Optical Interconnect Project

Phase 2

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Member Meeting ** San Jose** California

Outline

- HDP Optical Interconnect Project Phase 1
  - Overview
- HDP Optical Interconnect Project Phase 2
  - Definition and Directions

Outline

- HDP Optical Interconnect Project Phase 1
  - Outlook and Summary
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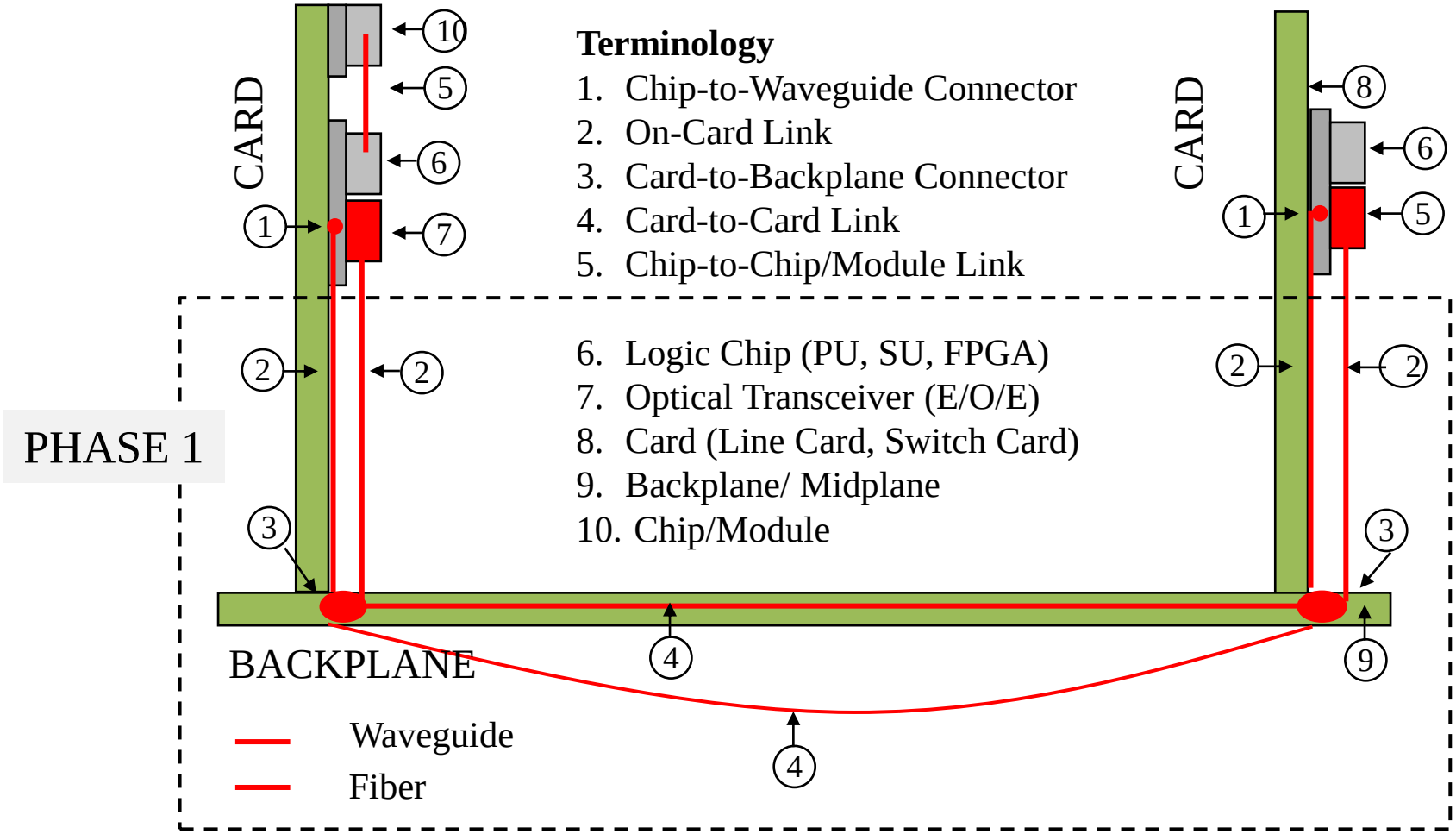
Optical Interconnection Model

