Multimode Fibers of Installed Base for 10 Gigabit Ethernet

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Abstract
MM Fibers of Installed Base for 10GbE

◗ **Benefit in Using MM Fibers of Installed Base**

   ♦ **No rewiring -- save cost, time, manpower, documentation**

   ♦ **Share media with other rates -- orderly migration to 10xGbE**

   ♦ **Market acceptance -- plug and play**

◗ **Issues of Installed Base**

   ♦ **Incomplete data --not enough for cable plant design**

   ♦ **Many defected DMD fibers -- identification**

◗ **Implementation Strategy**

   ♦ **Optimize launch conditions -- improve EMB**

   ♦ **Remove defected DMD fibers, -- TCP flow control**

   ♦ **New MM fibers for new installations -- InfiniCor (Corning)**

Improve Fiber Modal Bandwidth
MM Fibers of Installed Base for 10GbE

◗ **Facts About Fiber Bandwidth**

♦ **Fiber does not have a bandwidth -- BW needs source and fiber -- RC filter**

♦ **OFL bandwidth -- not existing in real applications, Yesterday's Measure (TIA)**

♦ **Improved EMB -- optimize launch condition**

◗ **Bandwidth Improvement**

♦ **Short-wave -- restricting launch to center**

♦ **Long-wave -- mode conditioner to minimize DMD**

♦ **Fiber refractive index profile -- non-defect parabolic profile, $f(r) = [r/a]^g$**

♦ **TIA FO-2.2 Task Group -- new FOTP for restricted launch bandwidth**

♦ **New MM fibers -- InfiniCor**

# Redefine Installed Base
MM Fibers of Installed Base for 10GbE

- **Replace OFL BW with EMB for Link Design**
  - Discard fiber OFL BWs -- 160/400/500 MHz-km
  - Use EMB from TIA FO2.2 Round Robin Data

- **Insufficient Field Data**
  - Limited population of sampled data
  - BW data not actual BW
  - Defected, DMD, fiber, distort field data

- **Remove Defected DMD Fibers**
  - TCP flow control -- high BER, retransmission, disconnection
  - Remove bad fibers -- reconnect to other fibers
  - Possible rejection ratio --- 5% to 15% maximum

# Modal Bandwidth Optimization
MM Fibers of Installed Base for 10GbE

◗ **EMB 700 MHz-km --- for 62.5 um/50 um at 850 nm**

  ◆ **Encircled flux @15 um >0.8 5**
  ◆ **Median EMB = 700 MHz-km**

◗ **EMB 1.0 GHz-km -- for 62.5um/50 um at 1300 nm**

  ◆ **Mode conditioner -- offset, dough nut (Digital Optics)**
  ◆ **EMB -- over 1.0 GHz-km**
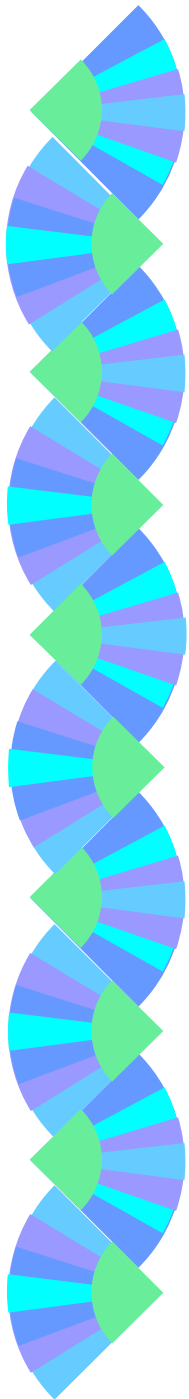
Operating Distance
MM Fibers of Installed Base for 10GbE

◗ **Required Fiber Bandwidth at 12.5 Gbps**

  ◆ **System Bandwidth:**

  $$0.8 \ xTb => (Tt^2 + Tf^2 + Tr^2 +)^{-0.5}$$

  $$BWf = 1/Tf => 8 \ GHz \ (or \ 2 \ GHz \ at \ 2.5 \ Gbps) \ ……………….. \ (1)$$

◗ **Fiber Distance at 12.5 Gbps**

  $$d = EMB/8 \ (or \ EMB/2 \ at \ 2.5 \ Gbps) \ km \ ……………………….(2)$$

◗ **Installed Base Fiber Distance at 12.5 Gbps**

  ◆ **Fiber 62.5 um --70 m(SW), 100 m (LW)**

  ◆ **Fiber 50 um -- 70 m (SW), 100 m (LW)**

◗ **Installed Base Fiber Distance at 2.5 Gbps**

  ◆ **Fiber 62.5 um -- 300 m (SW),   400 m (LW)**

  ◆ **Fiber 50 um -- 300 m (SW), 400 m (LW)**
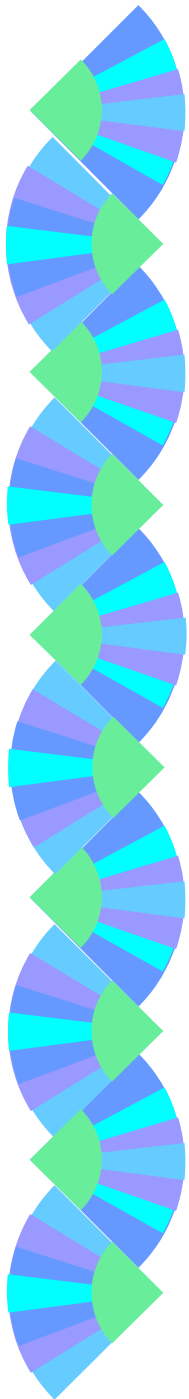
Conclusion
MM Fibers Of Installed Base for 10 GbE

◗ **Support 2.5 Gbps**

- ◆ **Up to 400 meter -- 1300 nm**
  - ▸ **Rejection ratio -- negligible**
  - ▸ **Mode conditioner, if needed -- off-set, dough nut**
- ◆ **Up to 300 meter -- 850 nm**
  - ▸ **Rejection ratio -- 10% to 150%**
  - ▸ **Restricted launch -- encircled flux-15 > 85%**

◗ **Support 12.5 Gbps**

- ◆ **Up to 100 meter - 1300 nm**
  - ▸ **Rejection ratio -- negligible**
  - ▸ **Mode conditioner, if needed**
- ◆ **Up to 70 meter -- 850 nm**
  - ▸ **Rejection ratio -- 10% to 15%**
  - ▸ **Restricted launch -- encircled flux-15 > 85%**