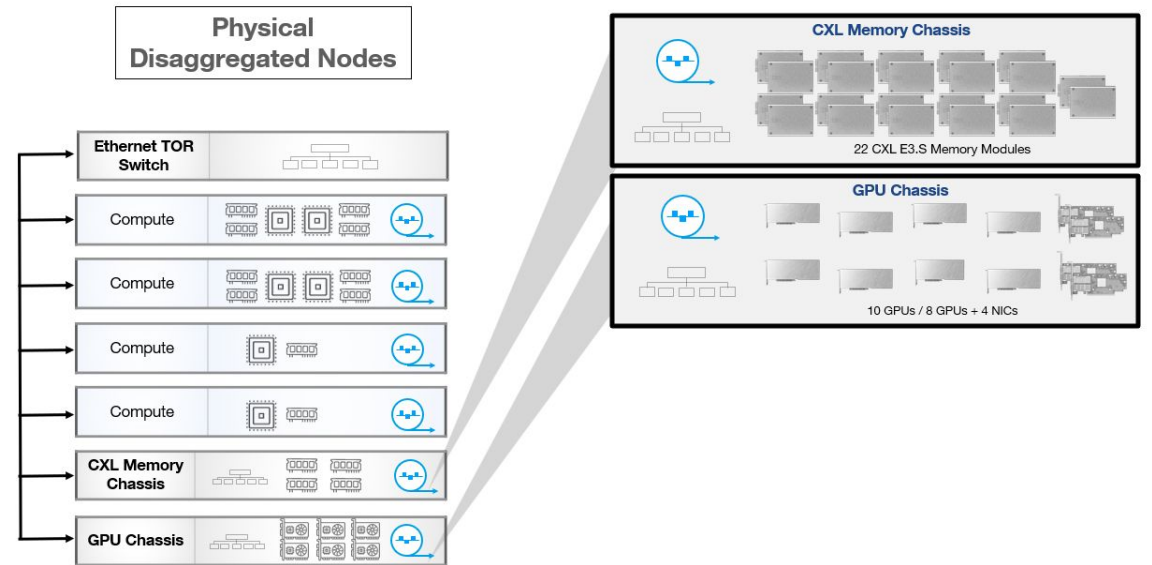


H3 Platform

Composable Infrastructure



Agenda

The logo consists of the letters 'H' and '3' in a bold, sans-serif font. The 'H' is black, and the '3' is blue. The logo is positioned in the top right corner of the slide, partially overlapping a decorative graphic of blue and white wavy lines.

- ❏ CXL 2.0 Solution Architecture
- ❏ Falcon C5022 Overview
- ❏ Falcon C5022 Testing Results
- ❏ Sample and Component Price
- ❏ Component Picture



Agenda

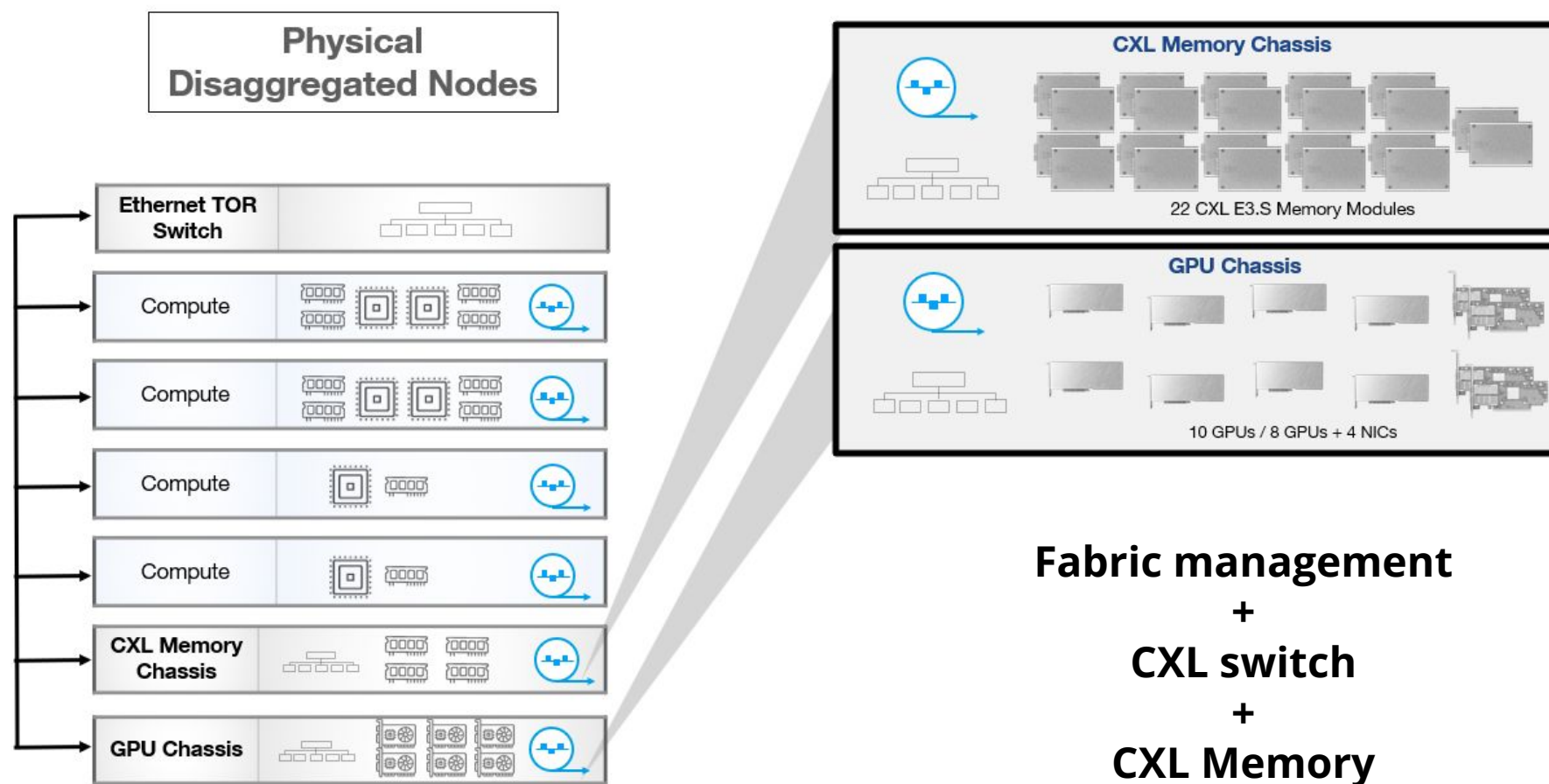
- ❏ CXL Cluster and Usage Case
- ❏ CXL Direct-attached Mode
- ❏ CXL 2.0 VCS Mode

The logo consists of the characters 'H3' in a bold, sans-serif font. The 'H' is black, and the '3' is blue. The logo is positioned in the top right corner of the slide, partially overlapping a decorative graphic of blue wavy lines.

