CG-OpenRack-19
Sled and Rack Specification
Version 1.0

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1 Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Description</th>
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<tbody>
<tr>
<td>11/16/2016</td>
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</table>

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4 Scope

CG-OpenRack-19 is a scalable carrier-grade rack level system that integrates high performance compute, storage and networking in a standard rack. As such, there are many possible system configurations. However, certain rules and requirements ensure that different modules will operate properly in compliant systems.
This document provides the detailed interoperability requirements of a CG-OpenRack-19 sled as well as the rack system. This document describes the physical makeup of the rack and sled with a focus on the interface between the sled and the supporting rack-level infrastructure. This includes mechanical requirements as well as requirements related to electrical power feeds, optical and electrical interfaces, airflow and cooling, and environmental robustness.

Specific thermal requirements have been purposely omitted due to the diverse range of system deployment scenarios which will ultimately dictate a variety of solutions. Mechanical dimensions and positioning relative to the frame/cabinet have been purposely omitted to allow flexible solutions.

5 Overview

This section describes the physical components of a rack-level system and their internal and external connections. In general, the system is made up of compute- and storage-centric sleds, Ethernet switches, a power source, and supporting rack infrastructure as shown in Figure 1.

There are five major system component types: the system rack, power conversion/distribution, Top-of-Rack switches, and two sizes of modular sleds housing compute and storage elements. A shelf includes one or two bays into which sleds fit.

- **System Rack**: The rack provides physical structure for the system, airflow control, security, and network interconnects.

- **Power Source**: Rack-mount power conversion and distribution infrastructure that provides a nominal 12VDC to two bus bar pairs mounted at the rear of the system. This specification only defines the 12VDC power delivery from the converters to the sleds.

- **Half-Width Sled**: A 2U enclosure that takes up half of the shelf width and fits into a 2-bay shelf. A common use of this sled size is to provide high density compute resources.
• Full-Width Sled: A 2U enclosure that takes up the full shelf width and fits into a 1-bay shelf. A common use of this sled size is to provide high capacity/throughput storage resources.

• Top-of-Rack (ToR) Switch: Each rack can be equipped with a variable number of management plane and data plane switches. Each of these aggregates management and/or data traffic to internal network switching planes; for example:

  • Device Management Switch: 1GbE downlink management traffic interfaces (e.g., to BMCs) and 10GbE uplink interfaces.

  • Application Management Switch: 1GbE downlink management traffic interfaces (e.g., to payload processors) and 10GbE uplink interfaces.

  • Primary Dataplane Switch: 10GbE downlink data plane traffic interfaces (e.g., to payload processors) and 40GbE uplink interfaces.

  • Secondary Dataplane Switch: 10GbE downlink data plane traffic interfaces (e.g., to payload processors) and 40GbE uplink interfaces.

Although the switch topology is not a fixed system requirement, it is recommended that a rack system include at least a Device Management Switch and Primary Dataplane Switch. Redundancy may or may not be part of the system configuration, depending on the application usage.
6 Sled Physical Specifications

The sleds are based on a uniform form factor that allows interoperability with the rack, and specifically the CG-OpenRack-19 shelves. They must have specific external dimensions, with external connections and features at specified locations in order to interoperate with the rack.

Sleds are positioned at a 2RU vertical pitch. The number of shelves within a rack is flexible, and can be defined by the required density or application. The vertical bus bars must be set to cover the sled area, or can extend beyond the sled area.

All dimensional tolerances are per DIN ISO 2768-mK, except sled height, width, and depth, which is +/-0.20mm.
Appropriate cooling **shall** be provided by each sled according to its own needs within the expected system deployment model. This may be accomplished with fans or air movers within the sled enclosure.

Sled airflow **should** be front-to-back for all sleds with fans or other air movers.

### 6.1 Sled Common Mechanical Dimensions

All shelves **shall** occupy a vertical spacing of 2 Rack Units (RU), equivalent to 3.50 inches (88.9mm).

All sleds **shall** have a vertical height of 84.0mm ±0.20mm as measured from the bottom face to the top face.

![Figure 2. Sled Vertical Height (front view)](image)

All sleds **shall** have a horizontal depth of 780.0mm ±0.20mm as measured from the front face to the rear face.

