



High Density is Here:

A Look at the Opportunity, Challenges & Options

September, 2020

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www.vertiv.com



WHO REMEMBERS THE CHILL-OFF 2 (OCT, 2010)

A CHAT ABOUT THEN AND NOW!

The Need for 20kw per Rack is immediate!
It was a crisis!

Participants

Virtualization & Enhanced
Server performance solved it!

FLASH
BACK



Rack Air Containment System (RACS)
Hot Aisle Containment System (HACS)



Vette RDHX
Passive Rear Door



LCP+
Contained Solution



Knürr CoolTherm
Knürr CoolLoop



iDataPlex



Liebert XDR Passive Rear Door
Liebert XDP/XDV/XDH



Sun Rear Door Cooling
Sun Modular Datacenter - (SunMD)



Direct Touch
Cooling Rack

FLASH
BACK

High DENSITY IS COMING!
This time for Real!



October 14, 2010

Hosted by Brocade

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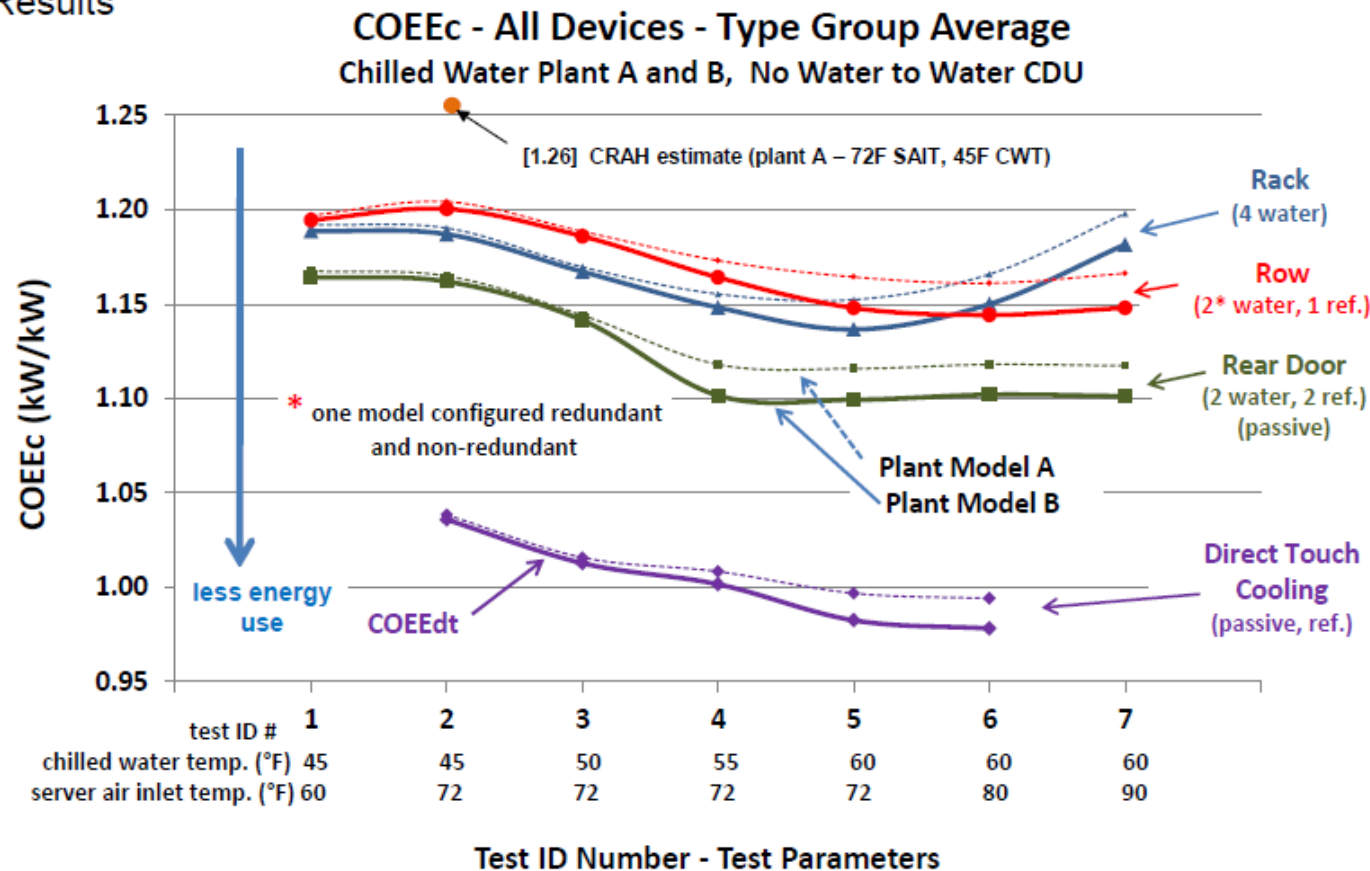


DATA CENTER
EFFICIENCY
SUMMIT



Chill-Off Results

Results



**FLASH
BACK**

**FLASH
BACK**



October 14, 2010

Hosted by Brocade



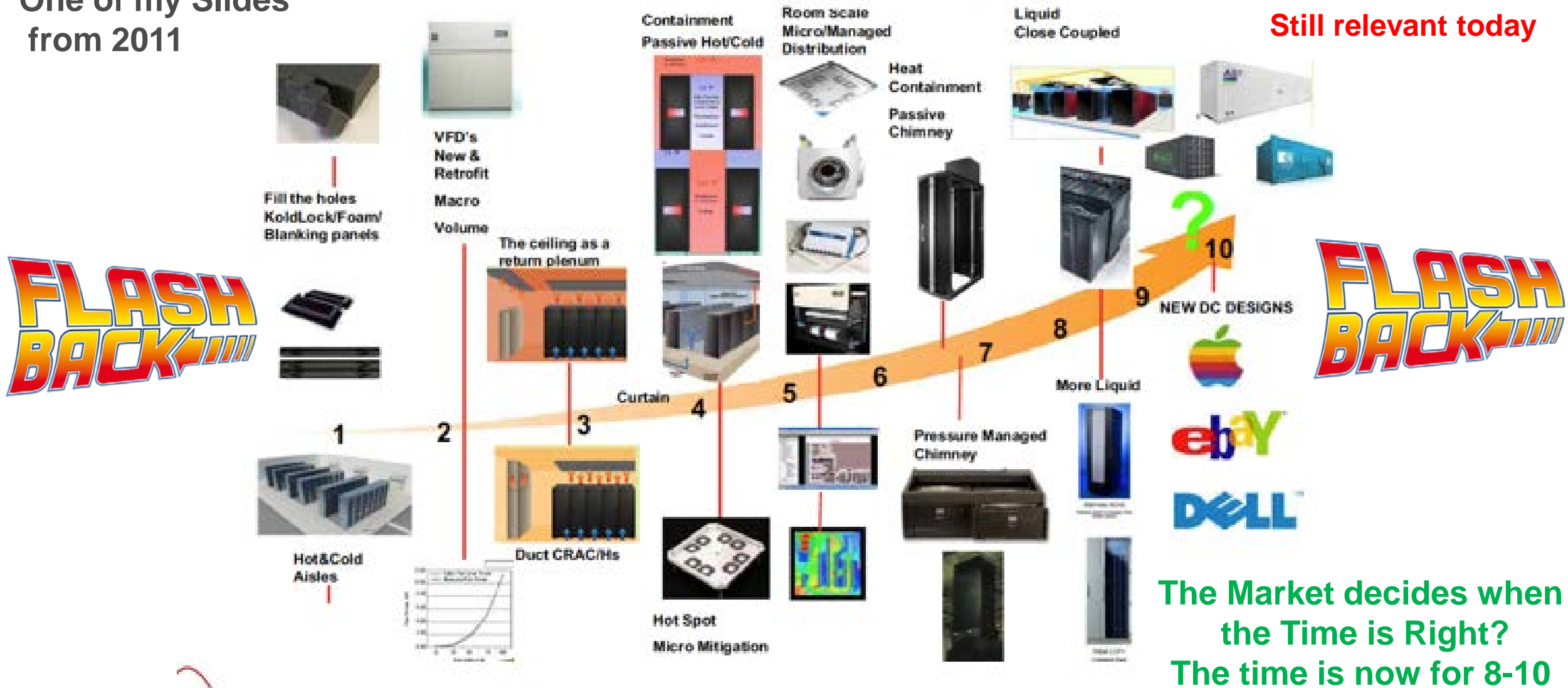
**DATA CENTER
EFFICIENCY
SUMMIT**

13



THE EVOLUTION – COOLING - TITLE 24 AND MORE

One of my Slides
from 2011



Today – NEW END-USER REALITIES & PARADIGMS

- It's not about Infrastructure! It's about the **application**, the **service** and the **business value**
- **Today it's about delivering Apps & Business value the best way possible! IT's been Weaponized!**
- Cloud Adoption has happened much faster then expected – **Cloud 1st Mentality** – But not **Cloud Everything**
- **Colocation has exploded** – The Colo space has really matured – Cross Connect/Managed Services/Offerings
- **The Edge is Exploding** - IoT- Billions of Things (30B things require 400 M Server like devices) - Wireless 1st, **5G is coming fast (13X the Towers and supporting Infrastructure!) AWS Outpost is a Tell!**
- The Primary Drivers are **AI (Artificial Intelligence), IoT, 5G** and Data Analytics. **High Density is here!**

Major Change/Disruption Underway! We/you have options! Lead it!



THE **DIGITAL TSUNAMI** IS COMING/**HAS COME!**

The Infrastructure to Support this needs to be built!

Billions of chirping things!

AI

IoT

5G

DATA

DATA

DATA

Billions of Bytes & \$'s Coming!

Opportunity will be Abundant!

