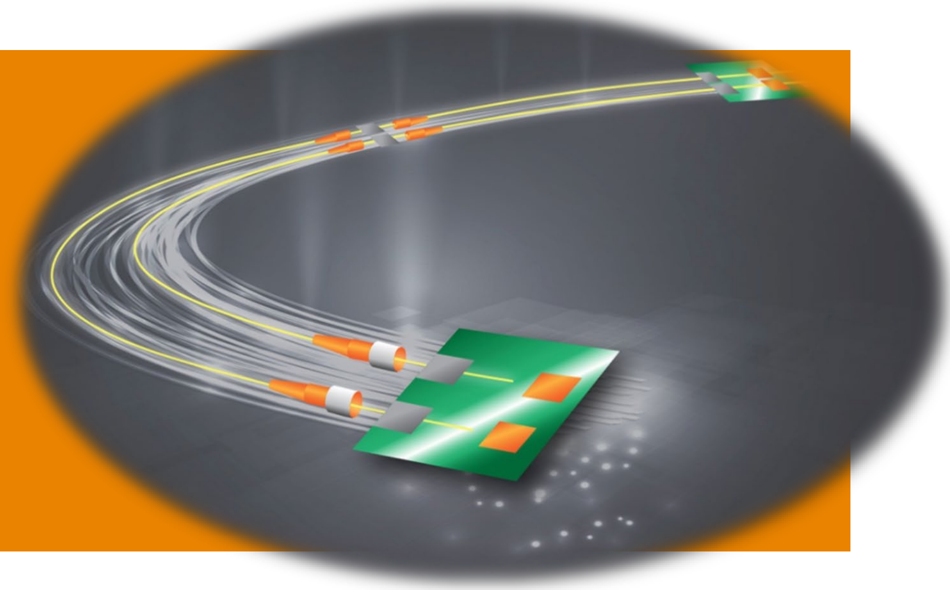
The Emergence of Optics in Levels of Electronic Packaging



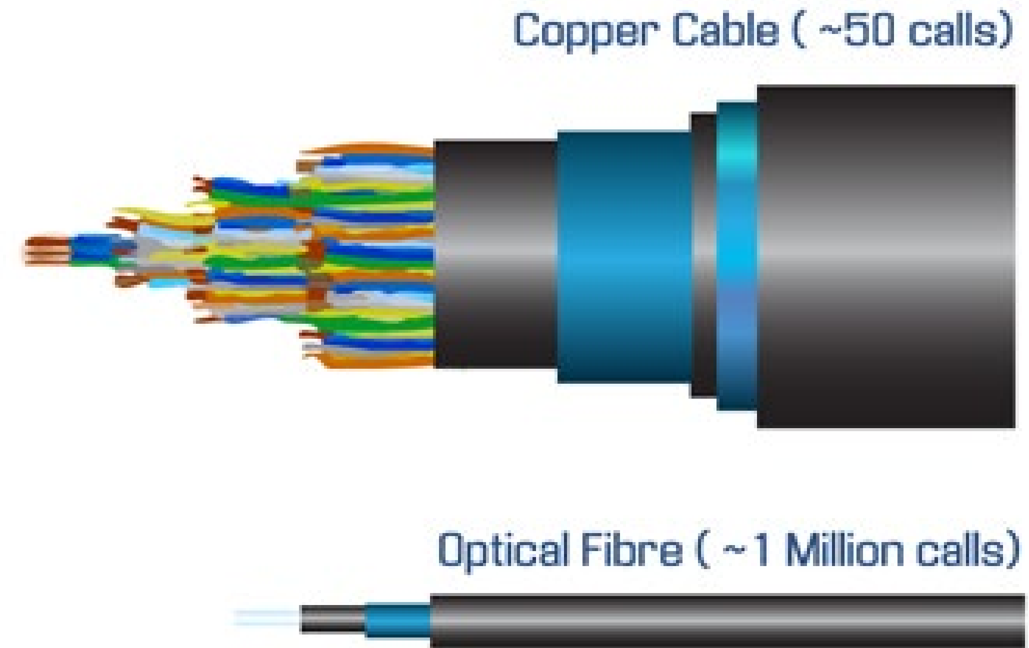
Mark Benton
Engineering Manager & Actives Product Manager - Rugged Fiber Optics
Aerospace Defense and Marine Business Unit

