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Harnessing light to power new possibilities

Flash Memory Summit

Advantages of optical CXL for disaggregated compute architectures

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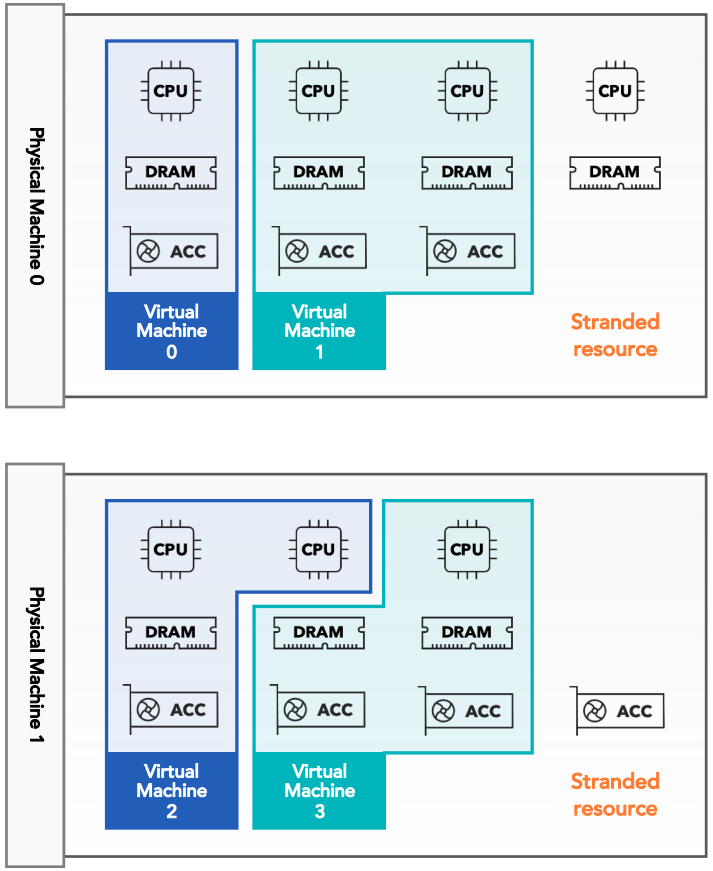
Agenda

Flash Memory Summit

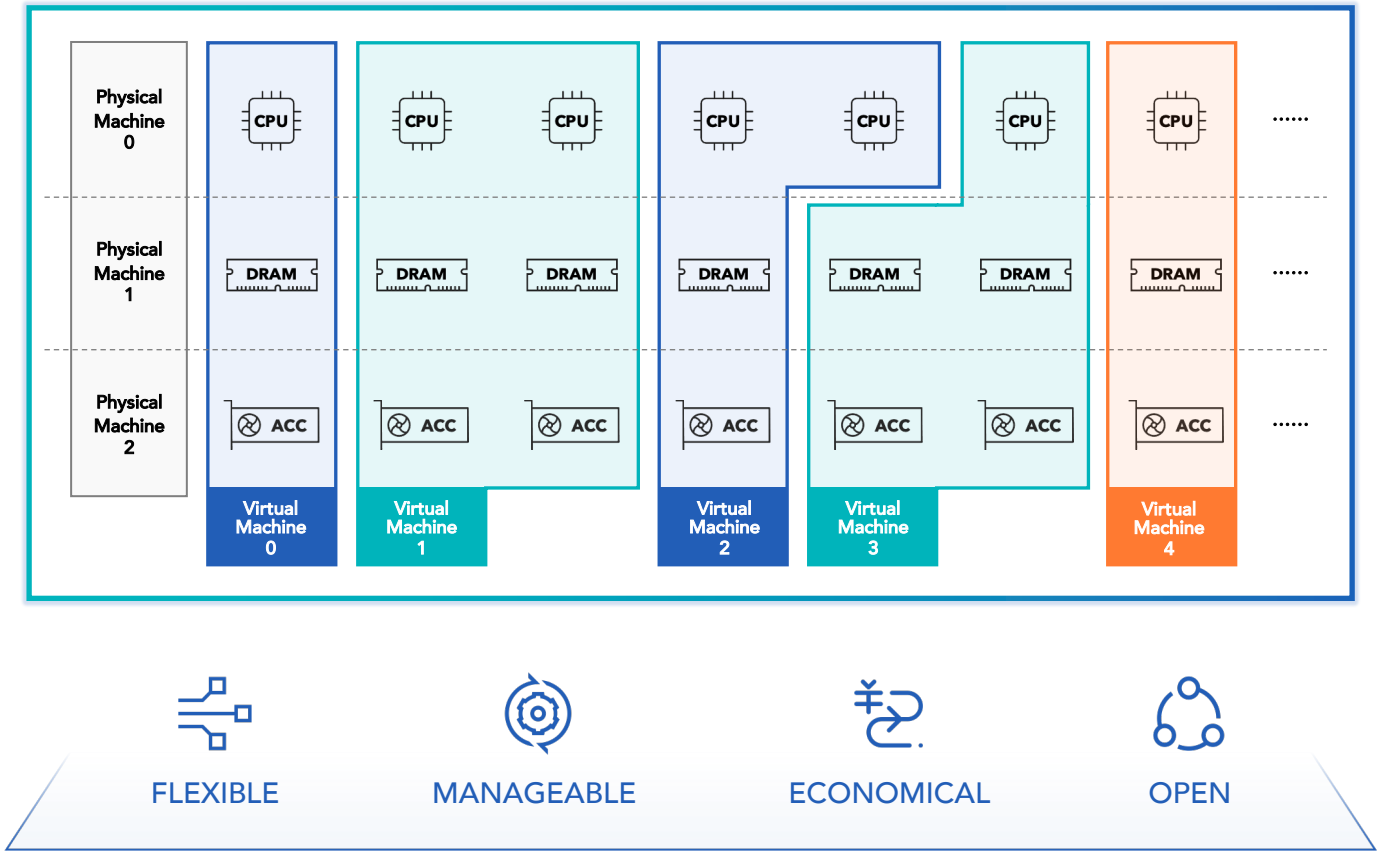
- Memory centric shift in the data center
- AI Large Language Model growth
- Need for optical CXL technology
- Case study: OPT inference benefits using optical CXL

