

# Progress toward an Open & Sustainable, Energy Centric Computing Architecture for today's AI & HPC Applications

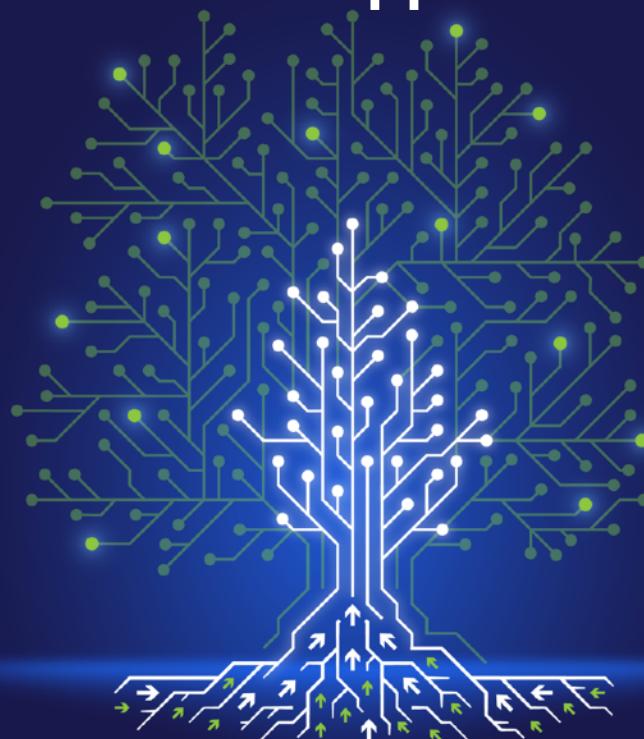
Power, Thermal & Interconnect  
aspects of a revolutionary computing  
Architecture

Scaling Innovation Through Collaboration



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24-25 APRIL 2024  
LISBON, PORTUGAL



# Progress toward an Open & Sustainable, Energy Centric Computing Architecture for today's AI & HPC Applications

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OCP HPC SubProject Technical Lead



SERVER



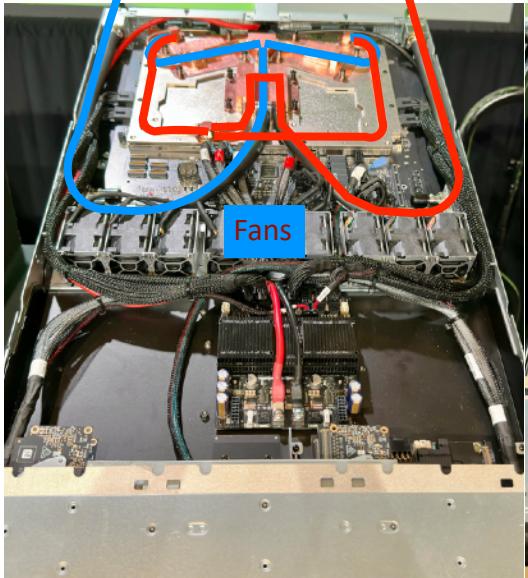
OPEN  
COMMUNITY®

# Overview

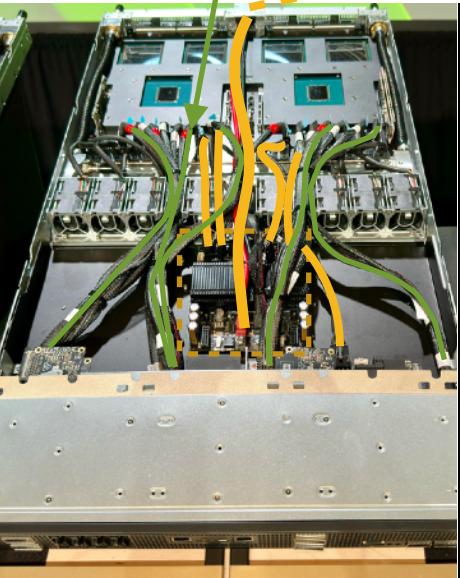
- OCP High Performance Compute Module, HPCM, from HPC to the Edge
  - Detailed Overview : OCP Global Summit, 2023 :-
    - <https://www.youtube.com/watch?v=6pGLyjar1WI>
- Efficient Power Delivery
- Thermal Management Concept including Energy Re-use
- Universal Topology Interconnect
- Summary & Call to Action