Michael Walmsley, Global Product Management – Connectors
Aerospace Defense and Marine Business Unit

EVERY CONNECTION COUNTS

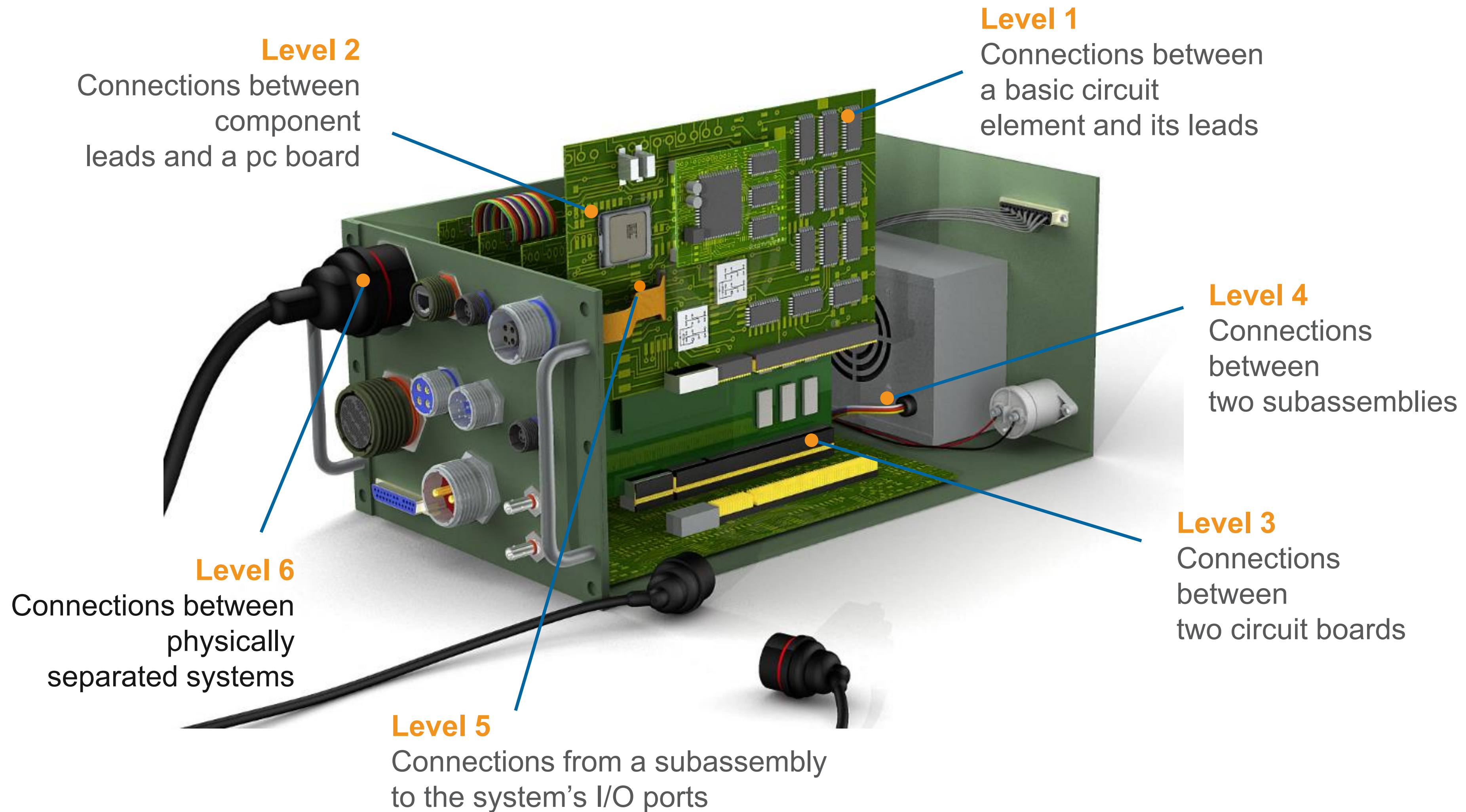
Why Use Fiber in Harsh Environments?