Disaggregation is the Future for Datacenter

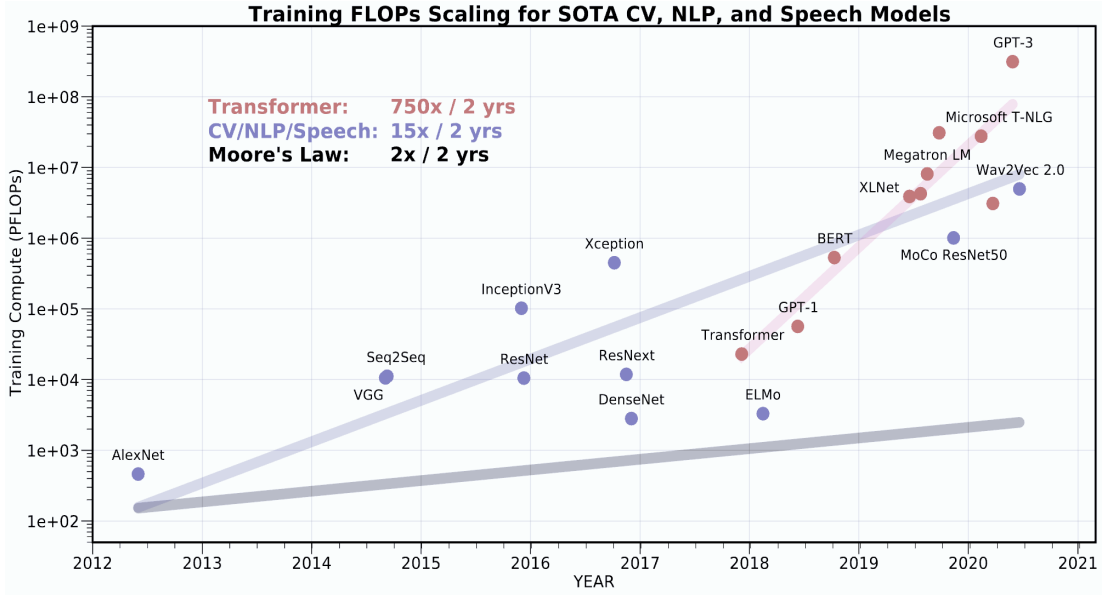
Traditional Datacenter



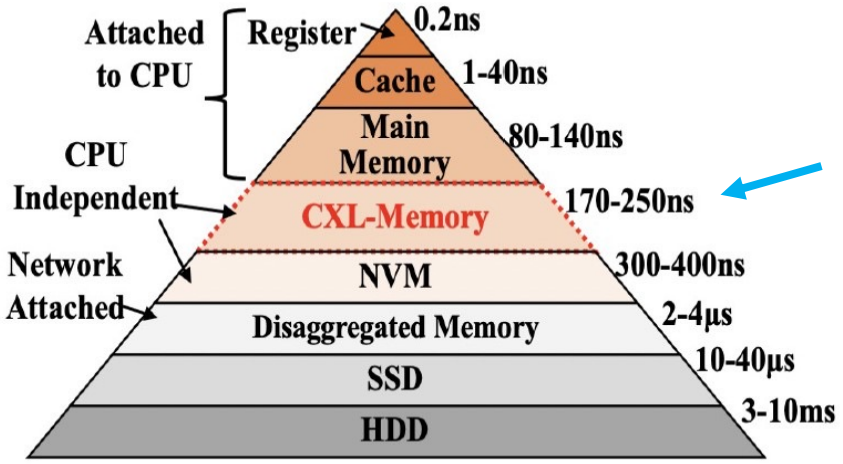
