VERTIV.

Breakout session
Solutions for High Density

Workshop leaders:

Slawomir Dziedziula, EMEA Director of Application Engineering Multi LOB and IRS

Piergiorgio Tagliapietra, EMEA Director of Application Engineering Thermal Management

Workshop facilitator:

Tanja Hoebe, Senior Marketing Manager EMEA

Agenda

VERTIV.

Manage challenges in high power computing applications
- Brownfield and Greenfield approach
- AI vs other HPC applications

Slawomir Dziedziula

Thermal Management
- Evaluation of the thermal technology approach: Air, Liquid, Hybrid
- Critical load identification and risk assessment

Piergiorgio Tagliapietra

Rack Solutions
- Traditional vs OCP approach
- Increased rack density changes expectations in rack specification: height, width, weight
- Rack PDU

Slawomir Dziedziula

Modular Solutions
- Speed of deployment
- UPS, Trinergy and switchgear integration

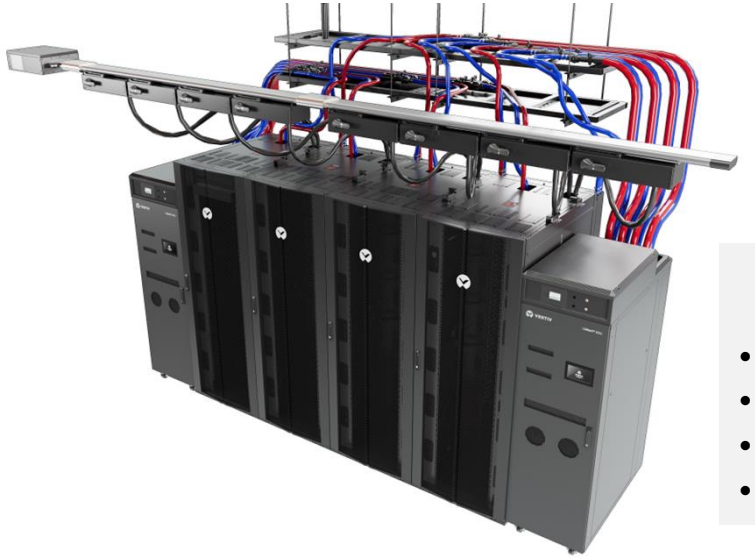
Slawomir Dziedziula

Manage challenges in high power computing applications

10 minutes

Brown vs Green Field - Design and Deployment

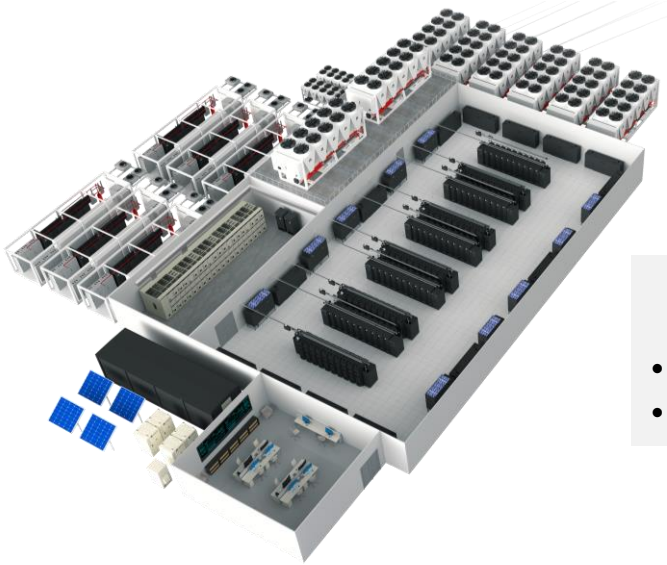
Rack and Row Solutions



Intended for

- Retrofits
- IT Whitespace
- AI Pilots
- Proof of Concept Testing

Modular / Data Center Designs



Intended for

- New AI Data Center builds
- Modular Data Centers

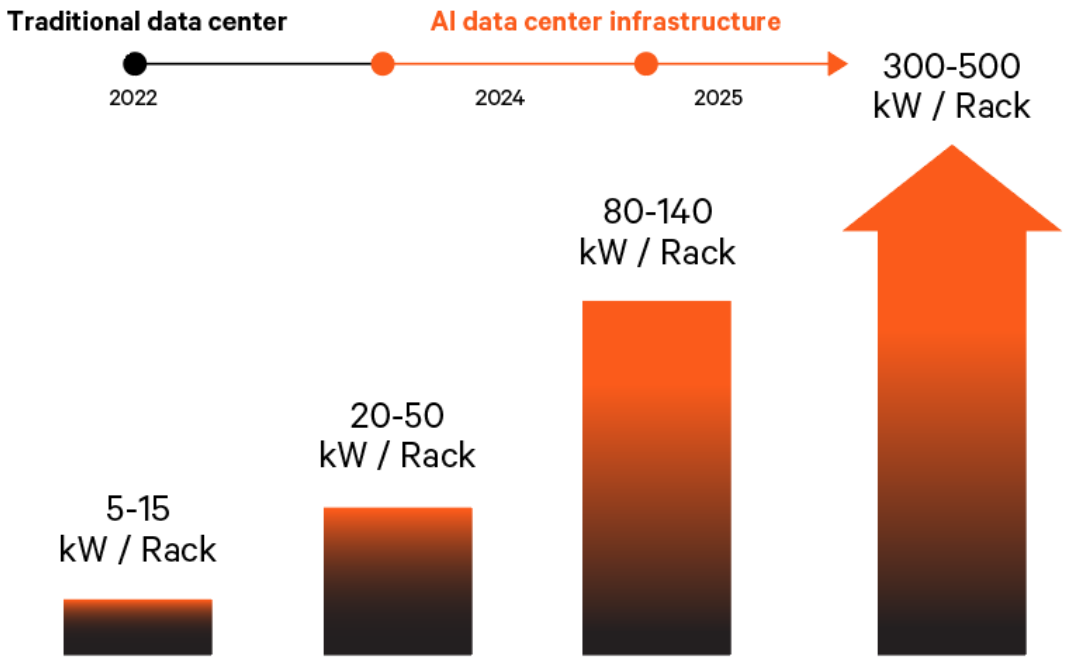
Standard Models Available

- Will be quotable & orderable through Oracle CPQ – schedule varies by model
- Design specifications available through sales portal and Vertiv.com
- Will be setup under policy 119 for channel partners

Note on Reference Designs

Vertiv 360AI Reference designs have been validated by Vertiv and are intended to kickstart opportunities for modular solutions and AI data center new builds.