Interconnection Model



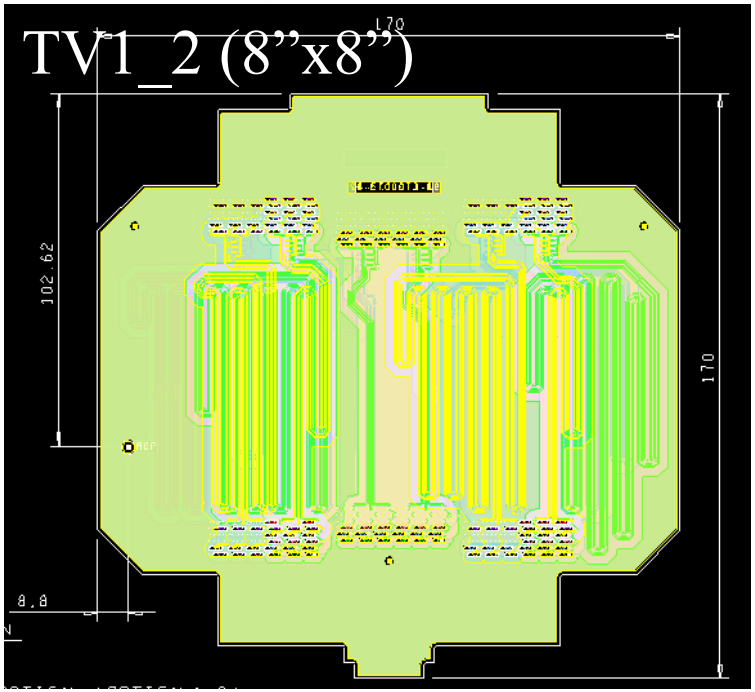
Terminology

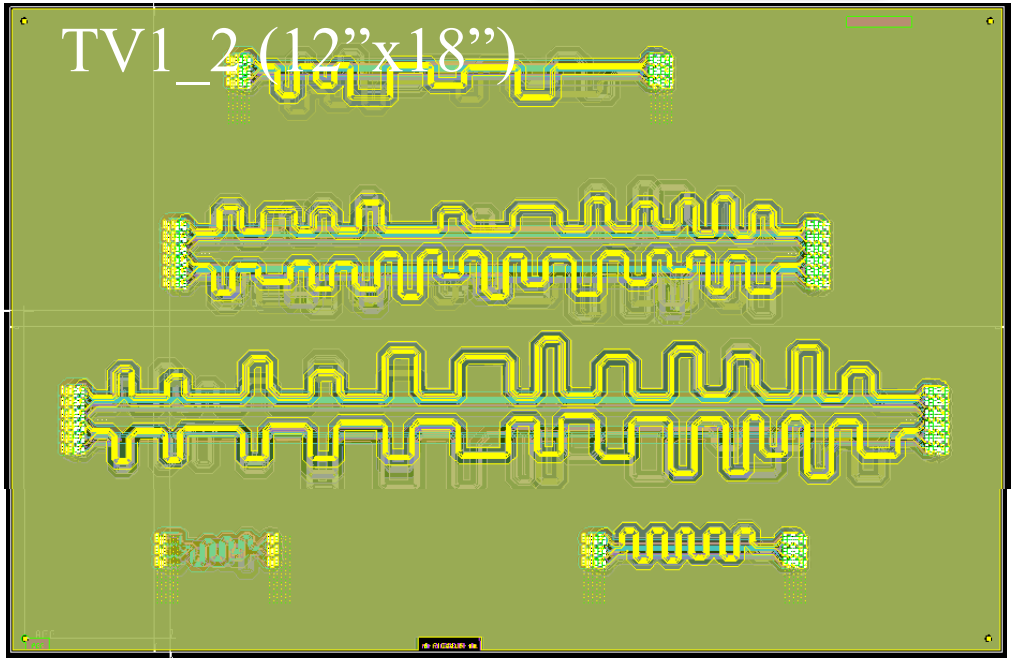
1. Chip-to-Waveguide Connector
2. On-Card Link
3. Card-to-Backplane Connector
4. Card-to-Card Link
5. Chip-to-Chip/Module Link
6. Logic Chip (PU, SU, FPGA)
7. Optical Transceiver (E/O/E)
8. Card (Line Card, Switch Card)
9. Backplane/ Midplane
10. Chip/Module