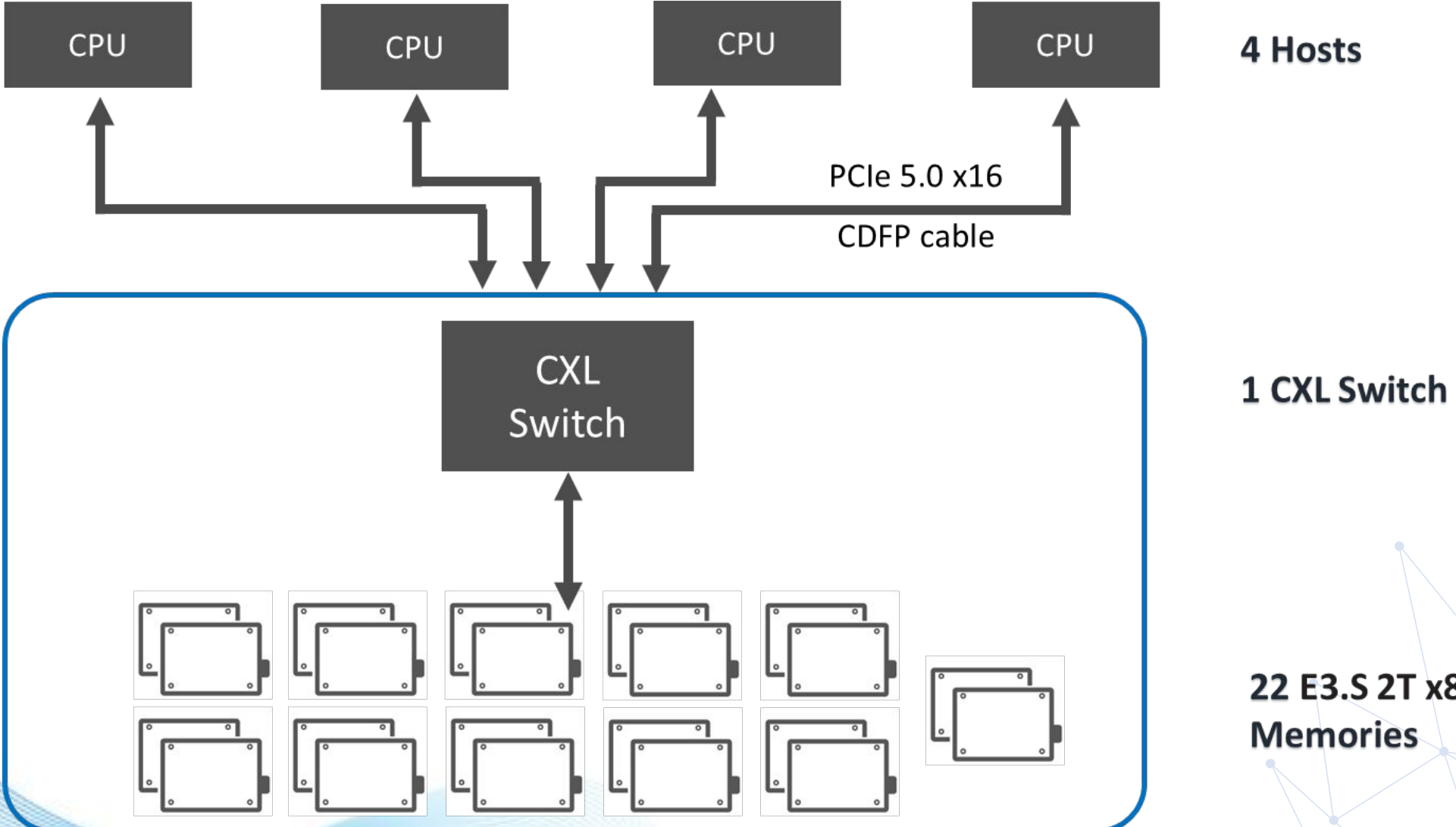
H3



Architecture: CXL 2.0 Memory Pooling and Sharing



Topology: 4 Hosts and One Falcon C5022



Chassis Front View



Top Cover

Press the button to open the top cover and to pull out the fans for replacement.



Buttons & LEDs

Power control
Power LED
UID LED

E3.S 2T Memory Slots

22 E3.S 2T slots
PCIe Gen5 x8

Chassis Rear View



BMC Port

RJ45 Ethernet port of BMC for chassis management

UID LED

Quickly locate device

Expandable PCIe Slots

Flexible configuration for double-width CXL AIC form factor cards or retimer cards

USB Ports

Only for H3 USB recovery and installation

VGA Port

Management Ports

RJ45 Ethernet port to access GUI

Host Ports

4 CDFP connectors

PSU

Redundant 1600W (1+1) Power Supplies



Chassis Top View



MCIO Cables

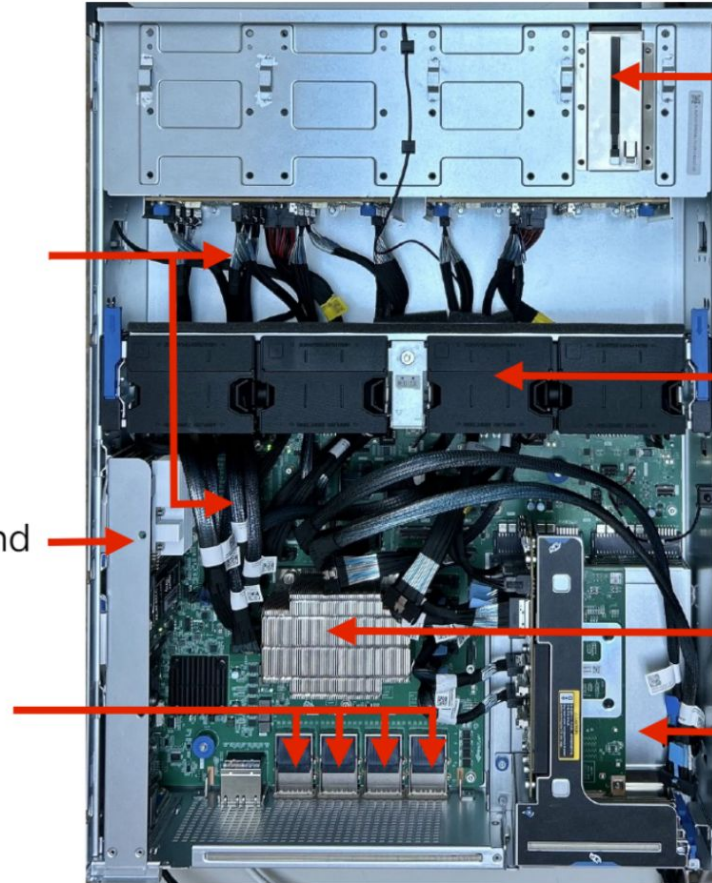
connect switch ports to device slots or to expandable PCIe slots