- Data Rate (Bandwidth)
- Low Signal Loss
- No EMI Interference
- Size
- Weight
- Safety
- Security
- Flexibility
- Cost



TE connectivity

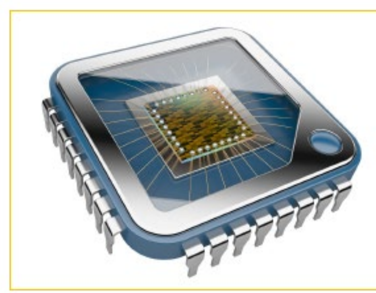
Each Interconnection Level Represents the Connection *Between* Two Levels of Electronic Packaging



TE connectivity

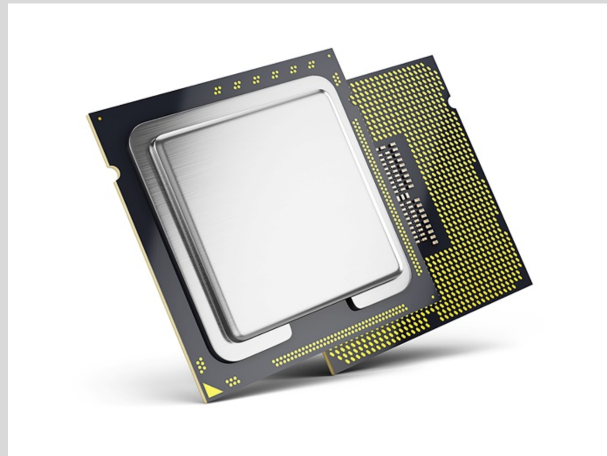
LEVEL 1

Connections between a Basic Circuit Element and Its Leads



COPPER

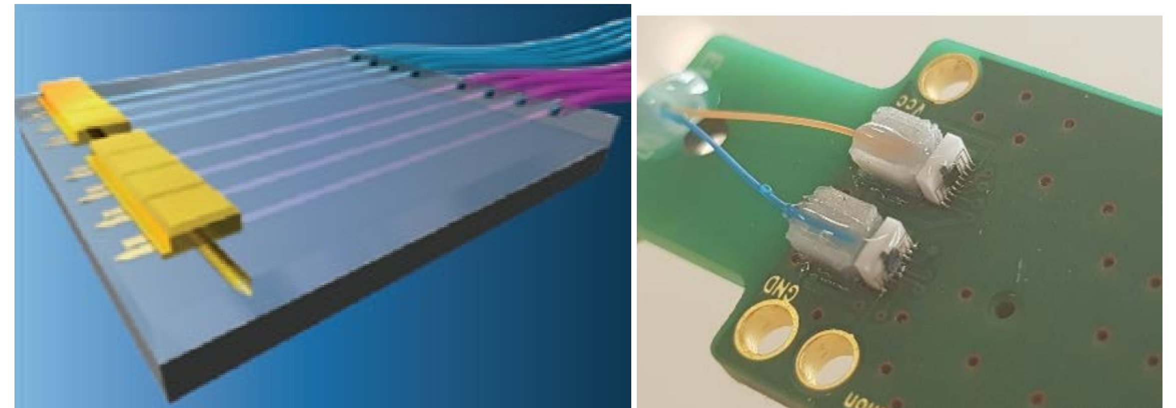
Processor to board – direct termination



Higher speeds, multicore, higher input/output count, increased power efficiency, …

OPTICS

Optical equivalent is the direct connection of laser diode or photodetector chips to optical waveguides via flip chip techniques or aligned to cleaved fibers using V-groove or similar approaches.