Description : TV1 (Phase 1)

- TV1 comprise of three distinct test vehicles used to verify design parameters and connectivity options for practical applications and Phase II demonstrator
- Two PCB design variants –
  - Small mixed signal PCB 8” (Waveguide/Copper)
  - Large 12”x18” PCB Backplane (Copper only)
- Two universal paddle card designs to test electrical end-to-end link parameters (provided by Cisco)
- Optical testing via externally launched test source and fiber-optic ribbons (passive optical test board)
  - Multimode λ = 850 nm VCSELs/PDs
- Results provide verified performance parameters for on-board copper and optical waveguide links
- Results provide direct copper-to-optical comparison metrics (SI, loss, cross-talk, density) in equal base (laminate, construction)

Test Vehicles and Trace Variables

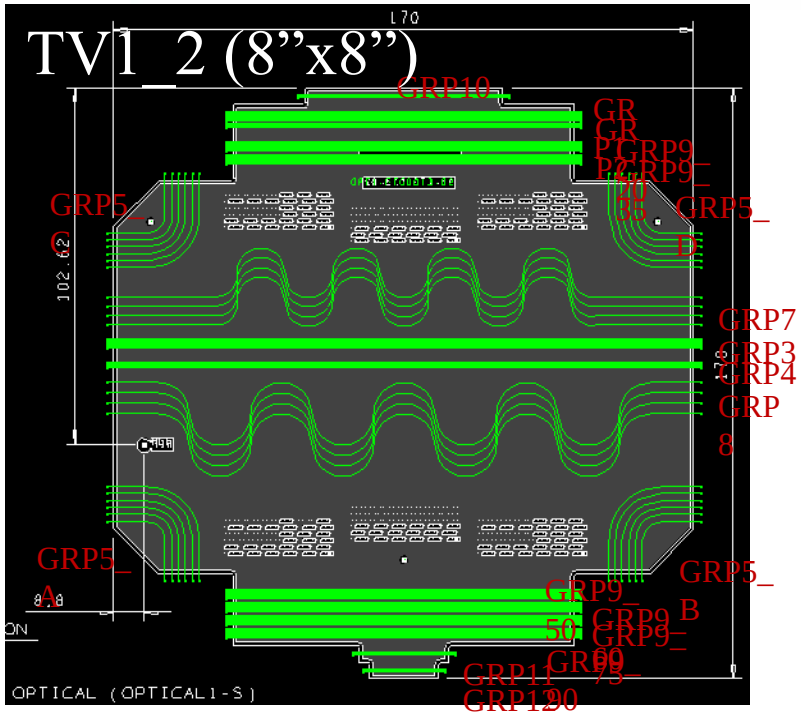




COPPER GEOMETRIES

- The channels are organized in groups, each group has three diff. pairs
- A group is identified with the length of the channel
- Channels length: 4,8,12,16,20,24,28,30,32”
- Within each group different spacing are considered to test cross-talk:
  - 12.5, 15.5 and 22.5 mils
- Diff pairs: L/S/L 7/9/7 mil, 100 Ohm

Optical Layout (FTG0013-02A)



Components

GRP1: Straight; L=100mm L/S 50/200µm
GRP2: Straight; L=100mm L/S 50/75µm
GRP3: Straight; L=170mm L/S 50/200µm
GRP4: Straight; L=170mm L/S 50/75µm
GRP5: 90-bend; ROC : 5,7,9,11,13,15 mm
GRP7: Casc.bend; ROC: 13mm
GPR8: Casc.bend; ROC :11mm
GRP9: Crossings: Angle: 90,75,60,50,35,20°
GRP10: Calibration for ...
GRP11: Calibration for ...
GRP12: Calibration for ...