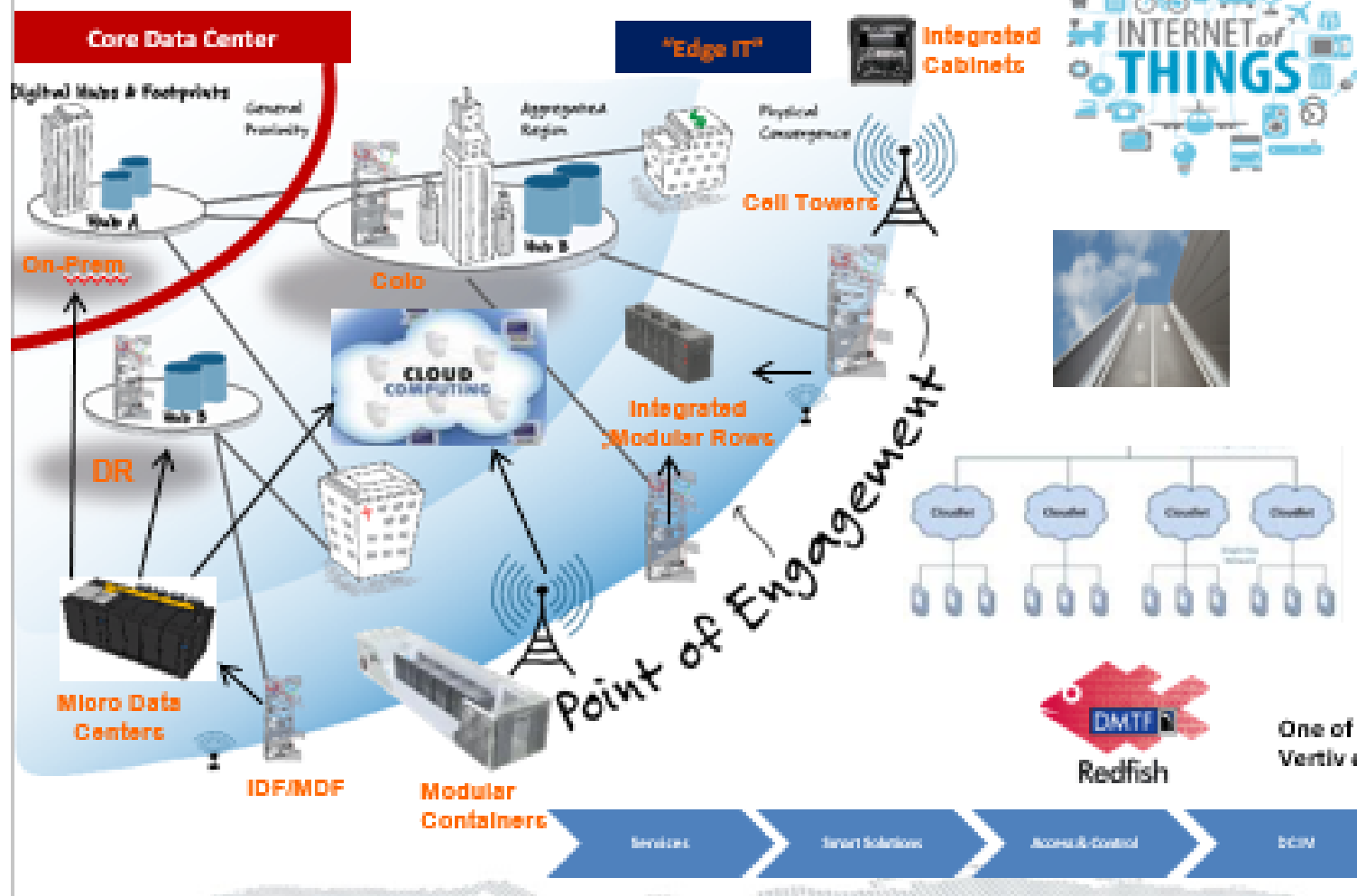
As will be the Infrastructure Challenges

DATA Is the New Oil/It's Currency!

You Will be Managing a Complex/Hybrid World!

That will now include High Density & HPC – In the DC and @ the Edge!

Cloud – Colo – On Prem – DR – Edge? YES!



Our world has become much more complex.

...but there's opportunity in managing complexity!

Challenges/Change drivers:

- Security
- Exploding Data Sources (8B to 20/60B by 2020)
- Virtual Everything
- Software Defined Everything
- Latency - Always on Everything & Every Where!
- Continued Lean Staffing
- Remote Access/Mgt. & Visibility a must!

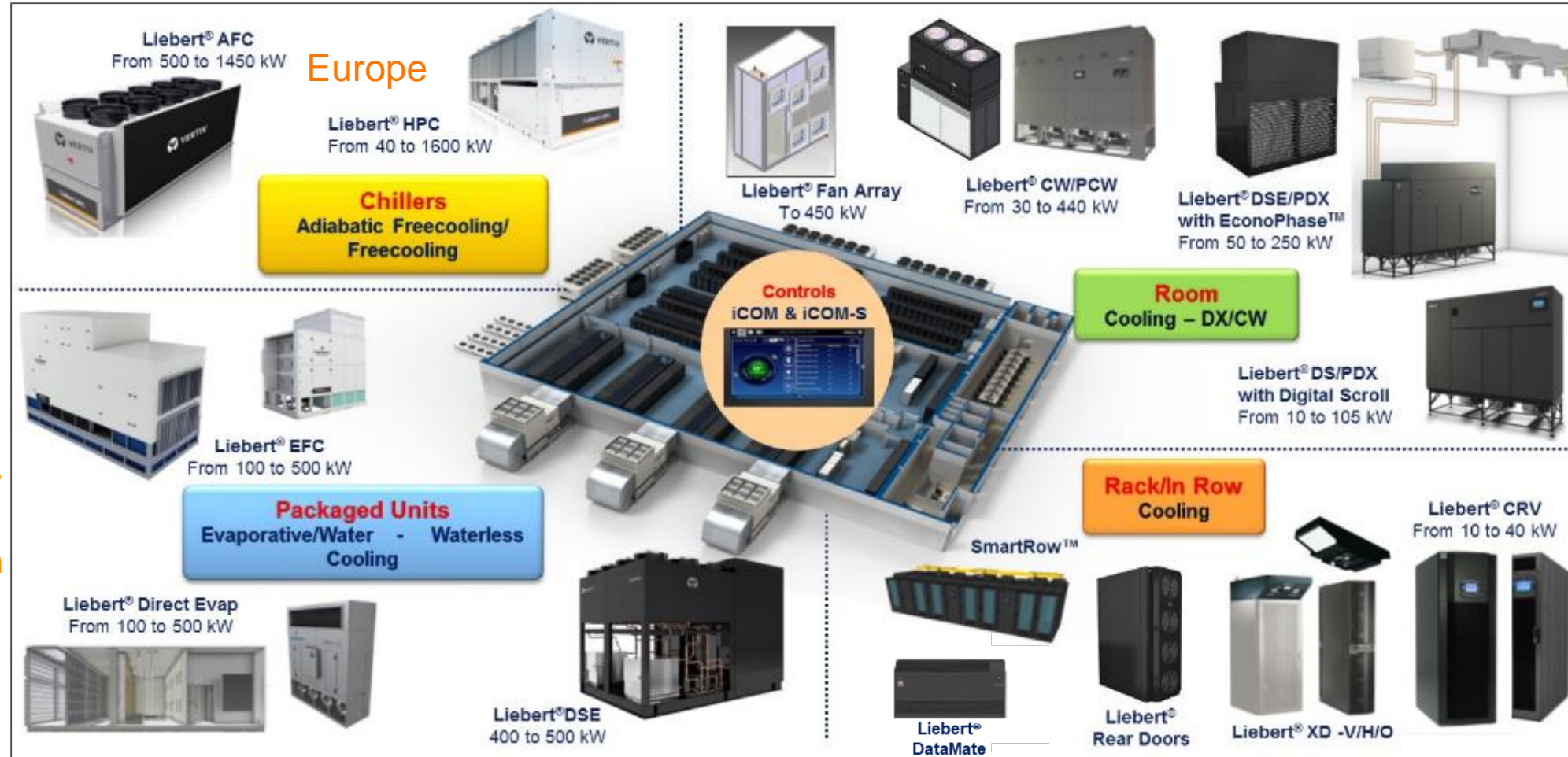
One of many emerging languages and Protocols for IoT Vertiv equip will be Redfish enabled

MANY TOOLS/SOLUTIONS FOR EVERYTHING! YOU HAVE OPTIONS! IN THE SPIRIT OF 7X24 – KNOW WE HAVE MANY COMPETITORS

Customer need/preference/drivers are many:

- Climate
- Building configuration
- Customer preference
- Efficiency
- Peak Power
- Edge to Cloud
- Range of building blocks
- Speed of Deployment

- **Solutions to drive first costs and operating costs**
- **Integration options for speed**
- **Industry leading comprehensive controls**
- **Monitoring Services and AI to drive greater optimization and predictive service**



A PLETHORA OF HIGH DENSITY COOLING OPTIONS & MORE COMING

Dell & Cool IT



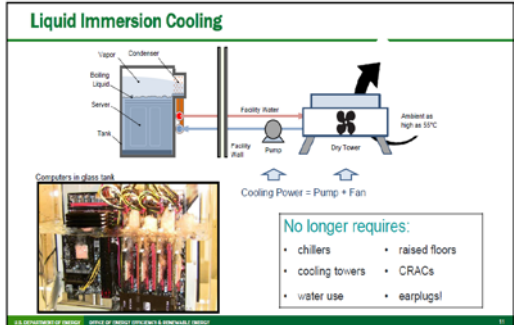
Cold Plate



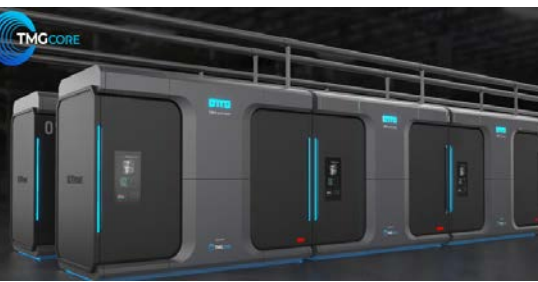
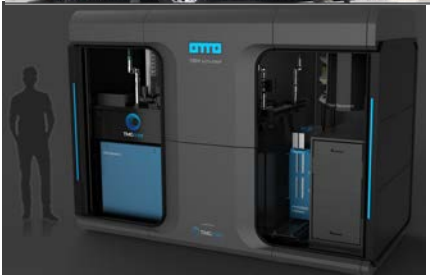
Heat Sinks



Single Phase Immersion Lots of players



Self contained/Healing Fully Automatic/Robotic 2 Phase



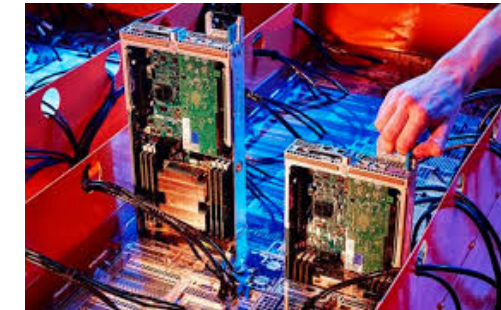
San Diego's Own



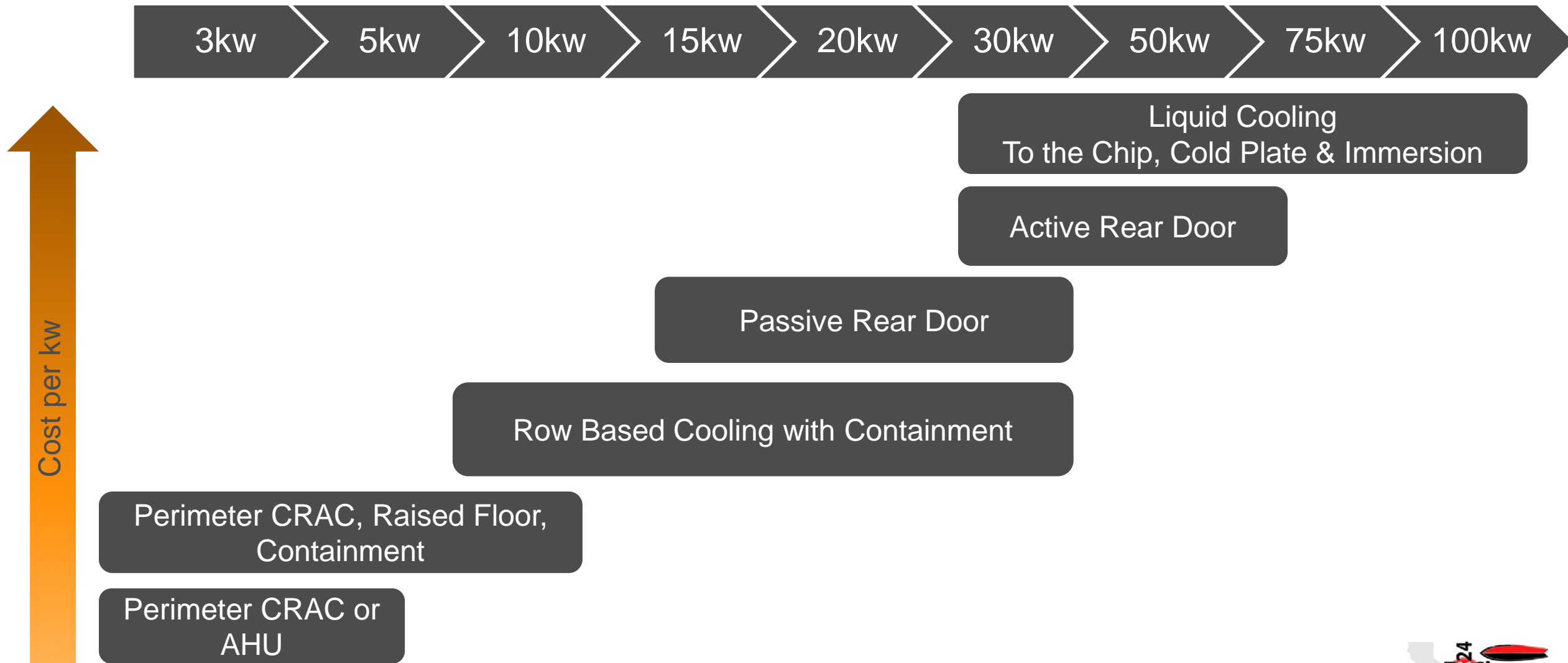
CDU's Liquid to Chip



Sandia Manifold/Feeds



Cooling Density Matrix – High Density is here!