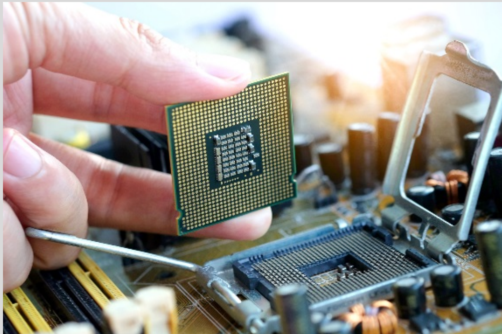
TE connectivity

LEVEL 2

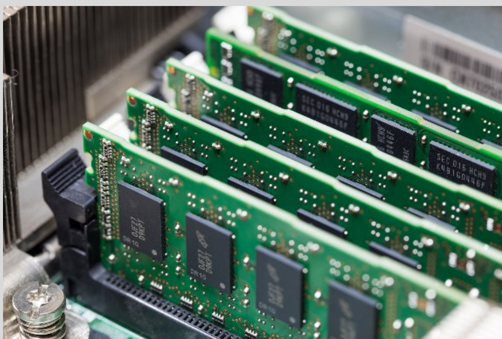
Connections between Component Leads and a PC Board

COPPER

CPU Sockets



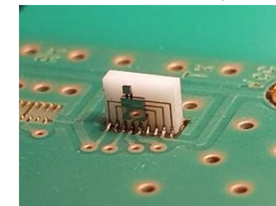
Memory Sockets



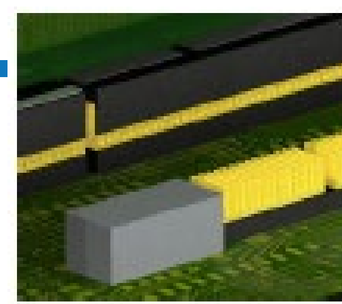
OPTICS

Optical examples include the optical subassemblies used in transceivers and pluggable transceivers like SFP+, and ParaByte parallel mid-board transceivers

Higher Density and Data Rate →



TE connectivity

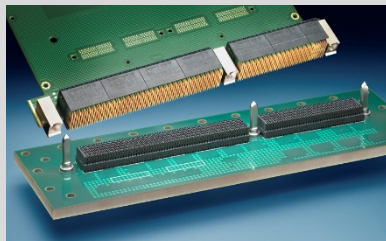


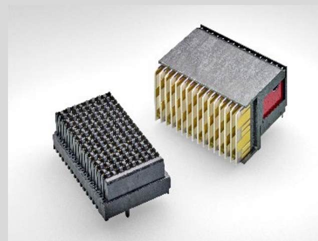
LEVEL 3

Connections between Two PC Boards

COPPER

Backplane Connectors





VME

MULTIGIG RT 2-R (VITA 46.0)

MULTIGIG RT 2-S (VITA 46.0)

MULTIGIG RT 3 (VITA 46.30)

NEXT GEN 56 Gb/s

Advancements in speed and density

Stacking Connectors

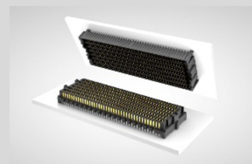
*PMC**

*XMC ** (VITA 42)*

*XMC 2.0** (VITA 61)*

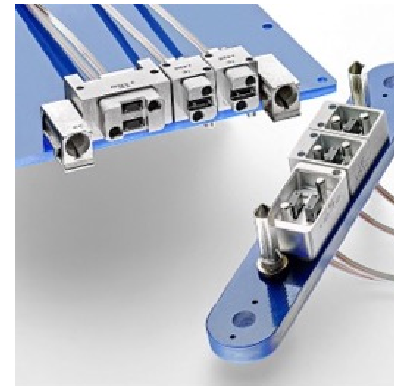
*FMC*** (VITA 57)*

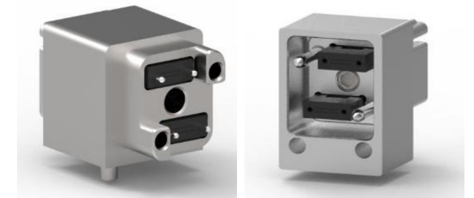
FMC+ (VITA 57.4)



