Marvell's Vision for Transforming Cloud Data Centers with CXL

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Forward-looking statements

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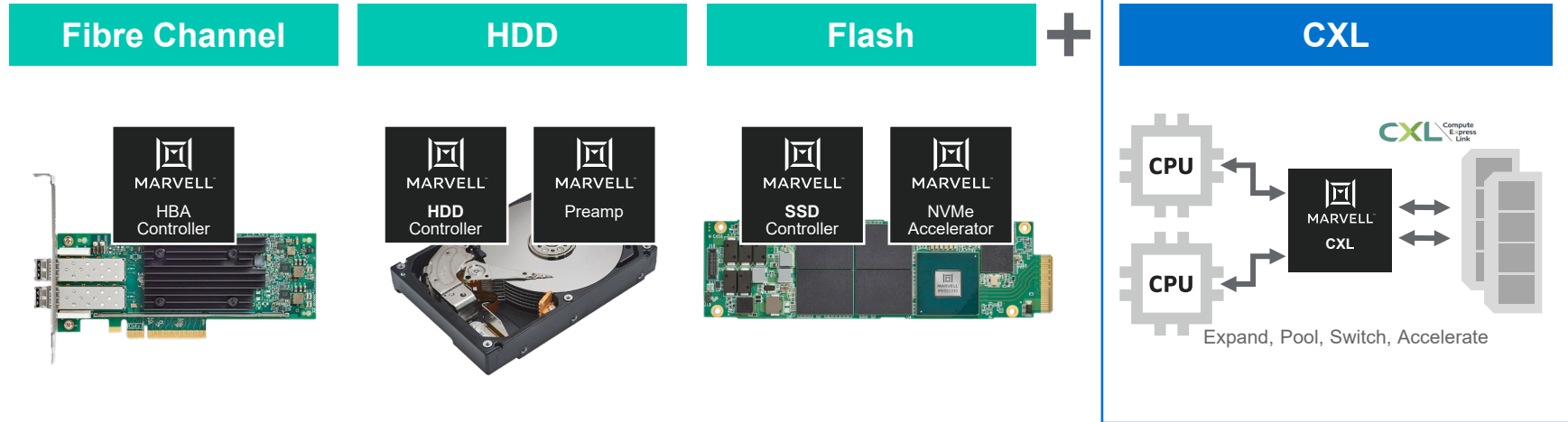
For factors that could cause Marvell's results to vary from expectations, please see the risk factors identified in Marvell's Annual Report on Form 10-K for the fiscal year ended January 29, 2022 as filed with the SEC on March 10, 2022, and other factors detailed from time to time in Marvell's filings with the SEC. The forward-looking statements in this presentation speak only as of the date of this presentation and Marvell undertakes no obligation to revise or update publicly any forward-looking statements.
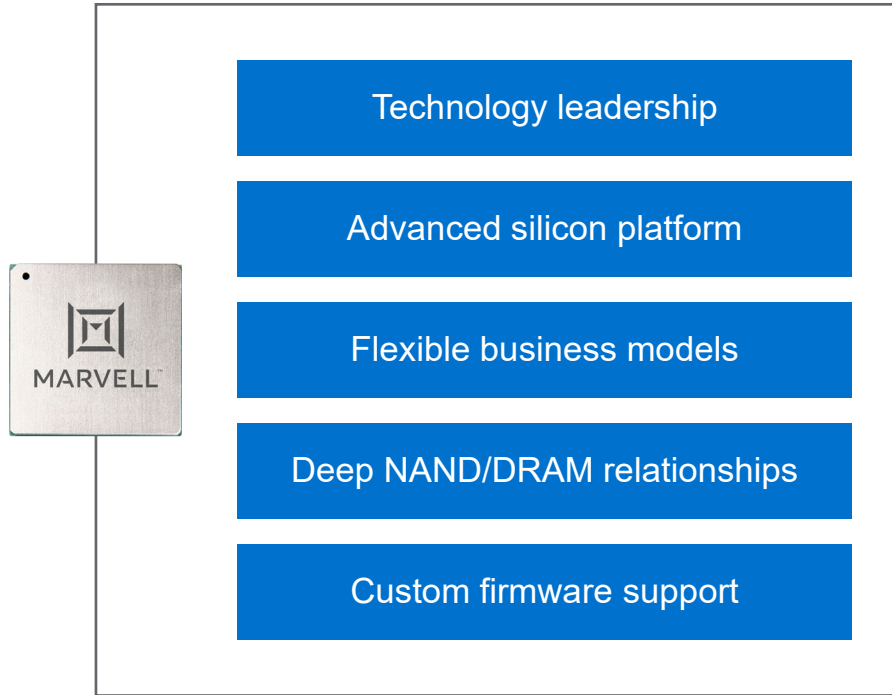
Dan Christman

