ALEXANDER SCHNEIDER

THE POWER OF EXCELLENCE

Direct Liquid Cooling

SEEEI 2021

Liebert®

Nigel Gore

Global Director, Liquid Cooling

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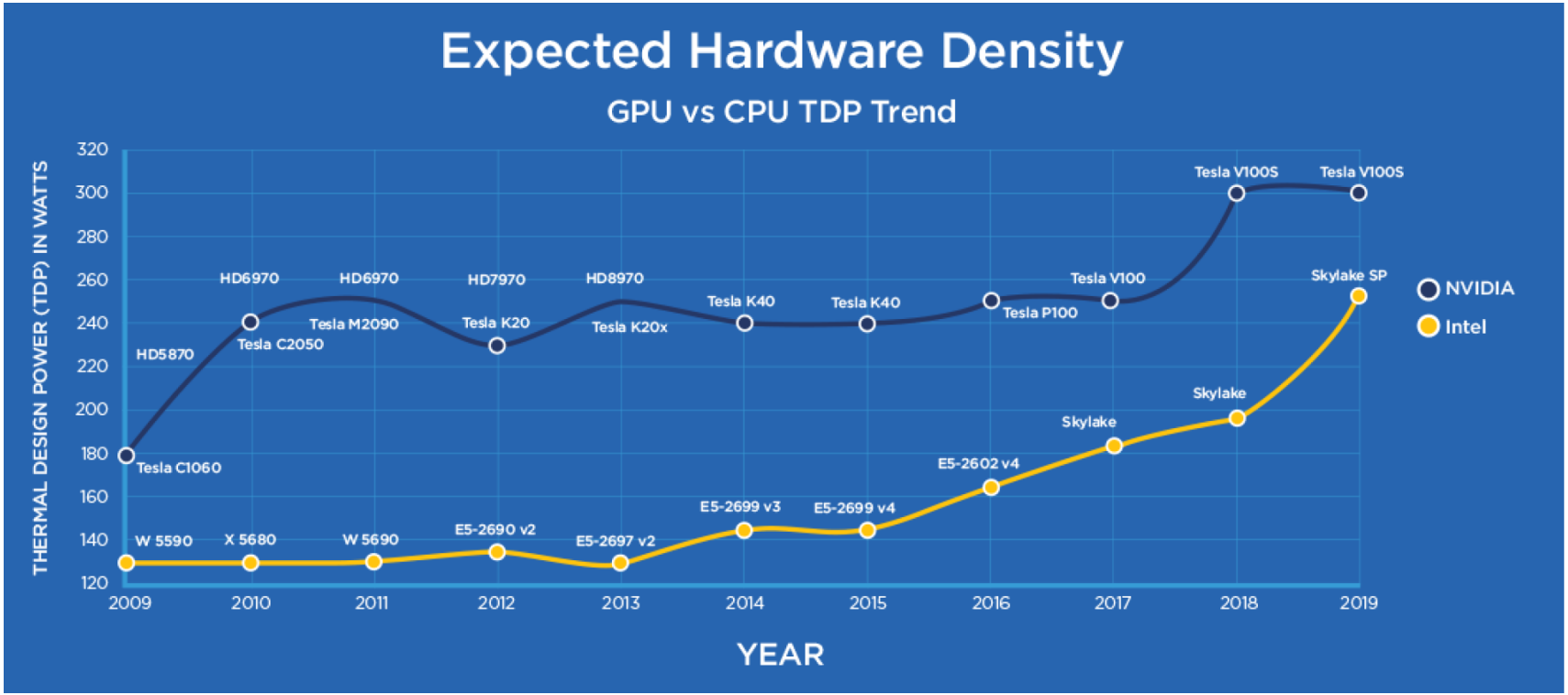
Why Liquid Cooling?

- Hot Chips
- Low Latency
- AI & HPC adoption beyond science labs
- Opex & Efficiency