BMC and mCPU

Chassis management and Device management

Host Ports

4 CDFP connectors



E3.S 2T Memory Slots

22 E3.S 2T slots
PCIe Gen5 x8

4 System Fans

CXL Switch

Xconn XC50256 Switch

Expandable PCIe Slots

Flexible configuration for double-width CXL AIC form factor cards or retimer cards

Software Features

Model Name

Falcon C5022

Management Interface

Redfish®, RESTful API, GUI

Fabric Manager

- Composable memory sharing among hosts
- Memory surprise add and remove
- CXL port configuration to host or device ports
- Configurable host memory address
- Link capability and status

Software Features of Memory Appliance Overview

Management System Features

- Real-time performance and link errors monitoring
- Device health status, power, and temperature management
- ELK central log server integration
- User authentication and role-based access control management

GUI: System Overview



NOTIFICATION (Latest 100)

| | |
|---------|-----|
| ERROR | 0 |
| WARNING | 0 |
| INFO | 100 |

THERMAL

| | |
|----------------|-----|
| Board | N/A |
| Device Average | N/A |
| CXL Switch | N/A |

SYSTEM PROFILE

| | |
|----------------|------------------------------|
| Model | Falcon C5022 |
| Vendor | H3 Platform Inc. |
| Serial Number | N/A |
| MAC Address | N/A |
| Firmware | 0.4.75 2024-12-16 |
| System Address | 192.168.1.35 |
| BMC Address | 192.168.1.30 |

Device

| | |
|--|--------------------------------|
| Switch #0 Port #4 CXL Memory Expander | Available: 128 GB, Bound: 0 GB |
| Switch #0 Port #11 CXL Memory Expander | Available: 128 GB, Bound: 0 GB |

GUI: Host/ Memory/ Binding Status



Resource Management

Host List [Bind](#) [Unbind](#) [Host Settings](#)

| | Switch Port# | CXL Type | Link Capability | Host Base Address | CXL Memory | Memory Chunk(s) | |
|-------------------------------------|--------------------|----------|-----------------|-------------------|------------|-----------------|---|
| <input checked="" type="checkbox"/> | Switch #0 Port #2 | 3 | No link | 88000000 | 0 GB | 0 | ▼ |
| <input type="checkbox"/> | Switch #0 Port #3 | 3 | No link | 2200 | 0 GB | 0 | ▼ |
| <input type="checkbox"/> | Switch #0 Port #9 | 3 | No link | N/A | 0 GB | 0 | ▼ |
| <input type="checkbox"/> | Switch #0 Port #12 | 3 | No link | 88000000 | 0 GB | 0 | ▼ |
| <input type="checkbox"/> | Switch #0 Port #14 | 3 | No link | 88000000 | 0 GB | 0 | ▼ |
| <input type="checkbox"/> | Switch #0 Port #15 | 3 | No link | 88000000 | 0 GB | 0 | ▼ |

Device List

| Switch Port# | Name | Memory Size | Link Capability | Status | Assigned to | Temperature | |
|-------------------|--|-------------|-----------------|-----------|-------------|-------------|---|
| Switch #0 Port #0 | | | No link | Empty | | | ▼ |
| Switch #0 Port #1 | | | No link | Empty | | | ▼ |
| Switch #0 Port #4 | CXL Memory Expander Controller M88MX5891 | 128 GB | Gen5x8 | Available | | N/A | ▼ |
| Switch #0 Port #5 | | | No link | Empty | | | ▼ |
| Switch #0 Port #6 | | | No link | Empty | | | ▼ |
| Switch #0 Port #7 | | | No link | Empty | | | ▼ |

GUI: Bind/ Unbind Memory to Host



Resource Management

Bind CXL Device of Server (Switch #0 Port #2)

Direct Mode - If your server platform does not have hot-plug capability, please power off the connected servers before clicking on [Yes] to proceed with "Unbind Action" operation.

| Switch Port# | Memory (Used/Total) | Alloc | Share |
|--------------------|---------------------|-------|---------|
| Switch #0 Port #4 | 0 GB / 128 GB | 128 | Private |
| Switch #0 Port #11 | 0 GB / 128 GB | 128 | Private |

Bound Memory Chunk List

Switch Port# Memory in use

No Memory Chunk is bound to the host

Bind >

< Unbind All

Undo

No Yes

GUI: Port Configuration



GUI Screenshot: Port Configuration

Navigation Menu:

- Overview
- Resource Manageme...
- Port Config
- Maintenance
- Event Logs
- Setting

Top Bar: Auto Refresh, admin (Administrator), Refresh, Home

Port Config

Undo Apply

| Switch Port# | Link Status | Port Type | Link Width | Port Type Config | Link Width Config |
|-------------------|-------------|------------|------------|------------------|-------------------|
| Switch #0 Port #0 | Gen1x1 | Device | x8 | Device | x8 |
| Switch #0 Port #1 | Gen1x1 | Device | x8 | Device | x8 |
| Switch #0 Port #2 | Gen1x1 | Host | x16 | Host | x16 |
| Switch #0 Port #3 | Gen1x1 | Host | x16 | Host | x16 |
| Switch #0 Port #4 | Gen5x8 | Device | x8 | Device | x8 |
| Switch #0 Port #5 | Gen1x1 | Device | x8 | Device | x8 |
| Switch #0 Port #6 | Gen1x1 | Device | x8 | Device | x8 |
| Switch #0 Port #7 | Gen1x1 | Device | x8 | Device | x8 |
| Switch #0 Port #8 | Gen1x1 | Management | x16 | Management | x16 |

