

Summary
**London UCL Calorimeter DAQ
Meeting**

9 January 2006

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Introduction to PCI Express- *A New Serial Multi Gigabit Commodity Data Bus*

And

***New Standards for Physics
Instrumentation and Accelerators***

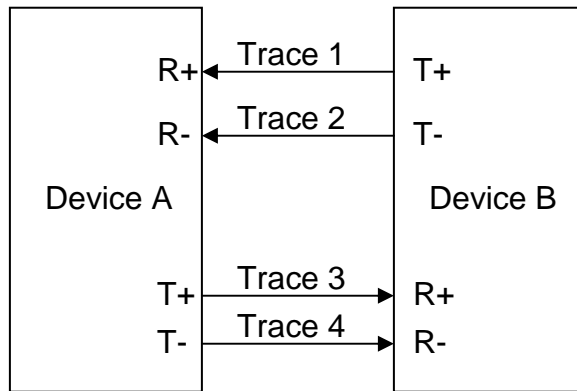
Satish K Dhawan
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Abstract

New PCs have a new bus called PCI Express is a dual-simplex, point to point serial differential low voltage interconnects that will consolidate application requirements for use by multiple segments in the industrial world. The signaling rate is 2.5 Gbit per second, with 8/10 bit encoding to embed clock in the data stream. On the transmit side parallel data is shifted out serially and on the receive side serial data is shifted into registers for parallel data output. The receiver also recovers the embedded clock.

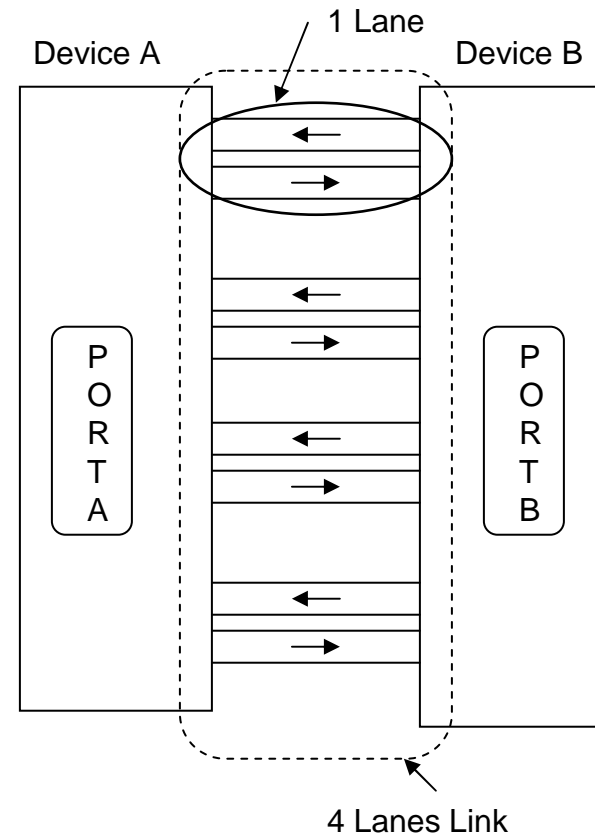
This bus can be used to connect module or boxes via twisted pair copper wires.

