



OIF

448 Gbps Per Channel Data Rate

Enabling AI's Future: The Path Forward

Nathan Tracy, OIF President
TE Connectivity, Sr Principal Engineer

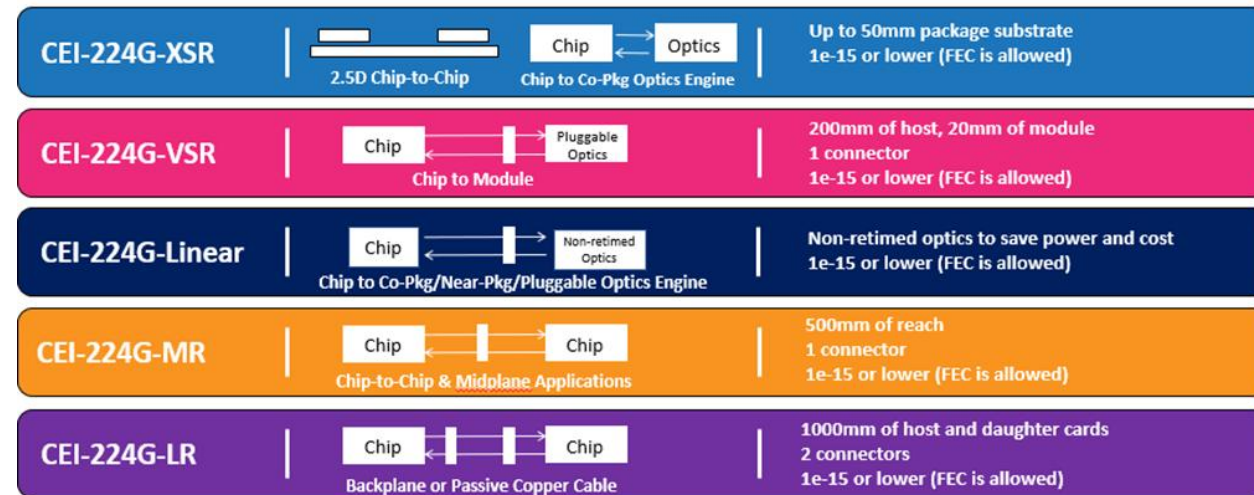
OIF Addresses Higher Rates & Power Efficiency

Name	Rate per pair	Year	Activities that Adopted, Adapted or were influenced by the OIF CEI
CEI-112G	112Gbps	2024	IEEE, InfiniBand , T11 (Fibre Channel), Interlaken, ITU
CEI-56G	56Gbps	2017	IEEE, InfiniBand, T11 (Fibre Channel), Interlaken, ITU
CEI-28G	28 Gbps	2012	InfiniBand EDR, 32GFC, SATA 3.2, SAS-4, 10GBASE-KR4, CR4, CAUI4, Interlaken, ITU
CEI-11G	11 Gbps	2008	InfiniBand QDR, 10GBASE-KR, 10GFC, 16GFC, SAS-3, RapidIO v3 , Interlaken, ITU
CEI-6G	6 Gbps	2004	4GFC, 8GFC, InfiniBand DDR, SATA 3.0, SAS-2, RapidIO v2 , HyperTransport 3.1 , Interlaken, ITU
Sx15	3.125 Gbps	2002-3	Interlaken, FC 2G, InfiniBand SDR, XAUI, 10GBASE-KX4, 10GBASE-CX4, SATA 2.0, SAS-1, RapidIO v1 , ITU
SPI4, SFI4	1.6 Gbps	2001-2	SPI-4.2, HyperTransport 1.03
SPI3, SFI3	0.800 Gbps	2000	(from PL3)

OIF has 25 years of history on development of next generation data rates



OIF has multiple 224Gbps projects to optimize for power



Is the Environment Different for the Next Rate (448 Gbps)?

- Market demand timing between data rates is compressing from approx. 3/4 years to possibly 2 years
- The dollars and market share that are at stake are much larger, making timing more critical
- Every new rate takes us closer to the laws of physics as well as Shannon's law
- Power is becoming an additional critical requirement
- Different networking and AI fabric applications have different 448 Gbps requirements

Yes! Everything is compressing

How Is It Technically Difficult?

