Agenda

10:30   Welcome
10:45   Rack and Power Project Update
11:00   Preferred Rack Level Power SKUs for Open Rack
Noon   Lunch and a Word from our sponsor Delta
1:00    Power Shelf Interoperability Specification Update
1:15    GE Power Shelf Contribution Update
1:30    Schneider V2 Rack Contribution
2:00    Advanced Cooling Sub-Project Roadmap Discussion
2:45    Wrap-Up
Welcome to the OCP Rack & Power Workshop!

Thank you to Steve Mills for organizing and to Delta for hosting.
The OCP Members and Community

Archna Haylock
Community Director
Archna@opencompute.org
Foundation Board

Mark Roenigk
Chairman/President
Facebook

Joshua Matheus
Goldman Sachs

Jason Waxman
Intel Corporation

Bill Laing
Microsoft Corporation

Brian Stein
Rackspace

Andy Bechtolsheim
Individual

Rocky Bullock
Non-Voting
OCP Membership Facts

- ~200 Corporate Members
  - Adopters
  - Suppliers (HW and SW)
  - Solution Providers
- 6000 participants in our community
  - Technical (HW and SW)
  - Sales/Business Development
  - Executives
  - Manufacturing/Process
  - Facilities
  - Academia
- Member Companies from all over the world

OCP Membership Directory:
https://www.opencompute.org/membership/membership-organizational-directory
LinkedIn Joins OCP, Continues Open19 Deployment in Its Data Centers

LinkedIn has joined the Open Compute Project, the Facebook-led open source data center initiative - OCP has lots of answers to LinkedIn’s questions about scaling its infrastructure to support exponential traffic growth - LinkedIn continues charging ahead with its own open source data center standard, Open19 - While there is
OCP Corporate Membership
<table>
<thead>
<tr>
<th>Features</th>
<th>Community</th>
<th>Silver</th>
<th>Gold</th>
<th>Platinum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sponsorship</td>
<td>—</td>
<td>1 event</td>
<td>2 events</td>
<td>3 events</td>
</tr>
<tr>
<td>Eligible for becoming a SP/Reseller</td>
<td>✓*</td>
<td>✓*</td>
<td>✓*</td>
<td>✓*</td>
</tr>
<tr>
<td>Summit sponsorship discount</td>
<td>—</td>
<td>10%</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>Speaking engagements</td>
<td>—</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>PL or IC position eligibility</td>
<td>1 PL position</td>
<td>1 PL or IC position</td>
<td>2 PL or IC positions</td>
<td>3 PL or IC positions</td>
</tr>
<tr>
<td>Voting keys</td>
<td>—</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>OCP Accepted™ product recognition</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>OCP Inspired™ product recognition</td>
<td>—</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Contributions</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Cost</td>
<td>$2,500</td>
<td>$60,000</td>
<td>$50,000</td>
<td>$40,000</td>
</tr>
</tbody>
</table>

* There is an additional fee to becoming a SP/Reseller.
OCP Membership Benefits

- Connect with other Industry leaders and innovators
- Get access to new industry trends
- Collaborate with like-minded participants to create leading edge solutions to industry challenges.
- Become part of a global community
- Participate in projects that are paving the way and addressing real time concerns of the community.
- Contribute your subject matter expertise while retaining control of your IP
- Showcase your OCP recognized products to potential adopters
- Join the “open” movement to achieve efficiency and growth and make an impact
OCP Community: Projects and SubProjects

**SERVER**
- PCI 3.0 Mezz

**NETWORKING**
- ONL, ONIE, SAI, SONIC, Campus Branch Wireless

**STORAGE**
- JDA Project

**RACK & POWER**
- Adv Cooling Solutions, Power Shelf Interoperability

**HW MGMT**

**HPC**

**TELCO**

**DC Facility**
- Modular DC

**Open Sys FW**

**SECURITY**
Each Project has a charter - READ IT
Each Project has volunteer leaders - 1 or 2 Project Leads and 1 Tech Steering Committee Rep - INTRODUCE YOURSELF
Some Projects have 1 or more sub-projects.
Each Project has a WIKI page. Sub-projects have their own WIKI. - READ IT
Each Project/sub-project has a mailing list. - JOIN THE LIST
Each Project/sub-project meets separately for their calls - some are monthly, some are weekly. - ATTEND THE CALLS
All calls are recorded. - LISTEN IF YOU CAN NOT ATTEND LIVE
Projects have workshops. - REGISTER FOR WORKSHOPS
From Concepts to Contributions:

Proposals and Ideas:
- From Project Community
- From other Open Orgs
- From Another Community via PL/IC/CTO

Project Community:
- Revisions
- Collaboration with other Project Teams

ICR:
- IC Vote
- OCP Recognition
- Marketplace if SP

Spec Design Product R/A
What is OPEN hardware?