X1 is 1 Lane: one Transmit and one Receive



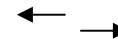
2 Twisted Pairs

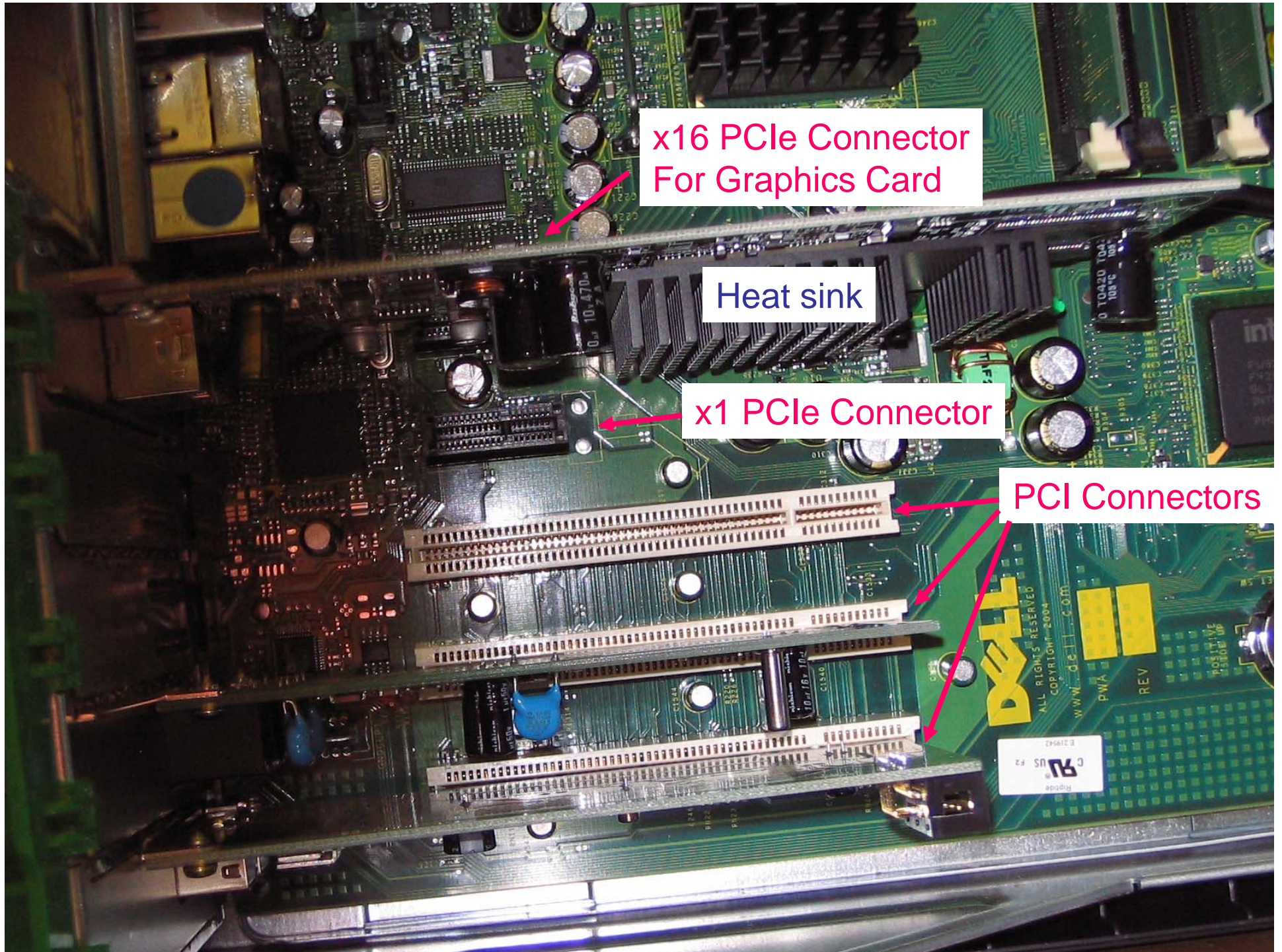
Point to Point Connections between Two PCIe Devices



Electricals

- Low Voltage Differential Signaling
- AC coupling on Transmit Side
- 800 mV min for Initial Bit Transition
- 505 mV min for Subsequent Bit Transition
- Above is done to Reduce Inter-Symbol Interference
- 4 Layer FR4. Signal Layers on Outside
- 100 Ohms Traces