![Figure 3. Sled Horizontal Depth (side view)](image)

All sleds **shall** have a 6.4mm hole on the rear sled face to receive alignment pin with maximum penetration of 21.5mm. The hole **shall** be 16.3mm above the bottom face of the sled enclosure and 59.5mm from the right face of the sled enclosure.
6.2 Sled Optical Connector Placement

All sled optical connectors shall have a nominal centerline position 32.50mm from the right face of the sled enclosure, and a mounting hole position 13.50mm from the rear face of the sled enclosure.

Figure 5.  Sled optical connector horizontal position (top-down view)

All sled optical connectors shall have a nominal centerline position 14.51mm from the bottom face of the sled enclosure.
6.3 Sled Power Connector Placement

All sled DC power connectors shall have a nominal centerline position 107.50mm from the right face of the sled enclosure.

All sled DC power connectors shall have a nominal centerline position 37.50mm from the bottom face of the sled enclosure.
6.4 Half-Width Sled Mechanical Dimensions

The half-width sleds share a common height and depth with full-width sleds. They occupy half of a shelf (left or right side), and fit two-across.

Half-width sleds shall have a horizontal width of 215.0mm ±0.20mm as measured from the left face to the right face.

Half-width sled front handles shall have a nominal centerline position 144.25mm from the right face of the sled enclosure.
Figure 10. Half-width sled handle horizontal position (top-down view)

Figure 11. Full-width sled horizontal width (front view)

6.5 Full-Width Sled Mechanical Dimensions

The full-width sleds share a common height and depth with half-width sleds. They occupy the full width of a shelf.

Full-width sleds shall have a horizontal width of 444.00mm ±0.20mm.

Full-width sled front handles shall have a nominal centerline position 143.25mm from the right face of the sled enclosure.
6.6 Mechanical Retention and Handle Features

All sled retention latches shall extend a minimum of 3.50mm from the left face of the sled enclosure.

All sled retention latch forward faces shall be set back 11.50mm from the front face of the sled enclosure.
All sled retention latches **shall** have a height of 13.10mm and be 17.96mm above the bottom face of the sled enclosure.

All sleds **shall** include retention pins extending 2.0mm +/-0.1mm from the left and right enclosure faces.
Figure 16. Sled retention pin horizontal extension (front view)

Sled retention pins shall be 4.20mm +/-0.1mm in diameter, and shall be 18mm from the enclosure front face and 10.00mm from the enclosure bottom face.

Figure 17. Sled retention pin horizontal extension (front view)

All sled front handles should extend 25.00mm from the front face of the enclosure.
Figure 18. Sled handle horizontal extension (side view)

All sled front handles should be centered 22.00mm from the bottom face of the enclosure.

Figure 19. Sled handle vertical position (side view)

All sled front handles should comply with the following dimensions.
6.7 Sled Front Interface

The front of each sled provides status information and allows operator input by way of indicator(s) and button(s). In order to give the operator a consistent interface, the following dimensions and functions should be followed, at a minimum.

Additional/alternate items are not precluded.

All sleds **should** include one operator panel for each separately managed server node. The dimensions of each panel are 34mm width and 14mm height.
6.8 Weight and Structure

CG-OpenRack-19 sled weights may vary over a wide range depending on the composition of the enclosure and the type of internal components.

<table>
<thead>
<tr>
<th>Sled Type</th>
<th>Nominal Weight</th>
<th>Expected Max. Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half-Width</td>
<td>25lbs, 11.4kg</td>
<td>30lbs, 13.6kg</td>
</tr>
<tr>
<td>Full-Width</td>
<td>65lbs, 29.5kg</td>
<td>75lbs, 34.0kg</td>
</tr>
</tbody>
</table>

7 Rack Physical Specifications

In order to achieve interoperability between sleds and the rack, certain dimensions of the rack, specifically the shelves, must be followed.
7.1 **Bus Bar Pair Construction**

The rear bus bar pairs provide 12VDC to the installed sleds.

The vertical bus bar pairs **shall** be constructed in compliance with the following dimensions.

*Figure 22. Bus bar pair dimensions (top view)*

7.2 **Bus Bar Location**

The rack **shall** have two vertical bus bar pairs to the rear of all shelves.