Disaggregated Datacenter



AI trends



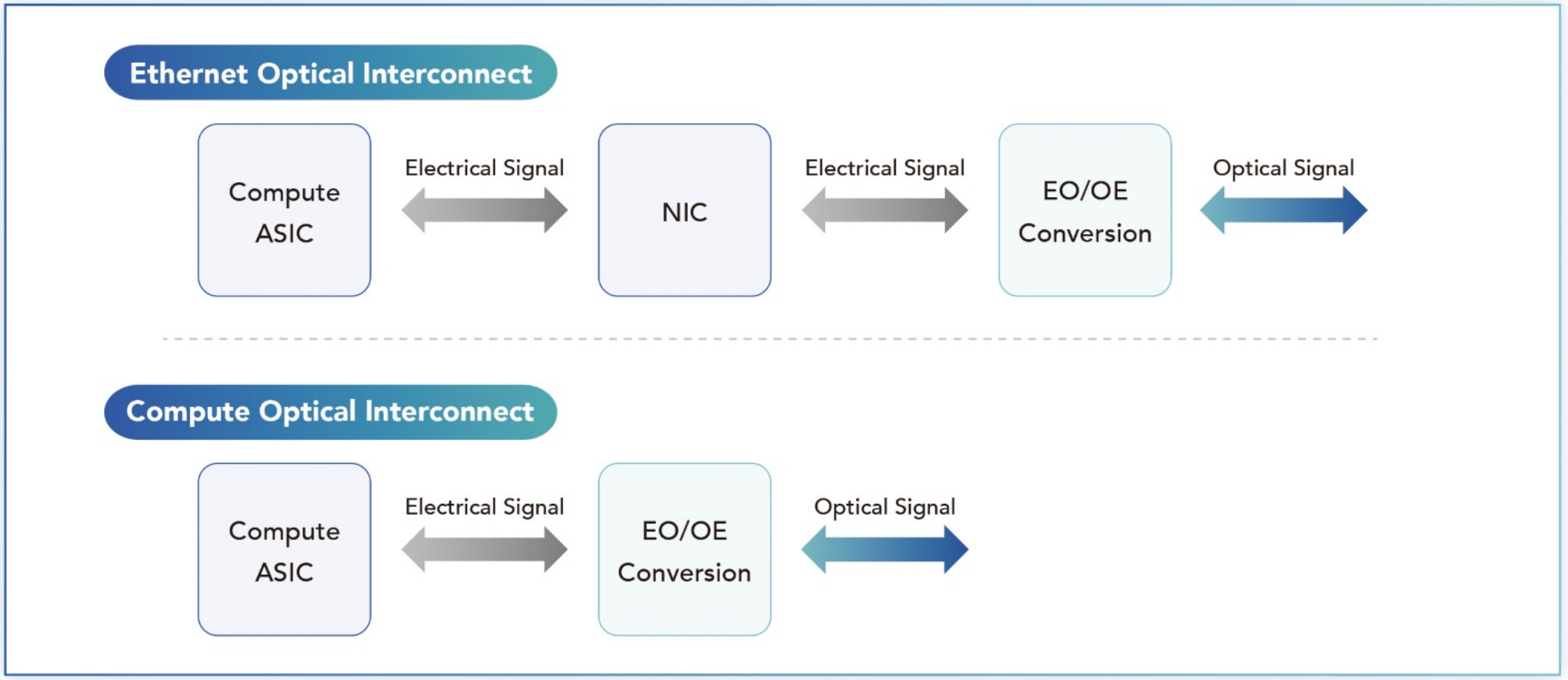
Source: https://medium.com/riselab/ai-and-memory-wall-2cb4265cb0b8