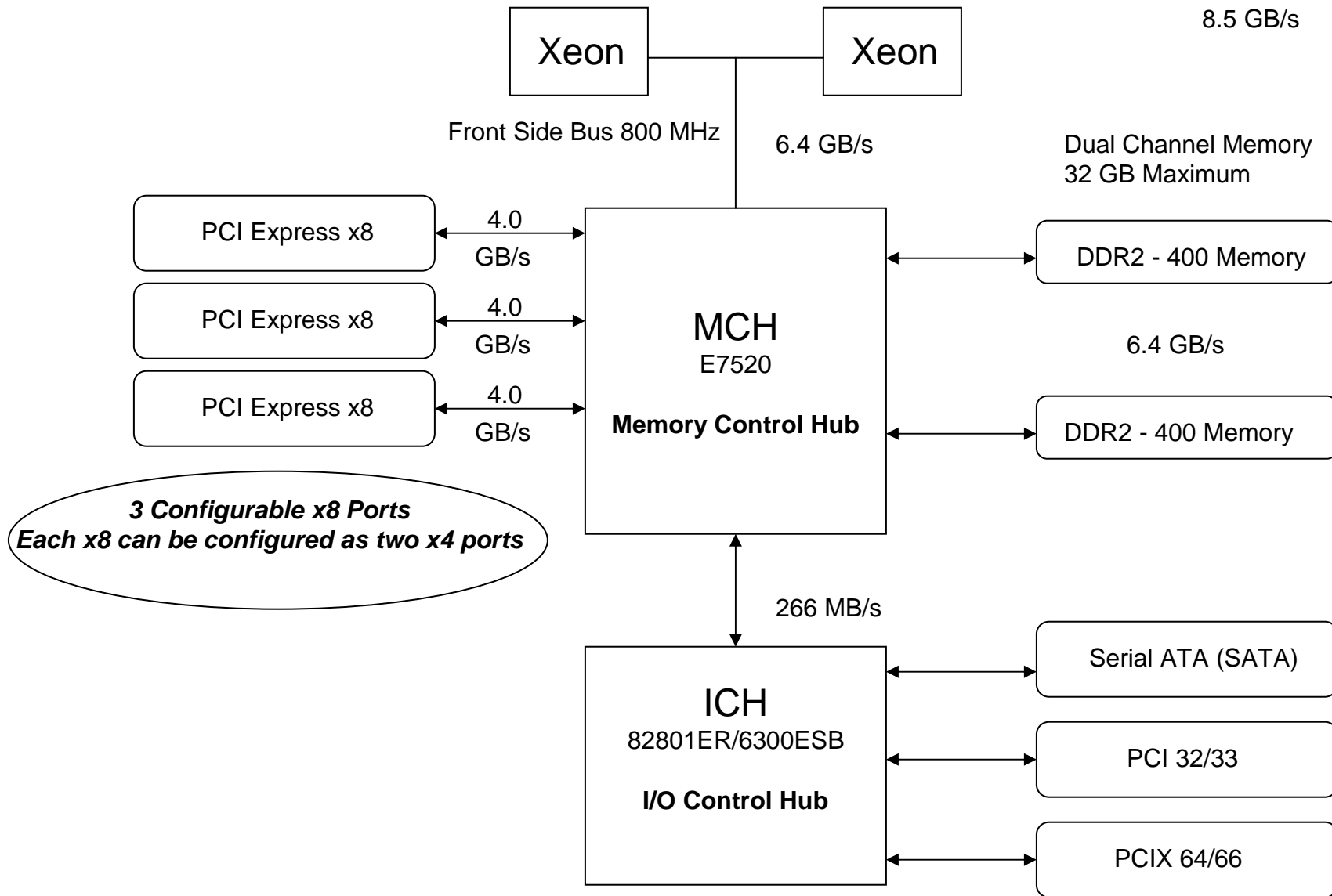


x16 PCIe Connector
For Graphics Card

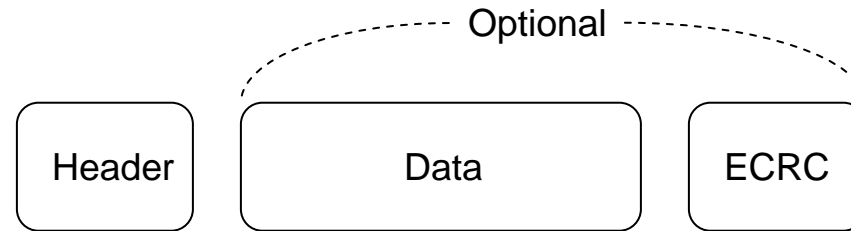
Heat sink

x1 PCIe Connector

PCI Connectors



Dual Processor Chipset



@ Transaction Layer



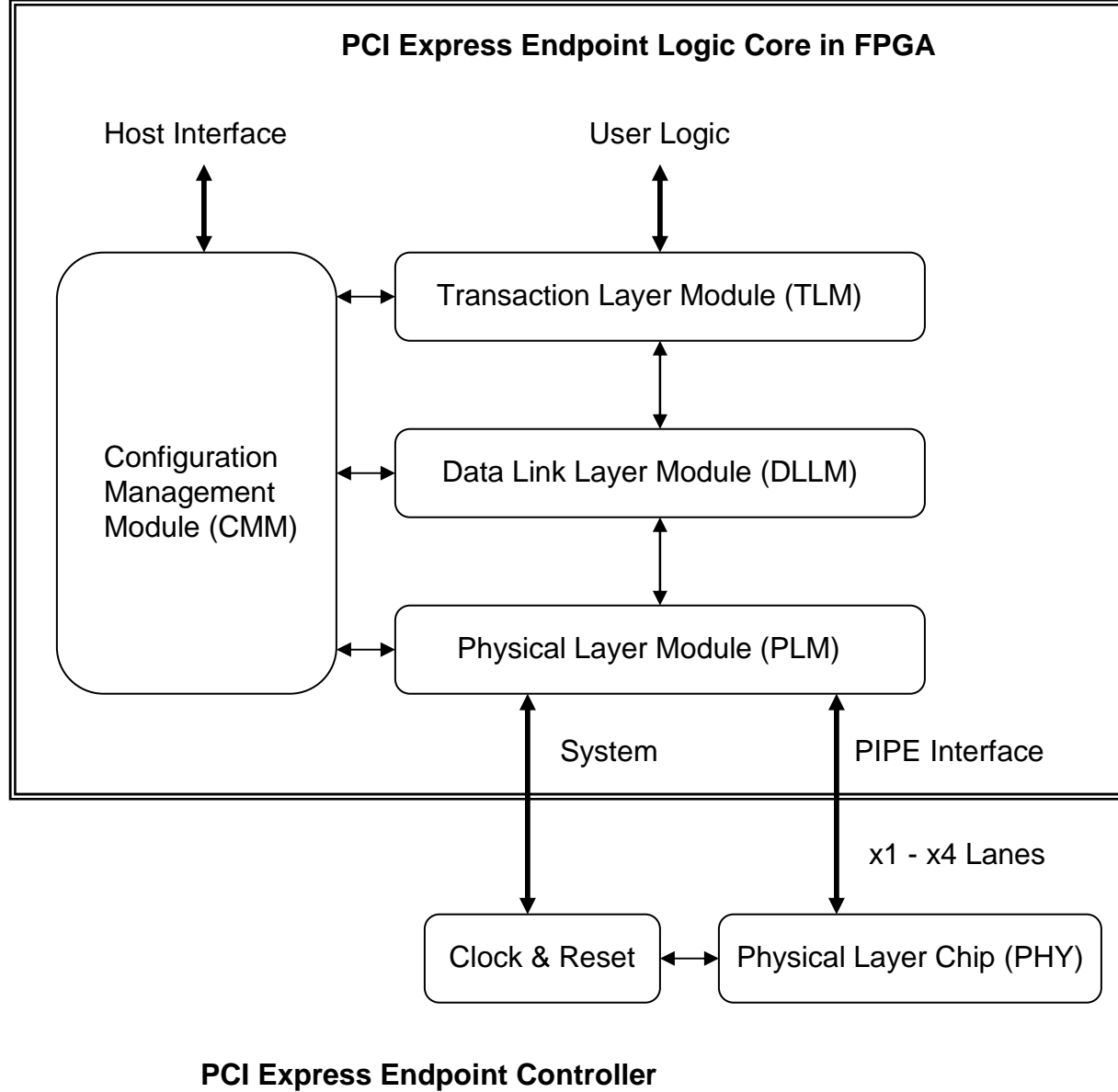
@ Data Link Layer



@ Physical Layer

Data: Maximum 4K Bytes – Typical implementation 256 bytes, limited by high speed SRAM

Transaction Buildup for a TLP through Architecture Layers