Each right-hand (facing front) vertical bus bar pair **shall** be centered 108mm ±0.20mm from the right side of the sled bay wall. Each left-hand vertical bus bar pair
shall be centered 229mm ±0.20mm from the right-hand pair. The bus bar pairs shall be positioned as follows relative to the shelf back wall and sled stop.

Figure 23. Bus bar pair horizontal location (top view)

7.3 Shelf Retention Feature

Each shelf shall have two retention slots at the front of each bay with the following dimensions.

Figure 24. Shelf retention slot locations

7.4 Shelf Latch Feature

Each shelf shall have two latch openings at the front of each bay with the following dimensions.
8 Sled Optical Data Port Requirements

All sleds have a rear-mounted blind-mate optical housing that supports data-plane and management plane connections to the spine switches. In order to interoperate with the connections made in the rack, the fiber positions in the rear connector must match the defined positions of the shelf connector.

All data and management interconnects between the sleds and the rack infrastructure pass through a single blind-mate connector housing set. Sleds have a rear-mounted blind-mate “daughtercard” optical housing that mate with a compatible “backplane” housing on the rear of the CG-OpenRack-19 shelves. In order to interoperate, both the shelf and the sleds must use the same ferrule and fiber position assignments.

The optical blind-mate connector housing supports four ferrules. Standard ferrules are available with 24 fiber positions (or more). The typical number of fiber positions in CG-OpenRack-19 is 12, and 8 fibers are loaded on each ferrule. The ferrule positions are color-coded, with each color corresponding to one of four network types.

8.1 Sled Common Data Port Requirements

Each compute or storage shelf has two or one “backplane” housings (respectively) that will blind-mate with the “daughtercard” version of the housing that is part of the installed sled.

All interfaces between server nodes and the rack infrastructure pass through the blind-mate optical connector at the rear of the compute and storage sleds.
The housing has four sections, each of which is capable of holding a single fiber optic ferrule. The sections are color coded

**Figure 26. Sled blind-mate section assignments (rear view)**

Sleds **should** use the green section of the rear optical connector for Application Management links.

Sleds **should** use the blue section of the rear optical connector for Device Management links.

Sleds **should** use the yellow section of the rear optical connector for Primary Data-plane links.

Sleds **should** use the red section of the rear optical connector for Secondary Data-plane links.

Note that alignment of blind-mate optical connections with a specific switching topology is not strictly specified in order to allow flexibility within a rack. However, a precise scheme must be adhered to for consistent application behavior.

### 8.2 Sled to Shelf Interconnects

All interfaces between server nodes and the rack infrastructure pass through the blind-mate optical connector at the rear of the compute and storage sleds.

<table>
<thead>
<tr>
<th>Assembly mounting</th>
<th>Connector description</th>
<th>Manufacturing part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sled</td>
<td>HBMT daughtercard housing</td>
<td>(Molex) 106105-2100</td>
</tr>
<tr>
<td>Sled</td>
<td>Power rail connector</td>
<td>(Methode) 5313-07458-00107</td>
</tr>
</tbody>
</table>
Table 3. Shelf Interconnect Components

<table>
<thead>
<tr>
<th>Assembly mounting</th>
<th>Connector description</th>
<th>Manufacturing part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelf</td>
<td>HBMT backplane housing</td>
<td>(Molex) 106105-2000</td>
</tr>
</tbody>
</table>

8.3 Interconnect Topology Example

To illustrate how the interconnect scheme defined in this specification may be used, this section provides an example of an interconnect topology.

In this example, each rack can be equipped with a variable number of management plane and data plane switches (also referred to as Top of Rack switches). Each of these aggregate management and data traffic to internal network switch functions such as:

- **Device Management Switch**: The 1GbE IPMI management ports (i.e. BMC port) of each of the rack component (i.e. servers, switches, power control, etc.) are connected to the downlink ports on the platform management switch. The uplink ports (10GbE) can be connected to a cluster or end-of-row (EoR) aggregation switch in the datacenter.

- **Application Management Switch**: All servers in the rack connect to this switch using a lower speed 1GbE port. This switch provides connectivity between the rack servers and external cluster or EoR switches to an application management network. The uplink ports (10GbE) connect to the application management spine switches.

- **Primary Dataplane Switch**: All servers in the rack connect to the downlinks of the primary dataplane switch using their first 10GbE port. The switch uplink ports (40GbE) provide external connectivity to the cluster aggregation switches.