OPTICAL GEOMETRIES

- The waveguide test components are divided into groups each with distinct characteristics and test function
- Waveguide variables: length, spacing, geometry (straight, bend, cross). Core 50µm
- Max. channels length: 7” (straight); 35” (spiral)
- Two groups with different spacing are considered to test cross-talk: 5 and 10 mils (125µm and 250µm)

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Phase 2 Demonstration TV

1st TV: Verification Test Vehicle (TV1)

- Board with connector interfaces
- Used to verify design parameters and connectivity options for TV2
  - Basic TV, basic performance ~~and reliability~~ testing by the team
  - Currently 3 available WG technologies to build TV1
  - Specification and design to fit all WG technologies
  - Design to include multiple WG components fitting realistic application targets
  - Connector interfaces that can be used for performance testing and for interfacing by OEMs and others to evaluate specific applications
  - Must allow application/company specific tests and interoperability testing

2nd TV: Demonstration Test Vehicle (TV2)

- Backplane with N Line Card(s) and M Switch Card(s)
  - More difficult TV, Enhanced testing by the team
  - Expanded specification challenging the technologies
  - Connector interfaces that can be used for performance testing and for interfacing by OEMs and others to evaluate specific applications
  - Must allow application/company specific tests and interoperability testing

Phase 2 Definition

- Experimental results and “lessons-learned” in Phase 1 will be used as input and design information for Phase 2
- Survey for OEM member participants on their wishes for requirements, specification items, features, and demonstration functions have been completed
- Work out “wish list” into baseline proposal/s
- Phase 2 project scoping and planning to complete Q1/13
- New team members particularly connectors suppliers and transceiver/ engine suppliers are needed
- Definition stage is open to any HDP member/ non member company/ organization to join and contribute input for planning

Input -> Requirements "Wish List"

- Demonstrator (Phase 2)
  - Waveguides
    - Multimode
    - Single mode (a must long-term)
    - Coupling interface to OM2,OM3, OM4 fibers
    - Waveguides surface and inner layer
    - Functions: Cross-overs, 90° (in-plane) bends, 90° (out-of-plane) bends, S-curves
    - Combination of different waveguide components e.g. non-orthogonal crossing on a bend, staggered cascading bends with different RoCs
    - Low loss low RoC 90° in-plane bends
    - Must include 90° turn solution (out-of-plane)
    - High delta WGs
    - Various WG mode diameters (35…70µm)
    - Waveguide taper
    - Photonic bandgap waveguides for 90° turn and coupling

- Demonstrator (Phase 2)
  - Transceivers
    - 10Gbps+
    - 4x4 wide bidirectional or 12-ch uni
    - 850nm
    - Mid-board engines (eg. Finisar (12+12 12G engine, 25Gbp (next gen), Reflex photonics, Avago, Samtec)
    - Edge-board transceivers including QSFP+, CFP, AOCs for rack-to-rack applications
    - Commercial SFP 850, 1310, 1550nm
    - Proprietary 1000nm
    - Small embedded
    - SMT type
    - Good SWAP
    - Module directly coupling with waveguides or coupling through fiber patch-cord
    - Off-the-shelf (no development req.)