SERVER TRENDS – DENSITIES ARE GOING UP!

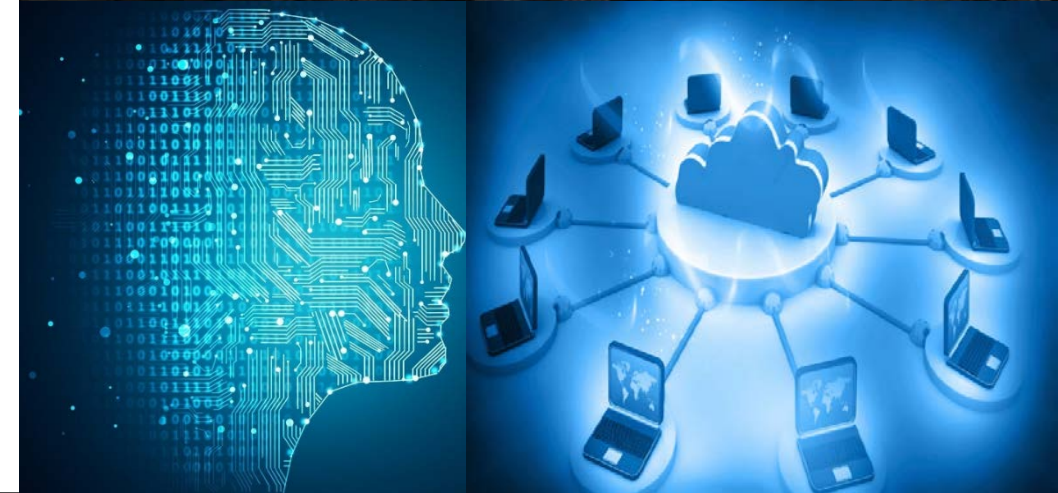
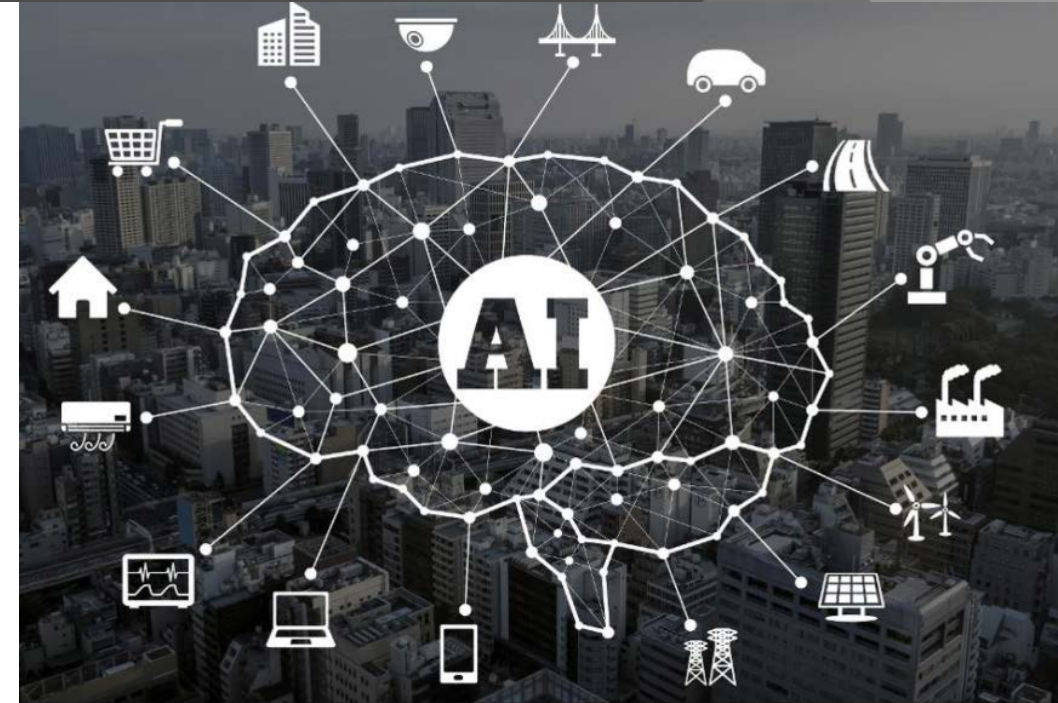
Server consolidation, Virtualization, Blades, HD Box's, GPU's

Emergence of GPUs for Artificial Intelligence & machine learning – NVIDIA, AMD, INTEL, IBM, now Tesla and others

Packing more kw into the cabinet – moving to greater than 26-50 kw per rack very quickly! And 100kw designs are out!

AI is Extremely Slow compute & Latency Intolerant!

Jan 2020 Apple, AWS and Microsoft announce the are moving Compute/AI to the Edge! **“Edge Cloud” is Born!**