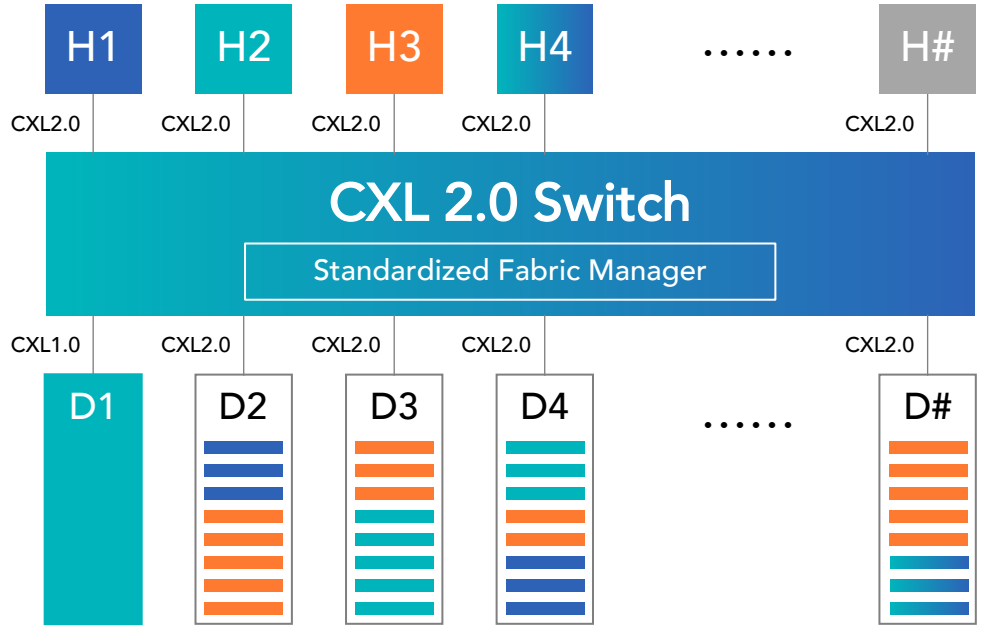
Source: https://hc34.hotchips.org/assets/program/tutorials/CXL/Hot%20Chips%202022%20CXL%20MemoryChallenges.pdf

- AI and Large Language Models will continue to grow and consume more compute
- Disaggregated memory architectures are required in order to continue to scale
- Optical interconnect is required to extend reach

Optical Interconnect Latency



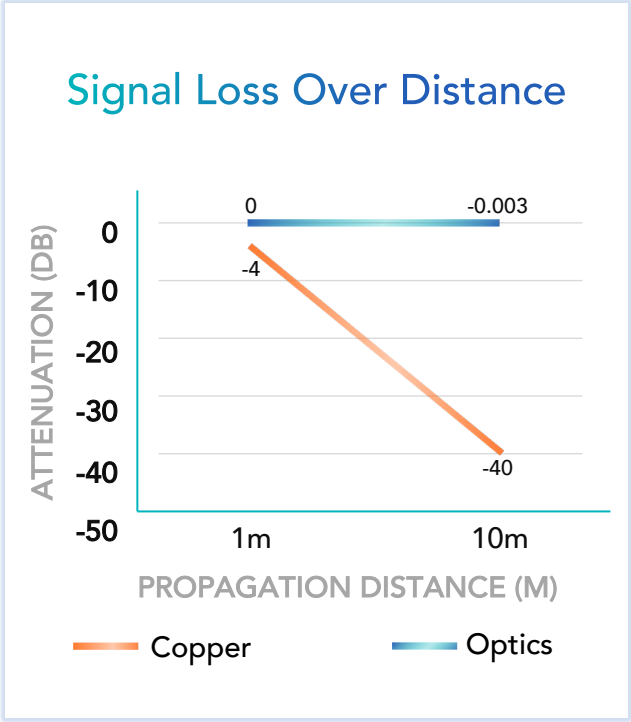
CXL is the Predominant Standard for Disaggregation