AI vs other HPC Applications

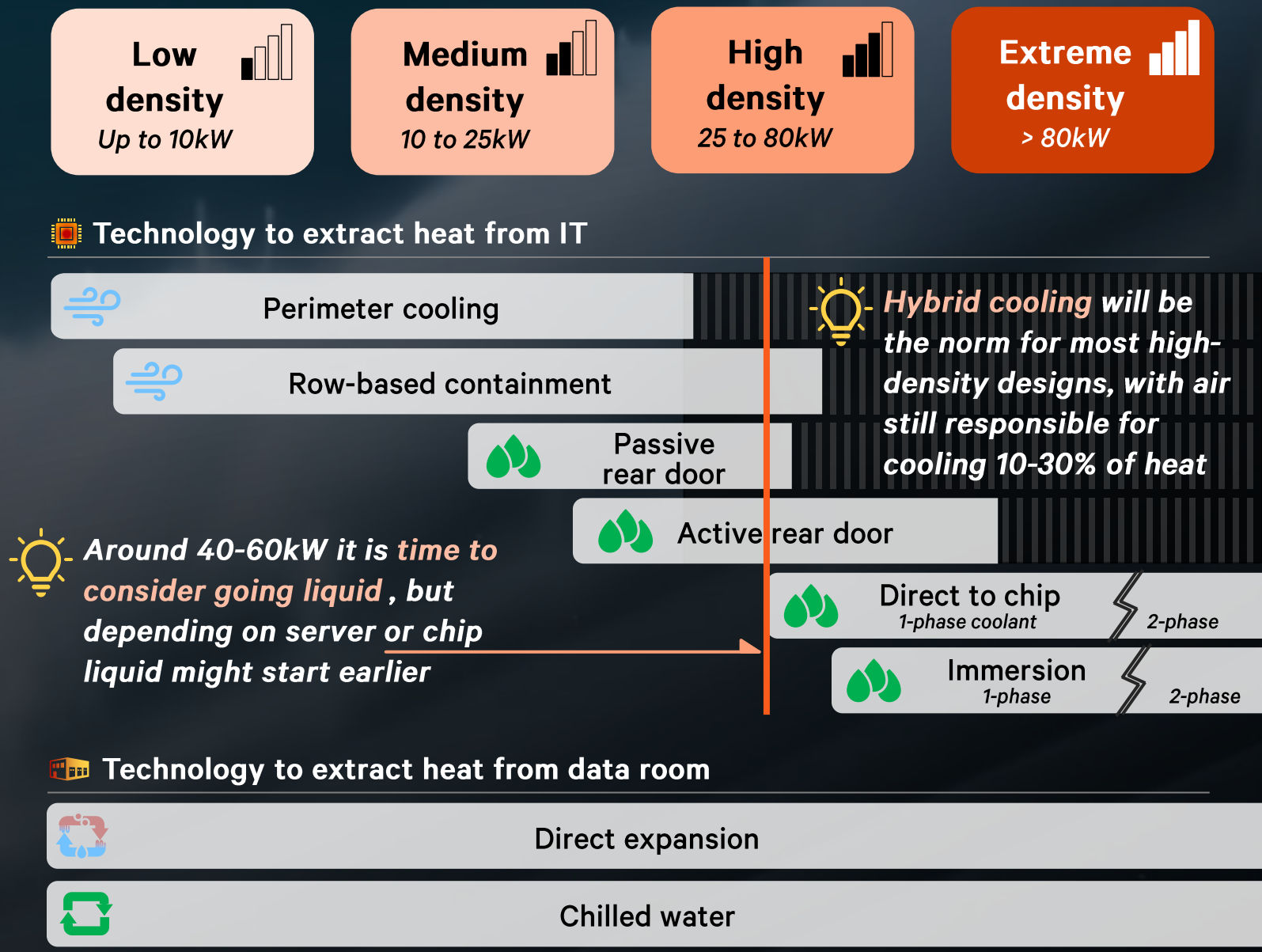


- **Healthcare:** Genome sequencing, drug discovery, and medical imaging analysis.
- **Aerospace:** Simulations of airflow over aircraft wings and structural analysis.
- **Automotive:** Developing self-driving cars, crash simulations, and testing new vehicle designs.
- **Finance:** Complex risk analysis, financial modeling, and fraud detection.
- **Energy:** Resource exploration, climate modeling, and optimizing energy production.
- **Manufacturing:** Product design optimization, quality control, and supply chain management.
- **Entertainment:** Creating special effects, animations, and video game development.
- **Academic Research:** Conducting scientific research, simulations, and data analysis.
- **Government:** National security, weather forecasting, and policy analysis.
- **Blockchain:** Mining cryptocurrencies, validating transactions, and ensuring the security of blockchain networks.
- **Artificial Intelligence:** Training and running AI models, such as deep learning and machine learning applications.
- **Gaming:** Real-time rendering of complex graphics and physics simulations in high-end video games.
- **Video Rendering:** Processing and rendering high-definition videos for film production, special effects, and animation.

Thermal Management

40 minutes

More compute packed in the rack is driving rack densities up, making the shift from air cooling to hybrid air-assisted liquid cooling a necessity.



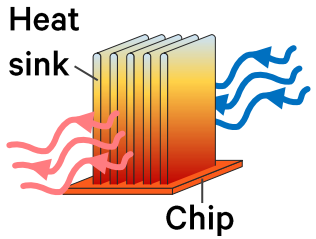
Liquid cooling designs must take into account very short ride-through times in case cooling equipment fails.

What is thermal inertia / thermal ride-through?

Thermal inertia: degree of **slowness which temperature changes in system**. A high thermal inertia system can cope for longer time until reaching maximum temperature.
Ride-through time: time between a **loss of cooling systems** and the resulting **interruption of IT systems** in a data center.