PCI Mezzanine Card, **Express Mezzanine Card, * FPGA Mezzanine Card*

OPTICS





VITA 66.1, 66.4 to 66.5, 66.6 …

VITA 66.X Optical Modules

Mid Board to Card Edge E/O/E* Conversion

Mid-Board Transceivers

Blind Mate Transceivers

* Electrical to optical or optical to electrical

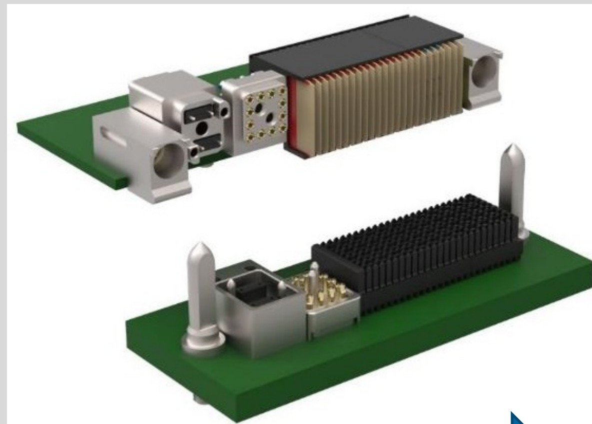
TE connectivity

LEVEL 4

Connections between Two Subassemblies

COPPER

NanoRF and MULTIGIG RT 3 Connectors in 3U VPX



Increased RF Density and Bandwidth

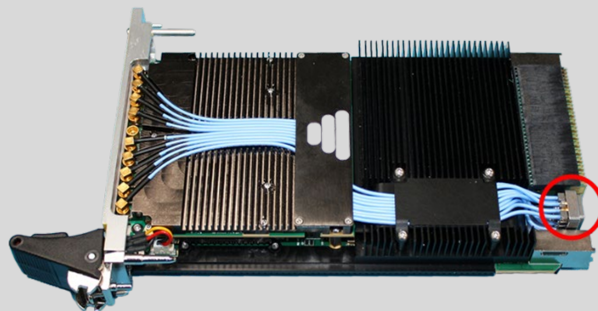


Image courtesy of Annapolis Micro Systems

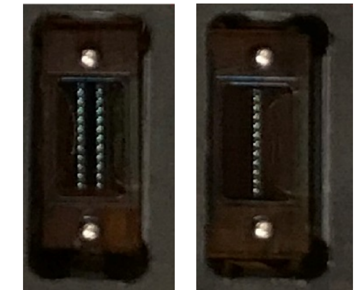
OPTICS

Termini Technology

A801 Physical Contact

MIL-T-29504 Physical Contact

Expanded Beam



Physical Contact and Lensed 12,24,48…MT Contacts

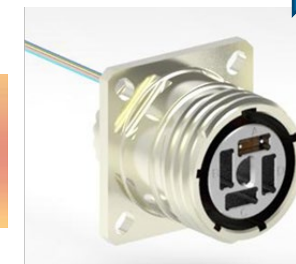
Higher Density Contacts and Cabling

Connector Technology

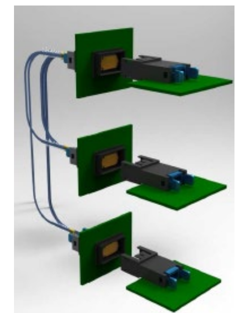
D38999 Ruggedized Circular PC & EB

Expanded Beam

Discrete Contact Circular & Rectangular Interfaces



MT Based Circular & Rectangular Interfaces



Optical Flex And Ribbon assemblies

LEVEL 5

Connections between a Subassembly and System’s I/O

COPPER

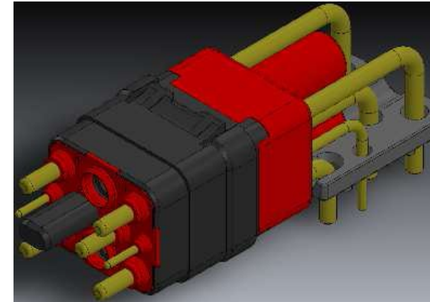
ARINC

Quadrax

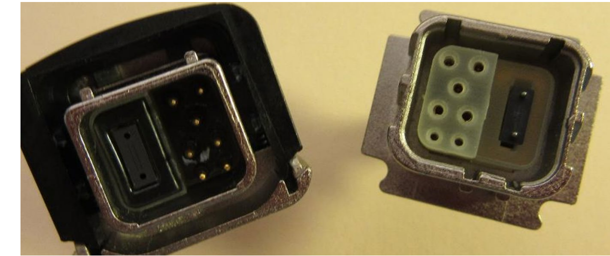
Speed, modularity

Rigid Flex

OPTICS

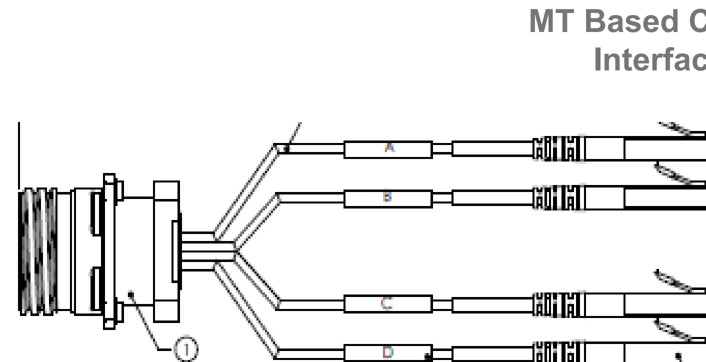


Hybrid Discrete contact Board Mount Modules