Hot Chips & Getting Hotter



Applications Driving Rack Densities to 50KW-100KW per Rack

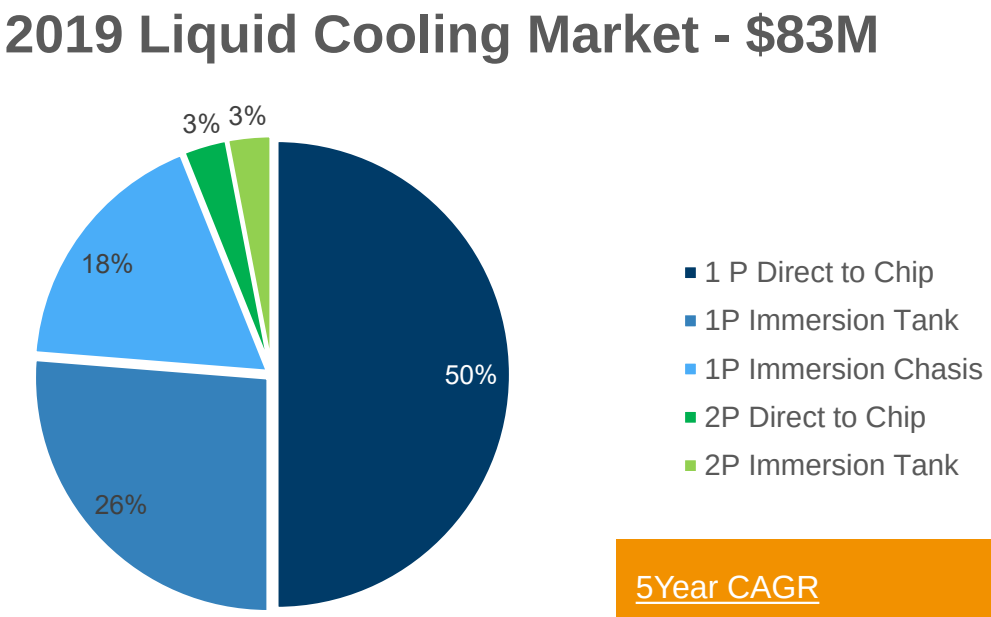
- Big Data Analytics using AI
- Low Latency Processing
- HPC, Simulation, Scientific
- Machine Learning
- Block Chain
- Gaming

Energy Efficiency

pPUE ranges from 1.02 - 1.05

According to liquid cooling vendors

High Density: What's happening in Liquid Cooling



5Year CAGR

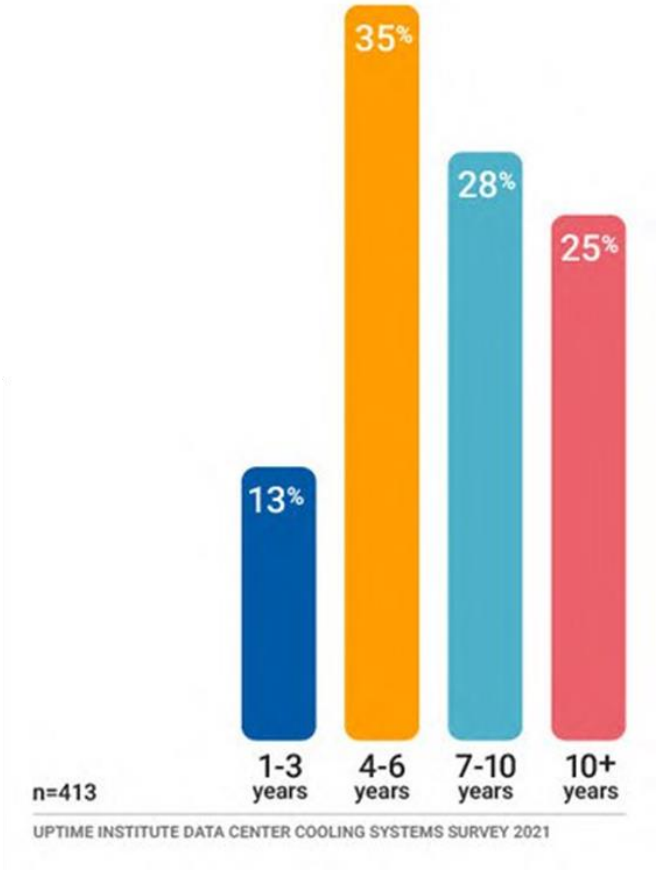
Direct to Chip = 16%

Immersion = 28%

Source: 2020 OMDIA Market Report

Few think air cooling will remain dominant beyond 10 years

Regarding data centers 1 MW or greater, for how long do you think air cooling will remain the dominant approach?



Different Types Of Liquid Cooling

1 Phase Cold Plate (Direct to Chip)

- Least disruptive to OEM supply chain
- Saves 8-15% over air cooling
- Leakage is an issue