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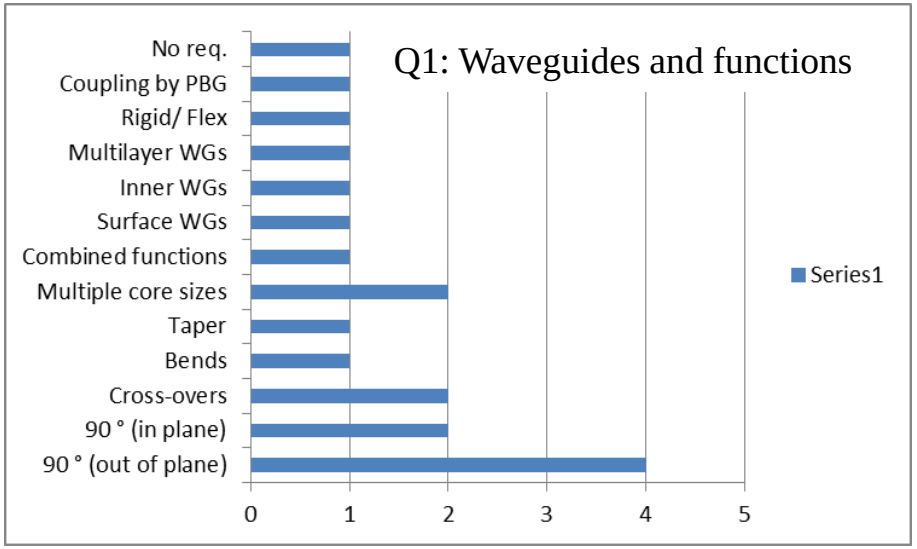
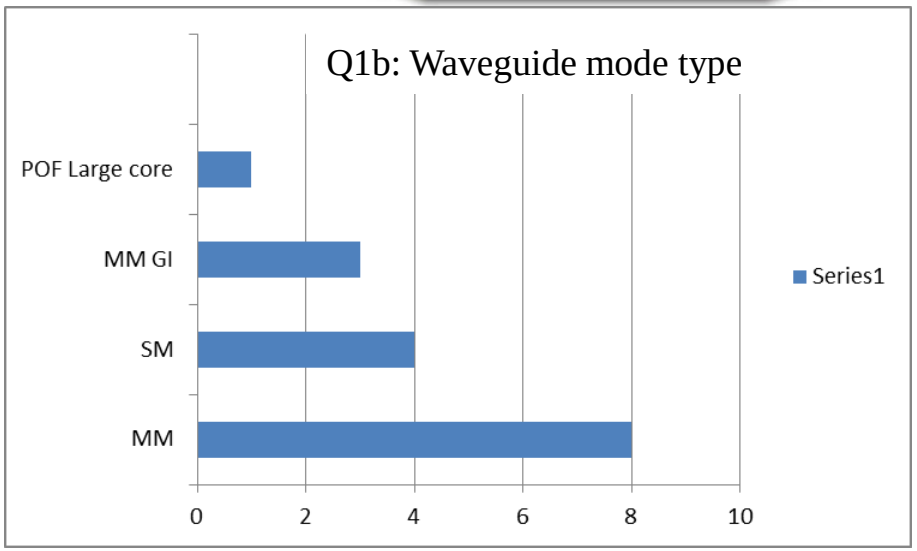
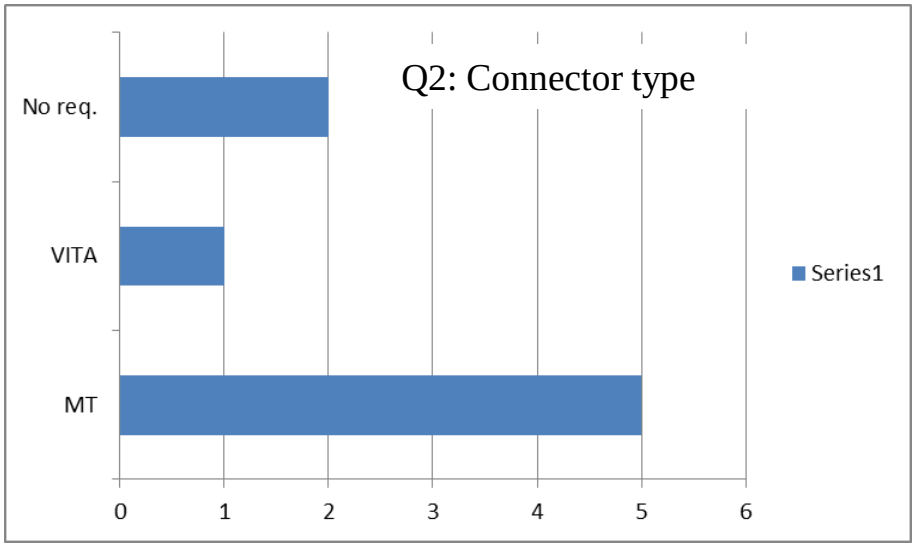
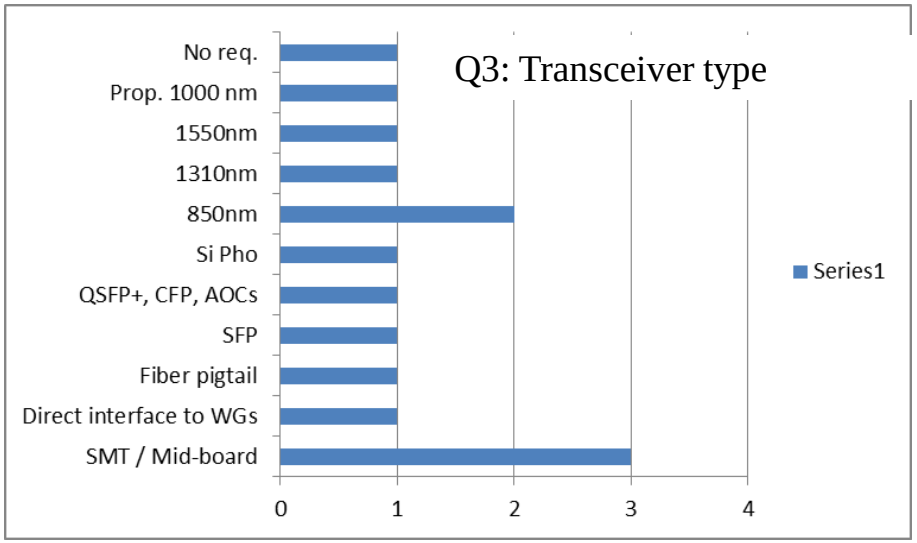
Input -> Requirements "Wish List"