EVP, Storage Products Group

Storage products group business

| Fibre Channel | HDD | Flash | + | CXL |

Expanding our market opportunity

Uniquely positioned to win in storage and memory

Technology leadership

Advanced silicon platform

Flexible business models

Deep NAND/DRAM relationships

Custom firmware support

+

TANZANITE
SILICON SOLUTIONS

Thad Omura

VP, Flash Marketing

Cloud data center memory challenges

Memory tied-down to xPUs

Cannot share

Bandwidth per core declining

Normalized growth rate

Increasing gap

3.5
3
2.5
2
1.5
1
0.5
0

2012   2014   2016   2018   2020

● CPU core count   ● Memory channel BW per core
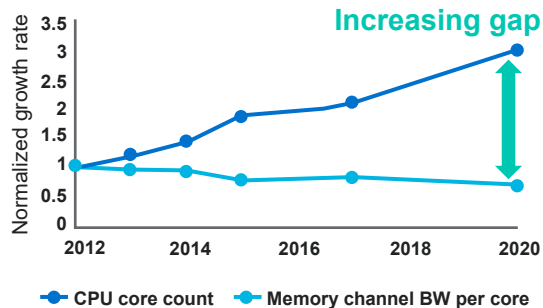
Source: Meta, OCP Summit Presentation Nov 2021

Degrades efficiency

No near-memory compute

DRAM DIMM
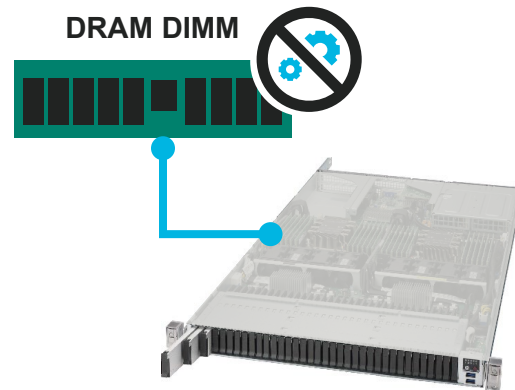
Limits performance

CXL is poised to address these issues
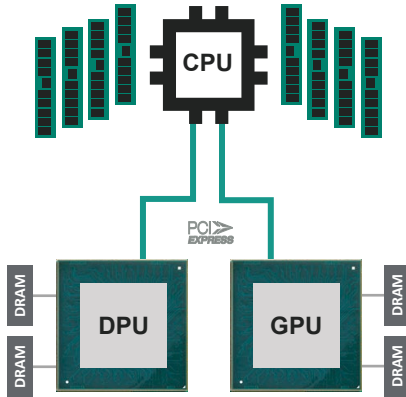
What is Compute Express Link (CXL)?
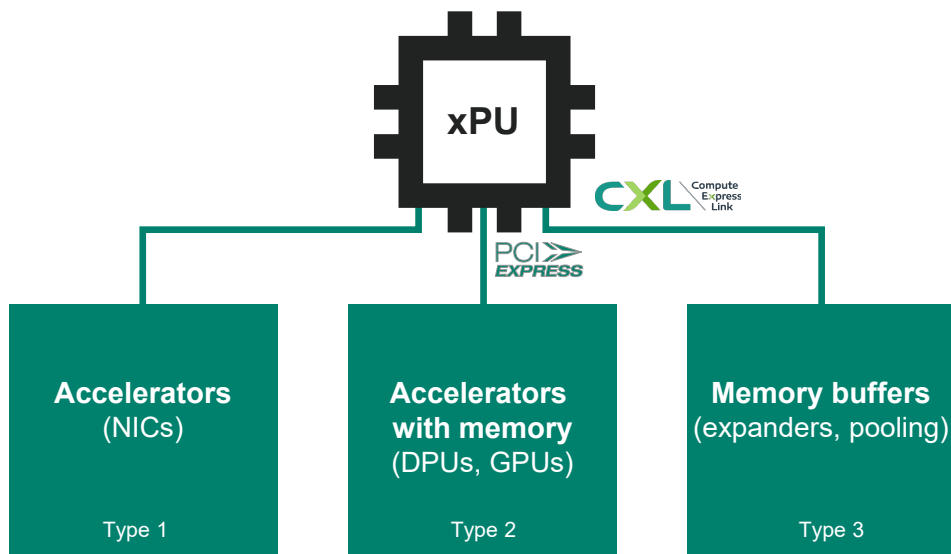
- Industry standard protocol
- Runs over PCI Express
- Low-latency interconnect
- Memory-optimized
- Cache-coherent