2 Phase Cold Plate (Direct to Chip)

- Saves 10% over 1Phase
- More expensive & complex over 1Phase

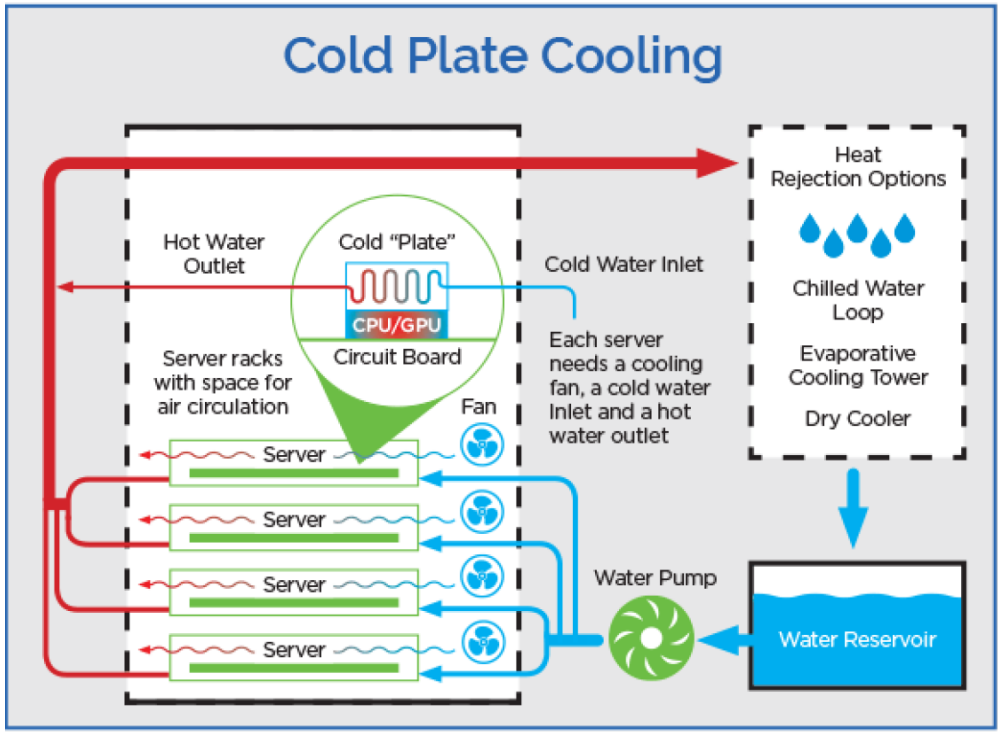
1 Phase Immersion Cooling

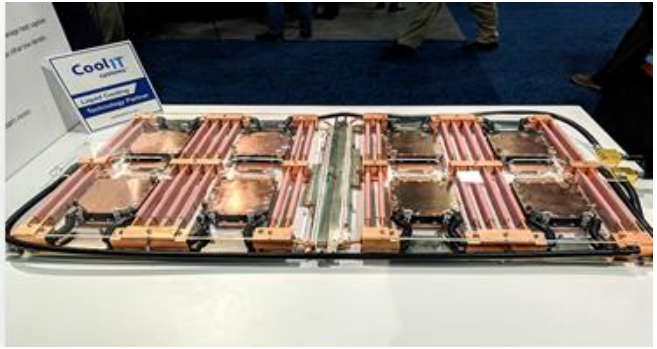
- Non-Evaporating & Environmentally Friendly Fluids
- Saves 5-15 % over Direct to Chip

2 Phase Immersion Cooling

- High fluid costs
- Pump energy savings
- Higher heat flux capacity over 1 Phase
- Complexity in design