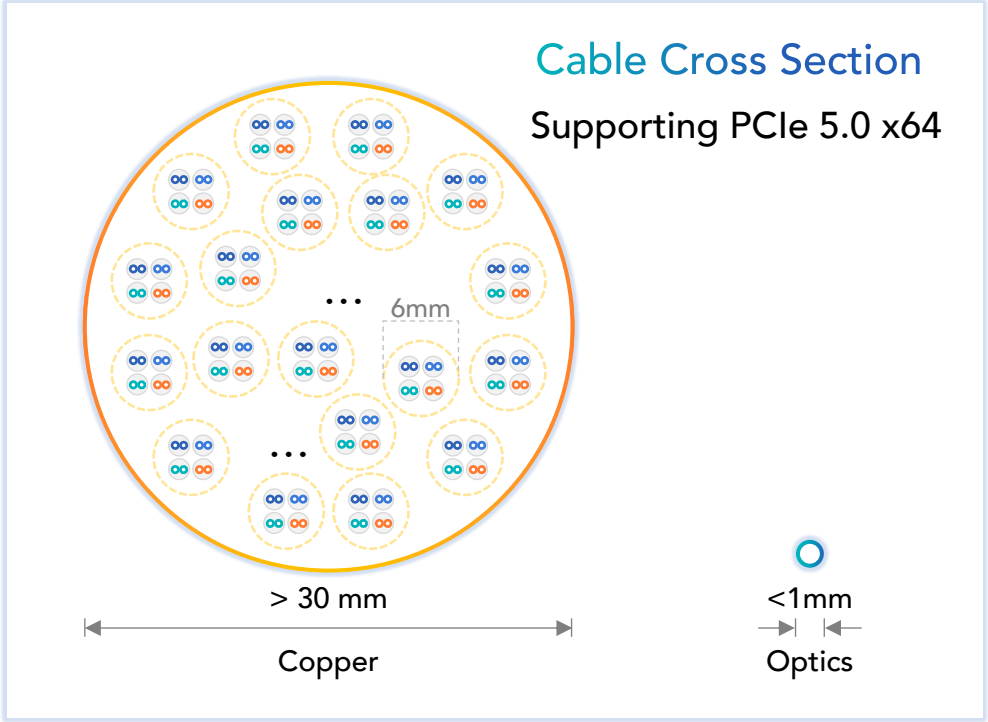
	Cache-coherence	Latency	Memory decouple
CXL	Yes	~100ns	Supported
RDMA (ethernet)	No	~3μs	Not supported

Wide adoption from most major industry players

Optical CXL is Required for Scaling



Assuming AWG26 wire, PCIe 5.0 signal



32 cables with diameter > 6mm (CAT8)