NVIDIA AUTHORIZED COLOCATION PARTNERS IDENTIFIED DGX READY



CLOUD & DATA CENTER

PRODUCTS ▾

SOLUTIONS ▾

APPS ▾

FOR DEVELOPERS

TECHNOLOGIES ▾

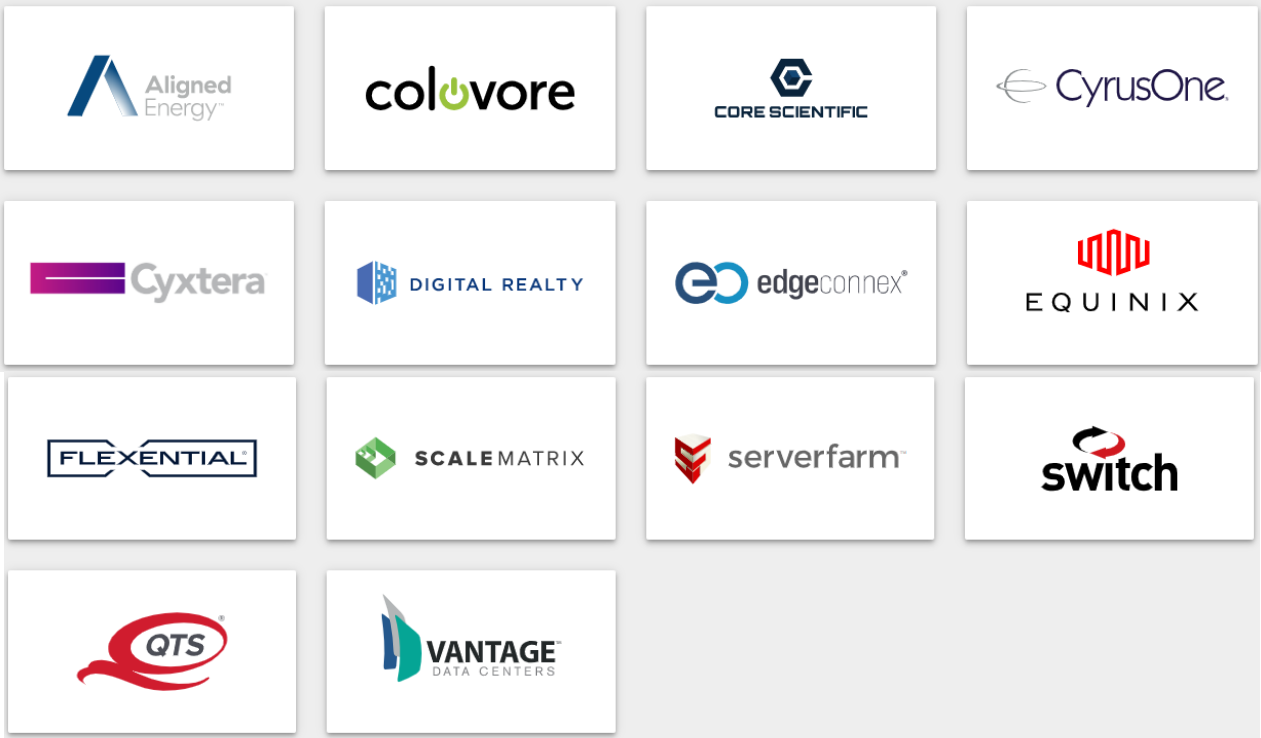
DGX System

To ensure adequate/
Infrastructure is
Available

DON'T LET INFRASTRUCTURE DELAY YOUR ROI FOR AI

Early DGX
11,000 watts, 4U
33k per rack

New DGX- A100
6,500 watts, 6U
26k – 39kw/more



colovore

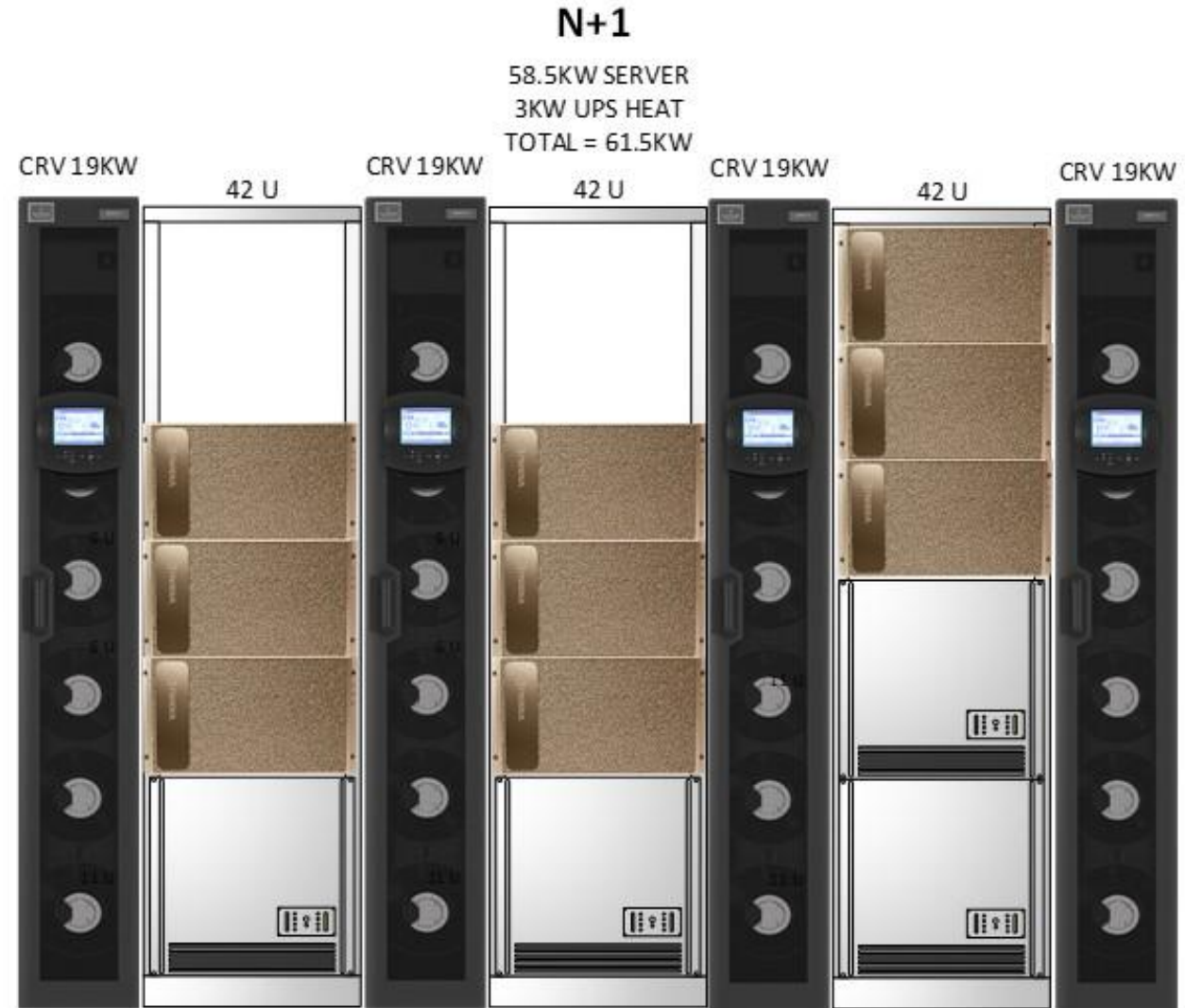


254 35kw/expandable to 55)
Over 1,000 DGX Servers
Startups arriving
Another Tell?

Vertiv™ 3R/3S/1UPS & 3R/3S/2UPS – INDOOR DATA CENTER

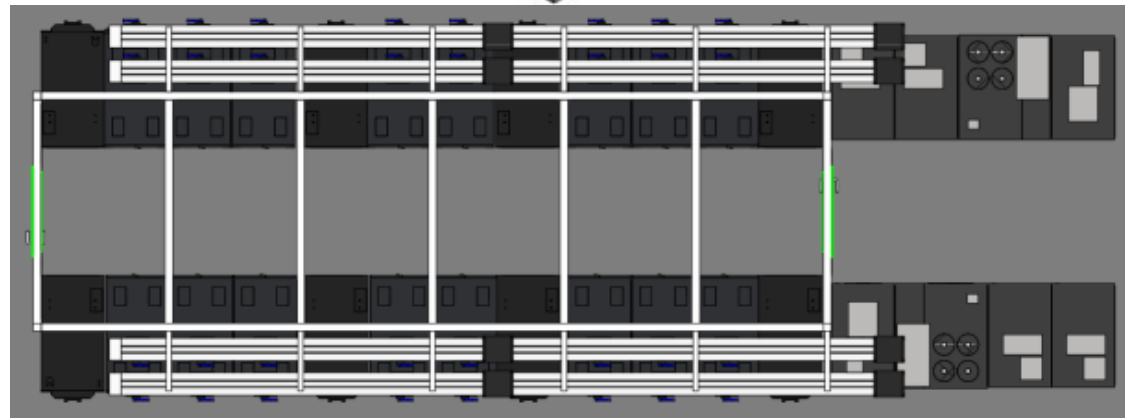
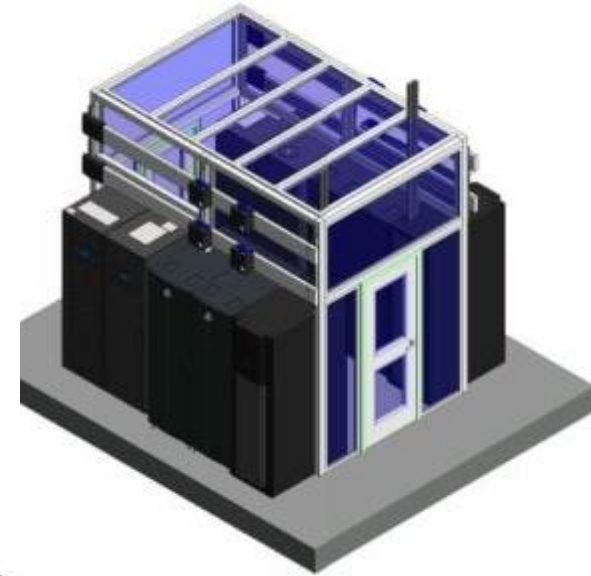
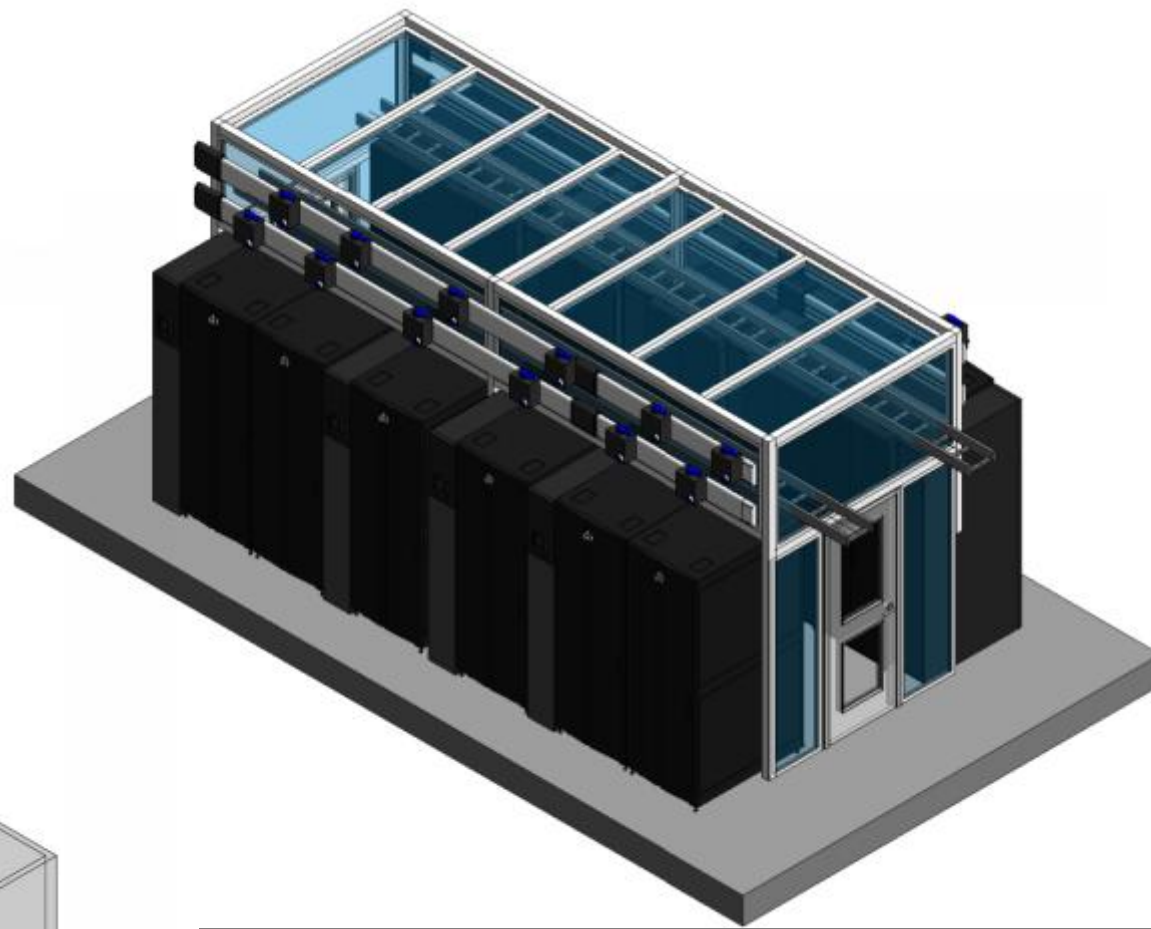
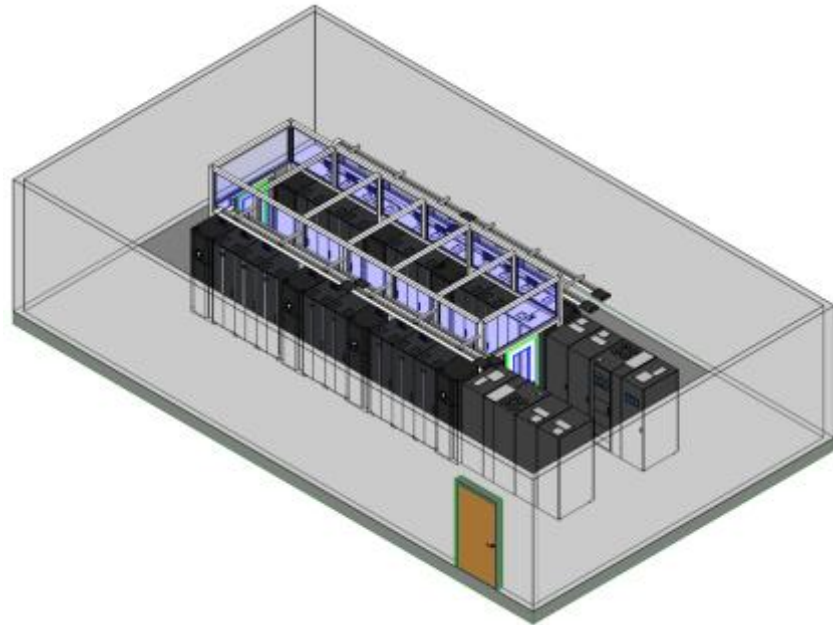
Features:

- 19.5kW per Rack
- Vertiv UPS GXT5 UPS 20KVA/20KW
 - (3) UPS (N)
 - (4) UPS (N+1)
 - 208VAC or 240VAC (L1/L2/N/G)
 - 4.5 minutes backup @ full load
- Vertiv Horizontal Rack PDUs
 - Basic / Monitored / Switchable Options
 - Vertical Options
- Vertiv VR Rack
 - 42RU
- Vertiv CRV In-Row Cooler
 - (4) 19KW CRV (N+1)
 - 12" wide each
 - DX and Chill Water Option
- Vertiv Containment Panels as Option