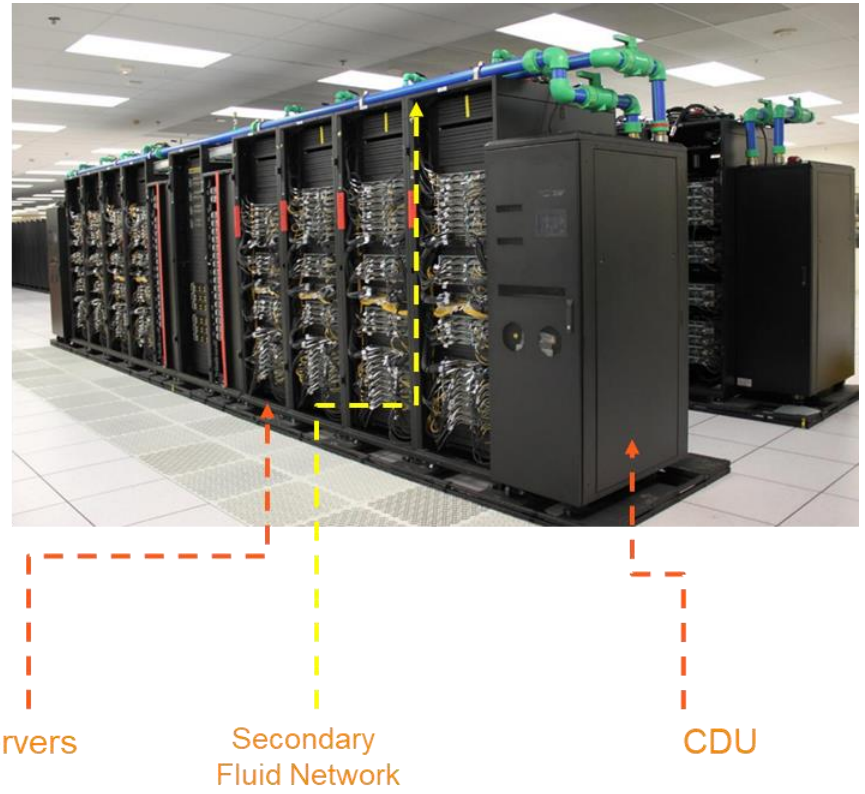
Cold Plate Cooling

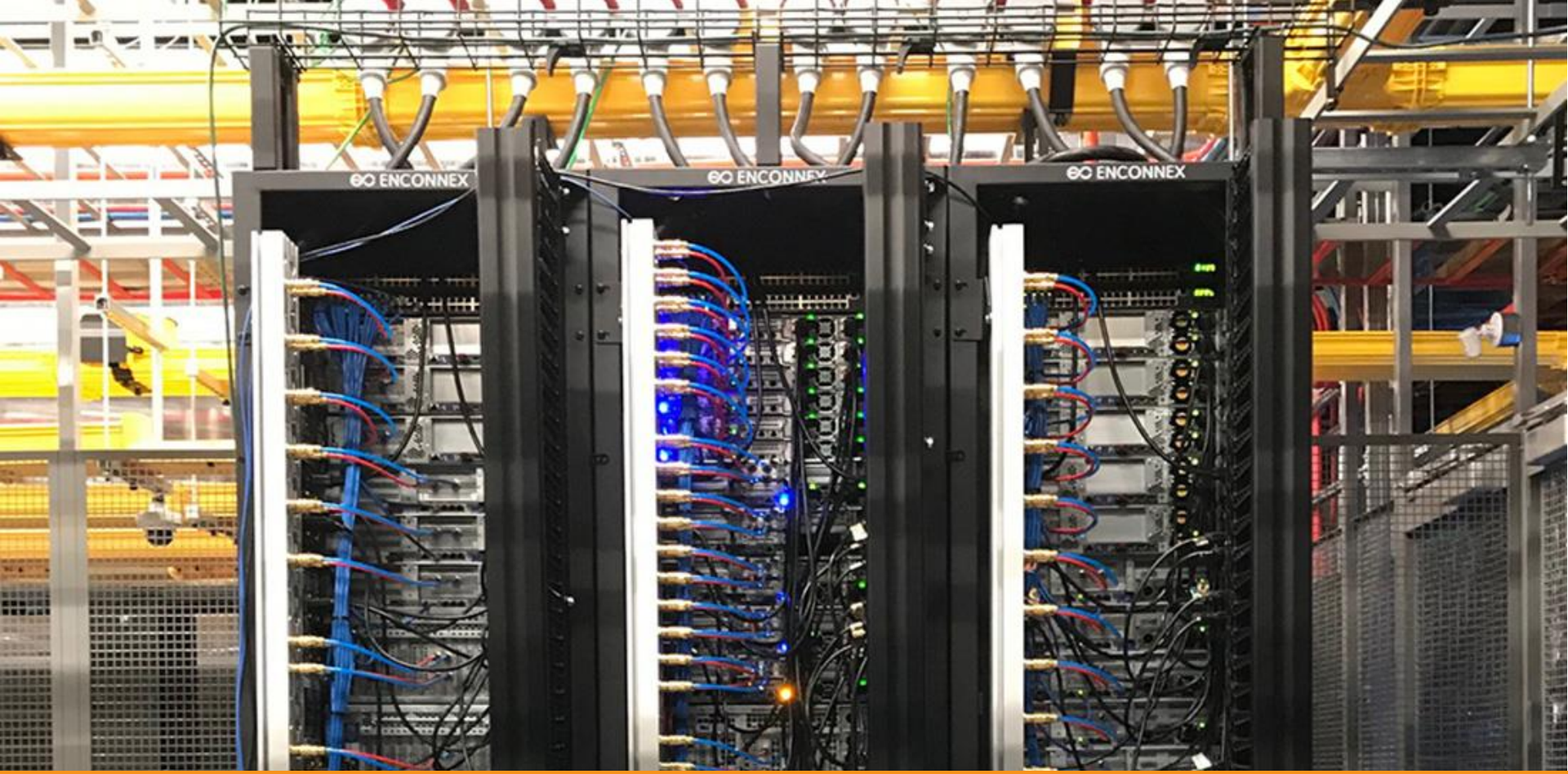




Cold Plate (Direct to Chip)

- Conduction through cold plates
- Integrated piping.
- 100-micron micro channels
  - need to eliminate particles/contaminants.
- 1-Phase: Water with additives, glycol, dielectric liquids
- 2-Phase: fluid changes phase into a gas as the heat transfer medium
  - Either dielectric or refrigerant liquids can be used as the two-phase liquids
  - Liquids are available with different boiling temperatures

