

# **Short-Reach on Parallel MMF** **for Low-Cost Higher-Speed Ethernet**

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# PMDs Standardized for 10GbE

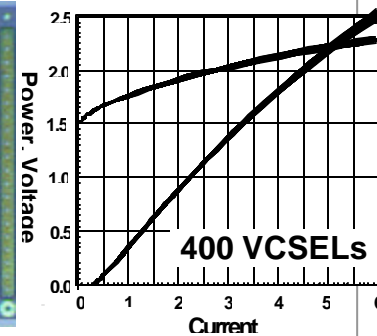
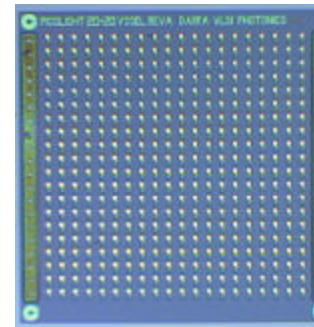
| <u>#PMDs</u> | <u>Reach</u> | <u>Media</u> | <u>10GBASE-</u> |
|--------------|--------------|--------------|-----------------|
| 1            | 40km         | SMF          | ER              |
| 1            | 10km         | SMF          | LR              |
| 1            | 300m         | MMF (OM-3)   | SR              |
| 2            | 220-300m     | MMF (Legacy) | LX4, LRM        |
| 2            | 15-100m      | Copper       | CX4, T          |

- 5 of the 7 PMDs are defined for reaches 300m or less
- Low cost is the driver

Compelling need for low-cost PMD for short reach

## VCSELs: Key to Low-Cost, Low-Power Optical Interconnects

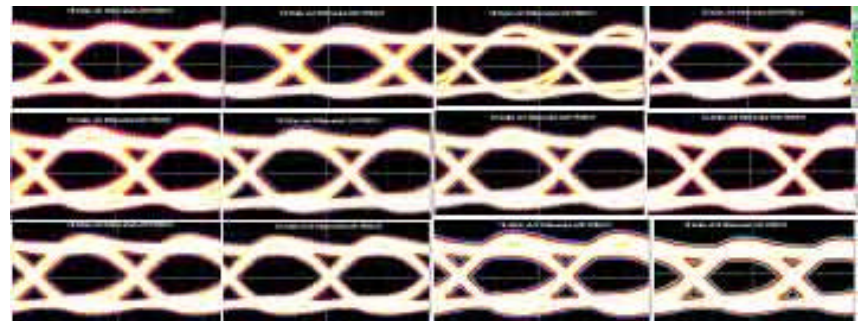
- **VCSEL**: Vertical-Cavity Surface-Emitting Laser
- **7mA**: Bias current at 10Gb/s at high temperature (DFBs >50mA)
- **10.3Gb/s**: Directly-modulated speed in products (10GBASE-SR)
- **20-25Gb/s**: Directly-modulated speed in reported demo's
- **12**: # array elements in products (SNAP-12)
- **400**: # array elements in demo's\* →
- **400mW**: Total module power in 10G SFP+
- **<3W**: Total power in 12x10G (Tx + Rx) pair
- **850nm**: Wavelength of most-mature VCSELs
- **1310nm**: Wavelength of new-product VCSELs (4G F-C)
- **Cost**: Low enough and with high enough volume for laser mice



\*sponsored by DARPA - VLSI Photonics with Northrop-Grumman

# Higher-Speed (~100G)

- Multiple-channel approaches dominate HSSG discussions
- Power dissipation puts copper-based solutions in serious question
- **850nm VCSEL/MMF products include:**
  - 10.3G serial links over 300m (SR)
  - 12x2.7G/12x3.3G parallel links, at least 300m
- **12x10.3G more difficult than 1x10.3G or 12x3.3G, but on the horizon**
- **12x10.3G over 300m demonstrated at OFC 2003 (IBM, Picolight) ↘**
- **12x10G demanded for:**
  - Infiniband QDR
  - Non-standardized applications



**Combining 10G with parallel is irresistible**

## Features of “in-sight” 12x10G

- **Cost-effective 850nm VCSEL/PIN arrays; low Tx current**
- **Tx and Rx fit into X2-width module or pair of SNAP-12's**
- **<3 watt power dissipation at outset**
- **Estimable cost - lowest of any optical solution**
  
- **Decrease module cost - reduce reach to ~150m**
- **Decrease fiber cost - use pre-terminated fiber “bundles”**
  
- **Other plausible modifications;**
  - Channel rate >10G → fewer channels/fibers
  - Muxing in fibers → fewer fibers

# Summary

- Diversity of Ethernet customers necessitates some PMD variety
- Many data centers demand high-volume, low-cost, ~150m
- Overwhelming historical demand for low-cost solutions
- 850nm 12x10G is demanded/leveraged by non-Ethernet applications
- For HSE, an 850nm VCSEL/MMF parallel approach promises:

- Lowest power
- Highest density
- High-volume demand
- Combines existing products
- Lowest cost



Compatibility and distinct identity to be part of HSSG effort for all PMDs

- Recommend that HSSG support an objective based on parallel-OM3 fiber reaching a distance of 100-300m
- # channels, line rate, reach TBD pending basic decisions