# Power, Thermal & Interconnect Challenge of Today's AI Racks

Complex Hybrid  
Liquid + Air Cooling



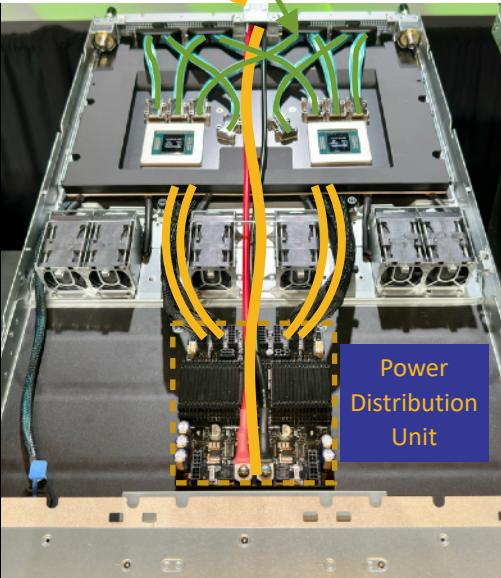
Grace-Blackwell Bring Up System



Grace-Blackwell Production System



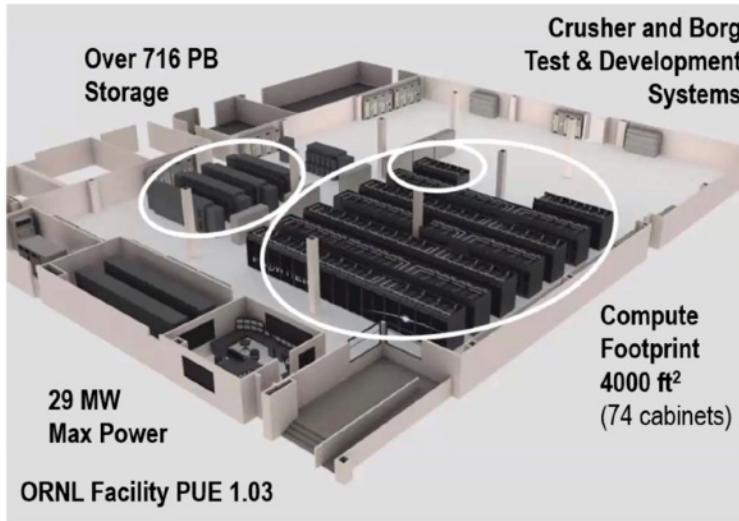
Grace-Blackwell Rack



Grace-Blackwell NVLink Switch

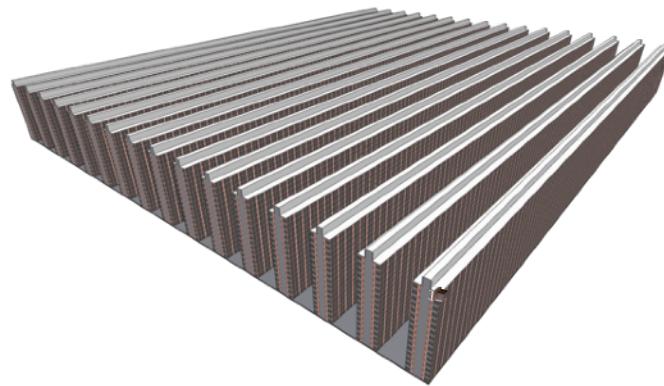
# Composable HPC with the OCP Wall Of Compute