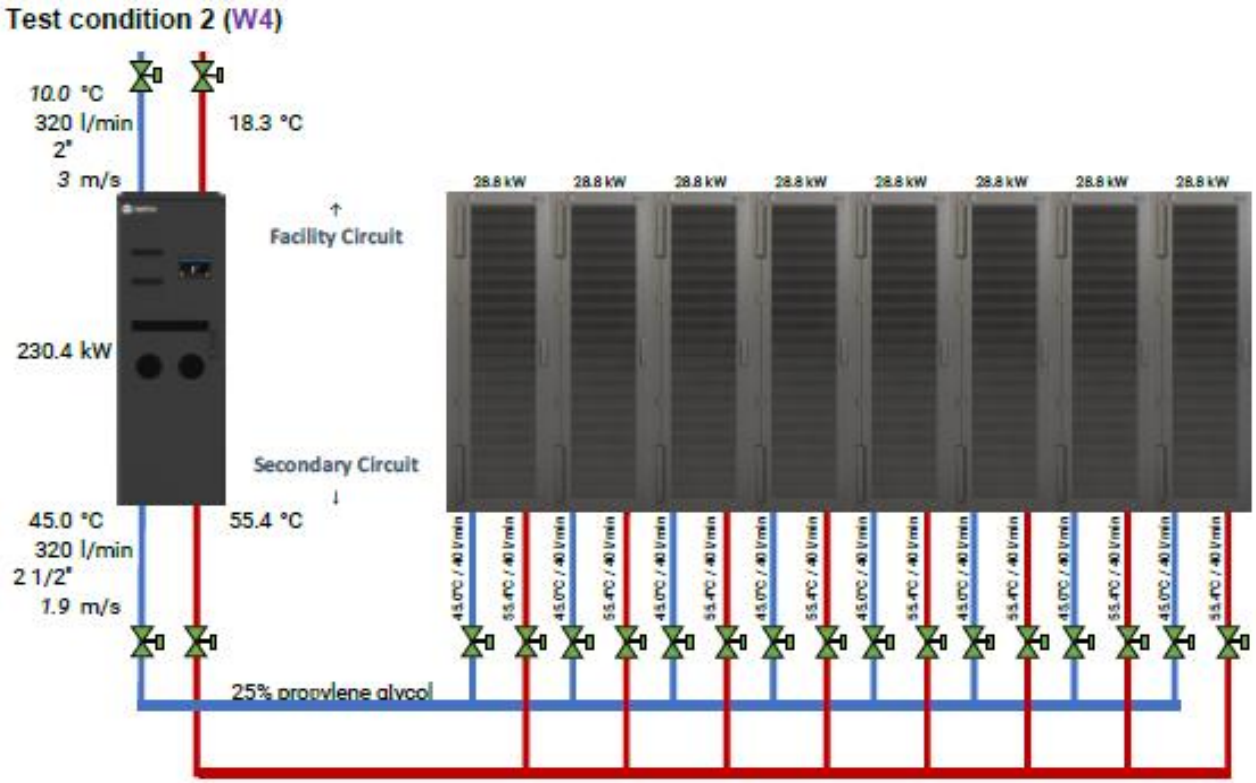


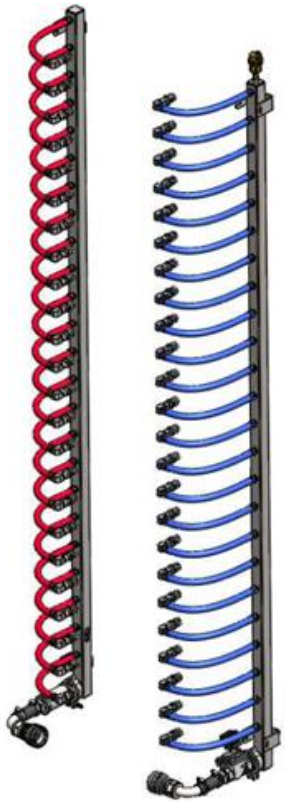


An example of cold plate implementation

Courtesy: Zuta Core

Liquid Cooling Circuit Layout





Cold Plate Cooling

Pros

- Energy Efficient high density
- Multiple server vendor adoption

Cons

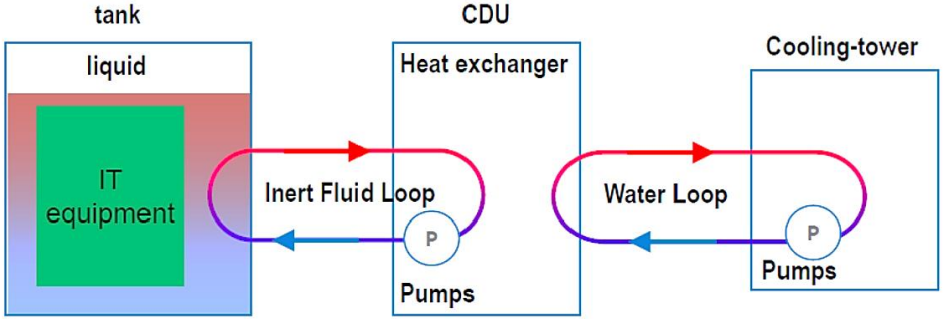
- Complexity: Rack Plumbing, pipes, valves
- Multiple Components: CDU, water connectivity
- Need multi loop water (FCS, TCS)
- Maintenance of water quality / chemistry
  - 100-micron micro channels
- Customer locked to 1 OEM source (wetted material compatibility)
- Complexity to integrate into an existing datacenter
- Leakage risk