- **Secondary Dataplane Switch**: All servers in the rack connect to the downlinks of the secondary dataplane switch using their second 10GbE port. This switch uplink ports (40GbE) provide external connectivity to the cluster aggregation switches.
9 Electrical Specifications

9.1 Power

The sections that follow provide information about the power specifications for the sled.

9.1.1 Power Connector

All sled power shall be supplied via a single DC power connector.
9.1.2 Input Voltage, Power, and Current

Table 4 lists the nominal, maximum, and minimum values for the sled input voltage. The maximum and minimum voltages include the effects of connector temperature, age, noise/ripple, and dynamic loading.

<table>
<thead>
<tr>
<th>Nominal voltage</th>
<th>Maximum voltage</th>
<th>Minimum voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.25V DC</td>
<td>12.95V DC</td>
<td>11.65V DC</td>
</tr>
</tbody>
</table>

The maximum amount of power allowed per sled is defined during system power allocation. The number of sleds in a chassis might be limited by the capacity of the AC power cord or by the cooling capacity of the deployment. Table 5 lists the input power allocation for a low-power sled (which may be either half- or full-width).

<table>
<thead>
<tr>
<th>Connector</th>
<th>Nominal voltage</th>
<th>System power allocation (in W)</th>
<th>Maximum current (in A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methode Mini-MCC Bus Connector</td>
<td>12.25VDC</td>
<td>1000W</td>
<td>105A</td>
</tr>
</tbody>
</table>

All sleds shall provide in-rush current control through the 12V bus rail; return-side in-rush control is not required. The in-rush current shall rise linearly from 0A to the full load current at a rate not to exceed 20A/ms. The ramp-up to full load shall not take more than 200ms).

9.1.3 Current Interrupt Protection

All sleds shall provide overcurrent protection at the point of power entry to the primary power distribution circuit.

9.1.4 Grounding and Return

All sleds shall directly connect the DC supply return to the enclosure case as part of a chassis grounding method.
9.2 Signal Interface

All interfaces between server nodes and the rack infrastructure pass through the blind-mate optical connector at the rear of the compute and storage sleds.

Figure 28. Network connection to sleds

9.2.1 Sled Data Connections

Each sled connects to the rack-level networks via a set of up to four optical ferrules in a blind-mate housing system. This connector system is positioned at the rear face of each sled and at the back of each shelf. When the sled is installed on the shelf, all of the ferrules automatically align and connect, which ultimately connects the on-sled network interfaces to the rack-level network switches.

Note, this is a logical diagram; as described in the overview section, there may be 1 or 2 bays per shelf.
The optical blind-mate system and the in-rack optical cables provide the end-to-end network connections to all installed sleds.

Figure 29.  Sled Blind-Mate Optical Connections, Front View

9.2.2 Signal Definitions

Table 6 below shows the fiber naming and assignments for the blind-mate optical interconnect.