Air cooling

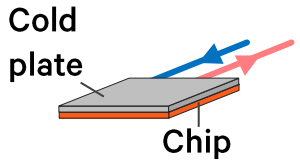
Heat is distributed through **large surface** of heat sink.



Volume of air around heat sink **acts as buffer** continuously collecting heat from heat sink and slowly moving with natural convection in case cooling system fails.

Liquid cooling

Higher heat flux with much **smaller heat exchange surface**.

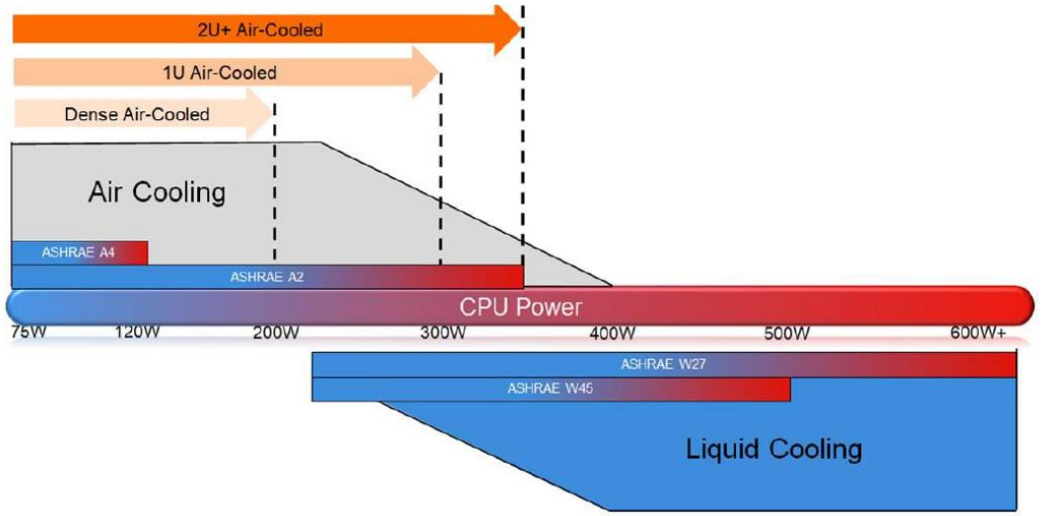


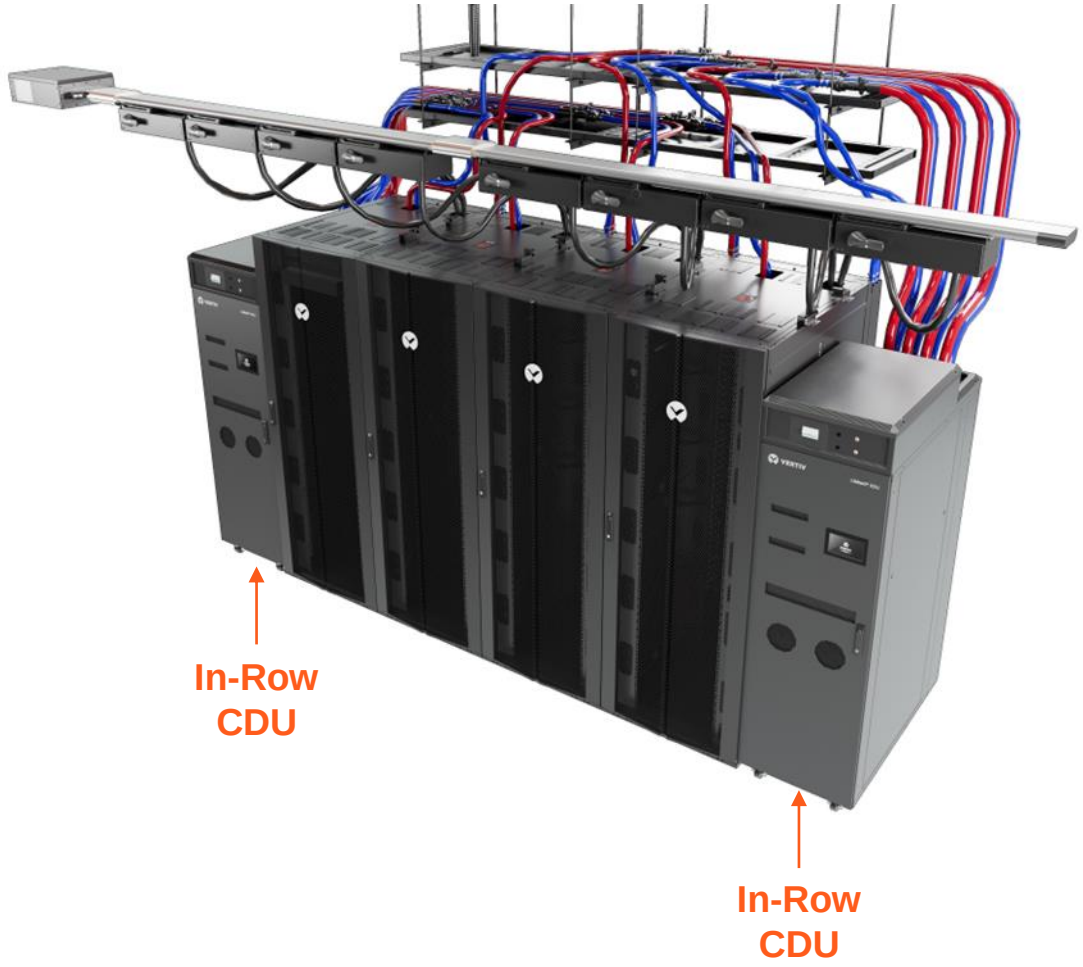
In case CDU fails, volume stuck within cold plate channels and pipes overheats very quickly and **cannot act as buffer** to the system.

- ✓ IT equipment can wait a few minutes until generator and cooling fully restarts without triggering IT shutdown.
- ✓ Cooling plugged on the mechanical bus, not the critical power bus.c
- ✓ IT equipment is forced to shut down in a matter of seconds if cooling equipment is down.
- ✓ Coolant distribution unit feeding SFN is plugged into a critical power bus.