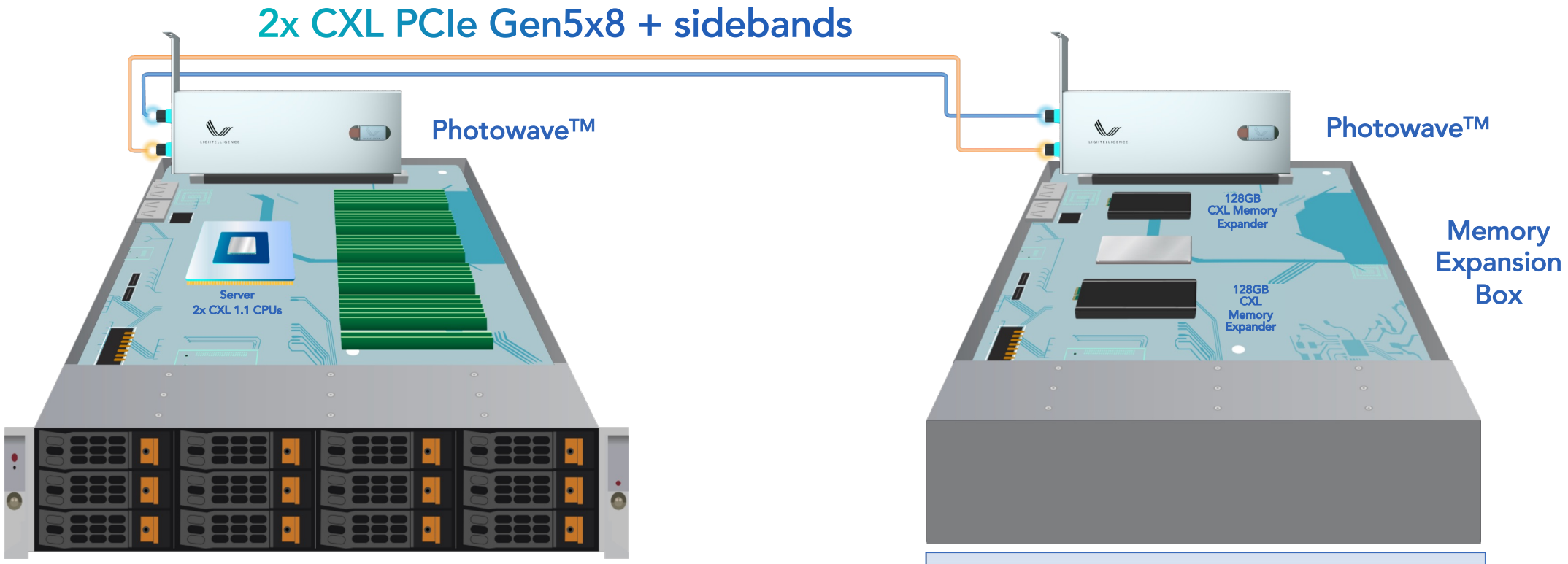
16 fibers with diameter of 0.125mm

Copper cable struggles to support CXL scaling beyond a few servers.

Optical CXL in the Datacenter

Photowave™ CXL over optics
Low Latency, High Bandwidth, Data Center Reach

Case study: LLM Inference



- 2U Supermicro server
- 2x AMD Genoa CXL 1.1 CPUs
- MemVerge Memory Tiering and Pooling Software
- Nvidia GPU running LLM inference
- All VMs access to CXL memory
- Secure application, encrypted data

- 2x Samsung 128GB Memory Expanders each with CXL/PCIe Gen5x8 link
- Upgrade to Memory Pooling in Q4

Demo @ FMS booth #915

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LLM Model List

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Model	Weight Memory(float16)	KV-Cache per sample(float16)	Activation per sample(float16)	Context length
OPT-1.3B	2.4 GB	0.095 GB	0.002 GB	512
OPT-13B	23.921 GB	0.397 GB	0.005 GB	512
OPT-30B	55.803 GB	0.667 GB	0.007 GB	512
OPT-66B	**122.375 GB**	**1.143 GB**	**0.009 GB**	**512**
OPT-175B	325GB	2.285GB	0.012GB	512

Entire OPT-66B model fits within one 128GB CXL memory expander

KV-cache Size: data_type * dimension* num_layers* batch_size * Context_len * 2

e.g., for opt-1.3B, FP16 -> 2Bytes * 2048 * 24 * 1 * 512 * 2 = 100,663,296 Bytes

Activation Size: data_type * dimension * batch_size * Context_len

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Results

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OPT-66B model results	Disk (NVMe)	CXL Memory	System Memory	MemVerge 60:40 Policy
Decode Throughput (Tokens/s)	1.984	4.859	6.216	6.237
Decode Latency (s)	338.7	138.2	108.1	107.7

CXL Mem. Achieves ~2.4x Higher Throughput than Disk

- **Average GPU-PCIe-Transmit-Traffic:**
  CXL: 882MB/s, System Memory 857MB/s, Disk: 582MB/s, MemVerge: 493MB/s
- **Average GPU-PCIe-Receive-Traffic:**
  CXL: 2365MB/s, System Memory: 2609MB/s, Disk: 1887MB/s, MemVerge: 2173MB/s