Specifications

Design Packages

Embedded SW

Contributed with a **Royalty-free, non-assert** License (CLA)

Products

IP retained by OEM/ODM
How this Community Contributes, Collaborates, & Consumes

Specifications

Reference Architecture

Tested Configurations

White Papers

Embedded Software

Design Files

Product Recognition

Case Studies

Workshops Summits

Testimonials Seminars

Videos
OCP Upcoming Events

• Workshop Today will be videotaped and will be available on the OCP Past Events page.
• Networking Engr Workshop – Target late Aug, San Jose, CA @ TBD. More info on OCP Events Page shortly.
• DCD Cloud + Colo - Day 0 (Oct 29) Workshops in planning stage - stay tuned
• IC Meetings occur every 6 weeks – to vote on any upcoming contributions and discuss strategic direction of the projects.
• OCP Regional Summit – Oct 1-2 Amsterdam, The Netherlands. Sponsorships still available and membership discounts are applied (20% for Platinum, 15% for Gold, 10% for Silver, 5% for Community). Registration is OPEN!!
• OCP Summit – March 14-15, 2019 San Jose, CA. Bundle Discounts are available if interested in both Europe and US Summits.
2018 OCP Regional Summit

Amsterdam, Netherlands

October 1-2, 2018
Rack and Power Project Engineering Workshop
24 July 2018 - Fremont
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2:45 Wrap-Up
Rack & Power Project Scope

Open Rack Standard

• Mechanical and Electrical standard for scale out
• DC distribution: 12VDC or 48VDC option
• Power & Resiliency options
• NEBS/Seismic considerations

EIA-310 Compatible Enclosures

• Sub-rack Enclosures
• CG-Open Rack-19 standard

Power Distribution and Conversion

• Applicable to OpenRack and EIA-310
• Power Rectifiers
• In-Rack Battery Backup
• Interoperability and component re-use
Rack and Power Project Update
<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Contributor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic Kit for Open Rack</td>
<td>Approved!</td>
<td>Nokia</td>
</tr>
</tbody>
</table>

This specification defines Optional Seismic kit for Open Rack V2 to fulfill the Zone 4 criteria defined by Telcordia GR-63-CORE

[Specification Link]
<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Contributor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Rack Busbar Interface Specification</td>
<td>Approved!</td>
<td>Rittal</td>
</tr>
</tbody>
</table>

Defines the technical specifications between the:
- Busbar assembly
- Open Rack frame
- Power Shelves

Specification Link
### Table 4. OCP Indicator legends

<table>
<thead>
<tr>
<th>Meaning</th>
<th>Preferred</th>
<th>Alternate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power On/Good</td>
<td>⚡</td>
<td>PWR</td>
</tr>
<tr>
<td>AC Good</td>
<td>~</td>
<td>AC OK</td>
</tr>
<tr>
<td>DC Good</td>
<td>⚪⚪⚪⚪</td>
<td>DC OK</td>
</tr>
<tr>
<td>Fault</td>
<td>⚠️</td>
<td>FAULT</td>
</tr>
<tr>
<td>Status</td>
<td>✅</td>
<td>STS</td>
</tr>
<tr>
<td>Fan</td>
<td>⚛</td>
<td>FAN</td>
</tr>
<tr>
<td>Over Temperature</td>
<td>🔥</td>
<td>OVER TEMP</td>
</tr>
<tr>
<td>Drive #</td>
<td>🔍</td>
<td>DRIVE #</td>
</tr>
<tr>
<td>End of Life Reached (BBU)</td>
<td>EOL</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Provide standards for OCP:
- Icons
- LED color
- LED behavior
- Indicator Placement
<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Contributor</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Three Phase 380 – 480 Vac to 48Vdc Power Shelf</td>
<td>Community Review</td>
<td>ABB</td>
</tr>
</tbody>
</table>

This True Three Phase 380-480Vac to 48Vdc Power Shelf powers 24kW of load equipment from a single 50A whip.
Enable multi-vendor sourcing of power components such as PSUs, Power Shelves, and BBUs, by ensuring interoperable functions.
<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Contributor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack and Power Redfish Profile</td>
<td>In Development</td>
<td>Shared</td>
</tr>
</tbody>
</table>