## Frontier Super Computer Footprint



~50,000 CPUs, GPUs & Switches

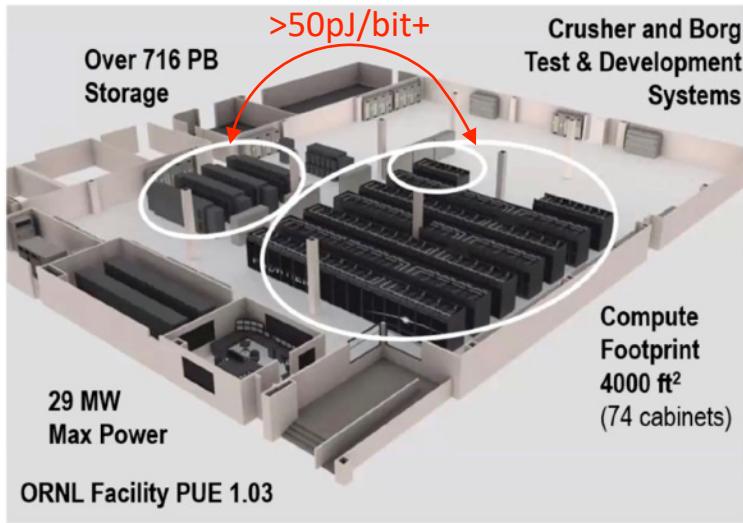
Frontier Concept, OCP Wall of Compute  
A Sustainable, Energy Centric  
Computing, System Architecture



~50,000 HPCMs,  
High Performance Compute Modules

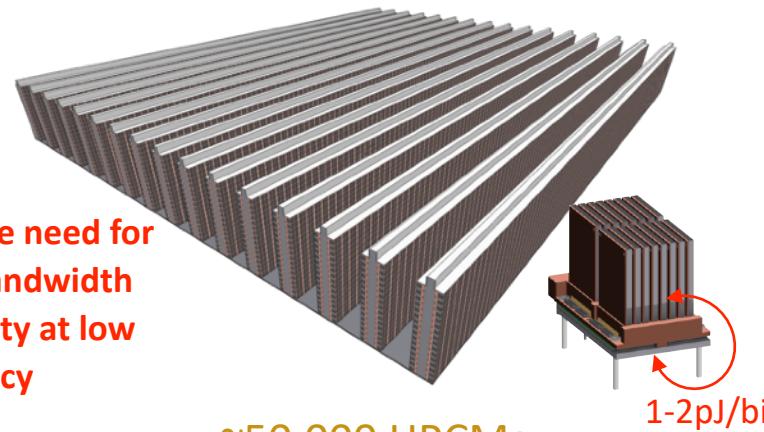
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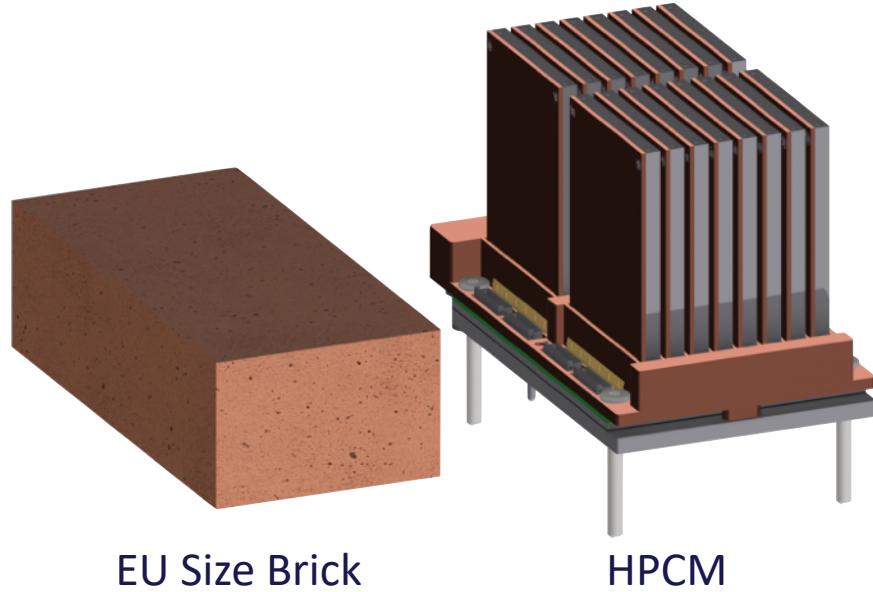