PHOTOWAVE™ OPTICAL CXL MEMORY EXPANDER

NEWS TEXT SUMMARIZATION

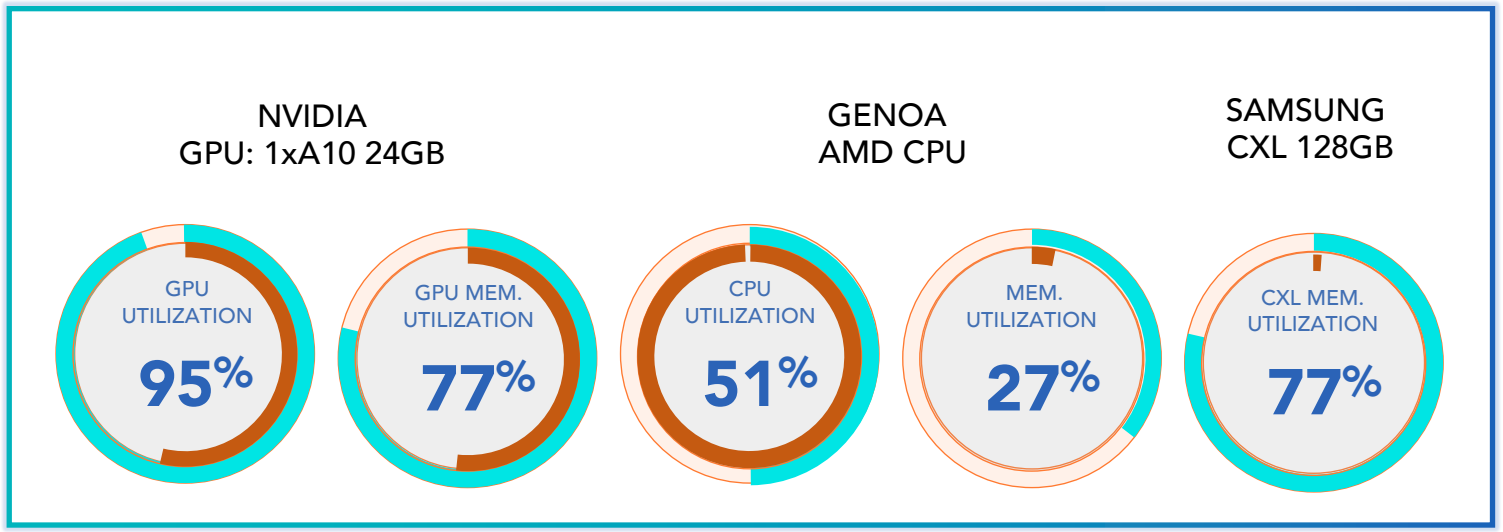
FILE TEXT INPUT

Summarize this text: In an attempt to build an AI-ready workforce, Microsoft announced Intelligent Cloud Hub which has been launched to empower the next generation of students with AI-ready skills. Envisioned as a three-year collaborative program, Intelligent Cloud Hub will support around 100 institutions with AI infrastructure, course content and curriculum, developer support, development tools and give students access to cloud and AI services. As part of the program, the Redmond giant which wants to expand its reach and is planning to build a strong developer ecosystem in India with the program will set up the core AI infrastructure and IoT Hub for the selected campuses. The company will provide AI development tools and Azure AI services such as Microsoft Cognitive Services, Bot Services and Azure Machine Learning. According to Manish Prakash, Country General Manager-PS, Health and Education, Microsoft India, said, "With AI being the defining technology of our time, it is transforming lives and industry and the jobs of tomorrow will require a different skillset. This will require more collaborations and training and working with AI. That's why it has become more critical than ever for educational institutions to integrate new cloud and AI technologies. The program is an attempt to ramp up the institutional set-up and build capabilities among the educators to educate the workforce of tomorrow." The program aims to build up the cognitive skills and in-depth understanding of developing intelligent cloud connected solutions for applications across industry. Earlier in April this year, the company announced Microsoft Professional Program In AI as a learning track open to the public. The program was developed to provide job ready skills to programmers who wanted to hone their skills in AI and data science with a series of online courses which featured hands-on labs and expert instructors as well. This program also included developer-focused AI school that provided a bunch of assets to help build AI skills.

SUMMARIZED TEXT OUTPUT

Microsoft has launched the Intelligent Cloud Hub program to equip students with AI skills through a three-year collaborative initiative. Around 100 institutions will receive AI infrastructure, course content, developer support, and access to cloud and AI services. The program aims to build cognitive skills and develop intelligent cloud solutions, while also expanding Microsoft's developer ecosystem in India.