Restful API Example

H3

```
▼ CXL RESTful API
  > Auth
  ▼ CXL
    > GET /h3api/v1/CXLDevices
    > POST /h3api/v1/CXLDevices
    > GET /h3api/v1/CXLDevices/<Device_Id>
    > PATCH /h3api/v1/CXLDevices/<Device_Id>
    > GET /h3api/v1/CXLDevices/<Device_Id>/MemoryChunks
    > GET /h3api/v1/CXLDevices/<Device_Id>/MemoryChunks/<Id>
    PATCH /h3api/v1/CXLDevices/<Device_Id>/MemoryChunks/<Id>
    > GET /h3api/v1/Port
    > POST /h3api/v1/Port
    PUT /h3api/v1/Port
    > GET /h3api/v1/Port/<Id>
    PATCH /h3api/v1/Port/<Id>
    > GET /h3api/v1/Hosts
    POST /h3api/v1/Hosts
    GET /h3api/v1/Hosts/<Host_Id>
    PATCH /h3api/v1/Hosts/<Host_Id>
    PATCH /h3api/v1/Hosts/<Host_Id>
    POST /h3api/v1/Hosts/<Host_Id>/HMD
    GET /h3api/v1/Profile
```

```
Body Cookies Headers (4) Test Results
Pretty Raw Preview Visualize JSON ↕
1 [
2   {
3     "BusNumber": "04:00.00",
4     "DeviceId": "c000",
5     "HostPort": "3",
6     "MappedMemoryCapacify": "128",
7     "MemoryCapacity": "128",
8     "ModelName": "CXL Memory Expander",
9     "PortNumber": "10",
10    "VendorId": "1b00",
11    "VendorName": "Montage Technology Co., Ltd."
12  },
13  {
14    "BusNumber": "27:00.00",
15    "DeviceId": "c000",
16    "HostPort": "",
17    "MappedMemoryCapacify": "",
18    "MemoryCapacity": "512",
19    "ModelName": "CXL Memory Expander",
20    "PortNumber": "11",
21    "VendorId": "1b00",
22    "VendorName": "Montage Technology Co., Ltd."
23  },
}
```

Restful API User Manual



| | |
|---|-----------|
| 4 API Definition | 11 |
| 4.1 GET /H3api/Hosts | 11 |
| 4.2 GET /H3api/PCleSlots | 12 |
| 4.3 PATCH /H3api/PCleSlots/<Slot_ID> | 13 |
| 4.4 GET /H3api/PCleDevices | 13 |
| 4.5 GET /H3api/PCleDevices/<Device_ID> | 14 |
| 4.6 POST /H3api/PCleDevices | 15 |
| 4.7 PATCH /H3api/PCleDevices/<Device_ID> | 15 |
| 4.8 GET /H3api/PCleDevices/<Device_ID>/Functions | 16 |
| 4.9 GET /H3api/PCleDevices/<Device_ID>/Functions/<Function_ID> | 17 |
| 4.10 PATCH /H3api/PCleDevices/<Device_ID>/Functions/<Function_ID> | 18 |
| 4.11 GET /CXLDDevices | 18 |
| 4.12 GET /CXLDDevices/<Device_ID> | 20 |
| 4.13 GET /CXLDDevices/<Device_ID>/MDs | 20 |
| 4.14 POST /CXLDDevices/<Device_ID>/MDs | 21 |
| 4.15 PATCH /CXLDDevices/MDs/<MD_ID> | 22 |
| 4.16 DELETE /CXLDDevices/<Device_ID>/MDs/<MD_id> | 23 |

Key Hardware Specification

| | |
|-------------------------|---|
| Model Name | Falcon C5022 |
| CXL Switch | 1 Xconn XC50256 CXL Switch |
| mCPU | Intel ATOM x86 CPU |
| BMC | Aspeed AST2600 |
| CXL Device Slots | Twenty-two (22) E3.S 2T PCIe Gen5 x8 slots |