Intel Specified Interface - PIPE: (Physical Interface for PCI Express)



20 bits In & 20 bits Out
@ 250 MHz

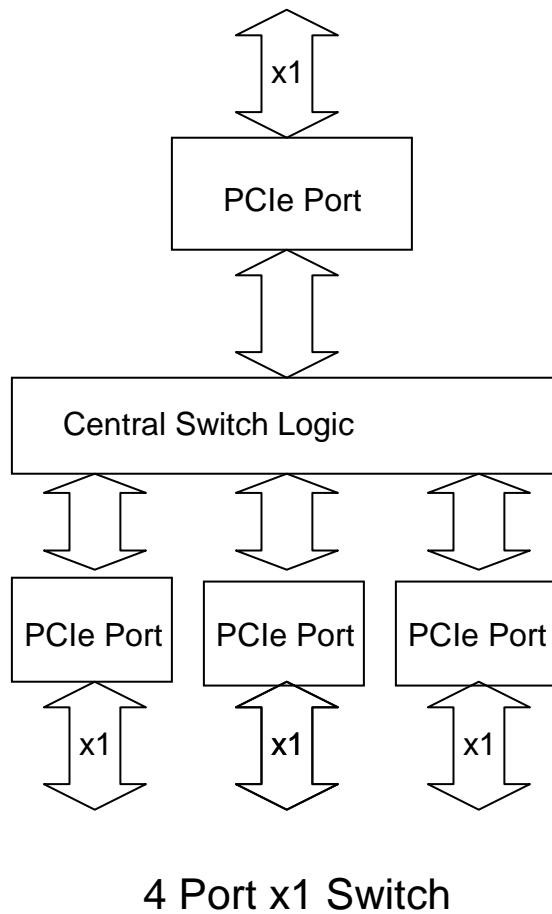
X4 End Point Controller in FPGA

Need End Point Controller in silicon

Current Products

- **Bridges:**
 - ❖ PCIe <> PCI
 - ❖ PCIe <> Infiniband
 - ❖ PCIe <> Gig Ethernet
 - ❖ PCIe <> USB

- **Need** PCIe <> Generic Data IO Bus
 - ❖ Easy to use.
 - ❖ Just Supply Data and Configuration.
 - ❖ Chip does the rest.