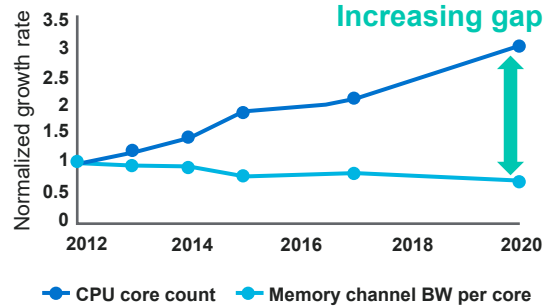**Tremendous ecosystem momentum driven by data center leaders**

Cloud data center memory challenges

Memory tied-down to xPUs

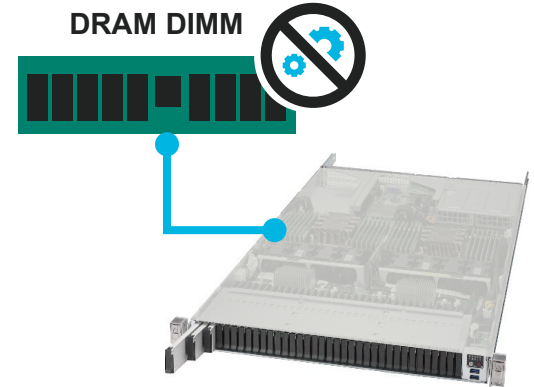

Cannot share

Bandwidth per core declining

Source: Meta, OCP Summit Presentation Nov 2021

Increasing gap

- CPU core count
- Memory channel BW per core

Degrades efficiency

No near-memory compute

DRAM DIMM

Limits performance

CXL is poised to address these issues

Cloud data center memory challenges

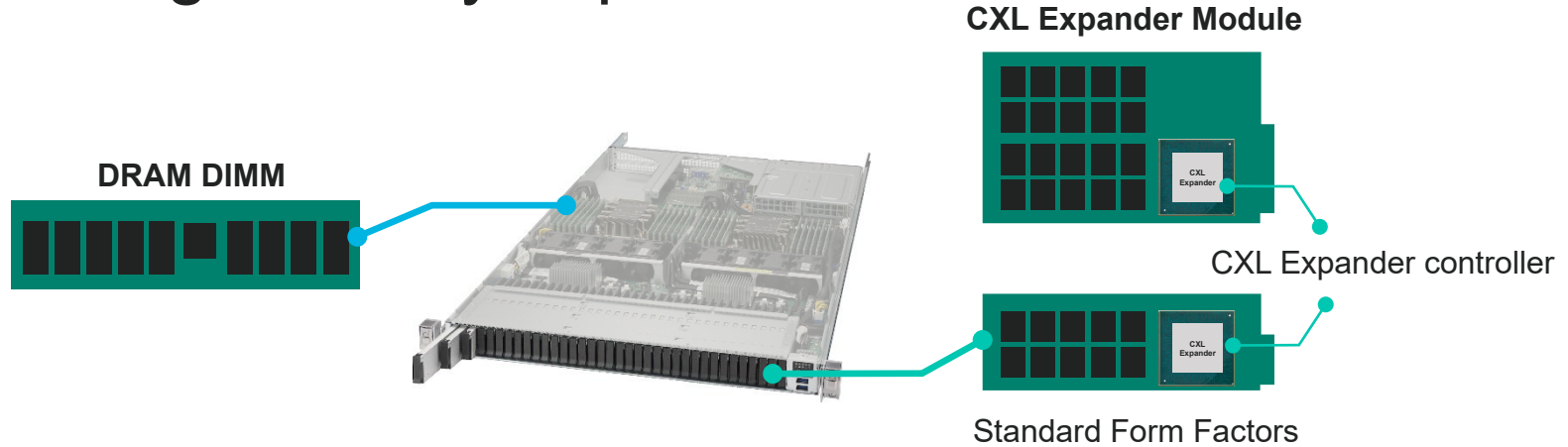| Memory tied-down to xPUs	Bandwidth per core declining	No near-memory compute
CXL Expander	CXL Expander	CXL Accelerator
CXL Pooling		
CXL Switch		