Key Hardware Specification

Host Interface - Configuration

Power

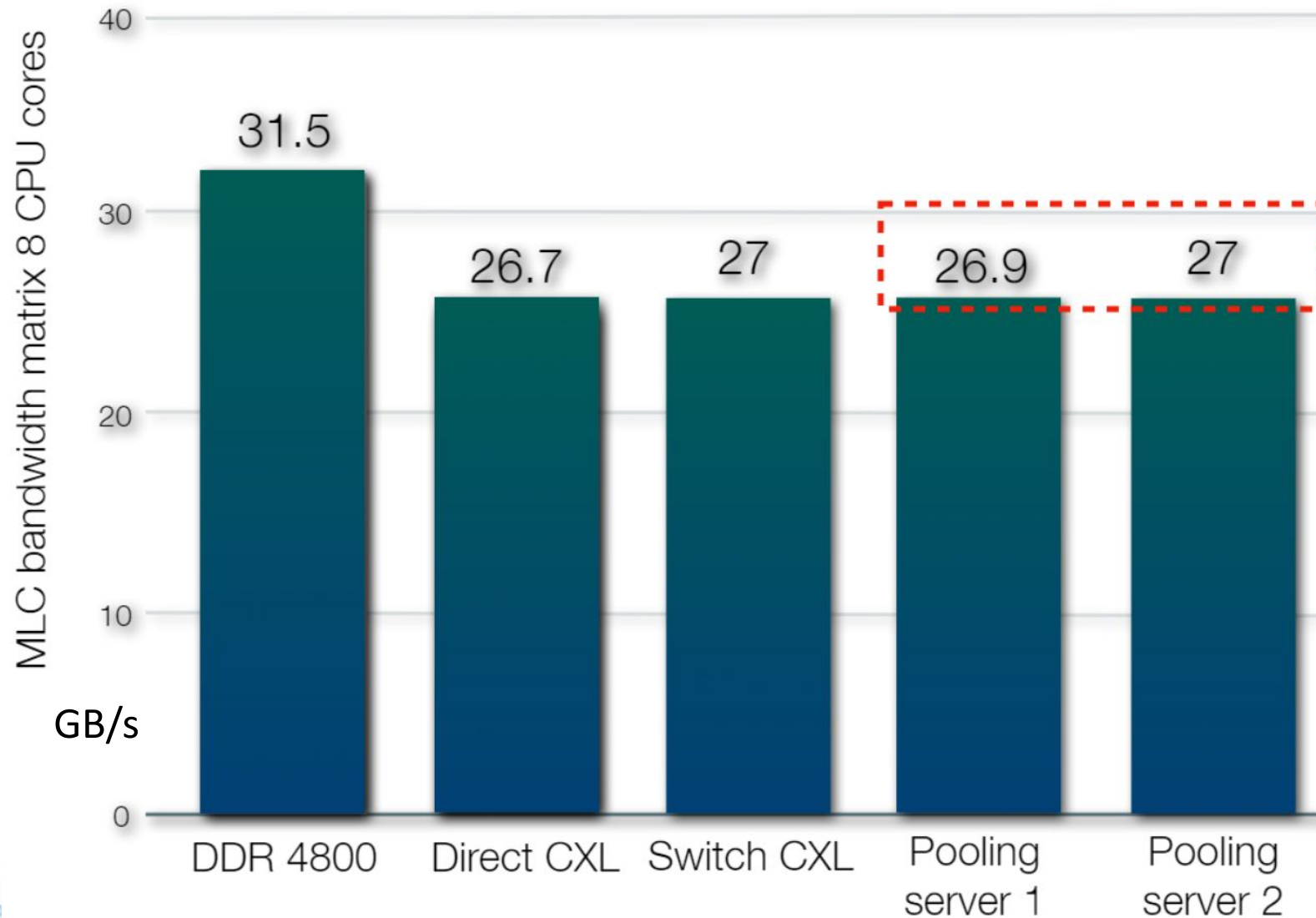
Fan

LAN

Dimensions

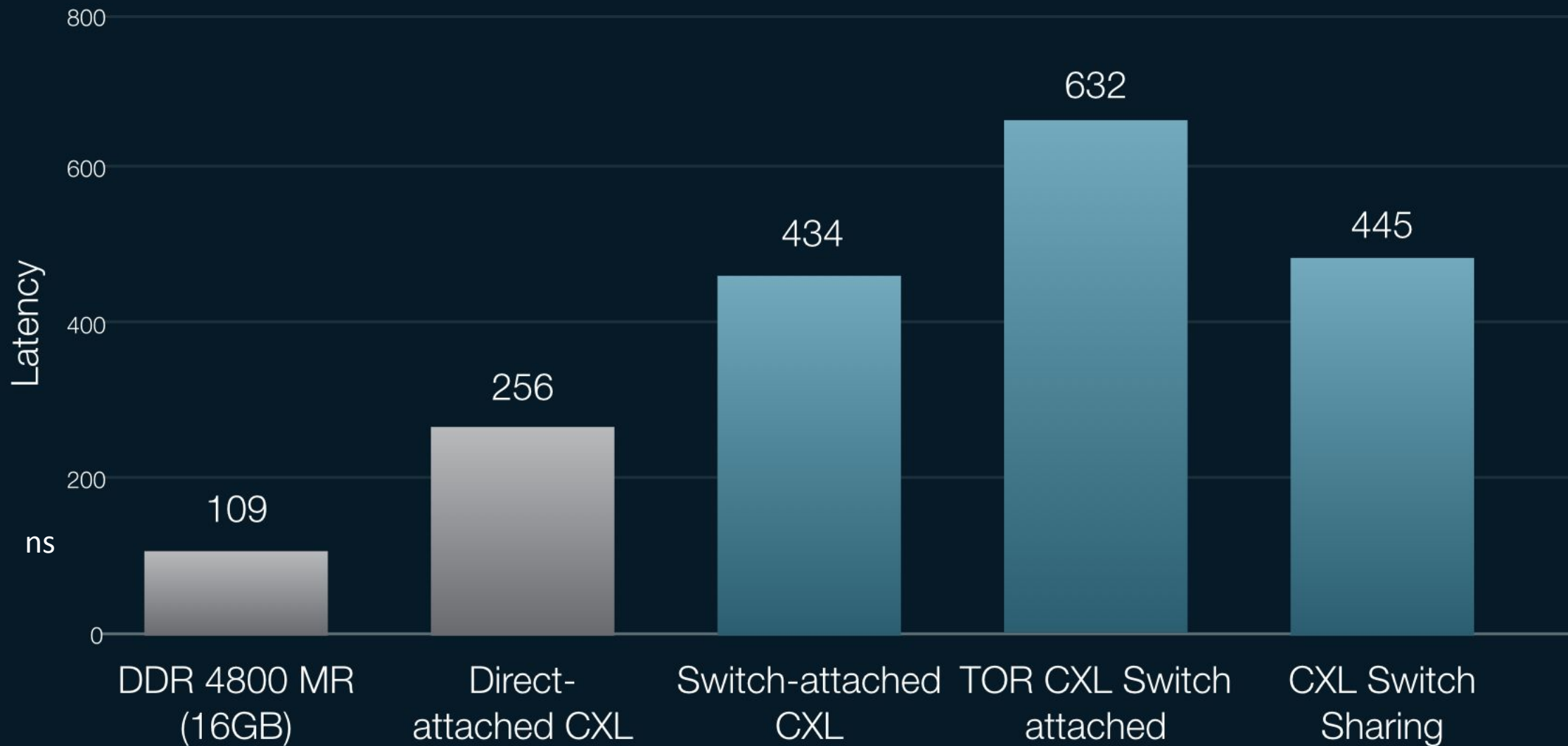
- Up to Eight (8) PCIe 5.0 x16 (Eight CDFP connectors)
- **One HBA** (host bus adapter) card on server host to connect to C5022 host port
- Two 2 (1+1) 1600W PSU CRPS
- Four (4) 80mm x 80mm hot-swap fans
- Five (5) RJ45 Gigabit Ethernet LAN port
- 3U; 130.35(H)*447(W)*670(D) mm