Switches

- ❖ 16 Lanes 4 Ports: Programmable x1,x2,x4,x8
- ❖ 32 Lanes 8 Ports: Programmable x1,x2,x4,x8,x16
- ❖ In Development; 8 Ports x8 Gen2 (5 GHz Signaling)

Bridges

- PCI – PCIe
- PCX – PCIe
- USB – PCIe
- 1394A – PCIe 400 mb/s
- Infiniband – PCIe
- But no Generic Dlo – PCIe Yet

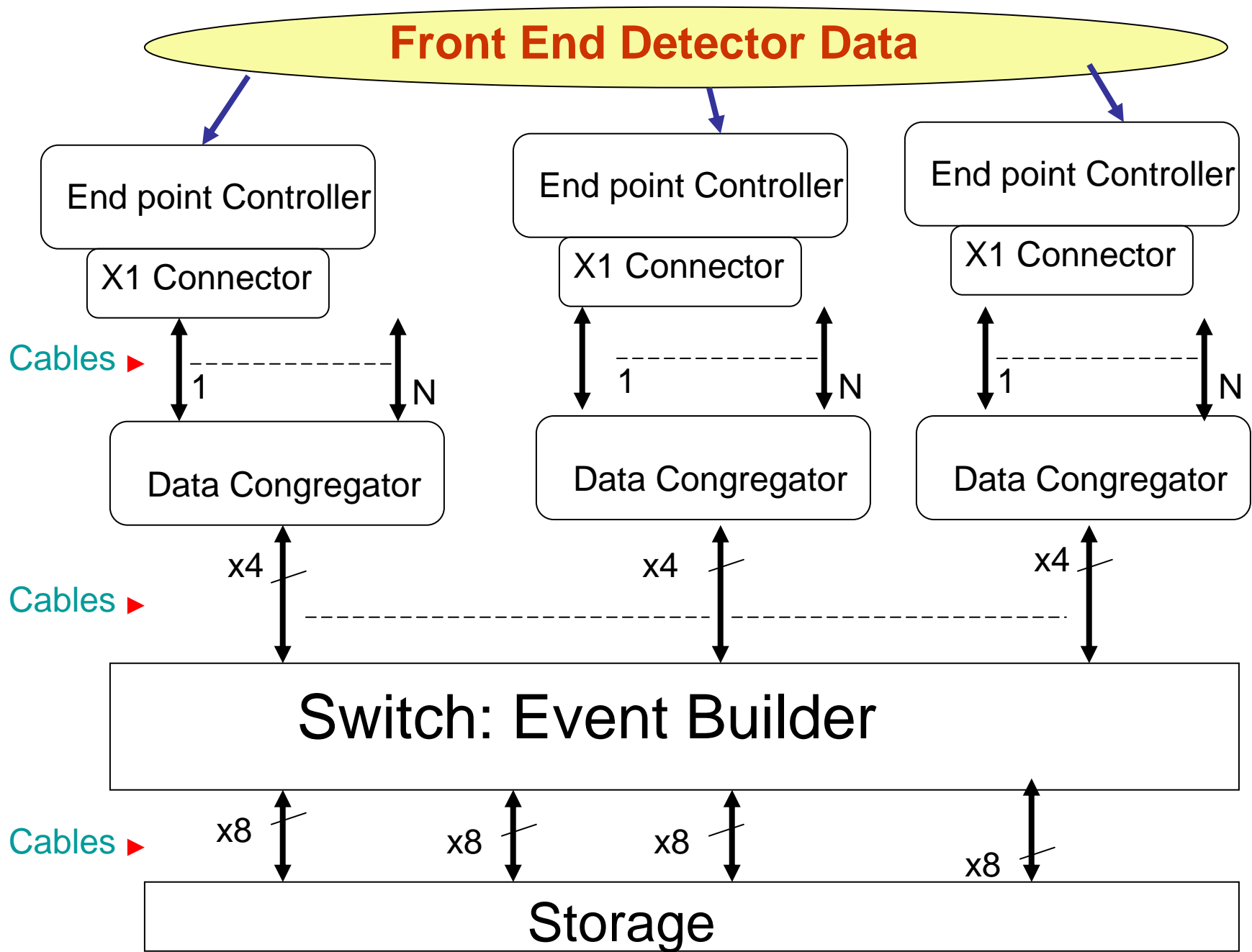
Standard Connectors & Cables for PCIe

PCI Express Switching / Bridging



x4 Cable: Stackable Connectors

Length ~7 meters CAT6 Cable



PCI Express Bus Compatible Offshoots