CXL is poised to address these issues

Addressing memory expansion

CXL Expander Module

DRAM DIMM

CXL Expander controller

Standard Form Factors

DIMM challenges
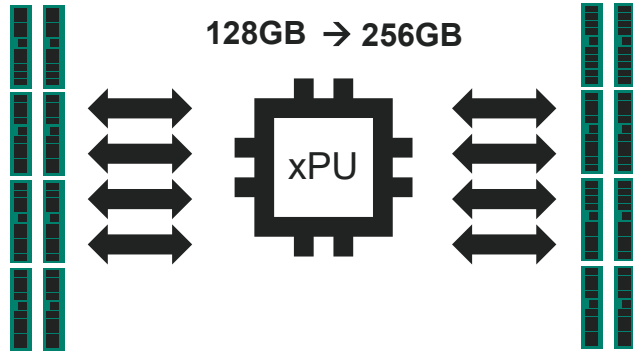
- Limited scalability
- Not serviceable
- No telemetry

CXL solution

- Scalable
- Improved thermals
- Pluggable
- Mix-and-match DRAM
- Telemetry
- Config flexibility

CXL memory expanders improve performance

Today: 2 DIMMs per channel (2DPC)

128GB → 256GB

xPU

1DPC same bandwidth as 2DPC

1DPC + CXL Expanders

128GB → 256GB

xPU

CXL Compute Express Link

CXL Expander
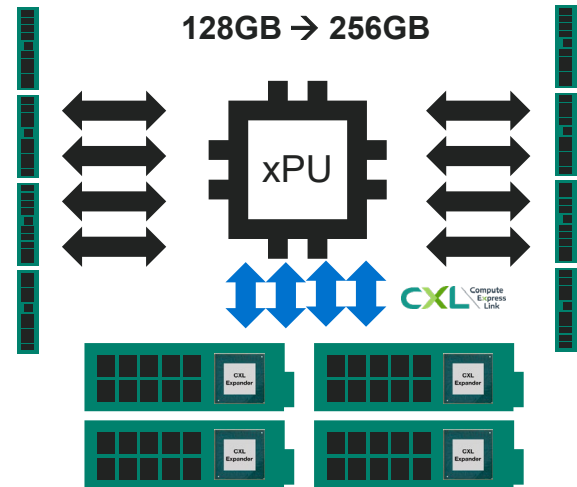
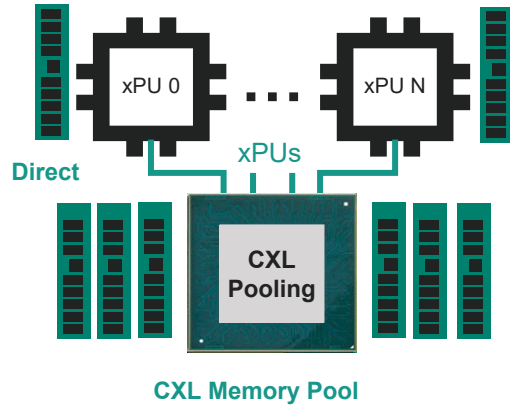Use PCI Express to open bandwidth