Test Results: Intel MLC 3.1 Max Bandwidth

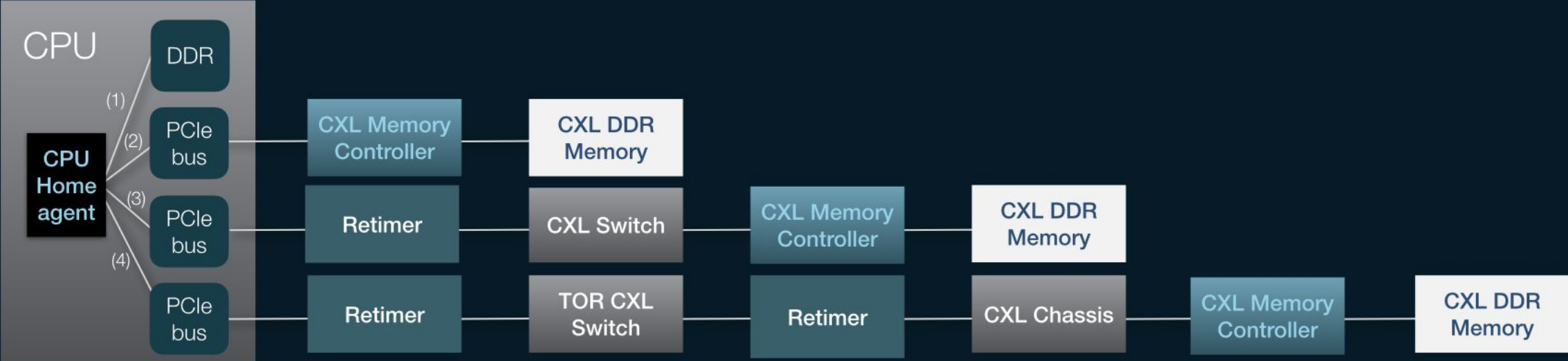


- Intel Xeon 5th Gen server 64 cores
- Linux 6.6.7 kernel

TESTING RESULT LATENCY COMPARISON OF DIFFERENT TOPOLOGY



ROUTE FROM CPU TO MEMORY



SKU Information

| SKU | Contents | Price (USD) |
|--|--|--|
| SKU1-- 2 Intel GNR servers+ CXL Appliance+ 4 Samsung memory modules | <ul style="list-style-type: none">• 1 CXL memory appliance• 2 GNR servers without CPU and memory• 4 Samsung E3.S 2T memory modules | <ul style="list-style-type: none">• \$ 27,000• \$ 12,156 (1U) / \$ 14,436 (2U)• \$ 8,239 (128GB) / \$ 20,271 (256GB) |
| SKU2-- 2 Intel GNR servers+ CXL Appliance+ 4 Micron memory modules | <ul style="list-style-type: none">• 1 CXL memory appliance• 2 GNR servers without CPU and memory• 4 Micron E3.S 2T memory modules | <ul style="list-style-type: none">• \$ 27,000• \$ 12,156 (1U) / \$ 14,436 (2U)• \$ 6,603 (128GB) / \$ 11,700 (256GB) |

Falcon C5022 Sample Price Information

| Description | | Amount (USD) | |
|-------------|--|--------------|------------|
| No | Item | Q'ty | Price |
| 1 | CXL 2.0 Chassis - 3U 22 slots main chassis (2x 1600W PSU) | 1 | |
| 2 | Standard E3.S 2T tray | 22 | |
| 3 | PCIE Gen5 x16 lanes CDFP retiemr card (for host server) | 4 | |
| 4 | CDFP to CDFP Cable (1 meter) | 4 | |
| 5 | Slide rail | 1 | |
| END | | | |
| | | | US\$27,000 |

E3.S Price

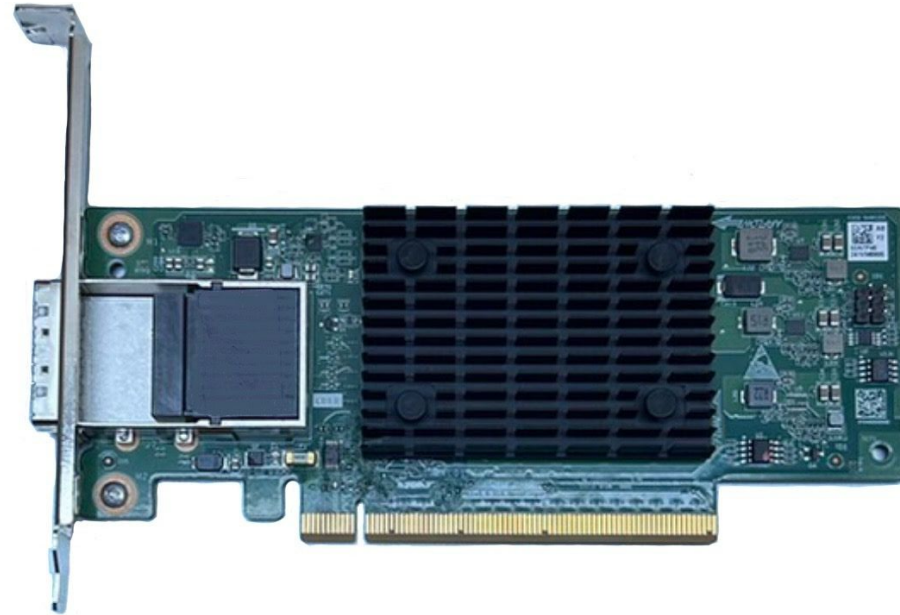
| Description | | Amount (USD) | |
|-------------|-------------------------------------|--------------|-------|
| No | Item | Q'ty | Price |
| 1 | Samsung CXL 2.0 Memory MD-220 256GB | 1 | 5,068 |
| 2 | Samsung CXL 2.0 Memory MD-220 128GB | 1 | 2,060 |
| 3 | Micron CXL 2.0 Memory CZ-122 256GB | 1 | 2,925 |
| 4 | Micron CXL 2.0 Memory CZ-122 128GB | 1 | 1,651 |
| END | | | |
| | | | |

AIC GNR Server Price Information

| Description | | Amount (USD) |
|-------------|---|--------------|
| No | Item | Q'ty Price |
| 1 | GNR server (1U server) 12-bay 2.5" hot-swap, 3x PCIe Gen.5 NVMe 4-port backplane , 8x 4028 FAN, 2x Gen-Z to PCIe x16 riser (for add-on card support), 2000W redundant CRPS Titanium, w/ liquid cooling (pumpless type x 2pcs), 6 x MICO cables , w/ MB, 28" slide rail, w/o bezel | 1 6,078 |
| 2 | GNR server (2U server) 24-bay 2.5" hot-swap, 3x PCIe Gen.5 NVMe 8-port backplane , 2x 2.5" SATA hot-swap, 4x 8056 FAN, 2x Gen-Z to PCIe x16 riser (for add-on card support), w/ air cool (2U standard heatsink x 2pcs), 2000W redundant CRPS Titanium, 12 xMICO cables , w/ MB, 28" slide rail, w/o bezel | 1 7,218 |
| END | | |



Host Adapter-- HHHL Re-timer Card



Installing in Intel GNR/ AMD Turin server for connecting to H3 CXL memory chassis

1m CDFP Cable



Connecting the EMR server to H3 CXL
memory chassis

Micron CXL Memory Module (256GB/ 128GB)



Micron CZ122 CXL Memory 256GB and 128GB

Samsung CXL Memory Module (128GB/ 256GB)