SmartAisle™

Reference Images



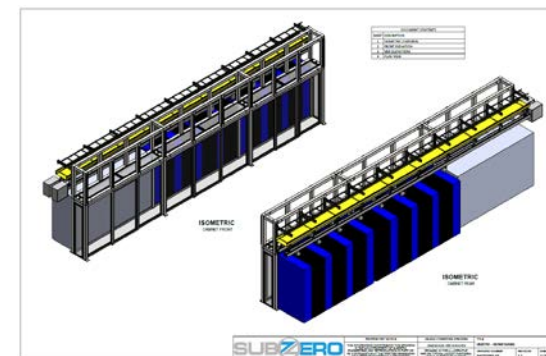
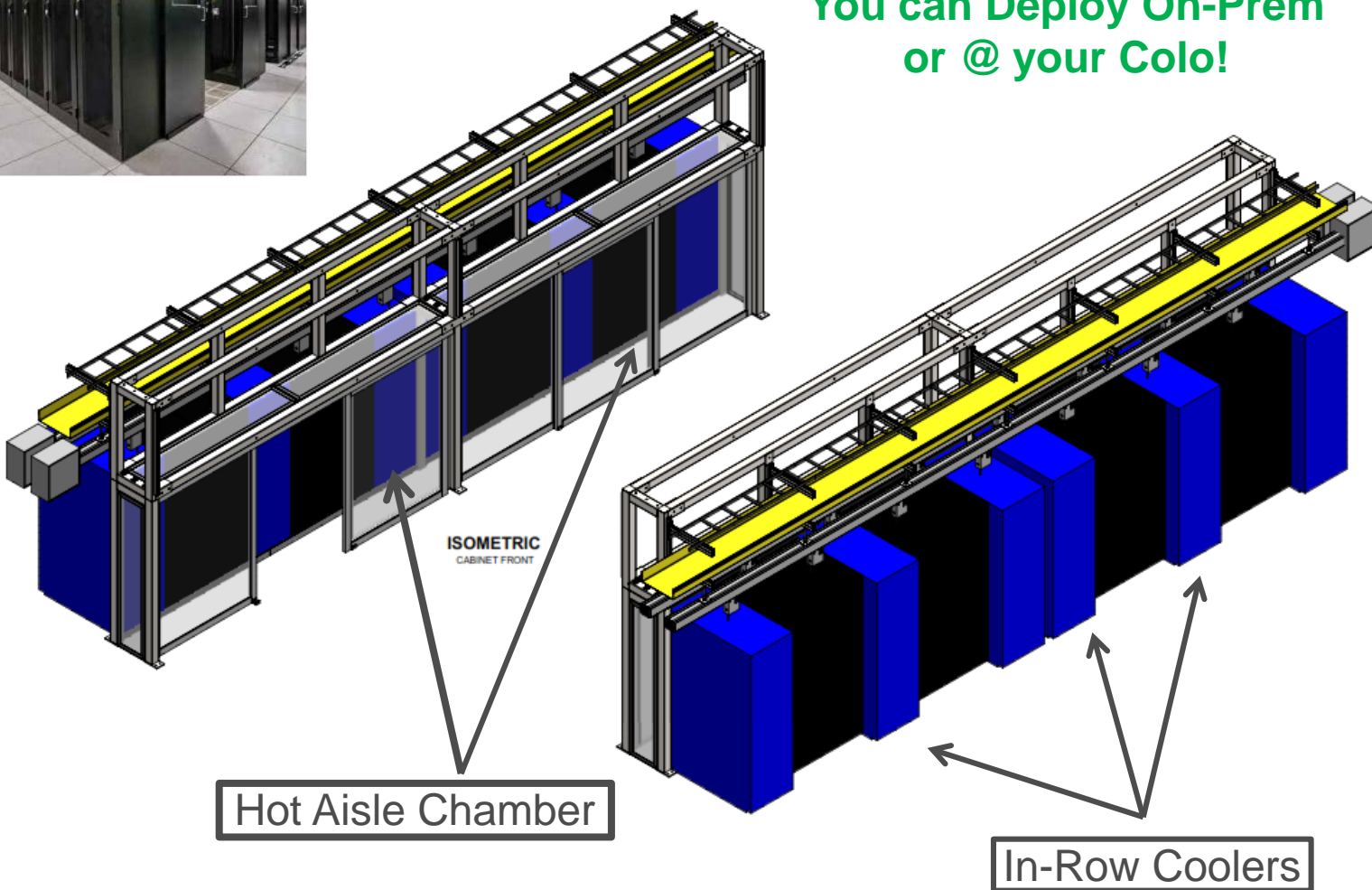
HEAT CONTAINMENT AN OPTION - COMPACT HOT AISLE CHAMBER



Increasingly Viable – Again!

You can Deploy On-Prem
or @ your Colo!

- Compact Hot Aisle Containment
- Closely Coupled **40 kW Row Coolers**
 - › Enables Higher Return Air Temp
 - › Back of Rack Chamber Access
 - Hinged Doors
 - Sliding Barn Doors
- › Enables **16 to 34 kW per Rack** at N+1
- › N+X redundancy
- › ICOM Teamwork Enabled



With or
With/out
Power Option

Vertiv™ SmartRow™ DCX – Reference Design 4 Racks N+1 (Indoor- DC In a Box)

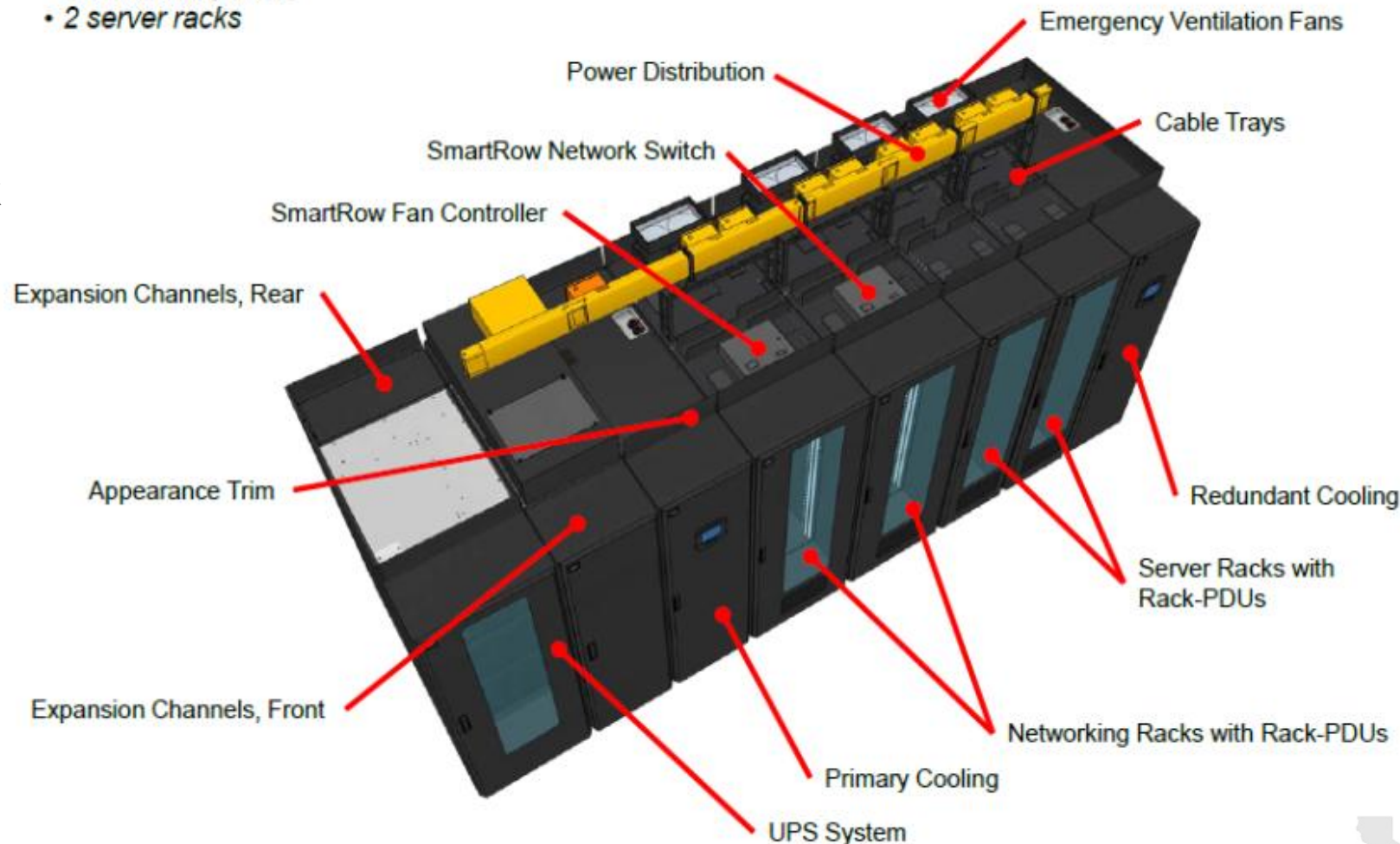
- 4 racks at 7.5kW average
(8.6 kW/rack max)
- 2 networking racks
- 2 server racks
- System Capacity 30 kW, N+1
(7 kW minimum load)

Data Center – Fully Contained!

- 1 DGX™ A100 per Rack
- Power
- Cooling
- Fire Suppression
- Remote Management

Suitable for:

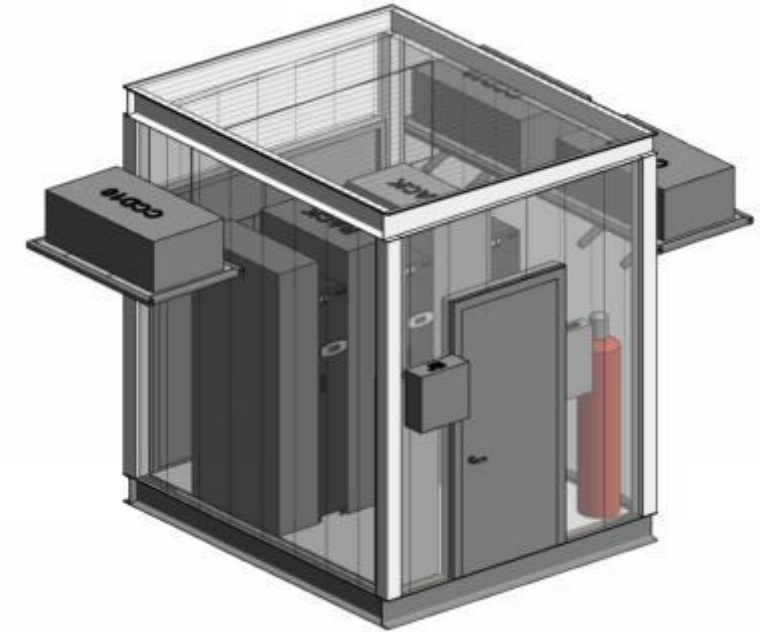
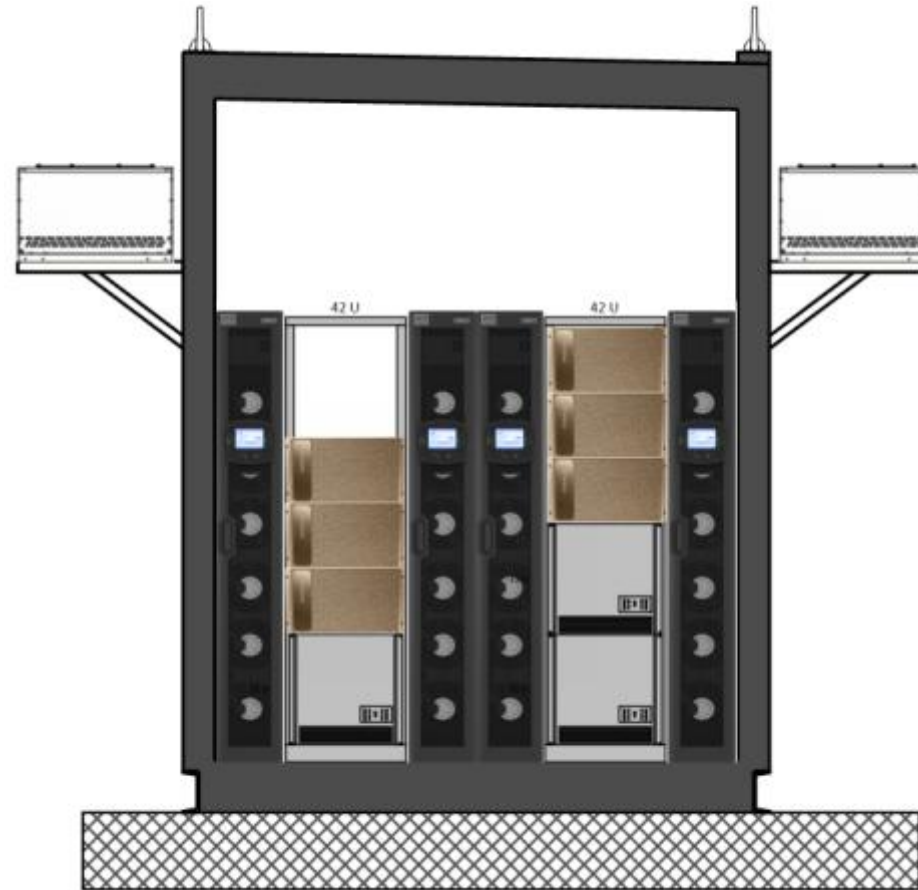
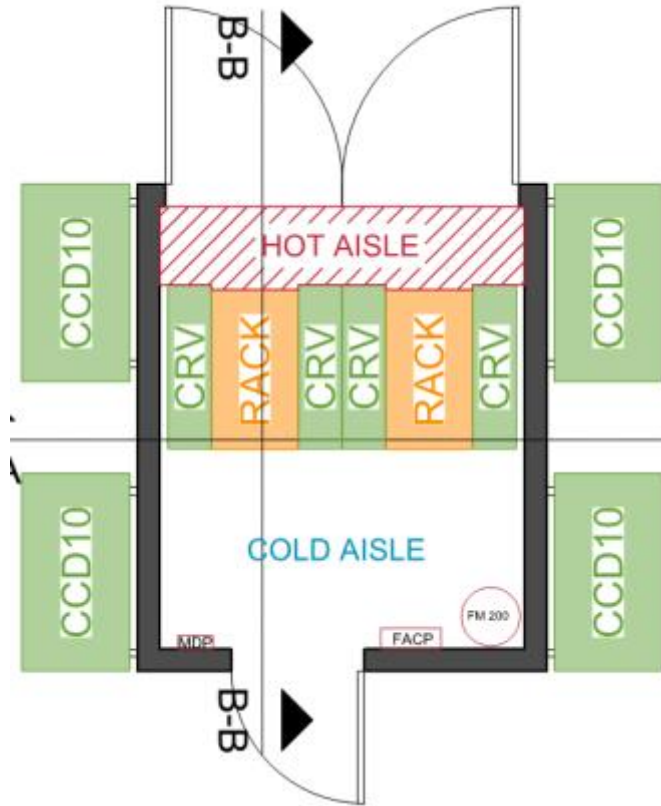
- Conference Room
- Warehouse
- Distribution Center
- Factory Floor