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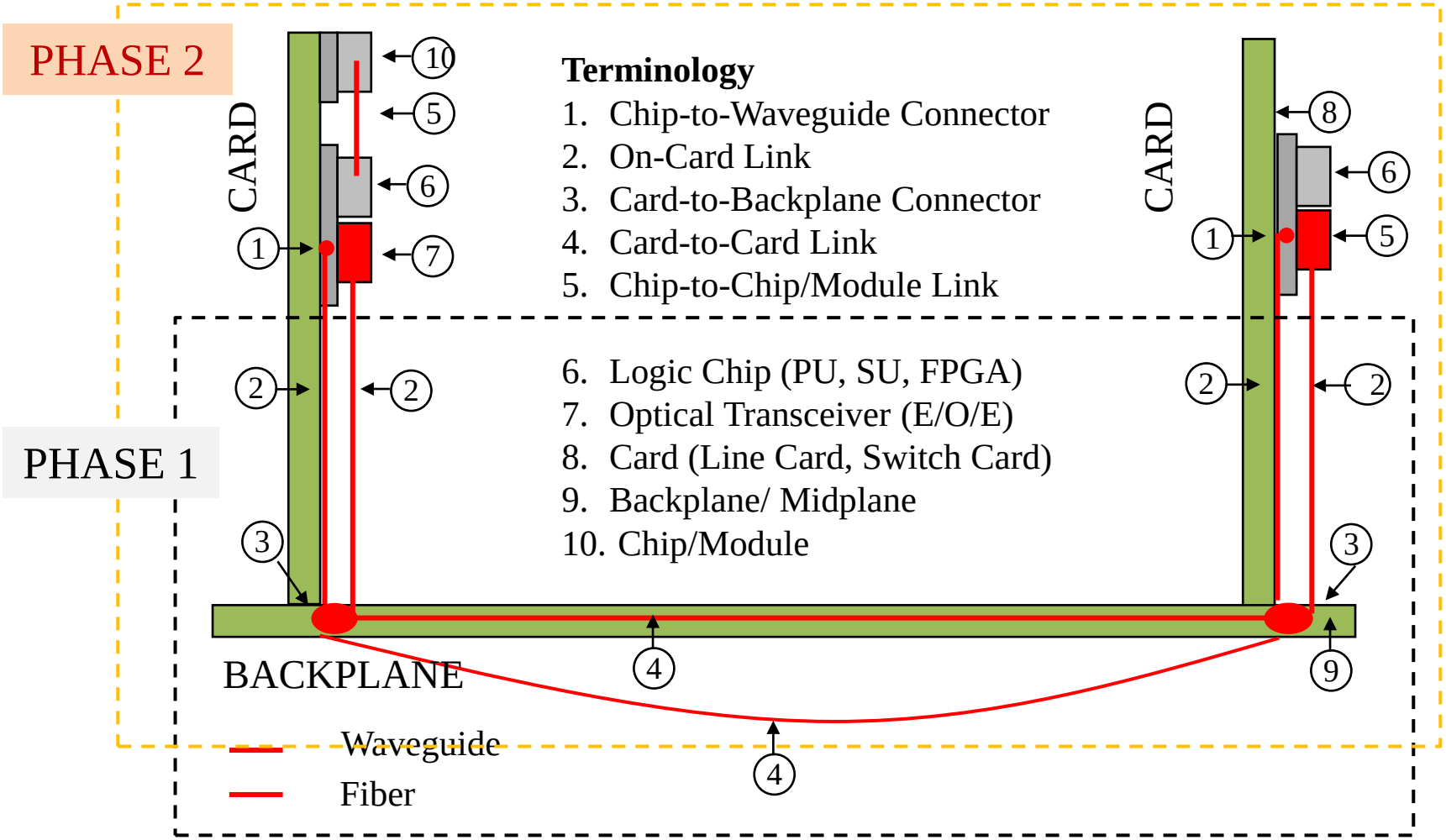