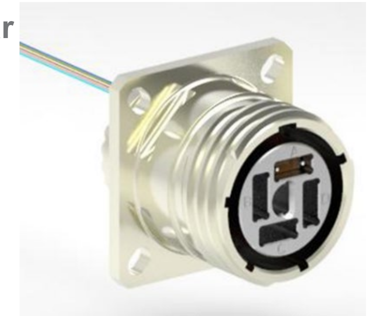
Hybrid MT Based Board Mount Modules

Higher Density PC and Lensed MT Connectors



Double Flange Board Mount Fiber Connectors

MT Based Circular Interfaces



TE connectivity

LEVEL 6

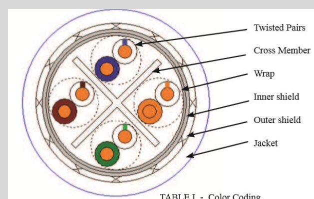
Connections between Physically Separated Systems

COPPER

Quadrax Contacts

CeeLok FAS-T Connector

Advances in cable and isolation/cancellation

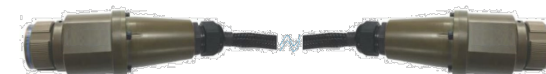


MIL-DTL-32546.1 CeeLok FAS-X Connector

OPTICS

Expanded Beam assemblies

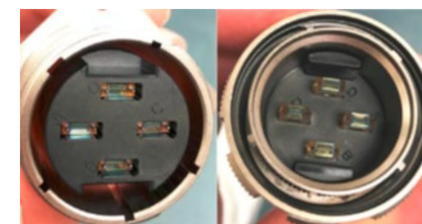
Physical Contact Assemblies



Active Optical Cables – Optical conversion in Level 6 assembly

Higher Density and Embedded E/O/E

Discrete Contact based PC and expanded beam assemblies



Higher Density PC and Lensed MT based assemblies

Summary Slide – Key Points

COPPER

- Copper interconnect technology is aimed at the need for increased density and speed
- Backplane connectors support 25 Gb/s and higher
- Contact density has increased 2-3X
- Higher speed copper I/O cabling

OPTICS

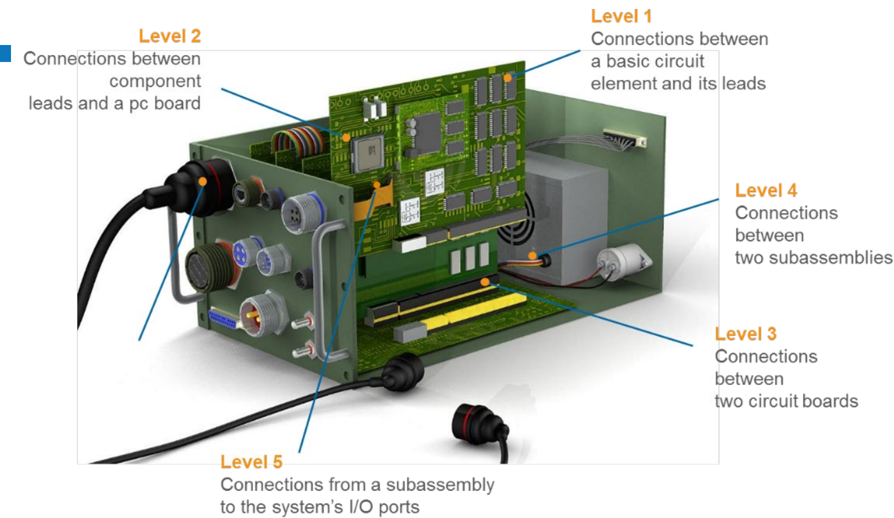
- Fiber can play a significance role as
    - Data-rate and distances increase,
    - where weight and space is tight
- Fiber interconnect technology
    - Reliable, time-tested ruggedness
    - Keeping pace with advances in transceiver packaging and density

