Backpack: Facebook’s 100G Modular Switch
Deep Dive

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Backpack System Introduction
Backpack: an open modular switch

- Hardware architecture: Ethernet only, fully open
- Network topology: dual stage spine-leaf
- Switch Software: FBOSS and OpenBMC
- Manageability: operated like server from BMC
- Density: 128 x QSFP28 100G support
- Building block: SWE (Switch Element)
  - Data plane: Tomahawk Switch ASIC
  - Control Plane: COM-e BayTrail CPU Module
  - Management Plane: BMC AST1250
Backpack: FB Modular Switch Platform

- Orthogonal Direct Architecture
- Disaggregated data, control, and management plane design
Innovative Design

- Fully Disaggregated Architecture
  - 12 Switch Elements (SWE)
  - Separate SCM module for Control CPU

- An Orthogonal Direct Chassis Architecture
  - All major module cards are designed to be mated orthogonally
  - Open up more air channel for a better thermal performance
  - Reduce the PCB trace length for better signal integrity
  - Support future 8x16 OD connector to double port and speed

- A sophisticated thermal design to support low cost 55C CWDM4 optics
Backpack System Components

- Line Cards (LC)
- Fabric Card (FAB)
- System Controller Module (SCM)
- Chassis Management Module (CMM)
- Horizontal Control Plane (HCP)
- Vertical Control Plane (VCP-L, VCP-R)
- Bus Bar Assembly (BBA)
  - Horizontal Bus Bar (HBAR)
  - Vertical Bus Bar (VBAR)
  - Horizontal Power Distribution Board (HPD)
- Fan Control Board (FCB)
- Power Distribution Board (PDB)
Backpack Rear view

- FAB-3
- FAB-4
- FAN-1 of FAB-4
- FAN-1 of FAB-3
- FAN-2 of FAB-4
- FAN-2 of FAB-3
- FAN-3 of FAB-4
- FAN-3 of FAB-3
- FAB-2
- FAB-1
- FAN-1 of FAB-1
- FAN-1 of FAB-2
- FAN-2 of FAB-1
- FAN-2 of FAB-2
- FAN-3 of FAB-1
- FAN-3 of FAB-2
Rear view without FAB

- VCP right
- Middle Alignment Frame
- Horizontal Control Plane (HCP)
- VCP left
- VBAR, Part of BBA (Bus Bar Assembly)
- HPD, Part of BBA (Bus Bar Assembly)
Line Card (LC)

- Two Tomahawk 3.2T ASIC
- 32 QSFP28 100G Ports
- Four DMO Connector to FAB for data plane signals
- Two DMO Connector to VCP for control plane signals
Interface of Line Card (LC)

- Tomahawk Left
- Tomahawk right
- 16-port from left Tomahawk
- 16-port from right Tomahawk
- VCP Right
- VCP Left
- FAB-#4
- FAB-#3
- FAB-#2
- FAB-#1

16-port from left Tomahawk
Fabric Card (FAB)

- One Tomahawk 3.2T ASIC
- Fan Control Board (FCB) is mezzanine card of FAB
- Four 6 x 12 DMO Connector to Four LC for data plane signals
- One 6x8 DMO Connector to HCP for control plane signals
Components of Fabric Card (FAB)

- Tomahawk ASIC
- CPLD
- DMO Connector To SCM
- BMC
- OOB 8-port GBE Switch
- Fan Control Board is mounted on the bottom side of FAB
- LC-#1
- LC-#2
- LC-#3
- LC-#4
Fan Control Board (FCB)

→ Mezzanine Card of Fabric Card (FAB)
→ Support 3 fan-tray
→ FCB CPLD control fan speed, CMM can control FCB CPLD via system I2C bus
Fabric Card (FAB) Assembly

- FAB Main Board + FCB Mezzanine Board
- Fan-tray plugged into FAB assembly and Mate to FCB
Chassis Management Module (CMM)

- AS2540 BMC
- OOB 16 port Switch BCM5396
- Console UART MUX for all LC and FAB COM-e CPU and BMC CPU
- Chassis Management I2C bus
System Control Module (SCM)

- Two COM-e CPU Module Cards
- COM-e CPU Module has one to one mapping to SWE
- 6x12 DMO connector to HCP
- SCM-LC has two COM-e mounted, SCM-FAB has only one COM-e mounted
System Control Module (SCM)

→ SCM-LC:
   SCM for Line Card

→ SCM-FAB:
   SCM for Fabric Card
Horizontal Control Plane (HCP)

→ Horizontal Control Plane for Galaxy Chassis
→ Connect to two CMM, eight SCM and VCP-L, VCP-R
Vertical Control Plane (VCP)

- Two VCP: VCP-L and VCP-R
- Connect to four LC
- Form the control plane of Backpack system together with HCP
Power distribution system

- **PSU**: PowerOne PFE3000-12
- **BBA (Power Bus Bar Assembly)**
  - HBAR: Receive power output from PSU
  - HPD: Provide power for CMM, SCM, FAB
  - VBAR: Provide power for LC
- **Power control and monitor cable**
  - CMM as controller
  - CMM ↔ HCP ↔ PDB Jumper cable
  - HCP ↔ SIM for System LED
Power Distribution Board (PDB)

- Four AC inlet: front access
- CMM can access four PSU through PDB
- Output power is load sharing on HBAR
Bus BAR Assembly

- BBA (Bus Bar Assembly) consists of:
  - HBAR: Horizontal Bar
  - HPD: Horizontal Power Distribution
  - VBAR: Vertical Bar

- HBAR Connect to PSU
  HPD for CMM, SCM and FAB
  VBAR for LC

- Sense wire to PDB
Typical Power Consumption

<table>
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<tr>
<th>PWM</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
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<tr>
<td>Normal condition</td>
<td>2670</td>
<td>2697</td>
<td>2726</td>
<td>2800</td>
<td>2896</td>
<td>3124</td>
<td>3290</td>
<td>3550</td>
<td>3729</td>
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<tr>
<td>One fan failure</td>
<td>2550</td>
<td>2627</td>
<td>2703</td>
<td>2768</td>
<td>2822</td>
<td>3056</td>
<td>3223</td>
<td>3428</td>
<td>3645</td>
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- Unit is Watt
- Measured with 3.5W eload
Thermal design

- Support 55C optic at ambient 35C environment
- 12 fan-tray on the rear panel
- Thermal Improved LC front panel design for better QSFP28 cooling
- Multiple on-board temperature sensor to monitor thermal healthy status of the system
**Fan-tray**

- Screw-less latch design for easy maintenance
- Powerful 80 x 80 mm CR fan
- Hot swappable
- LED on rear panel
- Each FAB carries 3 Fan-tray by FCB(Fan Control Board), total 12 fan-tray in galaxy chassis
Switch Element (SWE)

- Disaggregated architecture
- Switch element consists of three components
  - Tomahawk switch ASIC
  - COM-e CPU module
  - BMC
- 12 switch elements in Backpack
  - Each LC has 2 SWE
  - Each FAB has 1 SWE
Fabric Topology: CLOS

- Two Stage Spine-leaf architecture
- Fully non-blocking
- 12 Switch Elements
Optic transceiver

- Backpack support QSFP28 100G optic
  - CWDM4
  - Can support other MSA, such as SR4, LR4, CLR4, etc.

- Backpack support QSFP+ 40G optic
  - QSFP+ 40G SR4 optic (multi-mode fiber OM3/OM4)
  - QSFP+ 40G LR4 optic (single mode fiber)