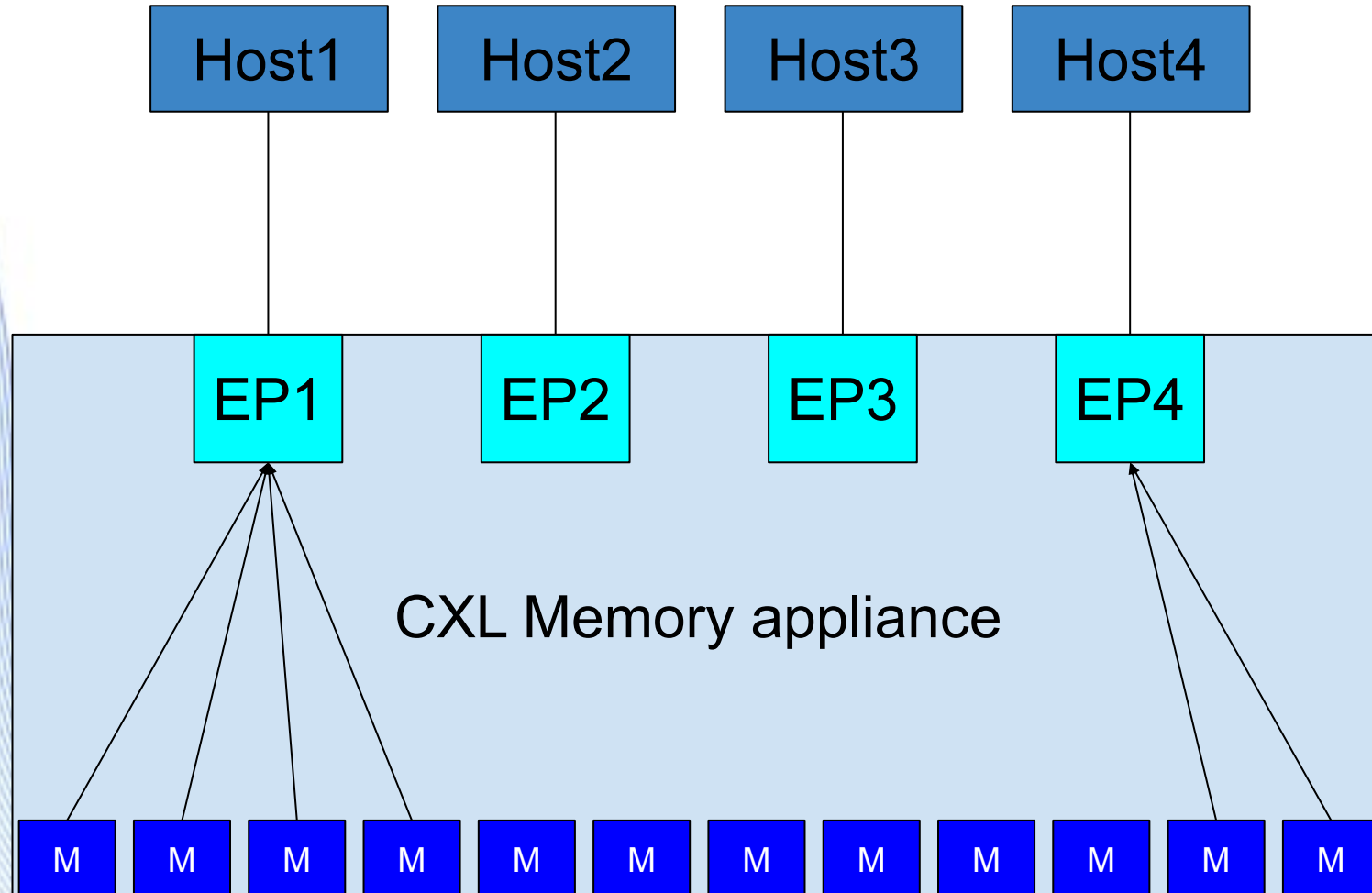


Samsung MD-220 CXL Memory 256GB

CXL Cluster-- Server, Memory, OS

| | CXL 1.1 Direct-Attached Mode | CXL 2.0 VCS Mode (working on) |
|---------------------------------------|--|--------------------------------------|
| Intel CPU | Granite Rapids (GNR) | Granite Rapids (GNR) |
| AMD CPU | Turin | Turin |
| CXL Memory Modules | | |
| Samsung | CMM-D MD220 (128GB & 256GB) | |
| Micron | CZ122 Memory Expansion Module (128GB & 256GB) | |
| Customized OS for CXL Solution | | |
| Linux Kernel | 6.2 for CXL 1.1 direct-attached mode 6.3 or later for CXL 2.0 VCS mode (no VPPB DEVSEC 8 support) | |
| Linux version | Ubuntu 22.04 LTS or 24.04 LTS | |

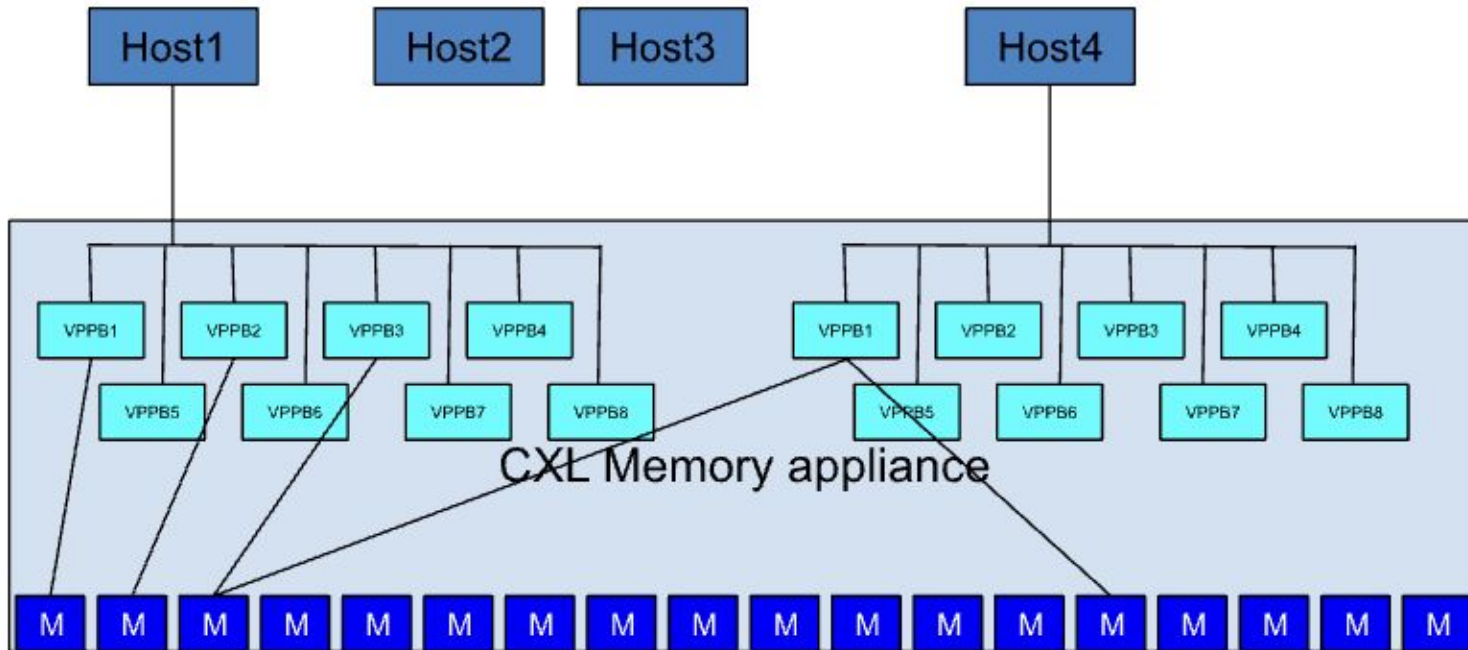
Usage Case 1-- Direct-attached Mode



CXL 1.1 configuration

1. CXL switch simulate the end points on the host port
2. CXL memory bound to the end points
3. Host scan the end point and create the host memory address for end point

Usage Case 2-- CXL 2.0 VCS Mode



CXL 2.0 configuration

1. The CXL switch creates virtual CXL devices (VCDs) for upstream ports (hosts)
2. CXL memory modules are mapped to these VCDs.
3. Each upstream port supports 4 VCDs, each with a 256GB memory capacity.