Note: Cabling between overhead MB power distribution and row equipment not shown



Vertiv™ 2R/3S/1UPS & 2R/3S/2UPS – OUTDOOR MODULAR



Suitable for:

- Outdoor
- Warehouse
- Distribution Center
- Factory Floor



RDHX (REAR DOOR HEAT EXCHANGERS)

NUMEROUS PLAYERS (OPTICOOL, MOTIVAIR, COOLCENTRIC & MORE)



Model	DCD35	DCD50	DCD Active		DCP200
Type	Passive	Passive	Active (fan assist)		Pumping unit
Capacity	Up to 35kw	Up to 50kw	35kw+	50kw+	200 kw – 1.3MW
Dimensions	600mm, 42U	800mm, 42U	600mm (24"), 42U	800mm (31.5"), 42U	78" x 34" x 35" (L x W, D)
Advantages	Small profile, lower cost, 180 degree door swing	Small profile, lower cost, 180 degree door swing	Supports higher capacities, monitoring capabilities, no back pressure on server fans		iCOM with dew point controls, redundant pumps

RDHx in Containers – Passive and Active Doors

High Density Anywhere



**Up to 35 KW Per Rack
Passive Coil**



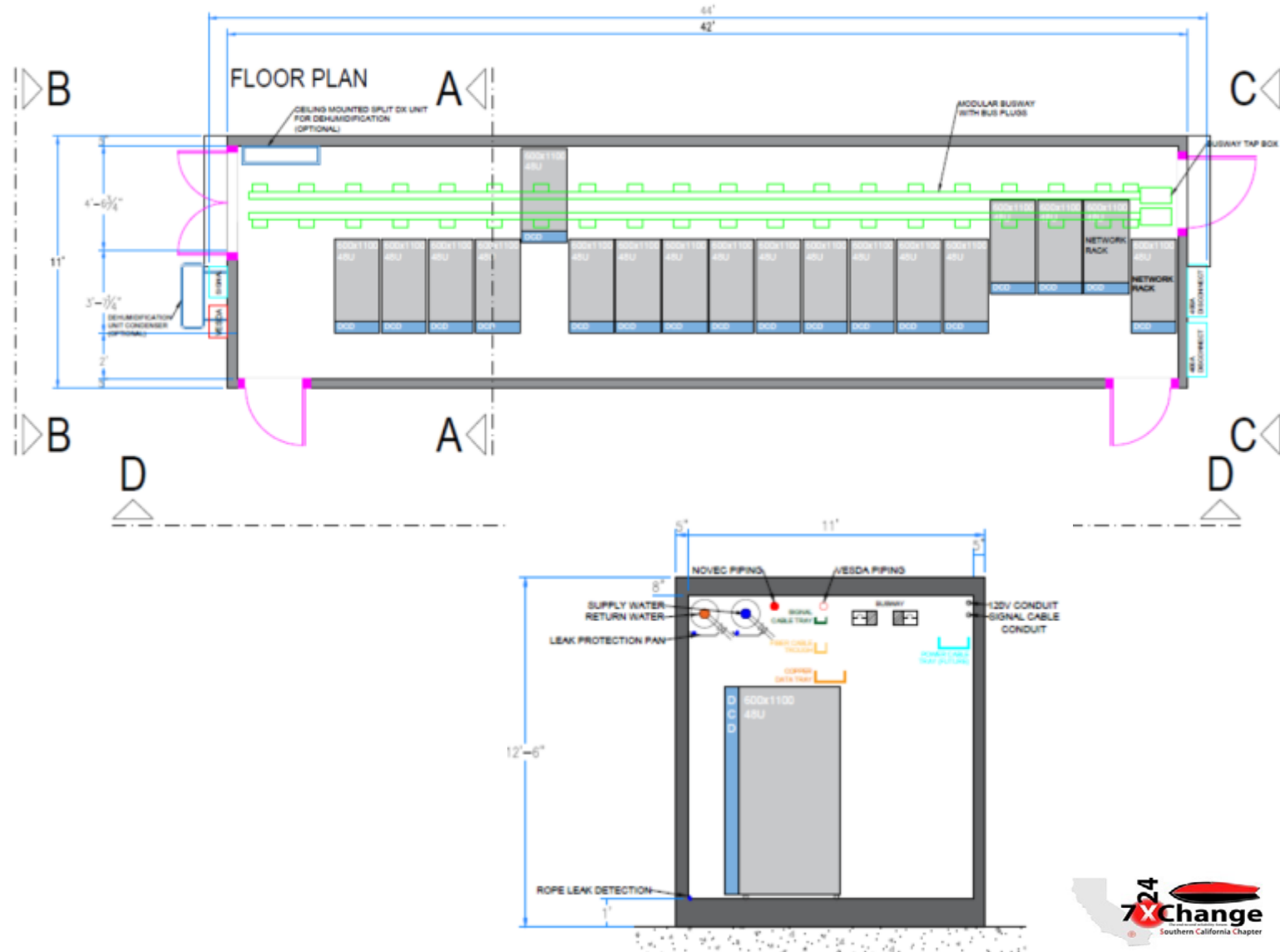
**Up to 55 KW Per Rack
w/Active Fan Kits**



Vertiv™ 3R/4S/1UPS & 3R/4S/2UPS

Features:

- 26kW per Rack (Can go to 50kw)
- Vertiv EXM UPS Floor Mount Remote
 - (1) UPS (N modules)
 - (1) UPS (N+1 modules)
 - 208VAC or 480VAC (3PH)
 - 4.5 minutes backup @ full load
- Vertiv Vertical Rack PDUs
 - Basic / Monitored / Switchable Options
- Vertiv VR Rack
 - 42RU
- Vertiv DCD Rear Door Heat Exchanger
 - 35KW DCD (N) W/Fan can go to 50kw
 - Easiest for facilities with chill water
 - Air cooled chiller can be provided
- Vertiv Containment Panels as Option



Vertiv™ SmartMod™ - 40 to 100kW (Outdoor/Pad ready)

Enclosure

ATS

UPS & Battery
system

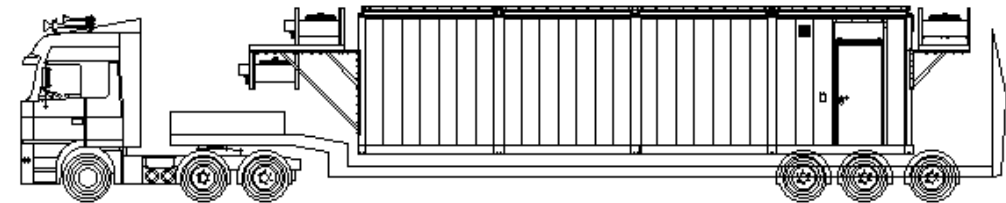
Busbar system

Fiber optics & Copper
Distribution

Fire Detection &
Suppression System

Cooling Units

IT Racks



Liquid Cooling – Some early Markets & Applications

Driven by Artificial Intelligence(AI), High Performance Compute(HPC), IT Compaction, and Harsh Environment

Cloud (15.3% CAGR*)

- Artificial Intelligence for Big Data Analytics
- IT Footprint compaction - same compute less space
- Increase Network Speeds
- Cloud Based HPC Services (15.3% CAGR 2020-2025)

*Source: Market Insights Report <https://www.marketwatch.com/press-release/cloud-high-performance-computing-hpc-market-is-likely-to-experience-a-tremendous-growth-by-2025-2020-03-04>

Media and Entertainment

- Film editing, animation, and special effects
- Video Streaming

Healthcare (41.5% CAGR – AI Growth in Healthcare*)

- Disease Diagnosis – Personalized to the Patient
- Intelligence for Patient Care
- Hospital Management and Optimization
- Research - Gene Sequencing, Cancer, ect...