AI's insatiable need for  
Memory Bandwidth  
AND Capacity at low  
latency

~50,000 HPCMs,  
High Performance Compute Modules

# The High Performance Compute Module, HPCM

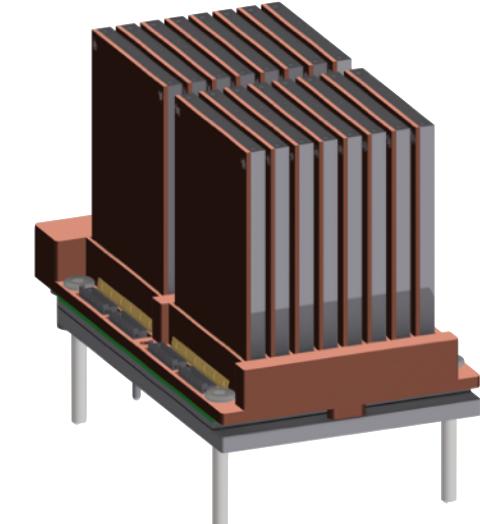
- Composable, Domain Specific Architecture building block
- Inspired by OAM, OCP Accelerator Module
- Any Processor, Accelerator, Switch <1KW
- 16x E3.S Memory / Media Modules
- Direct Water Cooling
  - With Energy Re-Use
- 8x Universal Interconnect Topology IO
  - Potential for 8TBytes/s CPO Bandwidth
- Scalable from HPC to the Edge



# Edge Composable - OCP HPCM Wall Of Compute

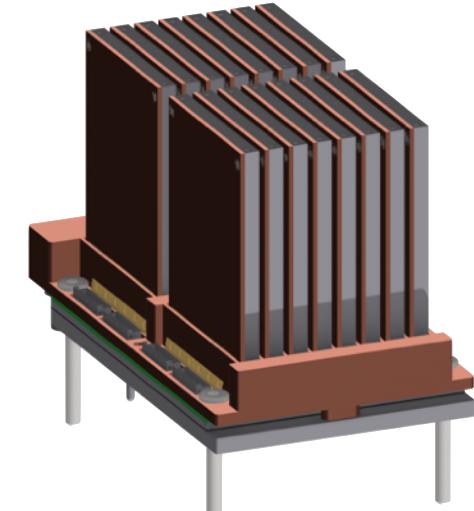


6 x 6 Edge Compute HPCM's in street side Telecom's Cabinet



HPCM

# Edge Composable - OCP HPCM Wall Of Compute



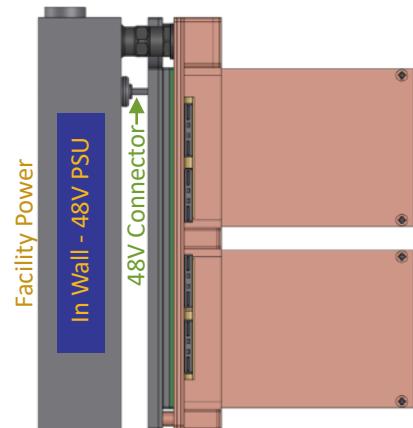
HPCM

# Efficient Power Delivery

- Power Delivery Copper Loss Distance
  - Up to 2.5M - Rack System
  - < 0.2M - HPCM Module
- Lower Cost - Less Copper
- Less Loss - Higher Efficiency