Table 6. Optical Connector Assignments

<table>
<thead>
<tr>
<th>Signal</th>
<th>Housing Section</th>
<th>Fiber Location</th>
<th>Description</th>
<th>Example Use (Switch Connections)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENET_SW1.1_TX</td>
<td>Blue</td>
<td>1</td>
<td>1GbE (1000BASE-SX) lane</td>
<td>1Gb Device Management Plane connection (BMC IPMI link)</td>
</tr>
<tr>
<td>ENET_SW1.1_RX</td>
<td>Blue</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENET_SW1.2_TX</td>
<td>Blue</td>
<td>2</td>
<td>1GbE (1000BASE-SX) lane</td>
<td>1Gb Device Management Plane connection (BMC IPMI link)</td>
</tr>
<tr>
<td>ENET_SW1.2_RX</td>
<td>Blue</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENET_SW2.1_TX</td>
<td>Green</td>
<td>1</td>
<td>1GbE (1000BASE-SX) lane</td>
<td>1Gb Application Management Plane connection</td>
</tr>
<tr>
<td>ENET_SW2.1_RX</td>
<td>Green</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENET_SW2.2_TX</td>
<td>Green</td>
<td>2</td>
<td>1GbE (1000BASE-SX) lane</td>
<td>1Gb Application Management Plane connection</td>
</tr>
<tr>
<td>ENET_SW2.2_RX</td>
<td>Green</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal</td>
<td>Housing Section</td>
<td>Fiber Location</td>
<td>Description</td>
<td>Example Use (Switch Connections)</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------</td>
<td>----------------</td>
<td>------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>ENET_SW3.1_TX</td>
<td>Yellow</td>
<td>1</td>
<td>10GbE (10GBASE-SR) lane</td>
<td>10Gb Primary Dataplane connection</td>
</tr>
<tr>
<td>ENET_SW3.1_RX</td>
<td>Yellow</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENET_SW3.2_TX</td>
<td>Yellow</td>
<td>2</td>
<td>10GbE (10GBASE-SR) lane</td>
<td>10Gb Primary Dataplane connection</td>
</tr>
<tr>
<td>ENET_SW3.2_RX</td>
<td>Yellow</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENET_SW4.1_TX</td>
<td>Red</td>
<td>1</td>
<td>10GbE (10GBASE-SR) lane</td>
<td>10Gb Secondary Dataplane connection</td>
</tr>
<tr>
<td>ENET_SW4.1_RX</td>
<td>Red</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENET_SW4.2_TX</td>
<td>Red</td>
<td>2</td>
<td>10GbE (10GBASE-SR) lane</td>
<td>10Gb Secondary Dataplane connection</td>
</tr>
<tr>
<td>ENET_SW4.2_RX</td>
<td>Red</td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: “Tx” and “Rx” are as referenced from the rack-level switch ports

Note: The example usage assumes the topology described in section 8.3; other use cases are possible.

Note: The fiber signals are presently defined at 1Gb/s and 10Gb/s speeds; future speed increases are possible.

### 9.3 Electromagnetic Interference Mitigation

The emission level of CG-OpenRack-19 sleds will be tested as part of a complete system. Because of this, sleds must be tested as part of a fully loaded rack-level configuration, including power distribution, power conversion, switching networks, and a maximum population of sleds.

Sleds shall meet FCC Class A when tested as a maximum population in a fully loaded rack-level system operating with a representative computational and data transmission workload.

### 10 Management

Each CG-OpenRack-19 server shall have a dedicated BMC for various out-of-band platform management services.
The health status of host processor should not affect the normal operation and network connectivity of the BMC.

The BMC shall not share memory with host processor.

The BMC management connectivity should work independently from host, and have no NIC driver dependency for Out-of-Band communication if using a shared-NIC.

The BMC shall support a remote console, also known as Serial-Over-LAN (SOL) through the management network.

POST codes should be displayed in SOL console during system POST.

Before the system has the first screen, POST codes should be stored and displayed in the SOL console in sequence. For example, display as “[00] [01] [02] [E0]...” etc.

After the system has the first screen in the SOL console, the last POST code received on port 80 is displayed in the lower right corner of the SOL console screen.

The BMC should support high-performance remote KVM and remote storage over the management interface.

The BMC shall be fully IPMI 2.0 and DCMI 1.5 Compliant.

BMC firmware shall support remote system power on/off/cycle and warm reboot through In-Band or Out-of-Band IPMI commands.

BMC firmware shall support a power-on policy selectable to be last-state, always-on, and always-off. The default setting is last-state.

A change of power policy should be supported by IPMI command and take effect without a BMC firmware cold reset or a system reboot.

Vendors should provide tool(s) to implement remote BMC firmware update, which will not require any physical access to the system. Remote update means either through Out-of-Band by management network or through In-Band by logging into local OS with data network.

Note – Server/node BMC IP addresses within sled locations can be discovered heuristically; there is no specification for any explicit/out of band identification mechanism.
11 Appendix

11.1 Appendix: Commonly Used Acronyms

This section provides definitions of acronyms used in the system specifications.

**BIOS** – basic input/output system

**BMC** – baseboard management controller

**CG** – Carrier Grade

**DCMI** – Data Center Manageability Interface

**EOR** – end of row

**IPMI** – intelligent platform management interface

**NIC** – network interface card

**OU** – Open Compute Rack Unit (48mm)

**POST** – power-on self-test

**RU** – rack unit (1.75”)

**SOL** – serial over LAN

**TOR** – top of rack

**U** – rack unit (short for RU)