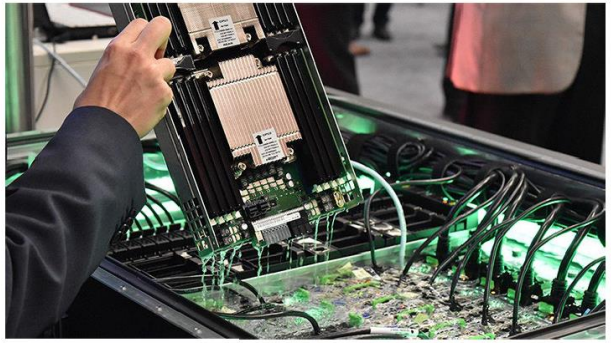
Table 1 Water Quality Guidelines for the FWS and TCS

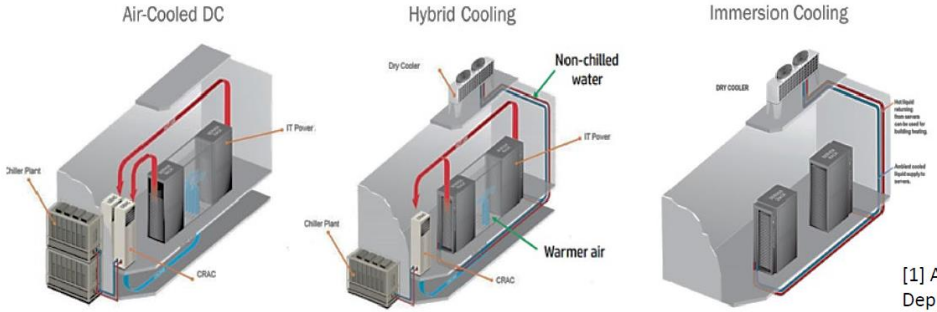
Parameter	FWS (Table 5.3, ASHRAE 2014)	TCS (Table 6.2, ASHRAE 2014)
pH	7 to 9	8.0 to 9.5
Corrosion inhibitor(s)	Required	Required
Biocide	—	Required
Sulfide	<10 ppm	<1 ppm
Sulfate	<100 ppm	<10 ppm
Chloride	<50 ppm	<5 ppm
Bacteria	<1000 CFUs/mL	<100 CFUs/mL
Total hardness (as $CaCO_3$)	<200 ppm	<20 ppm
Conductivity	—	0.2 to 20 micromho/cm
Total suspended solids	—	<3 ppm
Residue after evaporation	<500 ppm	<50 ppm
Turbidity	<20 NTU (Nephelometric)	<20 NTU (Nephelometric)