Create and publish an open industry standard specification and schema that meets the expectations of end users for simple, modern and secure management of scalable platform hardware.
OCP Strategy for HW Management

Open Source DCIM

BASELINE PROFILE

Server Profile Network Profile Storage Profile POWER Profile EDGE Profile

HDD Health
Profile will include existing power and thermal schema
• Additional NEW resources such as powershelves, energystoragemodules, psumodules
• Can include objects from DCIM like smart PDUs

IS THE ABOVE THE MOST LOGICAL WAY TO REPRESENT THE WHERE THE PROFILE FITS?
<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Status</th>
<th>Contributor</th>
<th>Activity</th>
<th>Target Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rack and Power Redfish Profile</td>
<td>In Development</td>
<td>Shared</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Generate initial list of elements for the rack and power schema/mock-up</td>
<td>Done</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Generate mock-up and test with validator to create initial feel of the validation process</td>
<td>Done</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Consolidate additional elements needed for the schema/mock-up</td>
<td>Sept 7, 2018</td>
<td></td>
<td>• Upload updated checklist</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Solicit inputs from members</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Schedule semi-monthly calls</td>
<td>By August Rack&amp;Power Meeting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Finalize process for determining the baseline for the Rack&amp;Power profile</td>
<td>Will be done on semi-monthly calls</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10:30   Welcome
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Noon   Lunch and a Word from our sponsor Delta
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2:45    Wrap-Up
Standardize Power SKU Options

Alex Lin / July 24th, 2018
OCP Rack & Power Workshop
About Penguin Computing

- U.S.-based 20 year old, global provider of hardware, software, and services for HPC, AI, & storage
- Home to Scyld® Beowulf cluster software & bare metal HPC on cloud Penguin Computing On-Demand™
- Over 300 OCP racks delivered to date based on Tundra™ Extreme Scale design
- Platinum OCP member, Penguin CTO Phil Pokorny is HPC representative of the OCP Incubation Committee
Open Rack Specification

- Rack Depth (800mm, 660mm)
- DC Busbar Voltages (12Vdc, 48Vdc)
- DC Busbar numbers (3, 1)
- No. of OpenU / Rack Heights (Not specified)
  - Common examples: 20OU, 22OU, 40OU, 44OU

Source: Open Rack Standard
## Power SKU Overview (12VDC)

<table>
<thead>
<tr>
<th>Key Spec \ Product</th>
<th>Product A</th>
<th>Product B</th>
<th>Product C</th>
<th>Product D</th>
<th>Product E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form Factor</td>
<td>1U</td>
<td>3U</td>
<td>2.5U</td>
<td>2.5U</td>
<td>2U / 4U</td>
</tr>
<tr>
<td>Rectifiers</td>
<td>6x 3kW</td>
<td>9x 3.3kW</td>
<td>6x 3kW</td>
<td>6x 2.5kW</td>
<td>6x ?</td>
</tr>
<tr>
<td>Max. Capacity (per Shelf)</td>
<td>18kW</td>
<td>26.4kW</td>
<td>18kW</td>
<td>12.5kW</td>
<td>12.5kW</td>
</tr>
<tr>
<td>Input</td>
<td>200-277 / 346-480 VAC</td>
<td>208/ 230/400 / 277/480 VAC</td>
<td>100/115/230/277 VAC</td>
<td>208/230 VAC</td>
<td>N/A</td>
</tr>
<tr>
<td>Busbar No.</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Busbar Amperage</td>
<td>244 A ~ 488A</td>
<td>350 A</td>
<td>732 A</td>
<td>488 A ~ 1,016 A</td>
<td>170 A ~ 339 A</td>
</tr>
</tbody>
</table>
# Power SKU Overview (48VDC)

<table>
<thead>
<tr>
<th>Key Specification \ Manufacturer</th>
<th>Product A</th>
<th>Product B</th>
<th>Product C</th>
<th>Product D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form Factor</td>
<td>1U</td>
<td>2U</td>
<td>2U (?)</td>
<td>2U</td>
</tr>
<tr>
<td>Rectifiers</td>
<td>6 x 4kW</td>
<td>9x 3.5kW</td>
<td>12x ?</td>
<td>4x 6kW</td>
</tr>
<tr>
<td>Max. Capacity (per Shelf)</td>
<td>19.5 kW</td>
<td>28 kW</td>
<td>33 kW</td>
<td>24 kW</td>
</tr>
<tr>
<td>Input</td>
<td>200 – 277 VAC</td>
<td>176–305 VAC</td>
<td>346~415 VAC</td>
<td>380~480 VAC</td>
</tr>
<tr>
<td>Busbar No.</td>
<td>1 or 3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Busbar Amperage</td>
<td>243 A ~ 900A</td>
<td>&gt; 117 A</td>
<td>413 A</td>
<td>300 A</td>
</tr>
</tbody>
</table>
Design Challenges