Same capacity with greater bandwidth and utilization
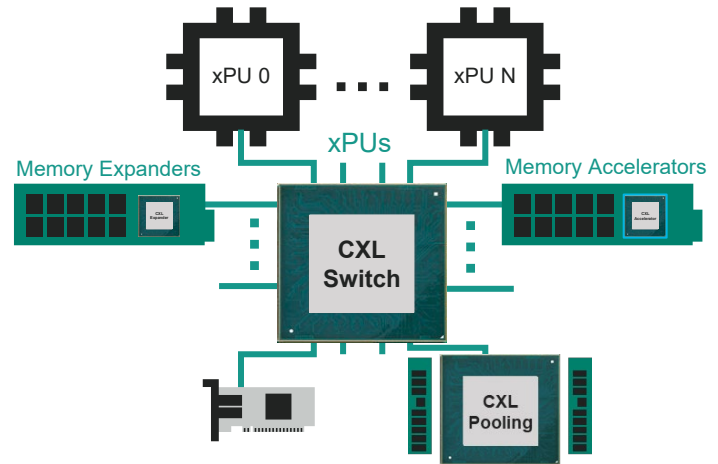
Sharing memory with CXL

CXL Pooling

CXL Memory Pool

- Pool memory across multiple xPUs
- Rescue under-utilized DRAM
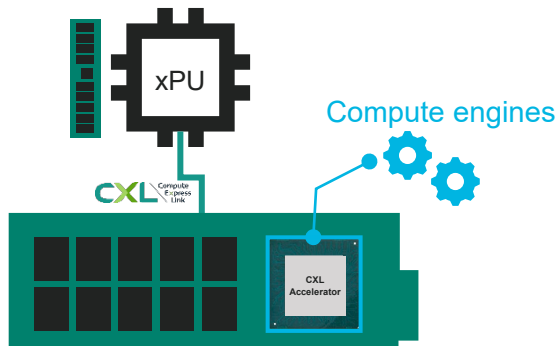- Scale memory independent of xPUs

CXL Switch

- Flexible to connect resources into fabric
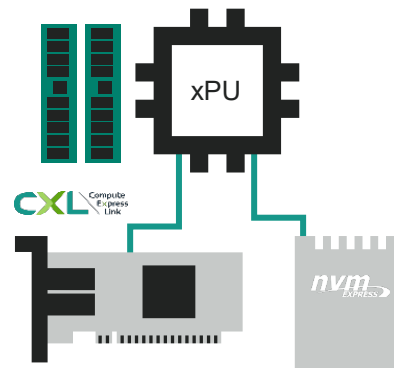- Scalable, serviceable
- Enables fully composable infrastructure
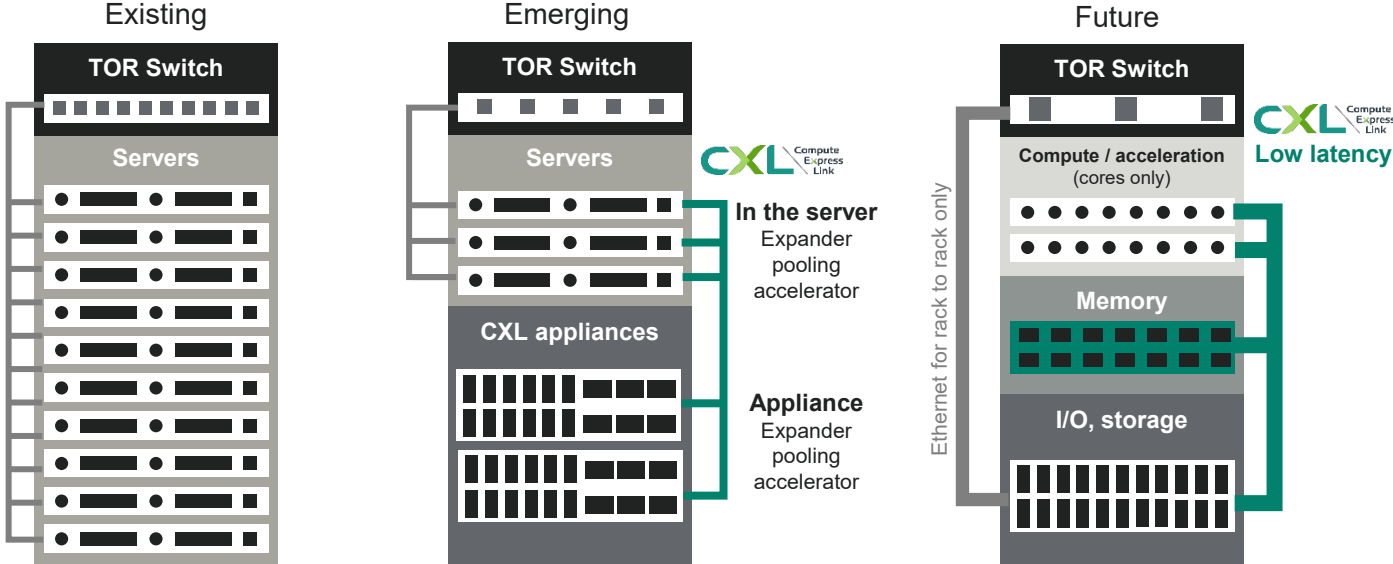
Accelerating with CXL