Form Factors

- ❖ ATCA
- ❖ AMC Advanced Mezzanine Card
- ❖ Express card
- ❖ SIO: Server IO cards for BLADE Chassis Backplane
- ❖ Micro ATCA
- ❖ Cables with connectors for x1 and x4

PCI Bus Compatible Offshoots

- ❖ cPCI with Hard Connectors
- ❖ PXI cPCI for Instruments – National Instruments
- ❖ Addition of PCIe to cPCI
- ❖ Addition of PCIe PXI

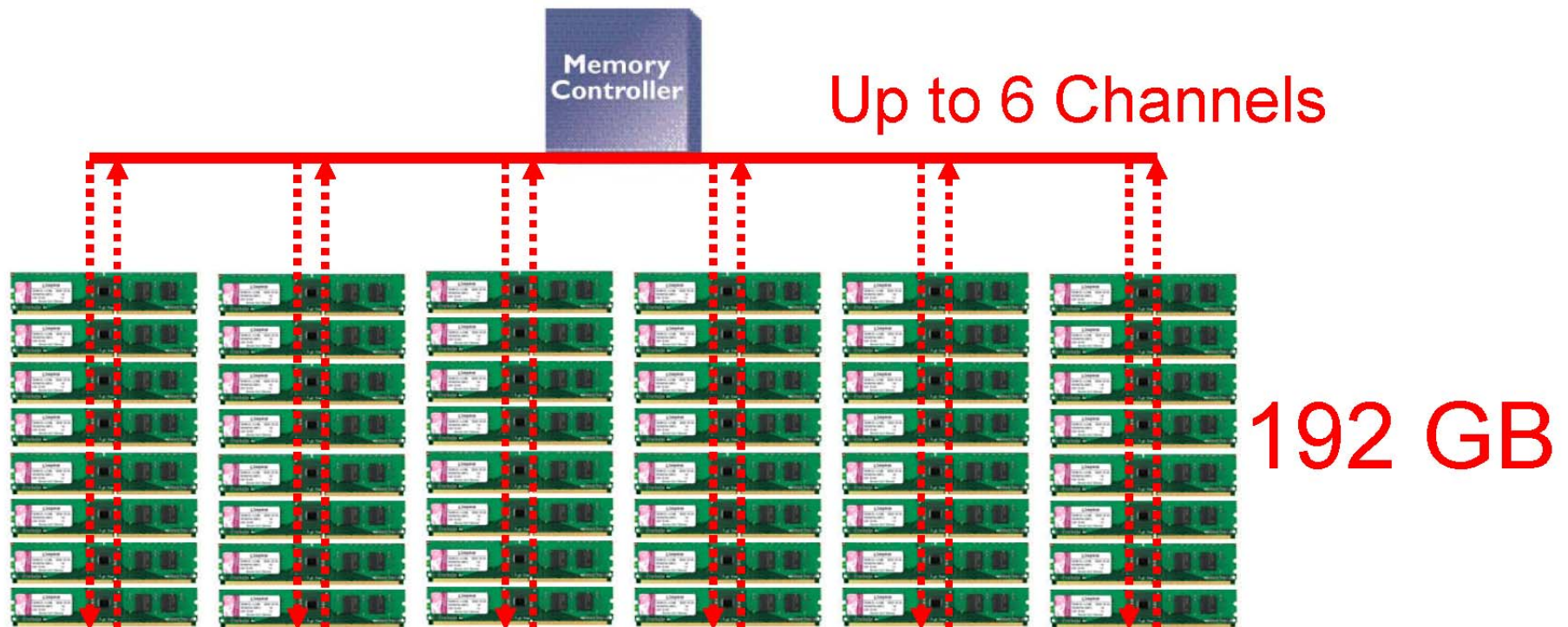
What is standard Here

- ✓ Communication Protocol
- ✓ Same Electrical Signals – Silicon
- ✓ Usage Models