Testing Configuration-- Direct Mode

Purpose

The direct-attached mode works as describe

- Intel GNR and AMD Turin
- Standard BIOS with specific BIOS settings
- End point is from 256GB to 4T
- 4 hosts for 22x E3.S
- Samsung and Micron CXL E3.S 2T Memory
- Linux kernel 6.2.x or later
- Ubuntu 22.04 LTS or 24.04 LTS

Cluster Configuration

Feature-- Direct Mode

Feature List

- CXL memory read/ write by hosts
- CXL memory pooling among hosts
- Memory surprise add and remove ONLY in chassis (host memory hotplug is NOT supported)
- Configurable EP memory address (from 256GB to 4T)
- CXL memory mapping status
- CXL memory health status

Feature Testings-- Direct Mode

Feature List

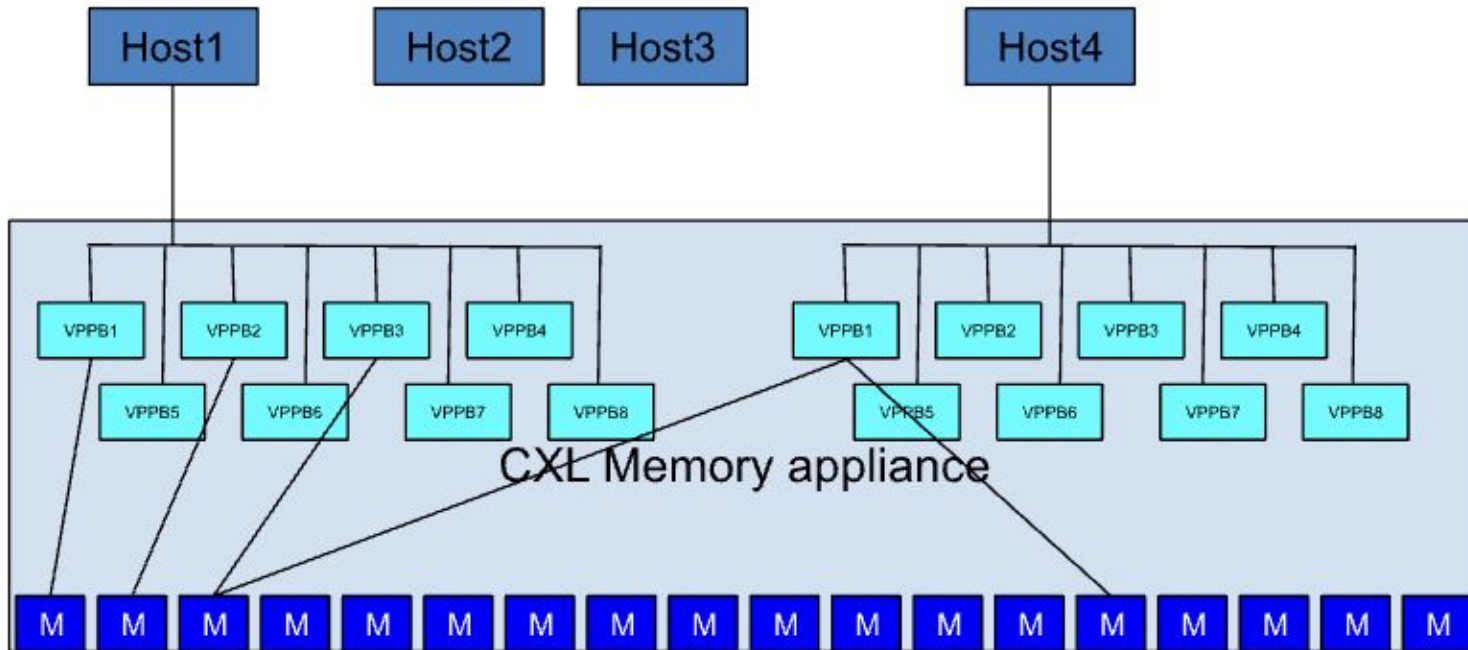
- CXL memory module LED light and chassis LED
- Link capability and status
- CXL memory co file
- Log dump and package
- SPI image update in the field (Xconn, JTAG header for mCPU SPI update)

Usage Scenario-- Direct Mode

Usage Scenario

- Whole memory module assignment
- Continuous memory address
- No memory hotplug on the host EP
- Only tested CXL E3.S memory module
- No AIC form factor memory usage

Usage Case 2-- CXL 2.0 VCS Mode



CXL 2.0 configuration

1. The CXL switch creates virtual CXL devices (VCDs) for upstream ports (hosts)
2. CXL memory modules are mapped to these VCDs.
3. Each upstream port supports 4 VCDs, each with a 256GB memory capacity.

Testing Configuration-- VCS Mode

Purpose

The VCS mode works as described

- Intel GNR and AMD Turin
- Standard BIOS with specific BIOS settings
- 8 VCS virtual devices on one root port
- The memory size of VCS virtual device is 256GB

Cluster Configuration

- 4 hosts with 32 VCS devices
- Samsung and Micron CXL E3.S 2T Memory
- Linux kernel 6.9 or later
- Ubuntu 22.04 LTS or later

Testing Configuration-- VCS Mode

Cluster Configuration

- Mixed Intel GNR and AMD Turin servers in one cluster
- Each server is with different DDR memory capacity
- Some hosts are with 1 root port connection while others are with multiple root port connections
- Various bound CXL memory to hosts
- Multiple access type and data size support

Feature Testings-- VCS Mode

Feature List

- CXL memory read/ write by hosts
- CXL memory pooling and sharing among hosts
- Memory surprise add and remove in chassis and host
- Auto-detect host memory address then write to the CXL global memory address
- CXL memory mapping status

Feature Testings-- VCS Mode

Feature List

- CXL memory health status
- CXL memory module LED light and and chassis LED
- Link capability and status

Usage Scenario-- VCS Mode

Usage Scenario

- Whole memory module assignment
- Assigned host memory address
- With memory hotplug on the host VCS
- The exact Linux version and operation procedures to avoid the DEVSEC 8 check
- Only tested CXL E3.S memory module
- No AIC form factor memory usage