The current OIF CEI-224G projects have demonstrated the technical challenges for electrical and optical implementation at higher rates. This is the starting point as we consider 448 Gbps

- Doubling the signaling rate again will require changes from prior increases
 - Electrical and Optical channels face different challenges
 - Through OIF's and other forum/organization's consensus building procedures, industry will work to find a middle ground solution that enables alignment between electrical and optical links
 - This consensus building is required across the entire channel: packages, host, interconnect, E-to-O, O-to-E.
 - By way of example, for the electrical portion of a channel, separate problems that need to be addressed include: Better signal integrity, optimal modulation, increasing of density
- Time pressure; a consensus-based direction can unify the technology; debate delays a unified direction and potentially fractures the technology that is adopted

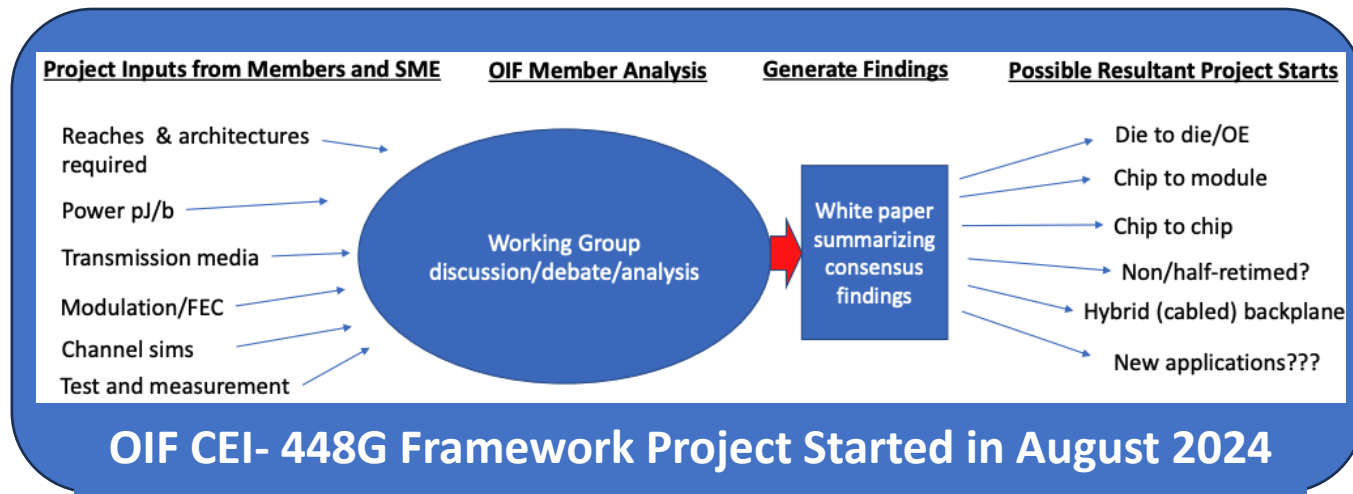
CHALLENGING BUT SOLVABLE ISSUES

When we work together

400G Imperatives

- Channel contributions to enable analysis of impairments at various Nyquist frequencies
- Aggressive (but realistic) optimization for IL, RL and Crosstalk (structures will improve over next 2 years).
- Seek the optimal set of tradeoffs to seek alignment between optical and electrical modulations
- Propose/analyze equalization options over architectures (end to end vs. distributed)

What's Happening For 448 Gbps at OIF?



Many contributions have been made investigating:

- Modulation/Nyquist frequency
- Architecture (CPO, CPC, Pluggable, Backplane, etc)
- Equalization schemes
- SerDes, DSP
- Thermal Management
- Increased density
- Packages / Channels / Interconnects

OIF has a history of developing optimized links for reach/power:

- CEI (Common Electrical I/O) SerDes/Channel specifications: > 25 year history
- Linear Pluggable Optics: First LPO project in industry
- Energy Efficient Interfaces: Standardized CPO formfactor

OIF 2 day 448 Gbps (400G) Workshop

With co-sponsors:

Ethernet Alliance

UEC

OCP

SNIA

UALink

Keynote Speakers: Google, Microsoft, Meta & OpenAI

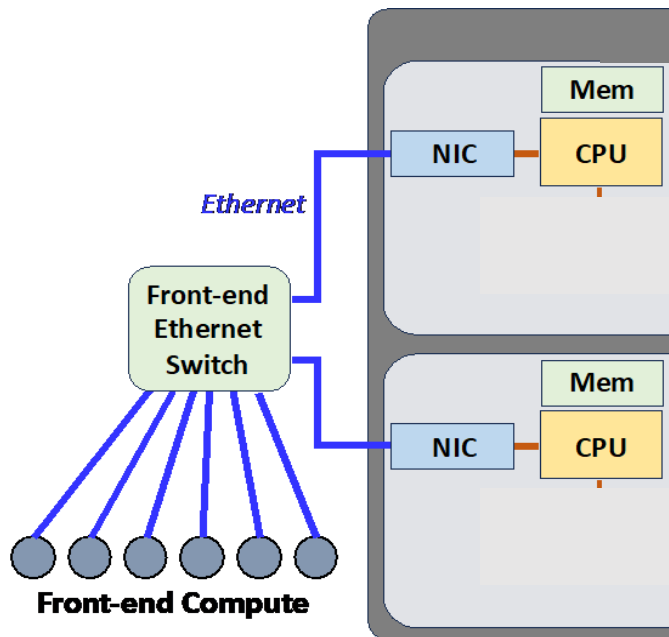
Energy Efficient Interfaces (EEI) Project

Necessary to support AI/ML architectures

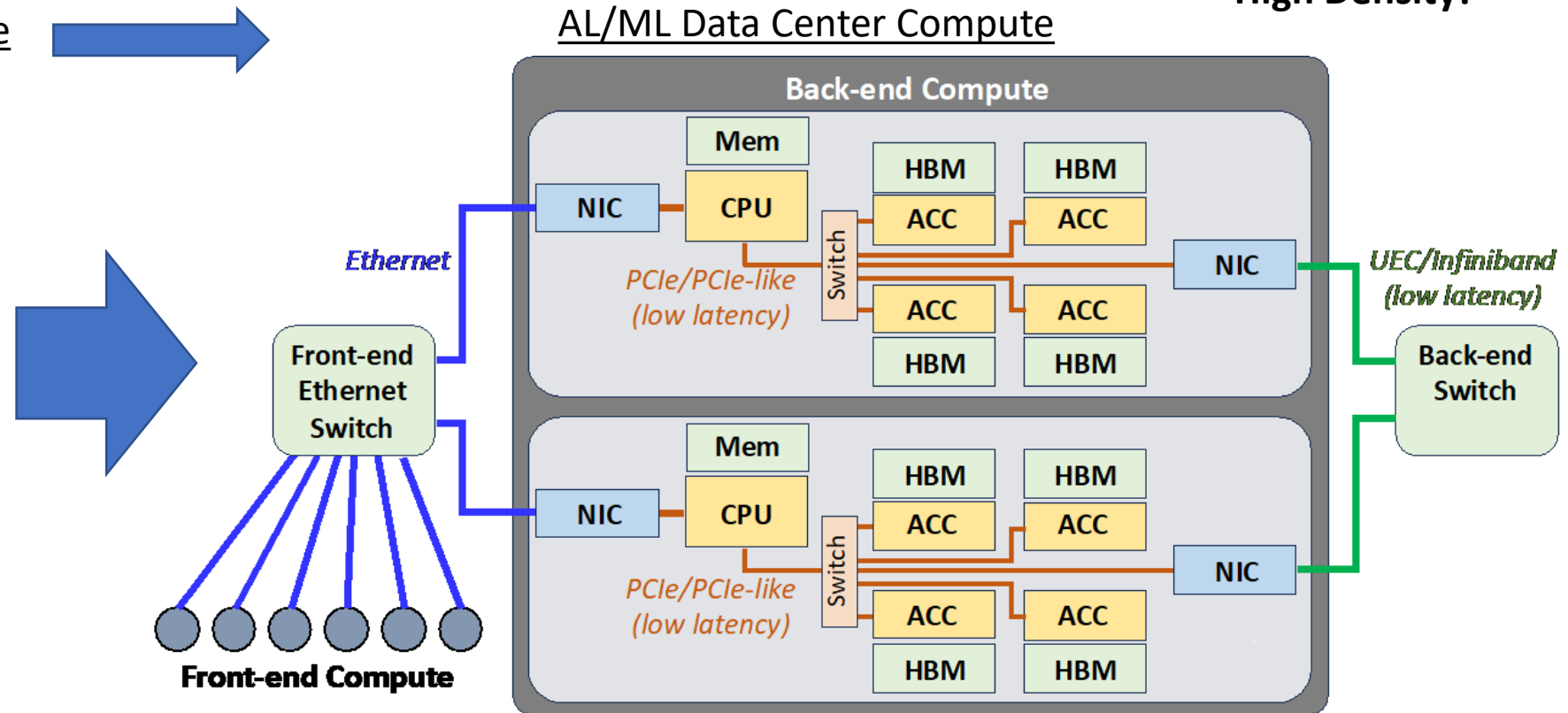
They are a “Network of Networks”, with some special requirements

Low Power!
Low Latency!
High Density!