* Source: PRNNews Wire - <https://www.prnewswire.com/news-releases/ai-in-healthcare-market-worth-31-3-billion-by-2025-grand-view-research-inc-300975059.html>

Government / University – (11.6% CAGR*)

- Military – Facial Recognition, Security, Autonomous Aircraft and UAV
- Research – Weather, Materials, ect..
- Exascale Computing

* Source: Hyperion

Oil & Gas / Mining

- Exploration Research and Simulation
- Compute in Harsh Environments

Manufacturing

- Research and Development – Visualization, Augmented reality. Simulation and Testing
- Shop Floor compute in Harsh Environment
- Machine Learning

Finance

- Tracking Stock Trends
- Automating Trading

Retail

Most Impacted by COVID-19 – Government, Manufacturing, Media, Manufacturing

Liquid Cooling Technologies (For where I sit, the OEM's are key)

70-80% of market

Direct to Chip (Cold Plate)

Removes 50-80% of Server Heat

1-Phase

Cold Plate



Header



Rack CDU



2-Phase

Central CDU



CDU (coolant distribution unit)

Liquid Cooling Value Prop

- 40-90% Reduction in Energy
- 40-60% Reduction in CAPEX
- 60-90% Reduction in Space (sq ft.)
- 50-80% Reduction in Maintenance Cost

20-30% of the market

Immersion

Removes up to 98% of Server Heat

Tank

Tank+CDU



1-Phase

2-Phase



IT Chassis

IT Chassis



Header



Rack CDU

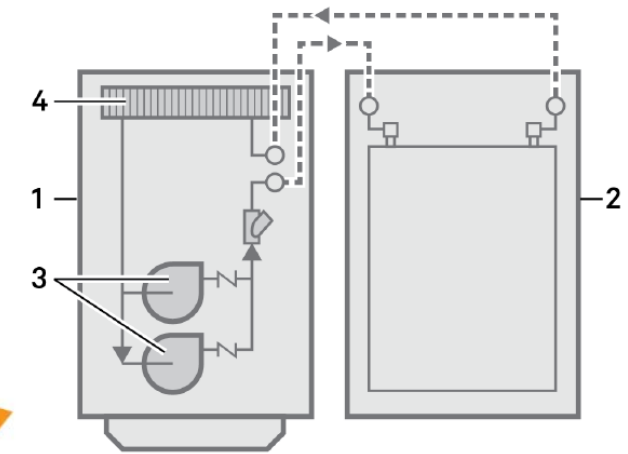


1-Phase

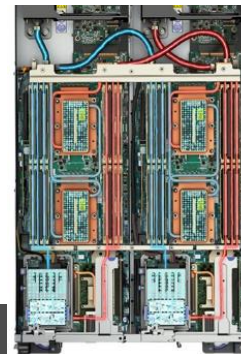
2-Phase

XDU 60 - For Direct to Liquid to Chip Applications (Numerous Vendor Options)

- The XDU is a one unit to one cabinet liquid cooling solution for liquid cooled servers.
- Circulated fluid picks up heat from parallel piped servers in the server cabinet. The XDU airflow cools the fluid, rejecting the heat to the hot aisle for removal by the perimeter CRAC unit(s).
- The XDU can be placed directly adjacent to or up to 25 feet equivalent from the server rack



Liebert XDU at SC 19 in Denver, November 18-21

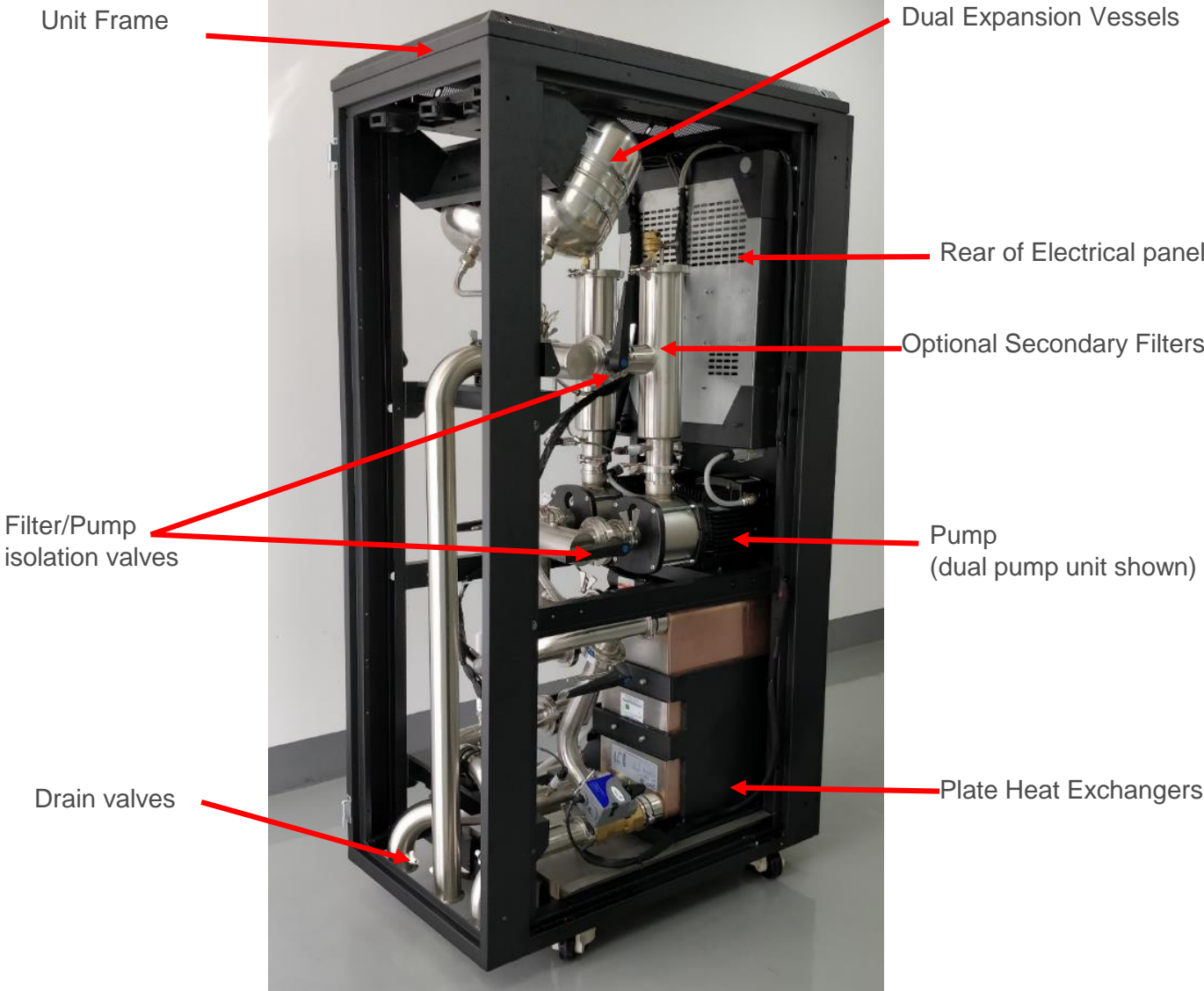


Single Water-cooled Server

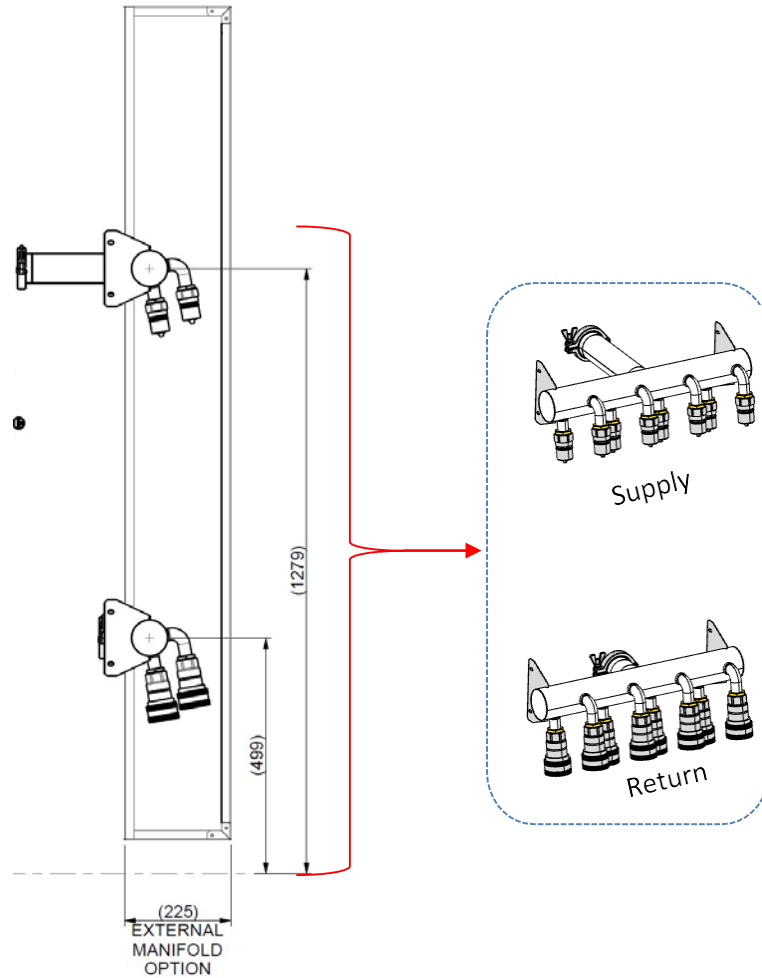
Next Gen CDU's
In The Works
From most players!

200kw – 1.3MW @ VERTIV

CDU Internal Component And Piping Layout, XDU450 CDU



CDU Manifold System Connections , 450 kw CDU, up to 1.3 MW



Manifold Side cart



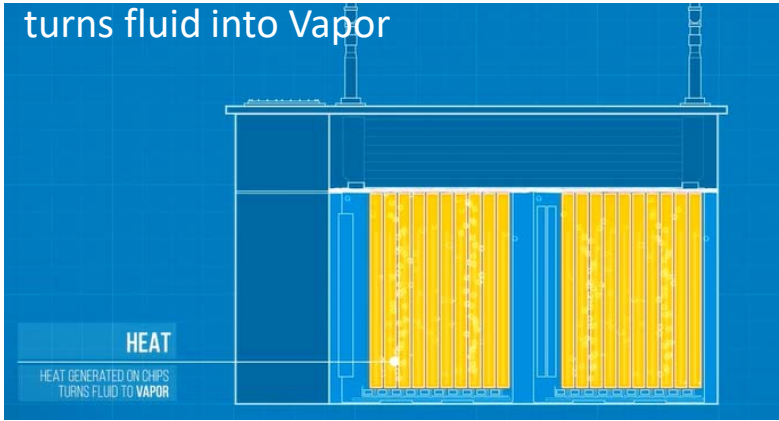
Rear of Unit



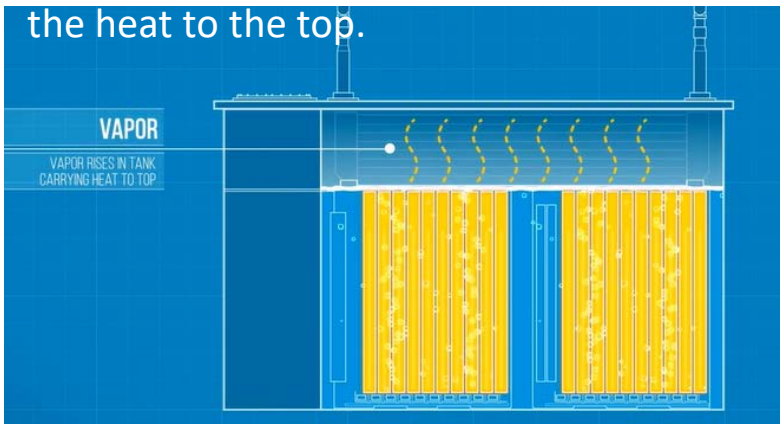
Panels removed
for clarity

2 Phase Liquid Immersion (2PLIC) Cooling : At-A-Glance (OEM's to drive timing)

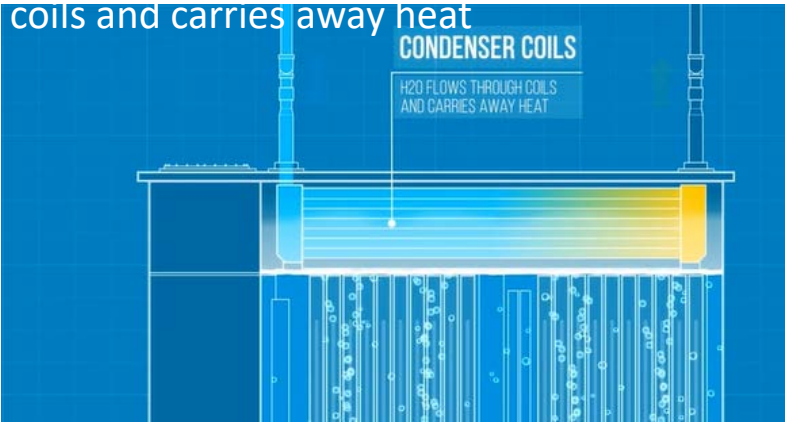
Step 1: HEAT:
turns fluid into Vapor



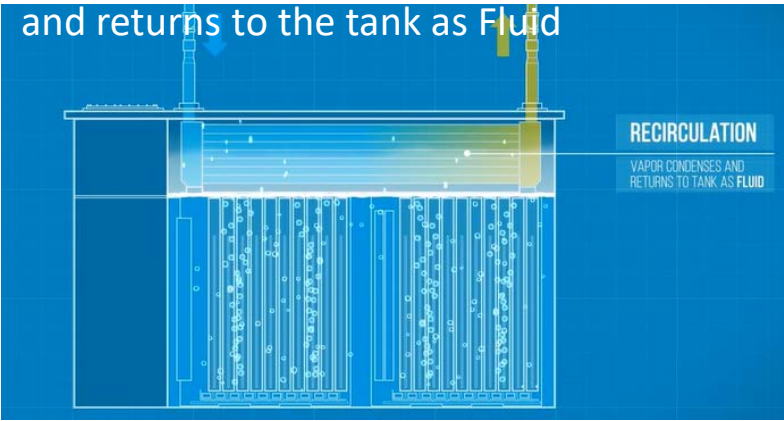
Step 2: VAPOR:
the heat to the top.