Demonstration proposals

- Scope
  - Demonstrate both non-orthogonal and orthogonal optical solution similar to electrical backplane
  - See/demo ability to plug modules into opto backplane
  - Link length : > 30cm
  - Short waveguide between ICs / long waveguide through a backplane
  - TV1 investigated separate waveguide geometries in isolation i.e. just bends, just crossovers. <u>In real routing applications most waveguides will comprise a combination of different waveguide components</u> e.g. non-orthogonal crossing on a bend, staggered cascading bends with different RoCs depending on what obstacles need to be circumnavigated.

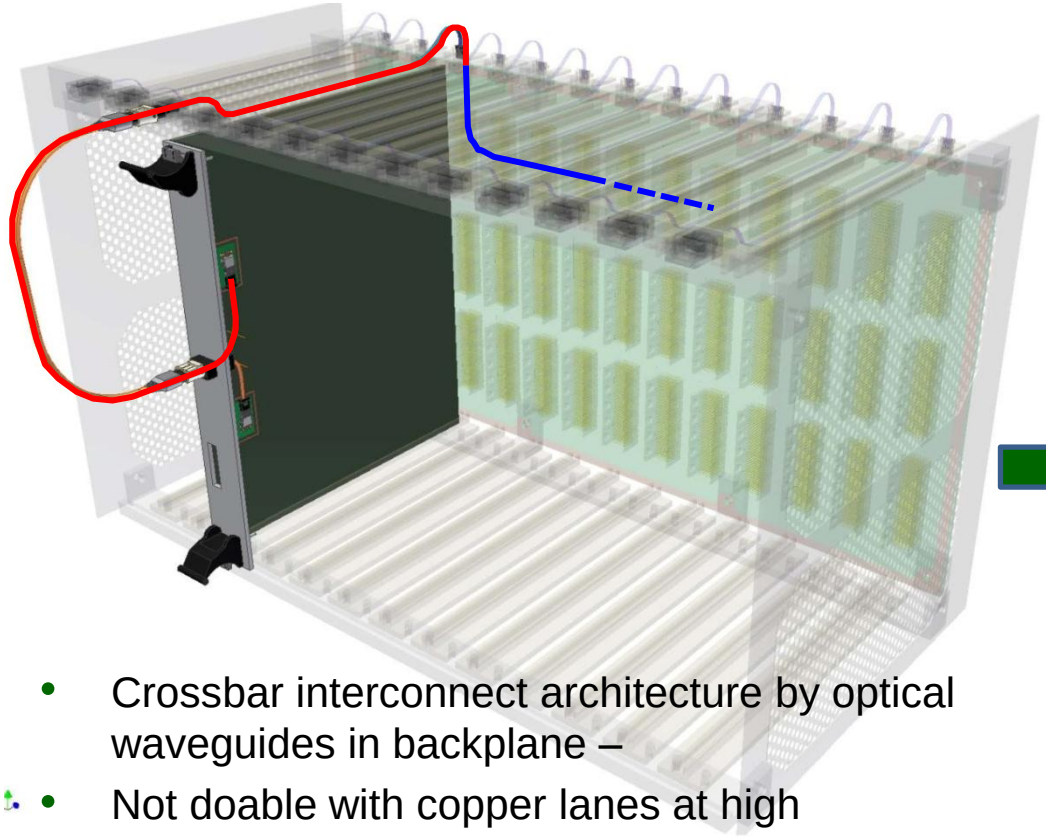
Demonstration proposals, cont.