TE connectivity

Design Considerations –
High Speed Copper or Fiber Optics?

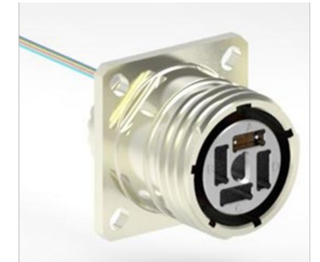
TE connectivity

Design Tutorial – Copper or Fiber?



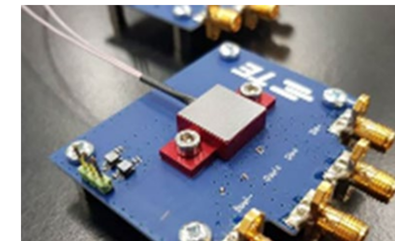
Levels of Packaging, Application Density, Data Rate, Transmission Distance & Operating Environment drive selections for…

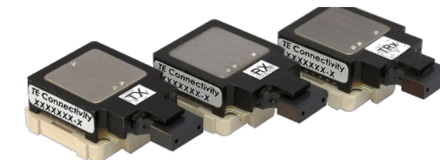
- **Operating Environments:**
  - Internal or External Harness?



- **High Speed Copper or Optical interface:**
  - 100 Mb/s vs. 25-50 Gb/s? and link length?

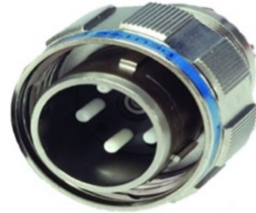
- **Optical Transceivers:**
  - Data rates, distance, pigtailed or connectorized?
  - Discrete fiber connections or parallel style?
  - Mid-board location or card edge?





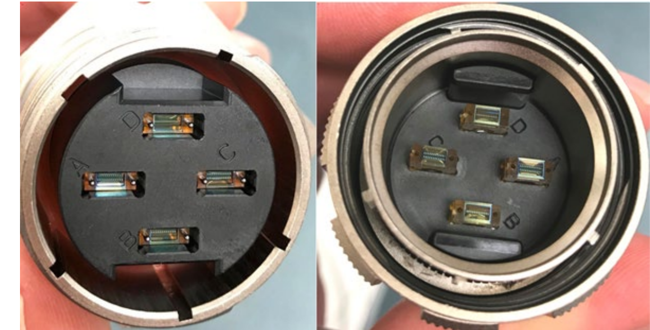
Physical Contact (PC) or Expanded Beam (EB)

Which Fiber Optic Contact Technology should I choose?



PC Connector

EB Connector



Comparison of PC and EB Connector Technologies

Performance Criteria	PC	EB
Insertion Loss	****	**
Return Loss (SM)	****	**
Return Loss (SM) – Unmated	*	**
Lateral Connector Misalignment	*	****
Connector Angular Tilt	****	*
Mating Durability	**	****
Water Exposure	***	**

Performance Criteria	PC	EB
Dust Exposure	*	***
Vibration Susceptibility	**	***
Repair	**	**
Cleanability	**	****
Wear	*	****
Wavelength Range	****	**

TE connectivity

Thank You

© 2019 TE Connectivity
CeeLok FAS-X, CeeLok FAS-T, MULTIGIG RT, TE Connectivity, TE, TE connectivity (logo) and EVERY CONNECTION COUNTS are trademarks owned or licensed by the TE Connectivity Ltd. family of companies.
ARINC is a trademark of ARINC Incorporated.
VITA is a trademark of VITA Corporation.
Other logos, product(s) and/or company names might be trademarks of their respective owners.