ATCA

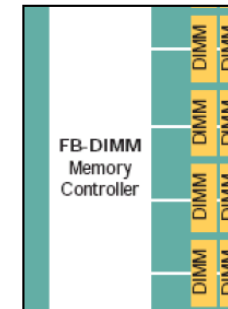
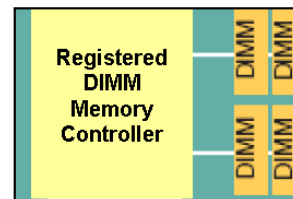
- Advance Telecom Computing Architecture
- Passive Back Plane
- 8 U Printed Circuit Board
- Dual Star or Full mesh
- - 48 Volt Power in
- x4 Traces
- Specifications for PCIe, Infiniband, GigE using
the same Back plane
- ❖ AMC (Advanced mezzanine Card)
- ❖ mTCA based on ATC specifications - 4 U PCB
- ❖ Interconnections for Servers

FB-DIMM Architecture is Expected to Scale Up



- ➔ **Total Memory: 48 x 4GB Dual-Rank FB-DIMMs (using 1Gb chips) = 192 GB.**
- First FB-DIMM servers expected to include up to 4 channels/8 FB-DIMMs (DDR2-533/667)

FB-DIMM Server Advantages¹



**DDR2-800
Registered DIMM Server**

**DDR2-800
FB-DIMM Server**

	DDR2-800 Registered DIMM Server	DDR2-800 FB-DIMM Server
Memory Capacity²	8 GB	32 GB (4x)
Memory Throughput³	12.8 GB/s Dual-Channel	~33 GB/s (2.5x) Quad-Channel
Ranks Limits⁴	2 ranks per channel	2 ranks per DIMM OK
Simultaneous Operations	1 (Read or Write)	2 (Read and Write)

¹ Based upon Intel-provided information. Hypothetical comparison assuming DDR2-800 memory.

² Server configuration-dependent; Registered DIMM server 8 GB = 4 x 2 GB single-rank modules; FB-DIMM server 32 GB = 8 x 4 GB dual-rank modules

³ Memory throughput computed in single operation mode. FB-DIMMs, due to 2 simultaneous-operation capability, may result in higher server performance.

⁴ Rank limits are platform-dependent. Per Intel, DDR2-800 servers will be limited to 2 ranks per channel or 4 ranks per server.

What is happening in Industry?

1. PCI Express Serial Bus in all new Intel PCs. Intel Synergy driving this standard.
2. ATCA- Advanced Telecommunication standard was initiated by Lucent Technology and pushed by Intel Corporation. Specifies backplanes with dual star for redundancy and full mesh for peer to peer communication. Same backplane can be used with different protocols- PCIe, Infiniband, RapidIO, and Ethernet.
3. Switches based on PCIe and Advanced Switching specifications for room area networks.
4. Silicon support chips: Bridges to PCIe from PCI, PCIX, Infiniband, RapidIO, Ethernet, USB etc. These will be commodity priced items. At present the USB interface chips are priced at couple of dollars each. We expect the PCIe chips will be less than \$10 each.

PCI Express: New PCs have a new bus called PCI Express. It is a dual-simplex, point to point serial differential low voltage interconnects that will consolidate application requirements for use by multiple segments in the industrial world. The signaling rate is 2.5 Gbit per second, with 8/10 bit encoding to embed the clock in the data stream. On the transmit side parallel data is shifted out serially and on the receive side serial data is shifted into registers for parallel data output. The receiver also recovers the embedded clock. This bus can be used to connect modules or boxes via twisted pair copper.

ATCA: is a promising new high speed modular standard, designed for telecommunications. The consortium supporting this standard consists of several hundred companies and commodity pricing will be available due to the industry's very large volumes. The standard was announced as ready for business in June 2004. We need to explore building a standard based on using the ATCA hardware as a starting point. There are at least 6 manufacturers making processor hardware (and well over a hundred making various elements).. Several have dual Pentium CPUs in this format.

