |
| Trise/Tfall (max. 20-80% response time) | 100 | ps |
| RMS spectral width (max) | 0.5 | nm |
| Average launch power, four channels (max) | +4.7 | dBm |
| Average launch power per channel (max) | -1.3 | dBm |
| Average launch power per channel (min) | -5.5 | dBm |
| Extinction ratio, (min) | 7 | dB |
| RIN (max) | -117 | dB/Hz |

* 64B/66B coding

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# Table 38-8 Receive

| Description | 62.5 mm MMF 50 mm MMF | 50 mm MMF | 50 mm MMF (new) | Unit |
|---|---|---|---|---|
| Signaling speed per channel (range) | 2.578 ± 100 ppm* | | | GBd |
| Wavelength (range), four channels | 805 to 895 | | | nm |
| Channel center wavelengths | 812.5, 837.5, 862.5, 887.5 ± 6.3 nm | | | nm |
| Channel separation | 25.0 | | | nm |
| Average receive power, four channels (max) | 4.7 | | | dBm |
| Average receive power, per channel (max) | -1.3 | | | dBm |
| Return loss | 12 | | | dB |
| Receive electrical 3 dB upper cutoff frequency (min) | 2000 | | | MHz |
| Receive sensitivity | -13.5 | -13.5 | -13.5 | dBm |
| Stressed receive sensitivity | -8 | -9.0 | -10.4 | dBm |
| Vertical eye closure penalty | 2.9 | 2.7 | 0.9 | dB |

* 64B/66B coding

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# Table 39-9 Link Power Budget

| Parameter | 62.5 μm MMF | 50.0 μm MMF | 50.0 μm MMF (new) | Unit |
|---|---|---|---|---|
| Modal bandwidth as measured at 850 nm (min overfilled launch) | 160 | 500 | 2200 | MHz*km |
| Link power budget | 8.0 | 8.0 | 8.0 | dB |
| Operating distance | 100 | 300 | 550 | m |
| Channel insertion loss | 2.03 | 3.10 | 4.44 | dB |
| Link power penalties | 3.64 | 3.50 | 1.84 | dB |
| Unallocated margin in link power budget | 2.33 | 1.39 | 1.72 | dB |

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# Evaluating PMDs

| | Objectives & Criteria | | | | |
|---|---|---|---|---|---|
| PMD Proposal | 100m on Installed MMF | 300m on New MMF | 2Km on SMF | 10Km on SMF | 40Km on SMF |
| **CWDM 850nm** | **Yes** | **Yes** | No | No | No |
| **Serial 850nm** | No | **Yes** | No | No | No |
| **Serial 1300nm (FP)** | No | No | **Yes** | No | No |
| **Serial 1300nm (DFB/ VCSEL)** | No | No | **Yes** | **Yes** | No |
| **CWDM 1300nm** | **Yes** | **Yes** | **Yes** | **Yes** | No |
| **Serial 1300nm (Cooled DFB)** | No | No | **Yes** | **Yes** | **~Yes** |
| **Serial 1500nm** | No | No | **Yes** | **Yes** | **Yes** |