2009 Technical Plan - Optoelectronics

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T.C. / TIG Meeting

Las Vegas, Nevada

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Advancing manufacturing technology

Technical Plan

- Agenda
  - Introduction
  - Preliminary Five-year plan
  - What has changed
  - Preliminary Gap Chart
  - Preliminary TIG Plan
    - Projects/programs to focus on short term -prioritize
    - Identify areas where research is needed -prioritize
  - Summary
  - Backup Info (High, Med, Low Priorities)

Introduction

Optoelectronics TIG

- TIG responsibility is to provide low cost, high yield assembly and test processes for optoelectronic systems and interconnects.
- Covers optical communications and related components and subsystems as described in the iNEMI 2009 roadmap.
- TIG Technical Plan developed over short time-frame (3 weeks). Feedback from approximately 10-12 people.

Optoelectronics 5 Year Plan

Drivers
- Cost reductions
- High speed applications (40G/100G)
- Rack-to-Rack Applications (active cables)
- Component Integration
- Power reduction
- Standardization
- Tunability
- FTTX

2009

Attributes

Reduced power

Tunability – 32 wavelengths in single module (C & L Bands)

Data rate - 40G / 100G

Fiber type – plastic fiber

Spectral efficiency (40G/100G)

Modulation format (40G/100G)

Deployed Technology

10G Data speed

Tunable 300pin

300pin 40G VSR

40G Test & Meas. (Limited)

Active Cables (<10G)

Research /Development

Active Cables (40G)

Tunable XFP

40G/100G Standards

Plastic fiber standards

Optical Backplane / Waveguides

Lens Cleanliness Standards

2011

Attributes

Reduced power

Tunability – 32 wavelengths in single module (C & L Bands)

Data rate - 40G / 100G

Fiber type – plastic fiber

Spectral efficiency (40G/100G)

Modulation format (40G/100G)

Deployed Technology

40G Data speed (300pin, CFP)

Tunable XFP / SFP+

40G Test & Meas.

Active Cables (40G limited)

40G/100G Standards

Research /Development

Active Cables (40G)

Plastic fiber standards

Optical Backplane / Waveguides

>100G Data speed (parallel)

40G/100G Cleanliness Standards

2013

Attributes

Reduced power

Tunability – 32 wavelengths in single module (C & L Bands)

Data rate - 40G / 100G

Fiber type – plastic fiber

Spectral efficiency (40G/100G)

Modulation format (40G/100G)

Deployed Technology

100G Data speed (limited)

Tunable (XFP, SFP+, CFP)

100G Test & Meas. (Limited)

Active Cables (40G)

Optical Backplane / Waveguides (Limited)

Research /Development

Active Cables (40G)

Optical Backplane / Waveguides

>100G Data speed (parallel)

2015

Attributes

Reduced power

Tunability – 32 wavelengths in single module (C & L Bands)

Data rate - 40G / 100G

Fiber type – plastic fiber

Spectral efficiency (40G/100G)

Modulation format (40G/100G)

Deployed Technology

100G Data speed

Tunable (XFP, SFP+, CFP)

40G/100G Test & Meas.

Active Cables (40G)

Optical Backplane / Waveguides

Research /Development

Active Cables (100G)

>100G Data speed (serial)

Terabyte Ethernet

What has changed

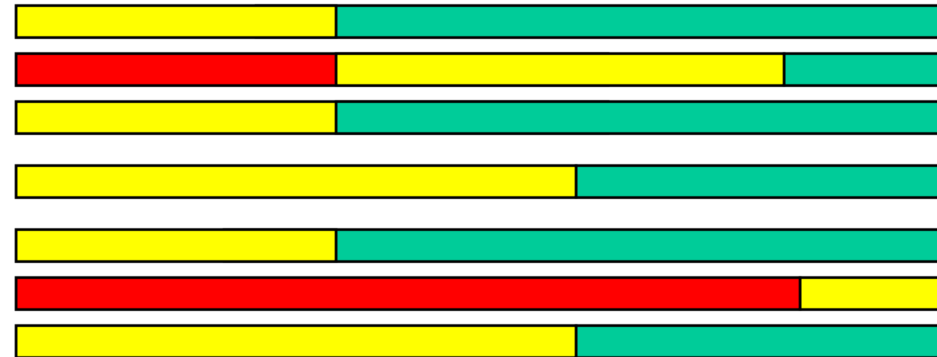
- Change in business climate due to the 2000 – 2005 electronics recession has had many major effects including markedly reduced volumes, extreme cost pressure, delayed rollout of new optic technologies.
- Cost reduction through moves to lowest cost labor areas
- Introduction of lower cost SFF, SFP, XFP modules
- Pluggable MSA transceivers and separate optical and electronic assembly.
- Deployment of 40G has been very slow to date. Finally, roll-out of 40G has started.
- FTTX has started in the U.S. (approximately 5% of houses in the U.S.)