Step 3: CONDENSER COILS
coils and carries away heat



Step 4: RECIRCULATION:
and returns to the tank as Fluid



**4,000 times more efficient
than air**

PUE: 1.028

54% Reduction in CAPEX

60%-80% Reduction in OpEx

90%-96% Reduction in SqFt

77% Reduction in Water Use



**20 MW
19,120 SF**

FULLY ENCLOSED, AUTOMATED, ROBOTIC LIQUID COOLING
(INTERESTING NEW PLAYER/PLATFORM)



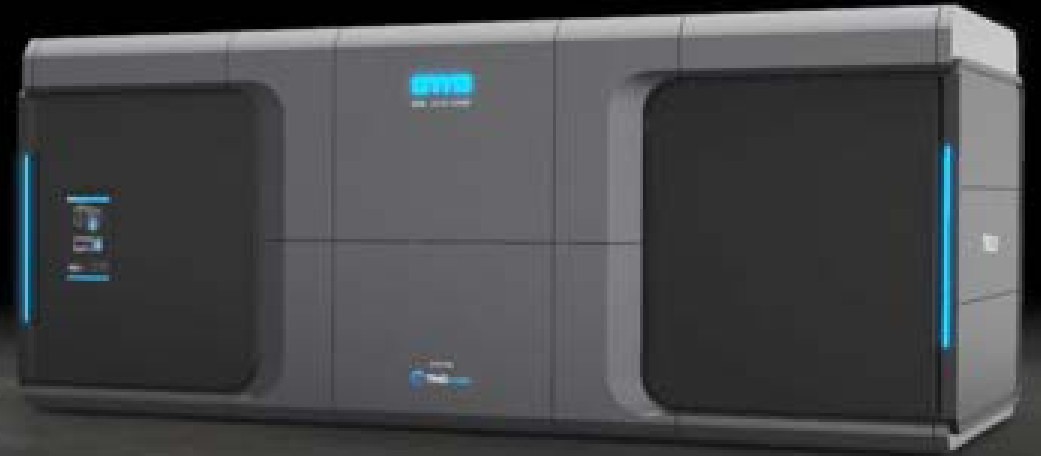
THE OTTO PLATFORM



OTTO EDGE 60XS
60kW



OTTO 120M
120kW



OTTO 600L
600kW

600KW HPC COOLING PLATFORM DOD APPLICATIONS



VERTIV planning to Build 600kw Version



**LIMITLESS
FIELD DEPLOYMENT
APPLICATIONS OF A
SKID-BASED LIGHTS-OUT
HYPER DENSITY HPC
COOLING PLATFORM**



- Designed to fit perfectly into a C130 or similar
- Global deployment capabilities
- Complete 600KW HPC Cooling Platform on a 160 sq. ft. skid
- Multi-hardware compatible
- HP, DELL, MS, TMGcore, etc.
- Lights-Out: self-healing with N+10 options for both server and PSU failure management
- Single-unit OTTO™ Deployment applications and Multi-Unit Clustering for HPC expandability
- Deployable in any Human Occupiable Climate (H.O.C)

LEGACY SUCCESS CAN = NEXT GEN CHALLENGES???

MOST EVERY VENDOR HAS A STORY LIKE THIS

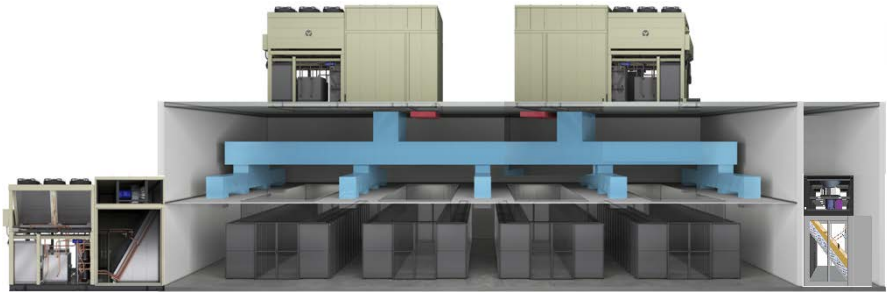


Possibly the most successful
VERTIV/Liebert Solution EVER!

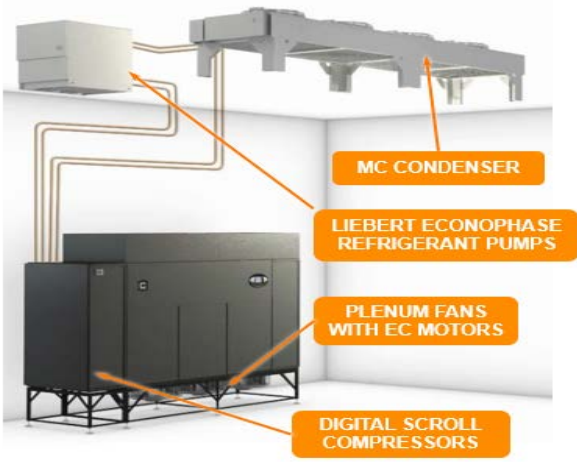
Now Has a HIGH DENSITY
CHALLENGE?



Problem Solved!

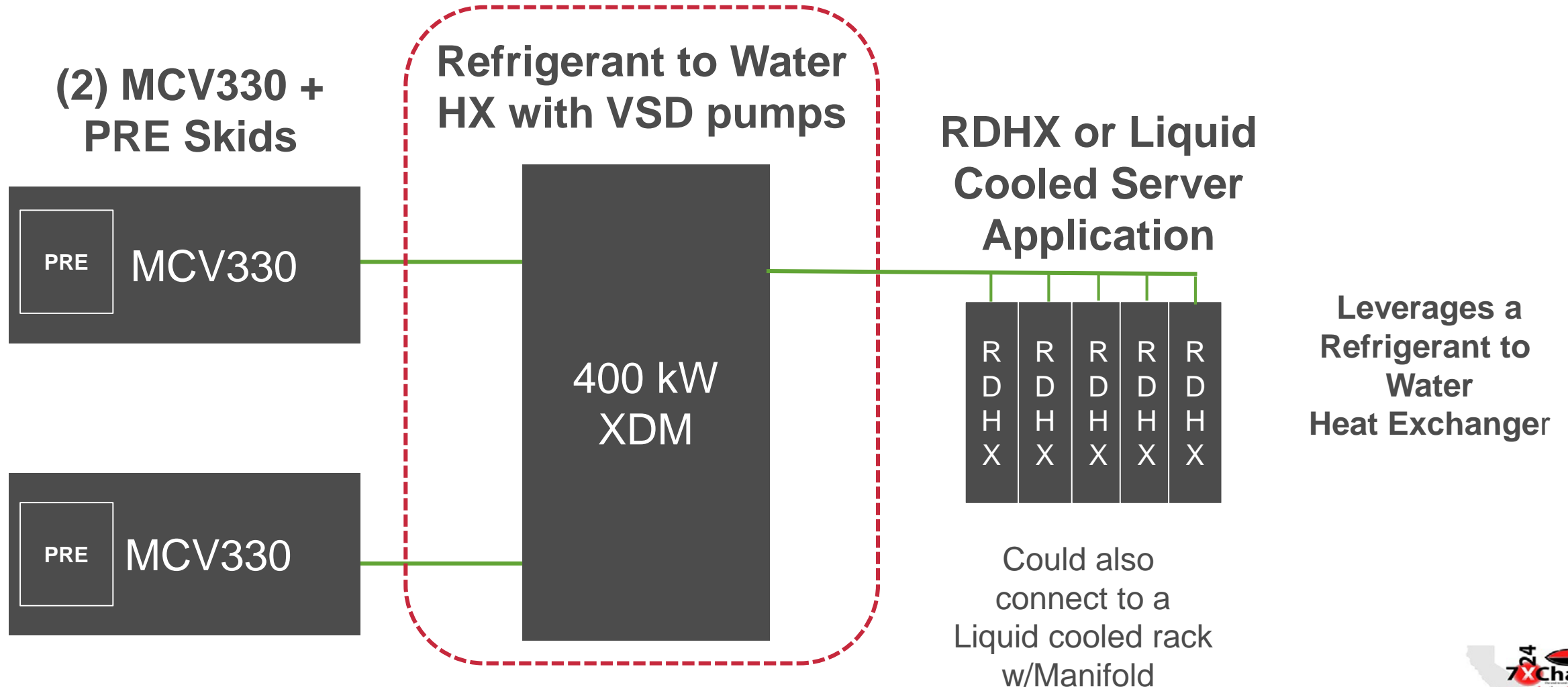


- Reliable, Low-Maintenance Operation
- No water usage, No water treatment
 - No outside air contamination
 - No dampers and louvers to maintain
 - Instant, automatic economizer changeover



Challenge Solved – 400 kW system (High Density w/DSE)

Includes two 200 kW modules for redundancy and added capacity (200kw option)





OPEN
Compute Project

Project Charter

The Advanced Cooling Solution project shall create specifications, standards, support documentation, or reference designs which enable global adoption of liquid cooling for the data center equipment with the goal of harmonization of liquid cooling solutions that benefit OpenRack and Olympus (EIA-310 compatible) based products as well as Project Scorpio in China. The project shall work with the other chartered OCP projects to accomplish this goal.

Project Goal

The project shall focus on standardization and definition of critical interfaces, operational parameters, and environmental conditions that enable a non-proprietary, multi-vendor supply chain of liquid cooled solutions.

Successful projects delivered by this project will include specifications that enable:

- 1.) a supply chain offering a variety of Liquid cooling-enabled IT devices (servers, storage, etc.)
- 2.) a supply chain for liquid-enabled racks.

Data centers that can immediately support 1 and 2

Having Collaboration/Discussions with ASHRAE

Advanced Cooling Solutions Project Charter

Embrace your NEW REALITIES & PARADIGMS - LEAD

- Understand the “Business Value” of your Apps and define where they belong
- Understand the potential Infrastructure Impacts of AI, IoT and 5G (own or rent?)
- If On-Prem/or your Edge, Know you have options to keep Legacy Sites relevant
- Leverage CFD Modeling/Partners to understand Impact/right Tech
- Be wary of “too New”! Consider Service? Your support requirements? Funding?



Embrace and Lead the Change! Be the Disrupter!

Enable Your Company to win!

Thank You! To the Panel Now!