Immersion Cooling

Single Phase Immersion Cooling

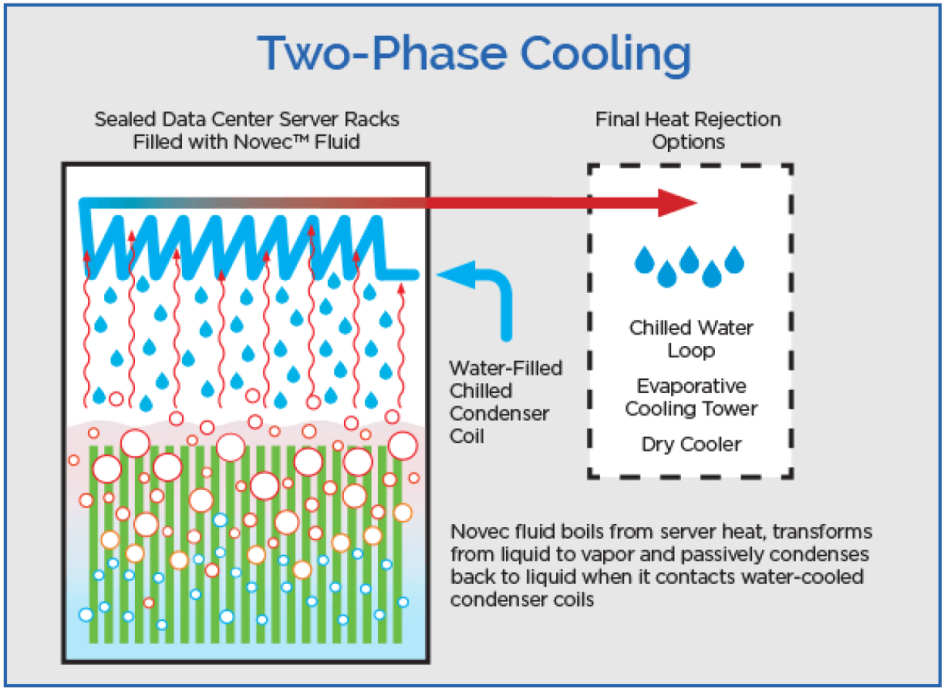


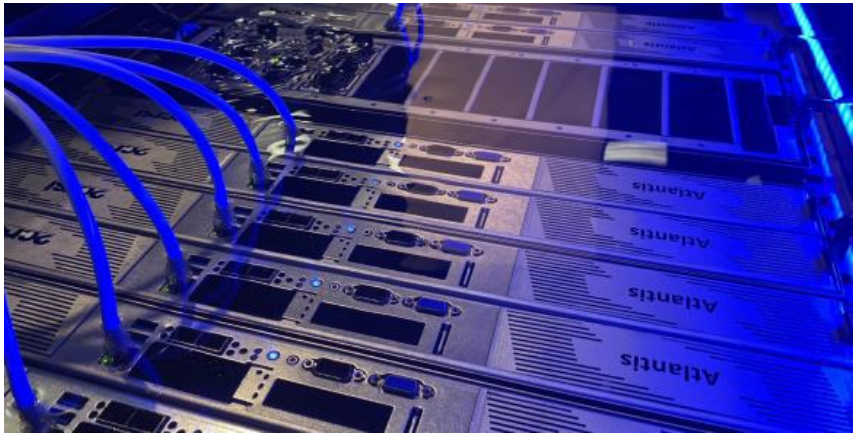




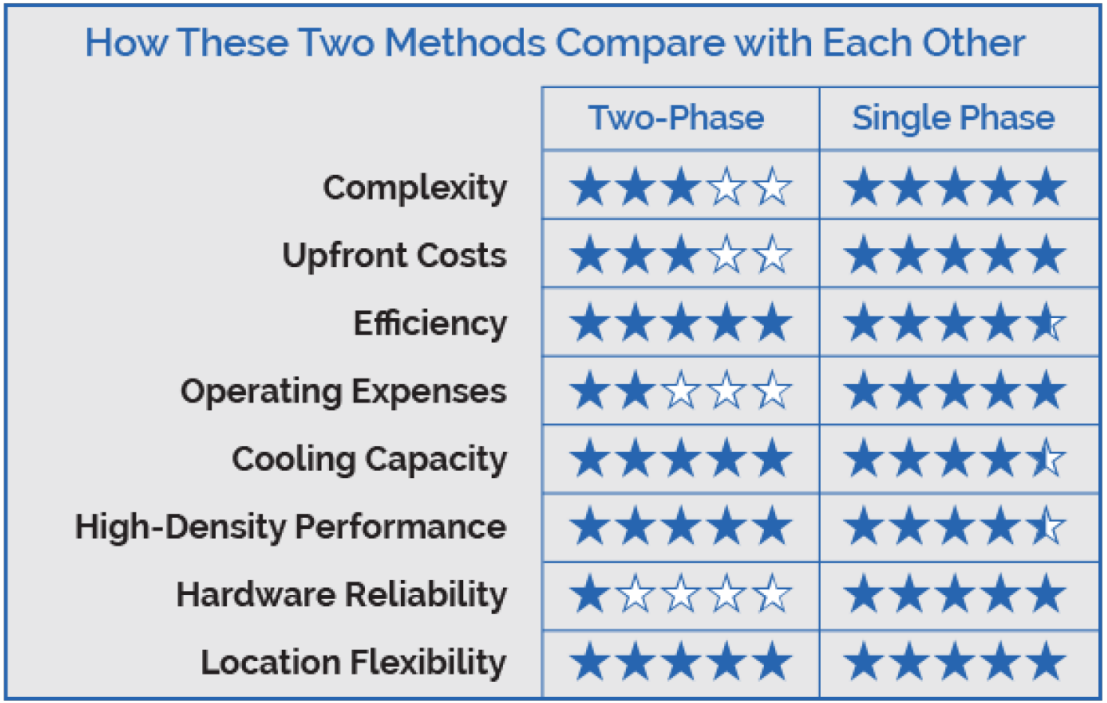
[1] Advanced Cooling - A Large Scale Deployment Experience Using Immersion Cooling, OCP summit 2019

2-Phase Immersion Cooling





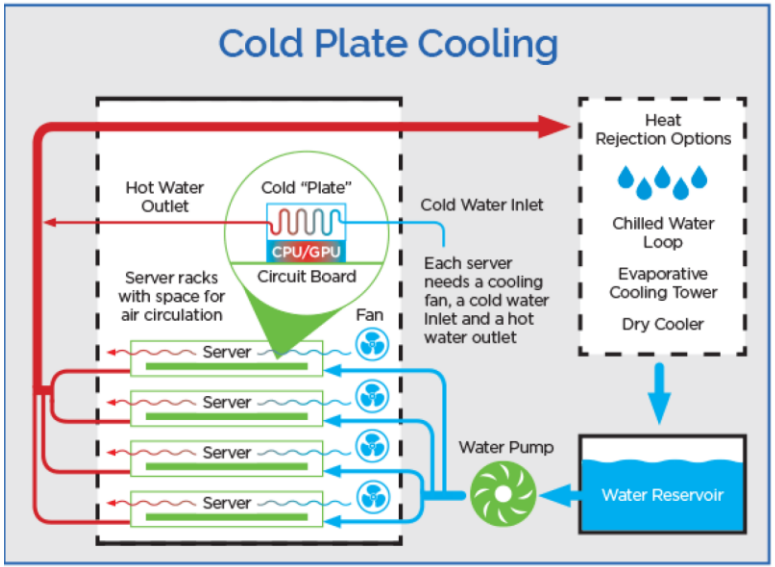
Single Phase Vs. Two-Phase Immersion Cooling