Traditional Data Center Compute



AI/ML Data Center Compute



Considerations – why 448Gbps is hard and why we have to make the right **system** decisions

Power

At the device level or at the rack level?

Data Rate

Is it possible we don't need to double?

Modulation

Single solution or optimize for electrical and optical?

Latency

Optimize for multiple applications?

Density

Beachfront property at the device level and at the rack level?

Reach

Electrical reach and Optical reach?

Reliability

How to optimize mix of technologies?

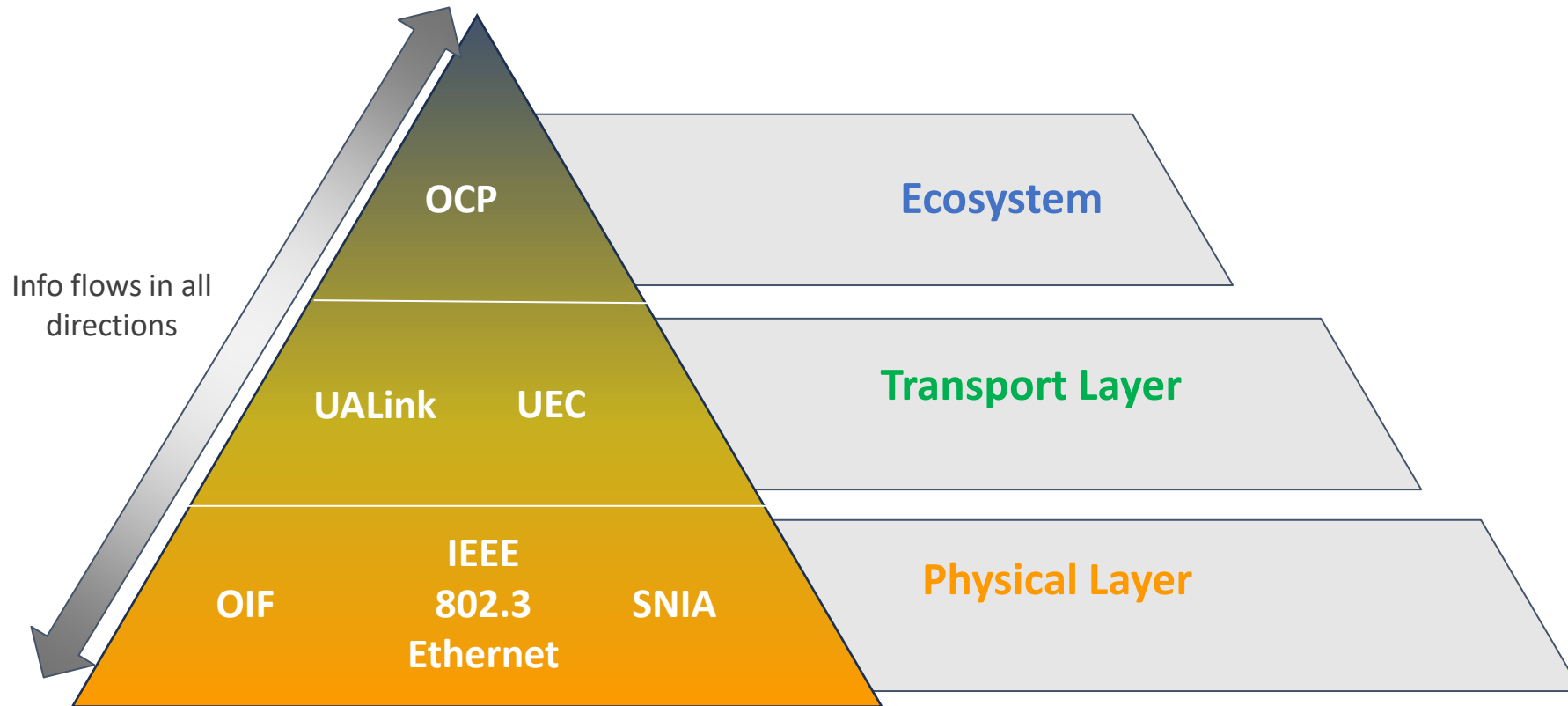
Timing

How do we time technologies optimally

Architecture

Maintainability, Pluggability, Serviceability?

Industry Organizational Alignment For AI



OIF

Thank You