Optoelectronic Gap Analysis

Technology

2009 2011 2013 2015

- 40G Data speed----------------------------------
- 100G Data speed- --------------------------------
- Tunable XFP/SFP+/CFP-----------------------
- 40G Active Cables -------------------------------
- PMD Compensation / Modulation Formats--
- Optical Backplane / Waveguides-------------
- Component Integration / Packaging----------



Test

- 40G Test & Measurement ------------------------
- 100G Test & Measurement -----------------------
- 40G/100G Test Equipment Cost -----------------

Standards

- 40G/100G Standards -------------------------------
- Plastic Fiber Standards-----------------------------
- Lens/40G/100G Cleanliness-----------------------
- MSA (Multi-source agreements) ------------------

Green = No Gap Issues or Resolved

Yellow = Known Gap Mitigation Techniques   Red = No Known Solution – Development Required

Optoelectronic Plan

- Tactical 1-2 yrs projects
  - Cleanliness and Scratch Impact – 40G/100G, High Power, Lens Devices
  - Active Cables for rack-to-rack applications - Evaluate cost impact and technology challenges (EMI, thermal, connectivity/assembly).
  - 40G / 100G - modulation schemes, interface standards, and manufacturing challenges
- Technologies requiring significant R&D effort (>5 years – anybody in industry can work on it)
  - Tunability of source, add-drop, and dispersion compensation
  - Optical waveguide, backplanes, chip-to-chip
  - Chips to implement E to O and O to E (next gen linecard design)
  - Practical backplane connector (eliminate cleanliness issues)

Summary

- **Further standardization is required in the area of 40G/100G, plastic fiber, and consumer market.**
- **Components are moving towards reduced physical size, lower power, and lower cost per bit all at higher data rates.**
- **Tunability across wavelengths will help reduce number of components required and reduce cost.**
- **Test and measurement solutions are still under development for 40G/100G applications.**
- **Storage applications and increased bandwidth needs at service providers are driving additional rack-to-rack requirements such as active cables.**

Initial Gaps for Optoelectronic

High Priority

- Optical component integration (hybrid / monolithic)
- Active Cables for rack-to-rack applications - Evaluate cost impact and technology challenges (EMI, thermal, connectivity/assembly).
- FTTX applications - need low cost components to meet market needs
- 40G / 100G - modulation schemes and interface standards, manufacturing challenges
- Optical waveguide, backplanes, chip-to-chip (> 5yrs)
- Cleanliness and Scratch Impact – 40G/100G, High Power, Lens Devices

Initial Gaps for Optoelectronic

Medium Priority

- Tunability of source, add-drop, and dispersion compensation
- On-die good-enough encapsulation for optics
- Technology to manage Wavelength drift with temperature
- Plastic optical fiber (cost benefit analysis & standards)
- Chips to implement E to O and O to E (next gen linecard design)
- Fiber optic component reliability standards for the consumer & commercial market.

Initial Gaps for Optoelectronic

Medium Priority (cont'd)

- On-chip: No known cost effective light source. (> 5 yrs)
- Highly reliable, very dense off-chip light source
- Higher density, low EMI connections to optical modules
- Very low cost high efficiency optical amplifier (multi-channel)
- SMPTE standard - video data transmission using optical transceivers
- Practical backplane connector (> 5 yrs)
- Wafer level test (input/output couplers)

Initial Gaps for Optoelectronic

Low Priority

- Surface coupled output structures (not VCSELs)
- Temperature compensation photonic circuitry
- Low cost array waveguide coupler to optics
- Differential signaling protocol to allow fade and x-talk immunity