Power and Cooling Must be Designed and Work Together

Liquid-cooling is needed for high-density



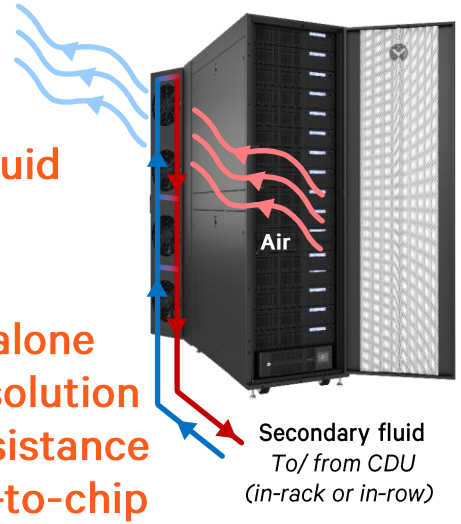


Liquid-Cooling Requires Dedicated UPS

- High-performance computing servers cannot go longer than **1-second loss** of flow without causing shutdown*
- Compare this to a 60-second acceptable outage historically…
- **Waiting for a generator to start is no longer an option!**
- UPS sizing and selection for CDUs require expertise to prevent failures (mechanical load)

Liquid cooling design options also include rear-door heat exchangers and immersion cooling.

Rear-door heat exchangers



- Highly efficient air-to-liquid solution.
- Available as standalone cooling solution or air-assistance in direct-to-chip designs providing room neutrality.
- Back-of-the-rack attachments. adaptable to existing rack architectures.
- Not as sensitive to contaminants as cold plates, less challenging fluid management.

Immersion cooling

- Highest heat rejection efficiencies amongst liquid cooling technologies, with no need of air cooling in most designs.
- Higher adoption in smaller standalone or pilot applications.
- Scalable technology with two-phase fluid options being able to handle extreme rack densities.

There is not one-size-fits-all answer in liquid cooling. Best technology will depend on site and application.

With liquid cooling, thermal loads cannot go down. What options are there to keep these loads up?

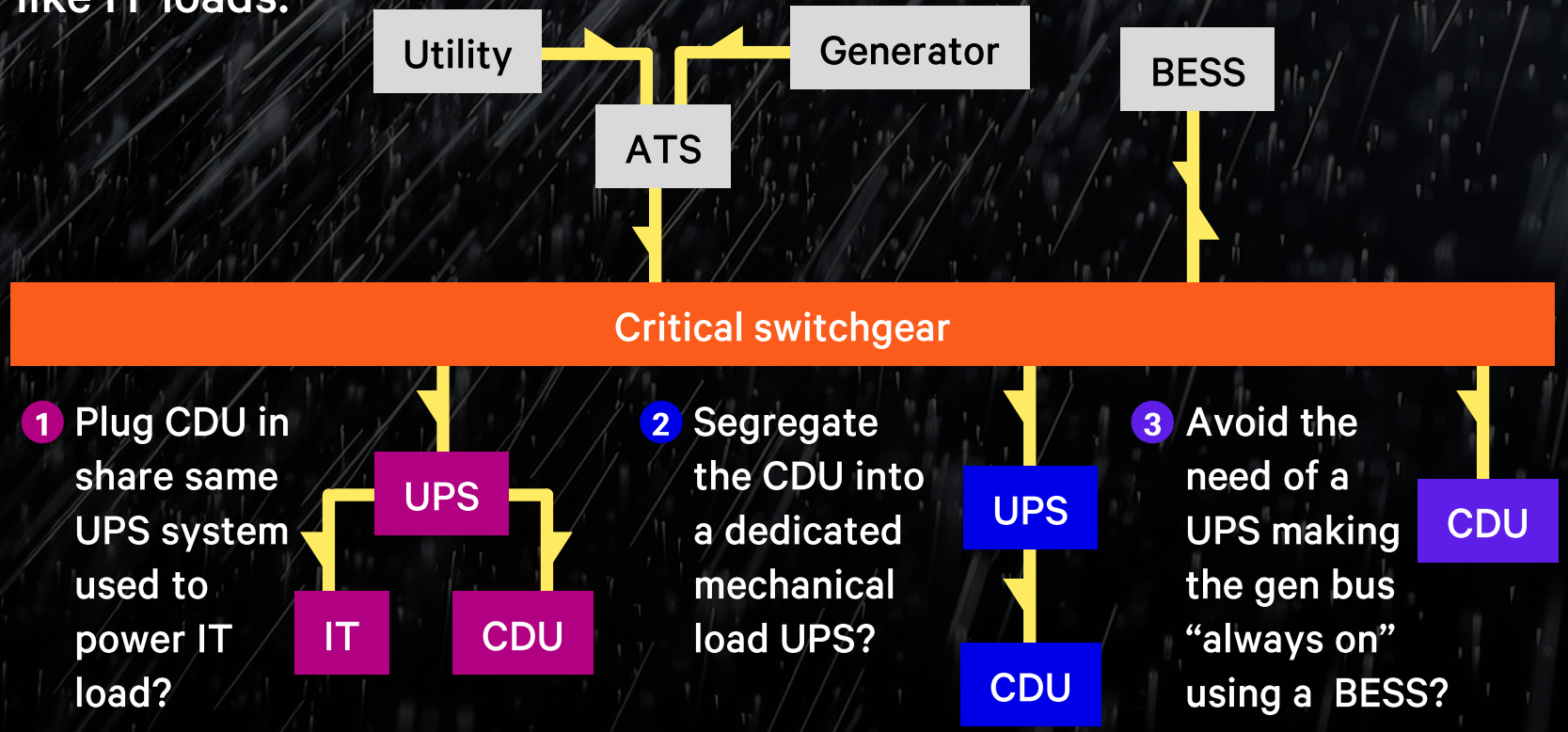
Air cooling

Thermal and housekeeping loads have historically been connected to the mechanical bus.

- When the utility went down, the UPS would maintain IT loads.
- Thermal and housekeeping load power would cycle (go off briefly before turning back on) on utility failure.