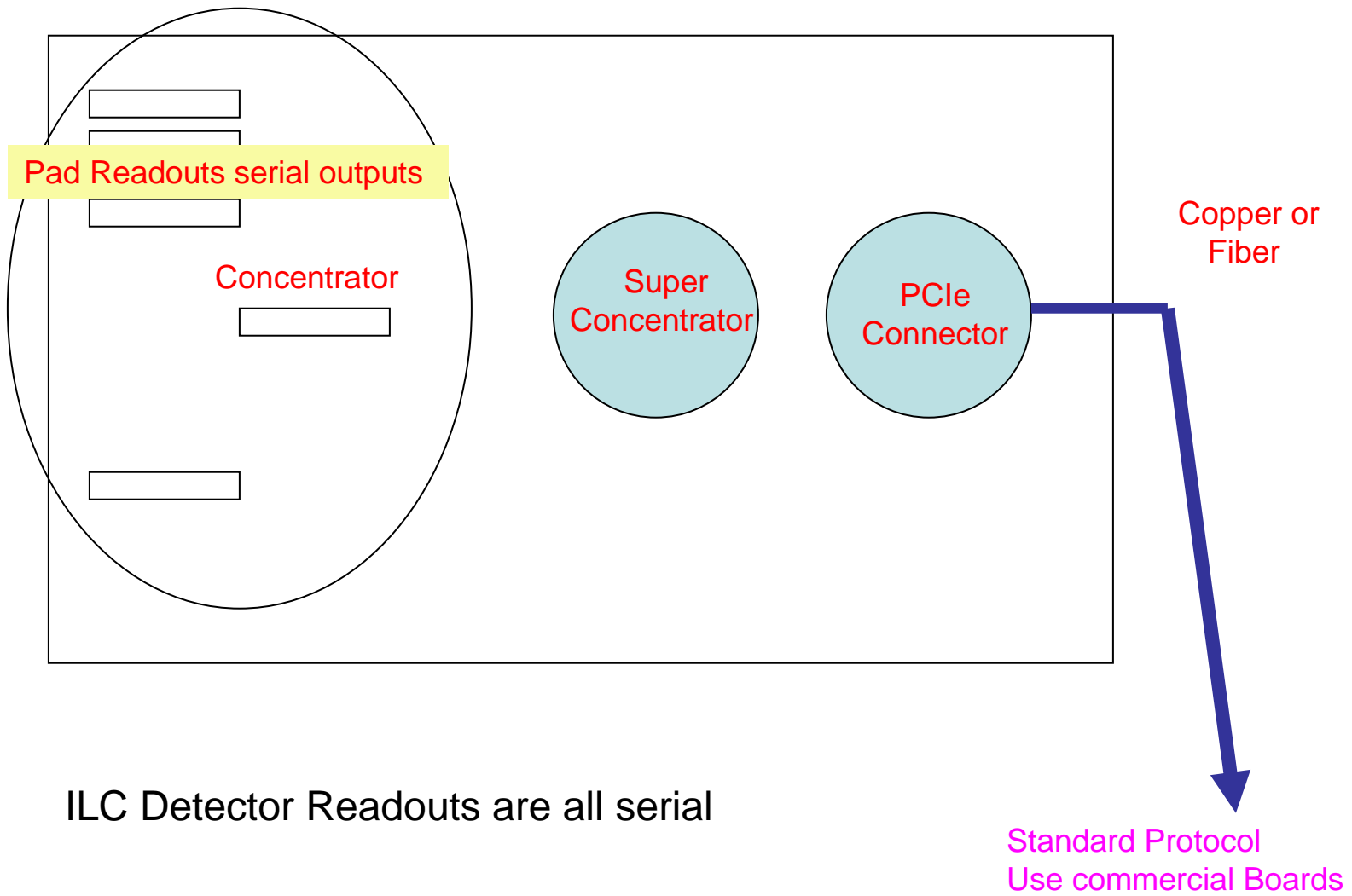
IO Device Virtualization Overview

System virtualization increases the number of system image instances within a client or server. The need for PCI I/O adapter sharing increases in proportion to the number of virtual systems. Even where a sufficient number of physical PCI I/O adapters could be installed, the sharing of those adapters may be desirable because it allows system images to share an underutilized adapter, thereby reducing overall system costs. The PCI-SIG's I/O Virtualization Workgroup is developing extensions to the PCI Express specification to support this technology. This presentation will provide an overview of the I/O Virtualization (IOV) work being performed by that workgroup including scope, a preliminary set of PCI IOV definitions, work requirements, and a high level time-line for the Workgroup.

Need New Standard for Physics Instrumentation

- Based on Commodity components
- Signaling Standard implemented in Silicon
- Standard Hardware
- Serial interconnections
- Start a Standards Group –
 - NIM/CAMAC/FASTBUS/VITA

ILC Digital HCAL 400k pads / 1meter Square



ILC Detector Readouts are all serial

Standard Protocol
Use commercial Boards

CX4 Plug With Optical Transceiver Inside - Preliminary