PHOTOWAVE™ OPTICAL CXL MEMORY EXPANDER



PARAMETERS

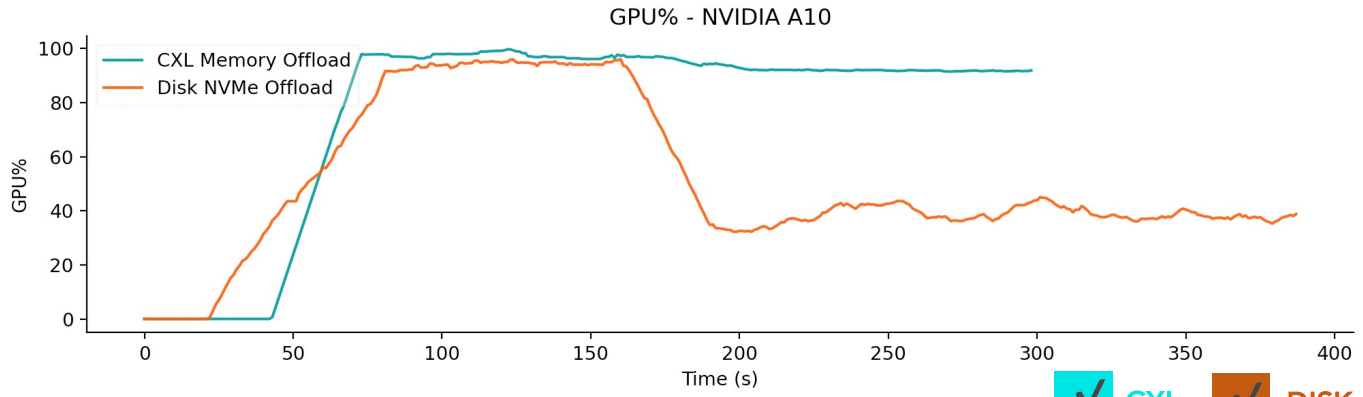
RUN MODE: **CXL**

INFERENCE ENGINE: FLEXGEN

WEIGHTS: 122.375GB

KV CACHE: 109.688GB

OPT-66B MODEL PROGRESS 99%



CXL NVMe

Summary of Results

CXL memory offloading is efficient and beneficial

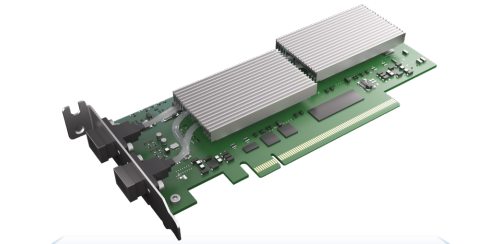
- LLM inference case study
- Allows use of lower cost memory

Similar performance compared to pure system memory

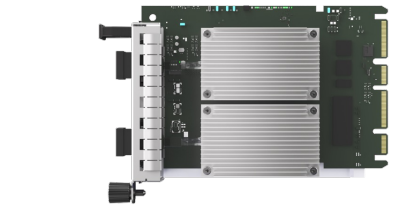
2.4x performance advantage compared to SSD/NVMe disk offloading

Improved TCO

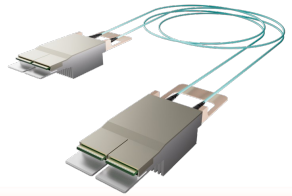
Photowave™ Form Factors



Low Profile PCIe Card



OCP 3.0 SFF Card



Active Optical Cables

Product Suite Features

- CXL 2.0/PCIe Gen5 x16
- Jitter reduction, SI cleanup
- Sideband signals over optics
- x8, x4 or x2 bifurcation
- End-to-end latency:
  - Card: under 20ns + TOF
  - AOC: 1ns + TOF

Endnotes

Algorithm & Software

- LLM: OPT-66B
- Batch size = 24
- Context length = 512
- Output length = 8
- FlexGen

Hardware configuration

Super Micro Server
- AMD EPYC 9124 16-Core CPU
- Samsung DDR5 4800 MT/s
- MEM0 size: 256GB
- MEM1 size: 256GB
- Bandwidth: 307GB/s

Nvidia GPU
- Gen4x16, DMEM size: 24GB
- Bandwidth: 32GB/s

Samsung NVME
- Gen4x4, MEM size: 1.92TB
- Bandwidth: 8GB/s

Samsung CXL Memory
- Gen5x8, MEM size: 128GB
- Bandwidth: 32GB/s