Liquid cooling

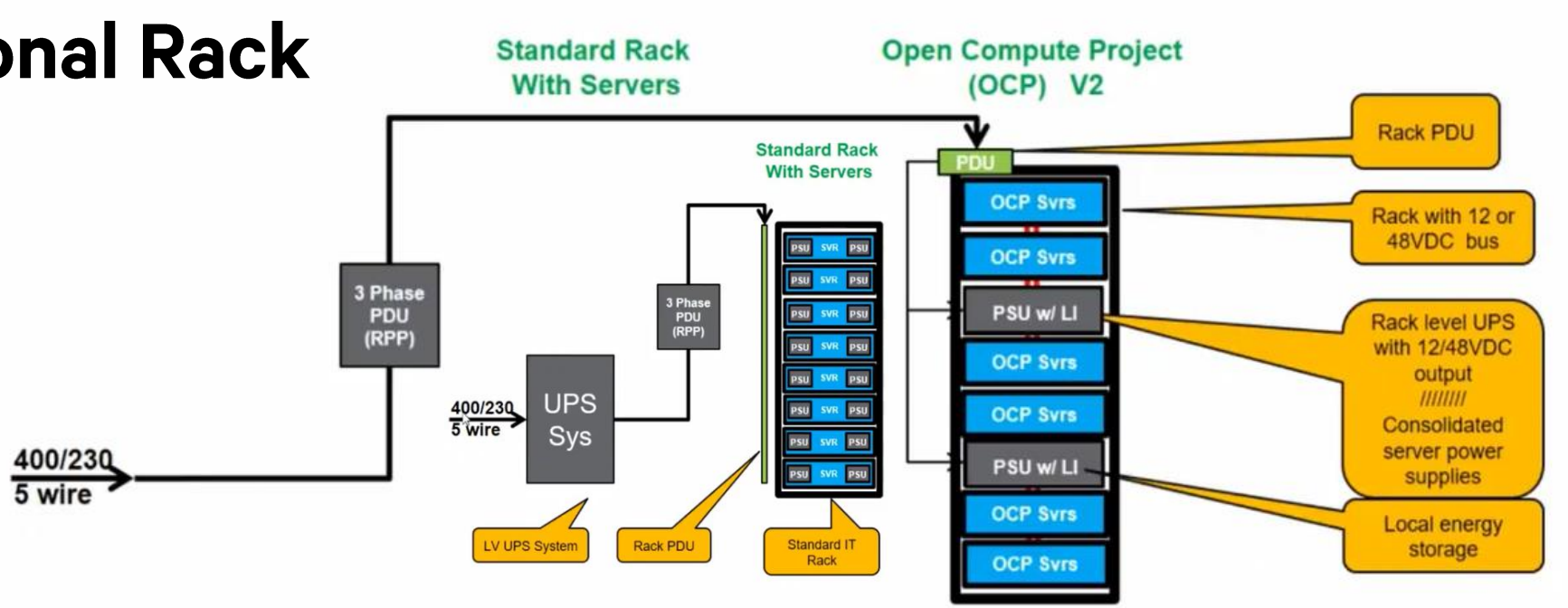
Coolant distribution units (CDUs) must be **powered continuously** just like IT loads.



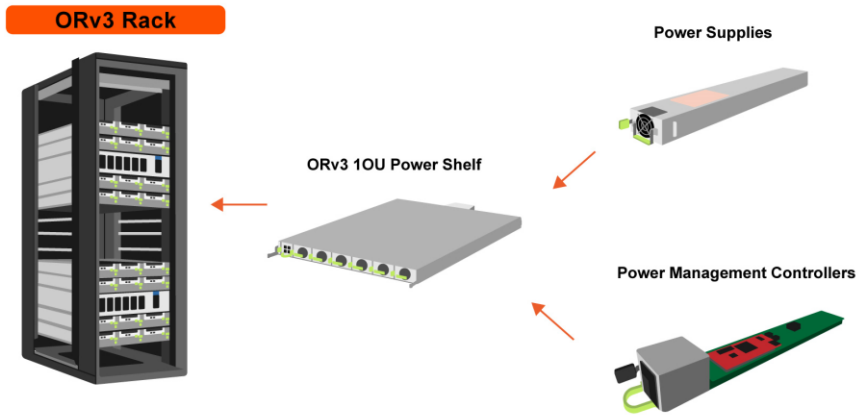
Rack Solutions

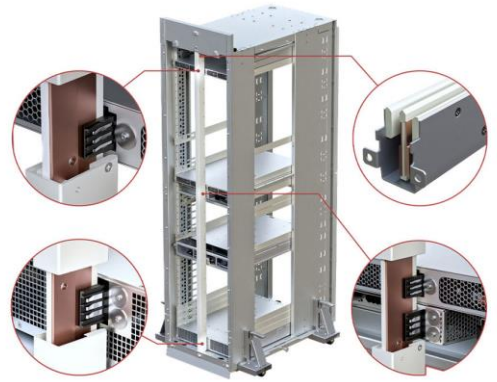
20 minutes

Conventional Rack vs OCP



Open Compute





Higher networking racks are being redesigned to handle heavier IT gear.

- ✓ **Stronger racks** to handle additional weight of IT gear and liquid volume and torque.
- ✓ Larger racks to allow for **HD rPDUs, manifolds, larger cables**, inlet/outlet **hoses**.
- ✓ **Retrofitting existing datacenters may become challenging** due to change in rack footprint.