- Implementation
  - 1. Realistic “pseudo” product, optical routing
    - Propose optical waveguide test designs for electro-optical boards with electrically routed components on them, say server motherboard or HPC or supercomputer controller.
    - We don’t have to build a complete supercomputer board of course, but if we used current PCB layout designs for HPCs or supercomputers (whatever is available) and attempted to design waveguides around them, then we would have a very good idea of the typical real routing challenges that waveguides would face in its first target application.
    - The test vehicle could be just the waveguides minus the HPC / server / supercomputer board in question.
  - 2. Realistic “pseudo” product, form factor
    - VMS/Eurocard form factors for at least one version of the test vehicles

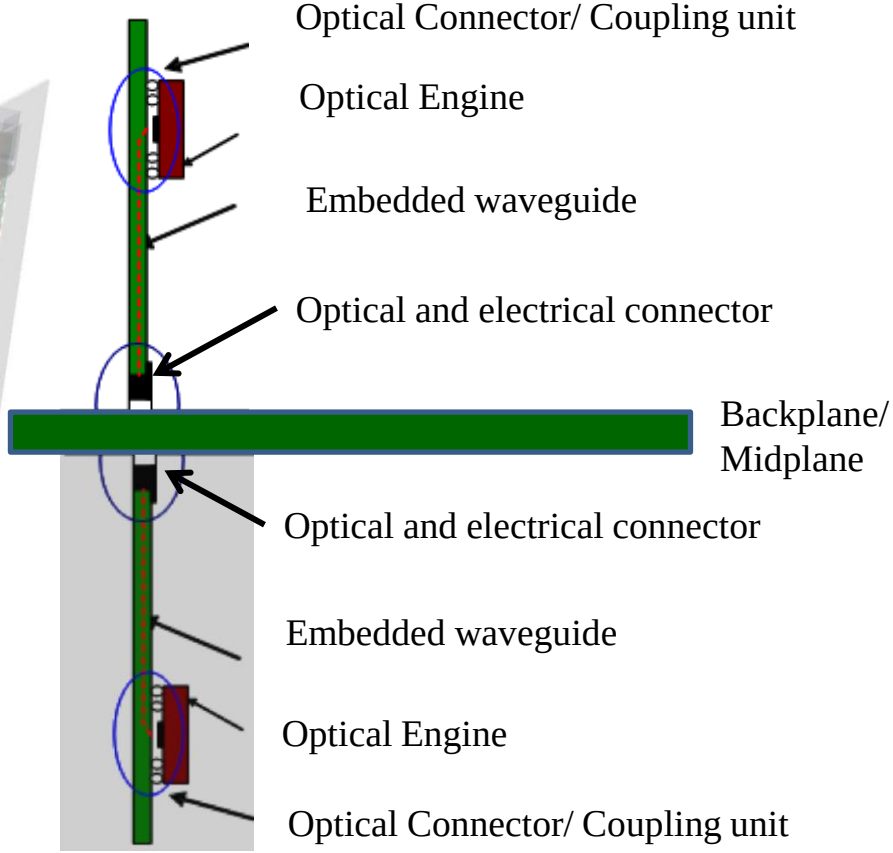
TBD's : Implementation Architecture

– These do not necessary represent final architecture proposal –

WG/F Backplane – Edge Access



WG/F Backplane – Orthogonal Case



- Crossbar interconnect architecture by optical waveguides in backplane –
- Not doable with copper lanes at high frequencies cost efficiently

Next Steps

- Phase 2
  - Definition, scope, proposal ...08/13
  - Plan, schedule, resources ...11/13
  - Implementation plan proposal ...3/14

Interested Participants

01-20-2014

- Testers, Contributors
  - Cisco
  - Alcatel-Lucent
  - Boeing
  - Celestica
  - Compass EOS
  - Ericsson
  - Fujitsu
  - Huawei
  - IBM
  - Intel
  - ITEQ
  - Juniper
  - National Semicon.
  - Nihon Superior
  - Oracle
  - Panasonic
  - Philips
  - Xyratex
- Design
  - Xyratex
- Devices
  - Ultra-Comm
  - Avago
- Connectors – optical
  - Optical Interlinks
  - FCi
  - Mitsui Chemical
  - Molex
  - TE
  - Avago
  - Us conec
- Connectors – electrical
  - Amphenol
  - FCi
  - Molex
  - TE
- PCB fabricators
  - Flextronics/Multek
  - TTM
  - Via System
- Waveguides
  - Optical Interlinks
  - Dow Corning
  - Panasonic
- Laminate materials
  - Hitachi
  - Isola
  - Rogers
  - Quandong Shenghyi
- Assembly
  - Flextronics

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