Designing for customers, Penguin Computing found the following issues:

- **Compatibility**
  - Wattage and current ratings are not as clearly defined
  - Difficult to switch power SKUs across manufacturers
    - Ex. Choosing PDUs on EIA racks
    - Ex. The bolt pattern of some products is offset by about 0.5 OU higher than the corresponding rack space

- **High capacity / density**
  - Multiple powershelves + A/B redundancy = 4 (or more) power cords to the rack.
  - Single IP management
  - 3 busbars
Wish List

- Power shelves & busbars for all sorts of Open Racks
  
  - 48V: 3 busbars to achieve higher power & lower the build cost (PDB space, busbar materials)
  
  - 2 power cords for A+B redundancy
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True Three Phase 380 – 480 Vac to 48Vdc Power Shelf
July 2018 Update
GE Critical Power (Industrial Solutions) is NOW ABB

- GE Critical Power, part of GE Industrial Solutions
- Now a Part of ABB Electrification Products Industrial Solutions
- Business as usual
- Increased investment and growth
- Expect increased OCP support
True Three Phase 380 – 480 Vac to 48Vdc Power Shelf

Scope

This Submitted document defines the technical specifications for:

- A true 3 phase 380 – 480 Vac to 48Vdc Power Shelf used in Open Compute Project Open Rack Standard V2.0
- The shelf is 2 open rack units high
- Is fed with a single 50A AC cord whip
- Delivers power using bus bar clips onto the 48V bus located in the shallow depth (660mm) cabinet as defined in Open Rack Standard V2.0
- Any / Multiple Position in the rack
True Three Phase 380 – 480 Vac to 48Vdc Power

Update / Traction

- 48V, 24KW Power Shelf
- Redesigned some internal parts and connector harness
- Now procuring pre-assembled power module connector and cable assembly
- Submitted up-dated CAD file, only minor changes to rail compliance
- Revision of the specification to follow shortly
- Limited interest to date
Battery Module
48V battery –12V VRLA modules
1 or 2 open rack units high
Delivers power using bus bar clips onto the 48V bus located in the shallow depth (660mm) cabinet as defined in Open Rack Standard V2.0
Connectorized hot-plug module
Integrated battery management
~3.8KW for 1 minute – 1 RU PbA version
Weighs 40 lbs for 1 RU PbA version
Other battery chemistries being evaluated
True Three Phase 380 – 480 Vac to 48Vdc Power Shelf

Next Steps

- 12V, two Module, 12V Power Shelf
- 3RU, includes 2 RU of battery
- feasibility Study – 3-4KW per module?
- Much Higher current
- Assessing interest

- Bi-directional converter for higher (48V) internal battery voltage and discharge voltage regulation
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Schneider Electric OCP V2 Rack
Submission for OCP Inspired recognition

OCP Rack & Power Workshop 24 July 2018
OCP V2 Rack Submission

**V2 Rack** submission complies with OCP
Open Rack Standard V2.0
(12V derivative)

Requesting ‘OCP Inspired’

Documentation supporting submission:
- Orderable SKU: AR6641
- Data Sheet
- 2D submittal drawings, DWG and PDF
- 3D DWG Model
- This PPT

Initial stocking strategy to cover NAM & Europe
## AR6641 – OCP Open Rack V2 Complaint

<table>
<thead>
<tr>
<th>Specifications</th>
<th>AR6641</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanical</strong></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>2010mm</td>
</tr>
<tr>
<td>Width</td>
<td>600mm</td>
</tr>
<tr>
<td>Depth</td>
<td>1067mm</td>
</tr>
<tr>
<td>Equipment Mounting Height</td>
<td>41OU</td>
</tr>
<tr>
<td>Equipment Mounting Width</td>
<td>21&quot;</td>
</tr>
<tr>
<td>Static, Dynamic &amp; Shipping Weight Capacity</td>
<td>1400KG</td>
</tr>
<tr>
<td>Color</td>
<td>Black</td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td></td>
</tr>
<tr>
<td>Busbar Nominal Voltage</td>
<td>12VDC</td>
</tr>
<tr>
<td>Busbar Material</td>
<td>Copper with nickel plating</td>
</tr>
<tr>
<td>Number of Busbar Pairs</td>
<td>1</td>
</tr>
<tr>
<td>Number of Power Zones</td>
<td>1</td>
</tr>
<tr>
<td>Busbar Cross Sectional Area</td>
<td>250mm</td>
</tr>
<tr>
<td>Max Current (amps) at 3.5 and 5 amps/mm²</td>
<td>875A / 1250 A</td>
</tr>
<tr>
<td>Warranty</td>
<td>5 Year (Repair or Replace)</td>
</tr>
</tbody>
</table>
Testing