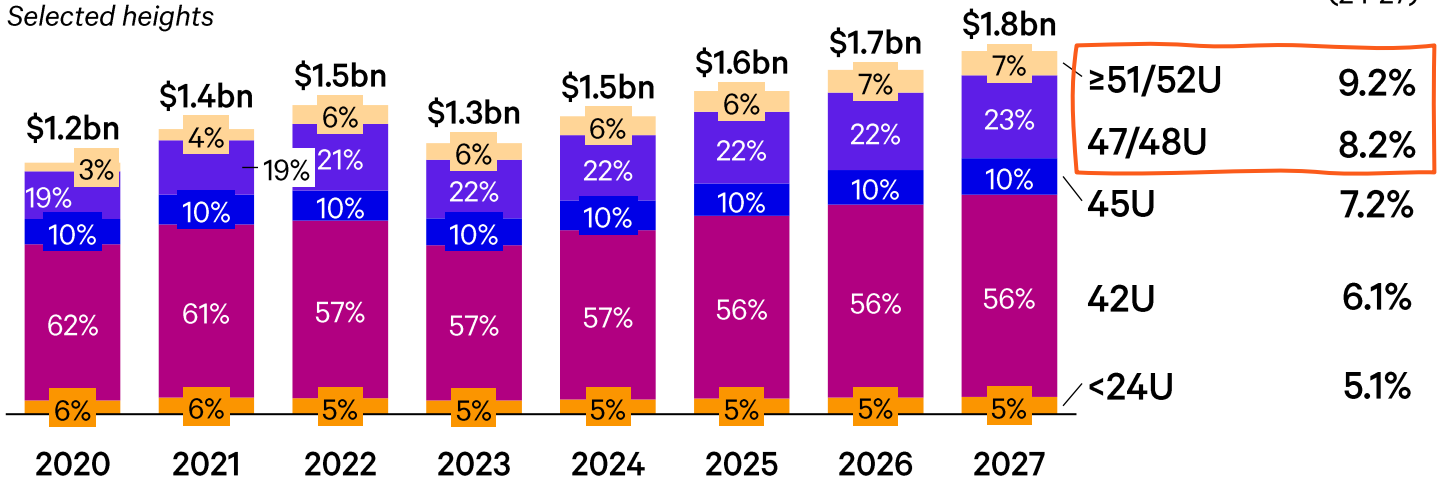
- ✓ Racks must have **drip pans with sensors** that communicate to a central management controller.
- ✓ **Smart shutoff valves** to rack and row must be used to automatically shut off liquid flow in severe leak situations.

Source: NVIDIA, Supermicro

42U still the dominant rack height, but taller racks slowly expanding with faster growth than shorter sizes.

Global rack enclosures market by rack height

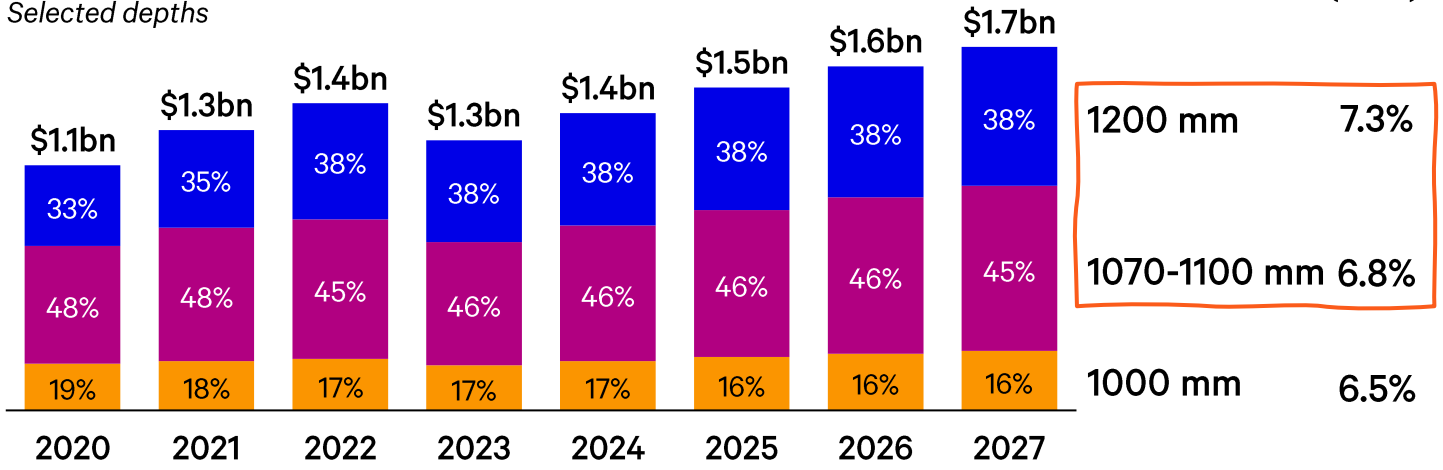
Selected heights



	CAGR (24-27)
≥51/52U	9.2%
47/48U	8.2%
45U	7.2%
42U	6.1%
<24U	5.1%

Global rack enclosures market by rack depth

Selected depths



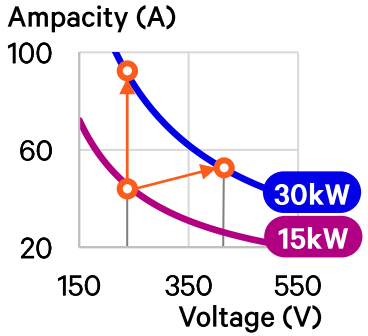
	CAGR (24-27)
1200 mm	7.3%
1070-1100 mm	6.8%
1000 mm	6.5%

Source: Omdia

AI is changing the IT rack, making them taller, wider and deeper.

Higher voltages need to be introduced to the data hall.

Doubling rack power requires **+16% amperage** if voltage moves from 240V to WYE 415V, but **2x amperage** if voltage stays at 240V.



Benefits of lower ampacity systems:

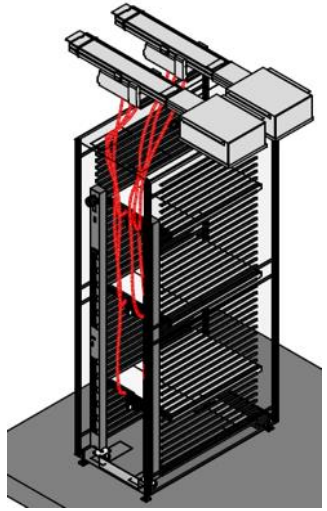
- ✓ **Lower energy losses** in the power distribution.
- ✓ **Lower wiring cost** with smaller diameter wires.
- ✓ **Lower weight and size** of wiring and other power components.

- ✓ **Multiple PDUs per rack to split load often not an option** due to limitation of space in the back of the rack.
- ✓ Higher capacities bringing in both **higher voltages and higher amperages**. New designs coming with WYE 277/480V forcing change in IT as standard server PSUs operate under 250V max. 60-80A PDUs are becoming part of the standard PDU offer, with recent custom units getting ≥100A.
- ✓ **Breaker space becomes a bottleneck**, with novel designs moving breakers from the strip to above the rack by busbar tap-off box.
- ✓ **Input plugs and cable are challenging**, hardwiring becomes needed or higher spec plug designs (e.g. Anderson plugs).