CXL Accelerator

- Coherent, efficient
- Accelerate analytics, ML, search, etc.
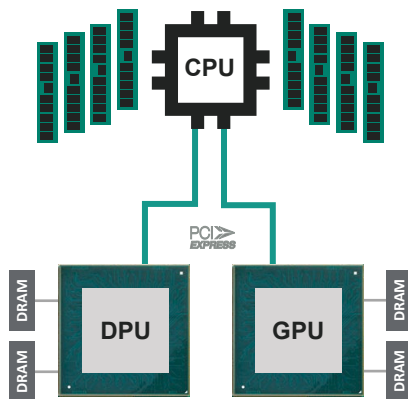- Improves efficiency and TCO

CXL I/O Acceleration

- DPU/NIC, SSD, …
- Accelerate protocol processing
- Composable I/O devices
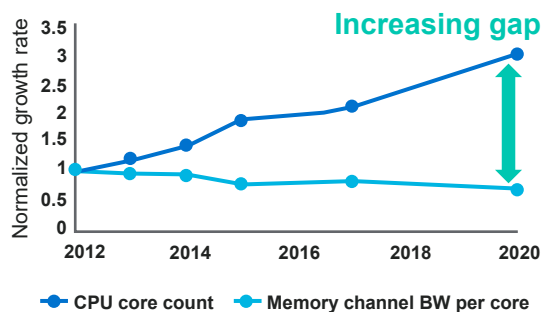
CXL data center vision: full composability

		Existing	Emerging	Future
Rack fabric		**Ethernet**	**Ethernet + CXL**	**CXL only**
Disaggregation		Storage and accelerators	+Partial memory	**+Full memory, all other**