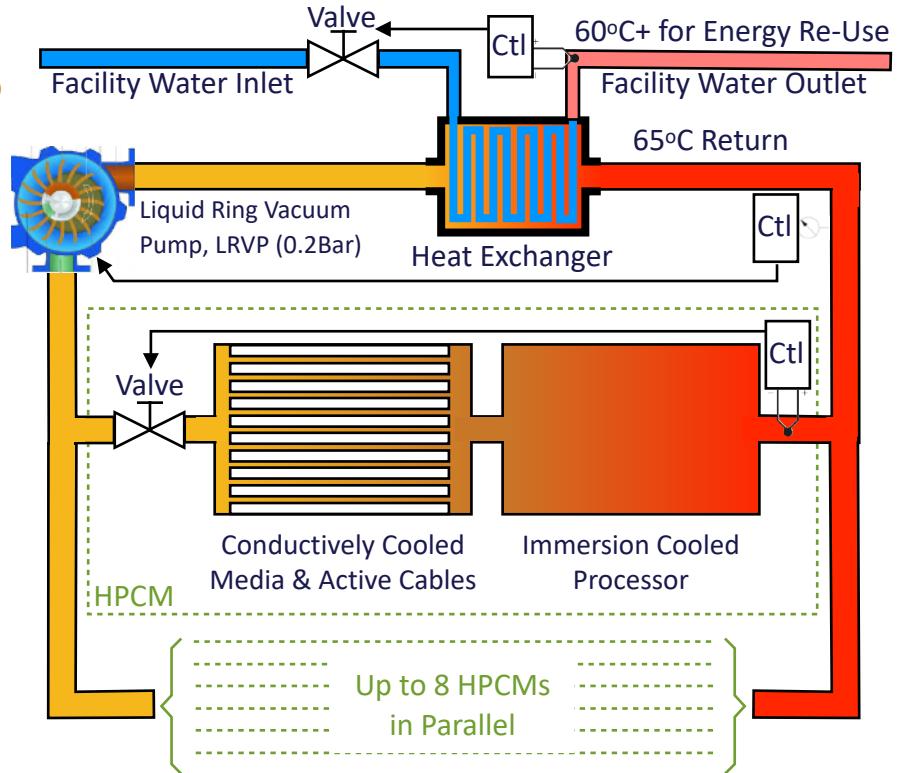


Copper Loss Distance <0.2M



# Wall of Compute - Thermal Management Concept

- Complex, 3 nested Control Loops
  - Facility Outlet Temp, Vacuum, 8x HPCMs Outlet Temp
- LRPV pulls 0.2Bar Vacuum
- 2 Phase, Inner Loop
  - 0.2Bar = ~65°C Water boiling point
  - >11x more efficient vs single phase<sup>1</sup>
- Conformally Coated Copper HPCM
  - ~7x more power/unit volume(copper)<sup>2</sup>
- Water 4x to 9x better thermal conductivity than PAO or Fluorinate<sup>3</sup>
- Potentially >300x Improvement over conventional Liquid Cooling Techniques, all things being equal