Rack PDUs are undergoing transformative design changes to meet the needs of high-density AI workloads.

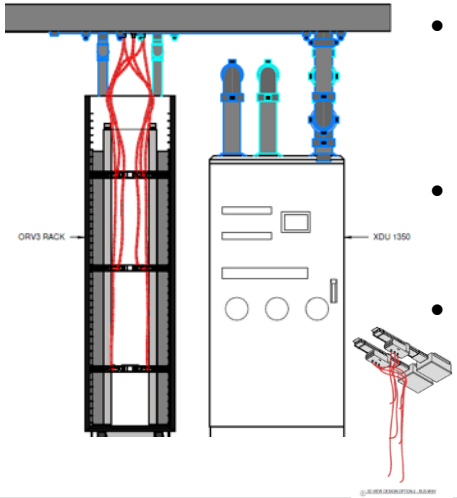
AI designs are privileging above-the-rack busbars v underfloor wiring for the ease to scale up and maintain.

Design 1



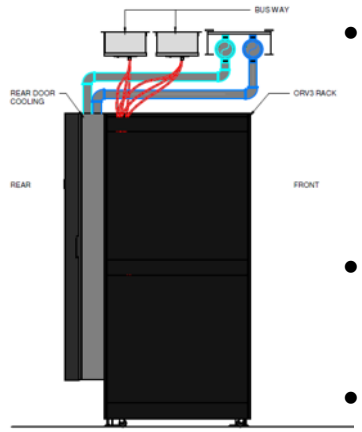
- 2x busbars
- 2x tap-off boxes (1 per busway, to 1 rack)
- 6x drop cables (3 per TOB)

Design 2



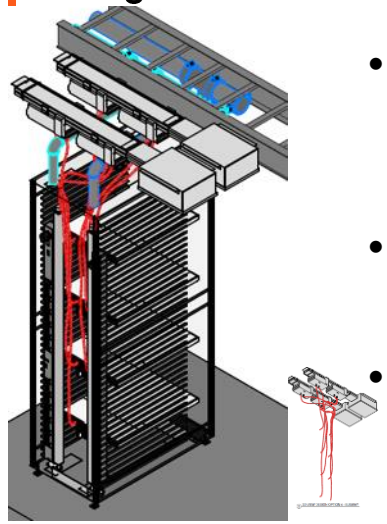
- 2x busbars
- 2x tap-off boxes (1 per busway, to 1 rack)
- 6x drop cables (3 per TOB)
- 1x secondary manifold

Design 3



- 2x busbars
- 2x tap-off boxes (1 per busway, to 1 rack)
- 6x drop cables (3 per TOB)
- 1x secondary manifold

Design 4



- 2x iMPB busway
- 4x tap-off boxes (2 per busway, to 1 rack)
- 8x drop cables (2 per TOB)
- 1x secondary manifold

Project – “High Ampacity” – Dec ‘24

Outline Scope

- Make >60kW-135kW rPDU’s rapidly available via the ETO-S process
  - Supported Voltage 240V / 415V 3Phase WYE *(277V/48V in future)*
- Introduce alternate higher Current Outlet(s) alongside existing IEC options *(30A Anderson & Bizlink)*
  - Maintain Input and Circuit breaker level Monitoring
- Maintain Outlet Switching / Monitoring for IEC outlets *(30A switching in future)*
  - Add higher Current circuit protection (25A, 30A)
  - Include fuses as alternates to circuit breakers

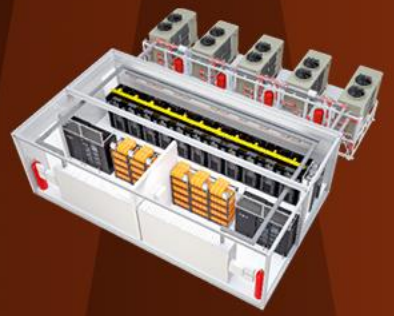
Project – “High Ampacity” – Dec ‘24

Input	Outlets Options	Breaker / Fuse Options	UL	CE	Physical Configuration
Single; 120A/125A 5 Pin IEC 60309 Plug	Saf-D-Grid U-Lock C19 U-Lock C13 Combination	30A 25A 20A 16A	70kW (100A)	88kW (125A)	Available in both 0U and 19” form factors
Single Hardwired			70kW (100A)	70kW (100A)	
Dual; 60A/63A 5 Pin IEC 60309			70kW (100A)	88kW (125A)	
Dual; 60A/63A Hardwired			88kW (125A)	88kW (125A)	
Single; Hardwired			80kW (116A)	80kW (116A)	
Single; Hardwired			90kW (130A)	90kW (130A)	
Single; Hardwired			100kW (145A)	100kW (145A)	
Single; Hardwired			120kW (175A)	120kW (175A)	

Modular Solutions

20 minutes

	LOW DENSITY & MEDIUM DENSITY	HIGH DENSITY	EXTREME DENSITY
POWER PER RACK	<20 kW	<50 kW	100+ kW
COOLING TYPE	In Row Cooling Perimeter Cooling	In Row Cooling Rear-Door Heat Exchanger Cooling Island	Perimeter Cooling Direct-to-Chip Liquid Cooling
TECHNOLOGY	AIR COOLED	AIR COOLED	AIR & LIQUID COOLED
INFRASCTRUCTURE SOLUTIONS	SmartMod™ SmartMod™ Max SmartMod™ Combo	MegaMod™	SmartMod™ HDX	MegaMod™ CoolChip



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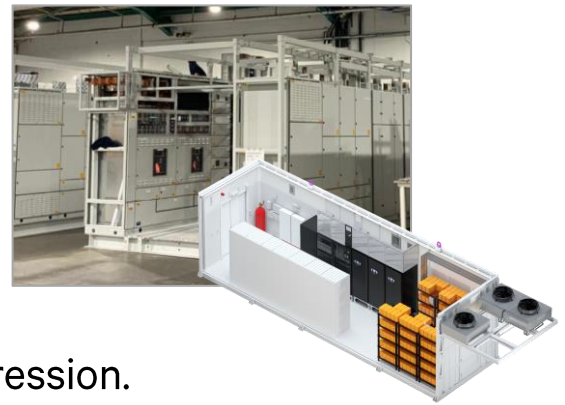
Power and cooling modules, and data room structure are the building blocks of prefabricated data center modular solutions.