Testing conducted to ensure performance for fully integrated deployments

Internal DVT tests
• Static test, 1680kg → no deformation
• Dynamic rolling 1000m, 1400kg → no deformation
• 6mm step test, 1400kg, 5 times → pass, no deformation
• 1” gap test, 1400kg, 5 times → pass, no deformation
• 5° ramp test, 1400kg → roll off pallet and roll on pallet

3rd Party Standards
• Vibration Resonance ASTM D3580-95 Method A
• Drop and Impact Test Schedule A – ASTM D4169-16
• Random Vibration Test Schedule E – ASTM D4169-16
• UL Mechanical Safety – UL 60950-1-07 (including tilt 10 degrees (IEC))
Compatible with Gemini – 15kW N+1 PSU
Existing OCP Inspired PSU

Basic Specs
- 15kW N+1 or 9kW 2N
- Modular input ATS for 2N input when in N+1 configuration
- 2OU
- 208-240VAC input
- 3kW hot pluggable modules
- 80 Plus Platinum efficiency – 94% @ 50 – 80% load
- Separate BBU shelf direct connects to busbar
- PSU can communicate with 2 BBU shelves
OCP Tenets for Schneider Electric OCP V2 Rack

- **Efficiency**
  - Electrical efficiency: Supports centralized PSU with busbar distribution
- **Scale**
  - 1400kg load capability supports shipping fully integrated racks
  - Busbar can support over 15kW per rack
  - Supply chain capable to supporting any volume
- **Openness**
  - Complies with existing OCP V2 rack spec
- **Impact**
  - Schneider Electric supply chain & channel will be able to support customers of all sizes
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Project Discussion: Enabling Advanced Cooling in Open Rack

Steve Mills        Technical Lead          Facebook
Bill Carter                    CTO                 Open
Compute
OCP Announces Advanced Cooling Solutions Sub Project

The new sub-project will focus on standardization and definition of: critical interfaces, operational parameters, and environmental conditions ... enable a non-proprietary, multi-vendor supply chain for ‘warm water’ cooling.
Discussion: Scope of Charter

The project may support more than one type of cooling architecture, such as:

- Direct liquid cooled cold plate solutions
- Immersion type solutions (single phase and 2-phase materials)
- Compressed air solutions

Successful projects delivered by this project will include:

- A supply chain offering a variety of interchangeable liquid cooled-enabled IT devices (servers, storage, etc.)
- A supply chain for liquid-enabled racks from multiple providers
Discussion: Scope of Charter

In-Scope Activities

- Determination of wetted materials, quality, and type
- Fluid physical properties and types
- Operating conditions and parameters
- Metrology of heat extraction performance
- DC to Rack Interfaces for Facility water loops
- Hot-plug drip-less valves between IT Gear and Rack
- Recommended Cold-plate attachment methods

Out of Scope Activities

REAR CHILLER DOOR or RDHx solutions
Advanced Cooling Sub-Project Meeting Info

Project meetings begin August 15th!
Meetings are scheduled for the first and third Wednesday of the month.
9-10am Pacific time.

Call details are available here.
Join the mailing list:
http://lists.opencompute.org/mailman/listinfo/opencompute-acs

Wiki:
https://www.opencompute.org/wiki/Rack_%26_Power/Advanced_Cooling_Solutions
Discussion: Identify Topics for Work Flows

Direct Contact IT Gear Liquid Cooling

- IT Gear Interface Definitions
- Hot-plug, dripless valve specifications
- Coolant Pump Management Protocols

Immersion

- IT Gear Specifications
- Facility Requirements
- Management Protocols
Agenda

10:30   Welcome
10:45   Rack and Power Project Update
11:00   Preferred Rack Level Power SKUs for Open Rack
Noon   Lunch and a Word from our sponsor Delta
1:00    Power Shelf Interoperability Specification Update
1:15    GE Power Shelf Contribution Update
1:30    Schneider V2 Rack Contribution
2:00    Advanced Cooling Sub-Project Roadmap Discussion
2:45    Wrap-Up