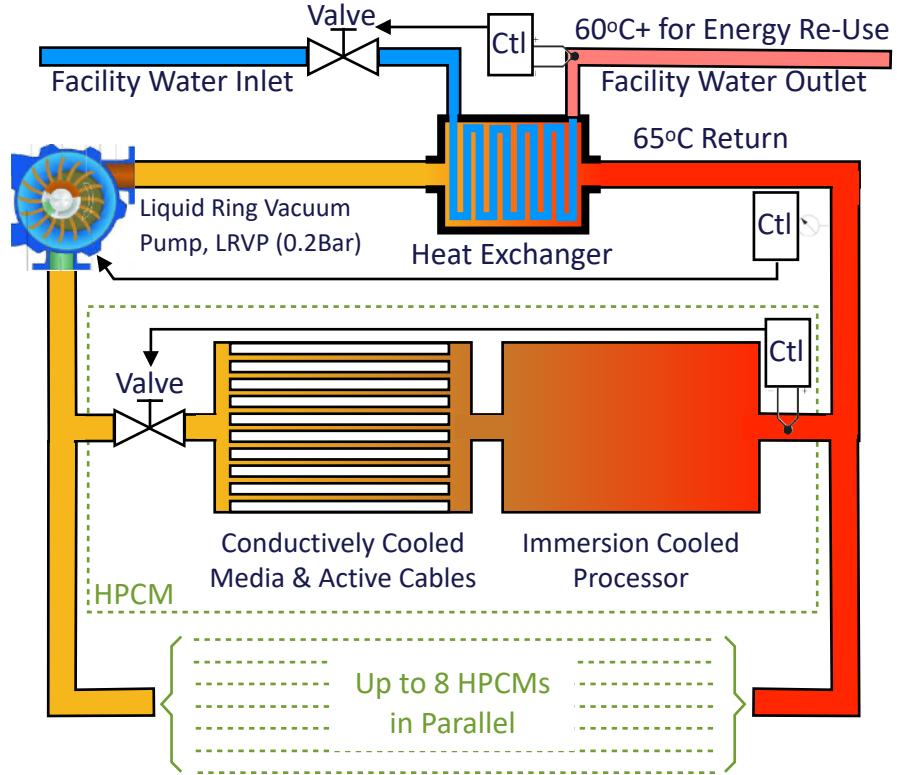
1. Source : Peter C. Salmon of [ElectronicInnovations.tech](http://ElectronicInnovations.tech)

2. UIUC Conformal Copper Coating Heat Spreader

3. Boyd Paper on Best Heat Transfer Fluids

# Wall of Compute - Thermal Management Concept

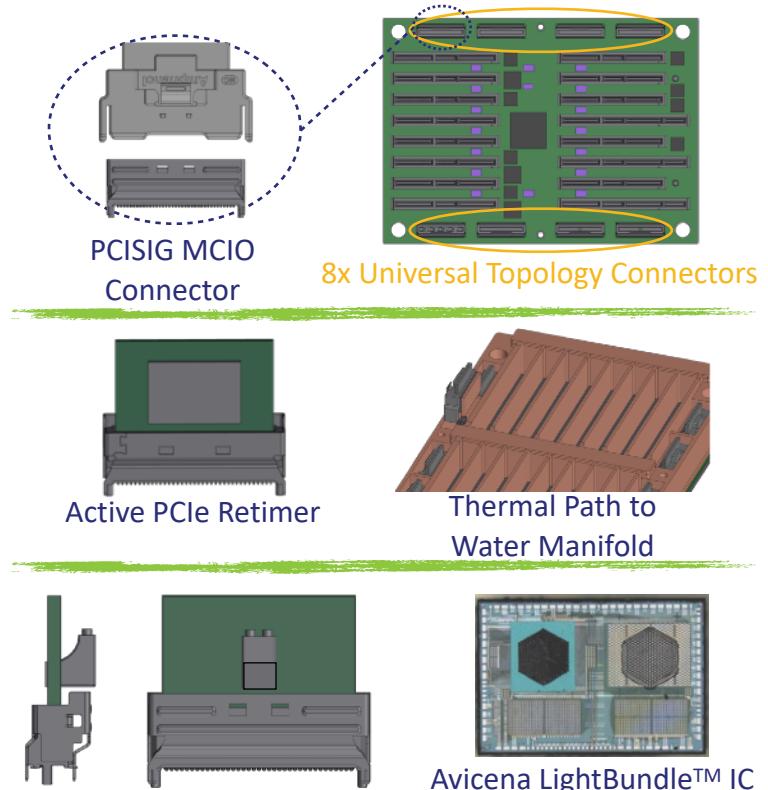
- Water Use Concerns
  - Electrically Conductive
    - Conformal Coating should Isolate
  - Bacterial Growth
    - Eliminate stagnant water areas?
    - Water Temperature may help?
  - Corrosion
    - Material mix Issues?
  - Water Treatment
    - Reduces thermal conductivity
    - Sustainability concerns