Power modules/ skids

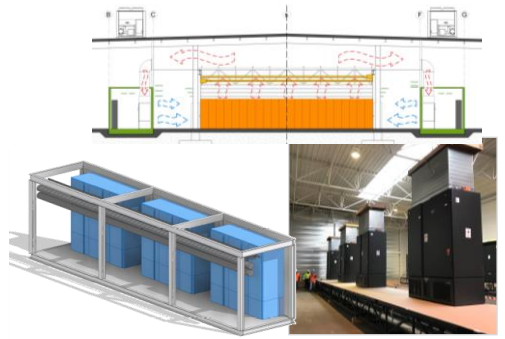


- Up to 5000A main distribution board with integrated ATS, UPS and batteries (Li-Ion or VRLA).
- Thermal management systems for electrical infrastructure.
- Access control, CCTV, fire detection and suppression.

Data room super-structure

- Prefab overhead super-structure for IT data rooms.
- Busbars and tap-off boxes, cable trays, fiber runners, aisle containment, lights.
- Fire detection and suppression elements (sensors, pipes and nozzles).

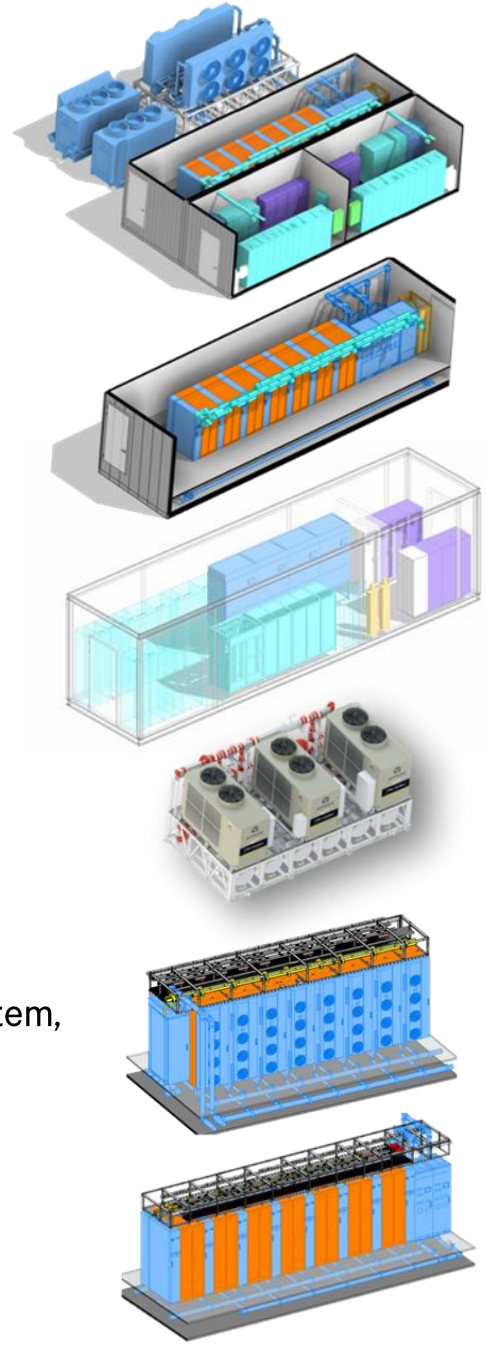
Cooling modules/ skids



- Placed around perimeter of the data room.
- Prefabricated piping and valves inside the skid.
- Variety of cooling options (CW CRAH, Fan wall, DX, IDEC, DEC).

Next-generation prefabricated modular data centers is already being deployed incorporating liquid cooling technology.

- **Next generation of data center infrastructure based on direct-to-chip liquid cooling**
  - Single-phase direct-to-chip
  - Cooling 5%-30% air / 70-95% llquid
  - 100+ kW/rack density
- **Fully prefabricated IT hall modules**
  - Liquid cooled racks
  - Cooling infrastructure (XDU, RDHx, air cooling, piping)
  - Busbar system, cable trays
- **Fully prefabricated power modules**
  - UPS units and batteries with LV distribution boards
  - Cooling infrastructure (PCW + piping), cable trays
- **Prefabricated cooling skid**
  - Piping infrastructure, drycoolers/chiller units
- **Prefabricated IT skids (stand-alone solution)**
  - Liquid cooled racks, cooling infrastructure, busbar system, cable trays
- **Preassembled overhead (existing building)**
  - Installable into existing or new infrastructure
  - Busbar, Cable Trays, Piping, auxiliary



Design 3: 1.2 MW Solution with 132 kW Racks

Design Highlights

1. Completely **prefabricated AI direct-to-chip cooled data center**, including complex pipework, power train and heat rejection systems.
2. Powered by **Vertiv™ PowerNexus**
3. **Skidded solutions** possible for quick repurposing of existing space.
4. Greatly **reduced** on-site deployment and commissioning **complexity.**
5. **Liquid cooling** works **in sync with air-cooled technology**, splitting the load to reject all the heat from the rack.

Solution Capacity	1.2 MW
Infrastructure Redundancy	N
IT Redundancy	N
Total IT Load	1176 kW
Rack Density (IT load)	8 racks at 132 kW, 10 racks at 12 kW
Rack(s)	18
Cooling Topology	76% Liquid (direct-to-chip) 24% Air (perimeter units)
Coolant Distribution	Vertiv XDU1350
Air cooling	Chilled Water Modular Fan Wall
Compute Rack PDUs	120A rack PDU, 2 per rack
Busbar	500A busbar, 2 per row 120A TOB, 2 per rack
Room/Row PDU	500 kVA PDU, 2 per POD
UPS for IT	1500 kVA UPS
UPS for Cooling System	240 kVA UPS, N+1

Building Blocks

PowerNexus	1x 1500 kW
IT Module	2x Liquid Cooled IT Modules
CoolFlex Mod	4x Fan Units
Heat Rejection Infrastructure	1.1 MW Vertiv AFC Chiller