Cloud data center memory challenges

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Increasing gap

Source: Meta, OCP Summit Presentation Nov 2021

● CPU core count ● Memory channel BW per core

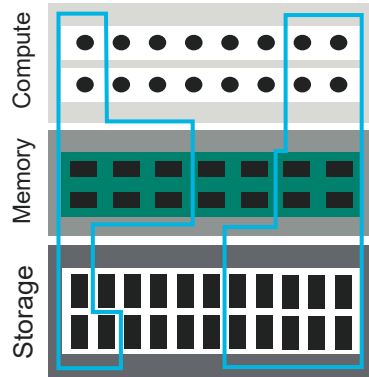**Degrades efficiency**

No near-memory compute

DRAM DIMM

Limits performance

CXL is poised to address these issues

CXL *solves* data center memory challenges

Disaggregated memory

Compute
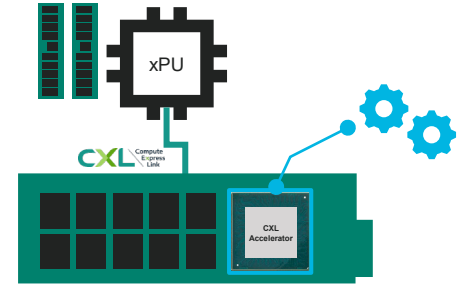
Memory

Storage

Fully composable

More bandwidth per core

xPU
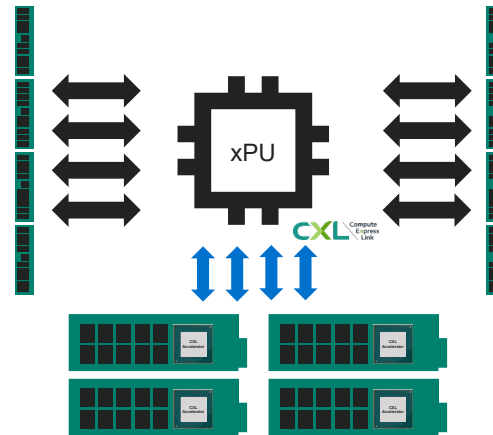
Optimize efficiency

Near-memory computation

xPU

Ultimate performance

CXL is disrupting cloud data center architectures

CXL technology roadmap

CXL 1.1

Architect

Memory Expanders

PCIe 5

CXL 2.0

Deploy

+ Pooling

+ Switch
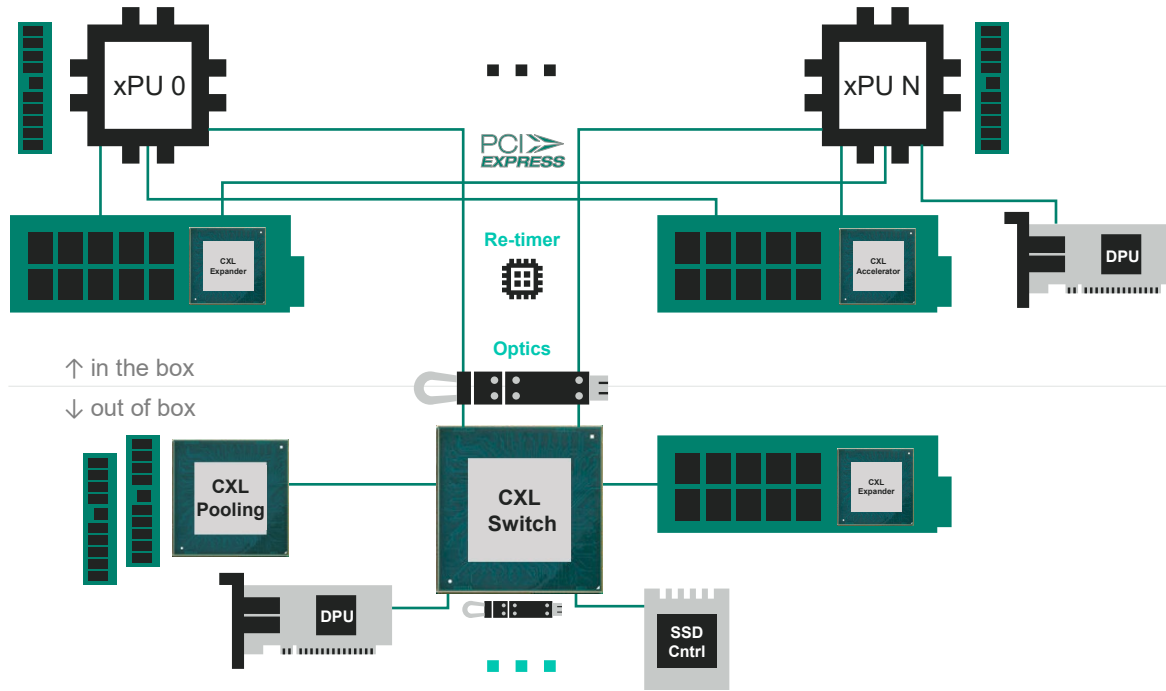
+ Accelerators

+ I/O

PCIe 5

CXL 3.0

Scale

+ Full hot plug

+ Switch w/ composability

PCIe 6

Comprehensive end-to-end CXL solutions

CXL opportunities

- Expanders
- Pooling
- Switch
- Accelerators
- Custom Compute
- DPUs / SmartNICs
- Electro-optics
- Re-timers
- SSD Controllers

Multi-billion $ opportunity

Summary

1	CXL is disrupting cloud data center architectures

2	Uniquely positioned to enable end-to-end CXL in data center

3	CXL is driving the next multi-billion-dollar opportunity

Thank You

MARVELL™

Essential technology, done right