Unproven, hypothetical concept only

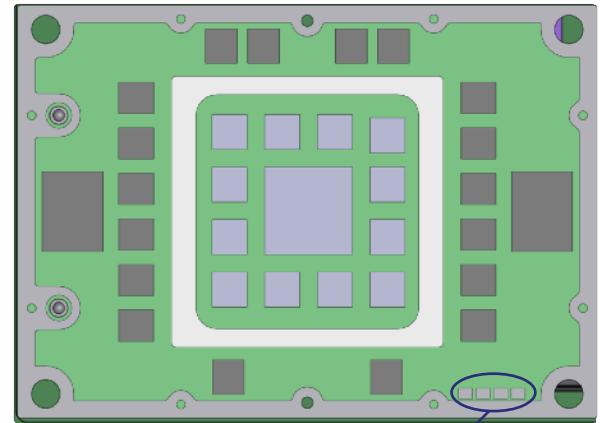
# Universal Topology Interconnect

- Protocol Agnostic
  - PCIe/CXL, GbE, NVLink, xGMI, Infiniband, etc.....
- X8 Transceiver Lanes
  - From 32G up to 224Gbps
- Sidebands
  - Tunneling over LTPI + Clocks
  - Cable Present Pin
- Active Cable Options - Retimers & Optical (<10W)
  - 12V Power Pins
  - Paddle Card Support for Active Components
  - Thermal path to HPCM Cold plate Manifold

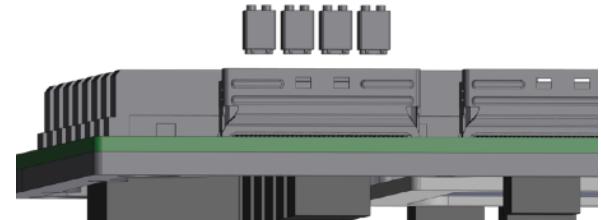


# Universal Interconnect - Passive Copper to CPO

- Protocol Agnostic
  - PCIe/CXL, GbE, NVLink, xGMI, Infiniband, etc.....
- X8 Transceiver Lanes
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- Active Cable Options - Retimers & Optical (<10W)
  - 12V Power Pins
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  - Thermal path to HPCM Cold plate Manifold
- **Passive Optical cable Option for CPO**
  - 8 TBytes/s Avicena LED Lightbundle™ example



4 Lightbundle™ ICs



# Summary

- Bold Ambitions to bring our Open Computing Architectures into the 21st Century
- A Sustainable, Energy Centric Computing, First mindset is core to our Vision
- This requires Innovations through collaboration across all our Industry Silos
- Thermal Management is a major challenge and we have some crazy ideas!
- AI & HPC require System IO Bandwidths to skyrocket & we need to plan for this!
- Revolutionary change requires Open Collaboration, Thanks OCP!



# Help OCP bring the HPCM Vision to a Reality

- We need broad industry cross discipline collaboration
  - Thermal, Power, Electrical, Mechanical, Software, System Management, Test
- Help us convert our Thermal Management Concept into reality
- Help us realize a Universal Interconnect that supports an evolving IO Landscape
- Join our OCP HPC Subproject Workgroup
  - Mailing list: <https://ocp-all.groups.io/g/OCP-HPC>
  - Wiki : <https://www.opencompute.org/wiki/HPC>
  - Meeting Calendar : <https://www.opencompute.org/projects/project-and-ic-meetings-calendar>
    - Every other Tuesday, 8am Pacific

# Thank you!



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