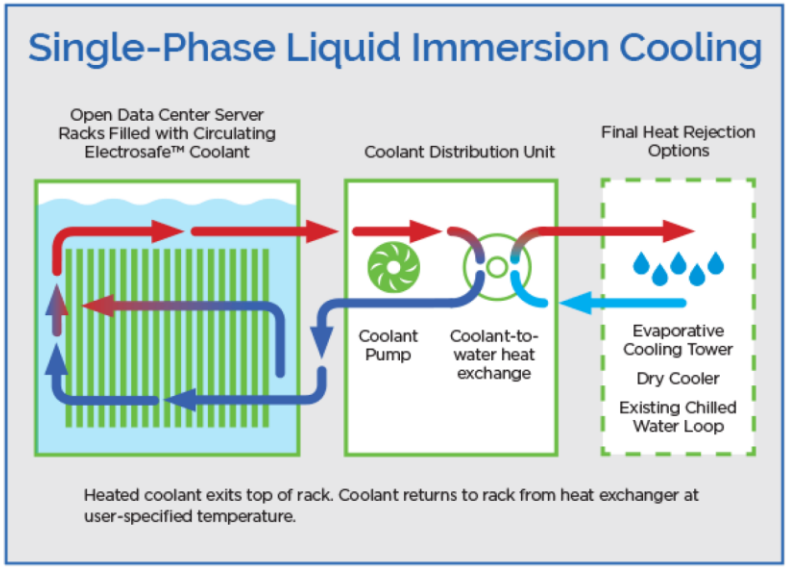
★ – Poor ★★★★★ – Excellent

https://www.grcooling.com/blog/data-center-cold-wars-part-3-single-phase-immersion-cooling-versus-cold-plate/

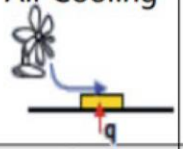
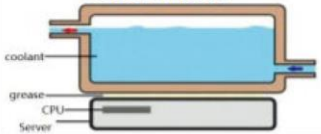
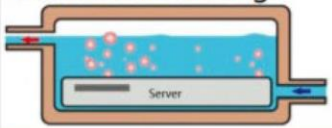
SP Liquid Immersion is less complex than Cold Plate



Reduced Complexity



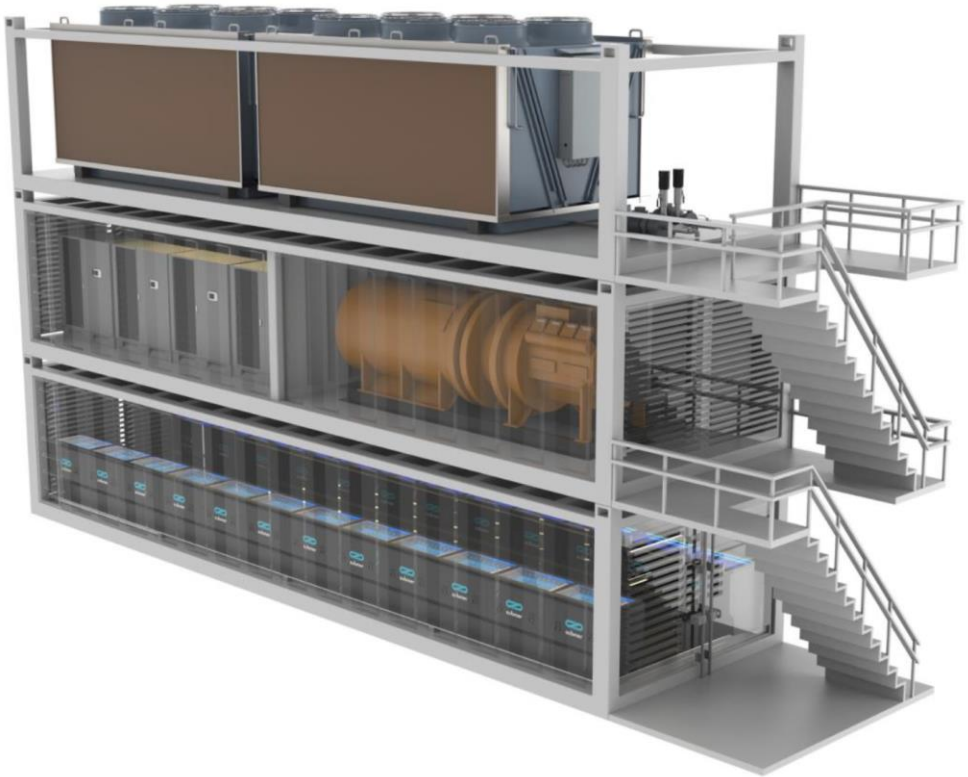
Cold Plate Vs. Immersion Cooling

	Air Cooling	Cold Plate	Immersion Cooling	0 means "Base Line" + means "Better" - means "Worse"
				
Cooling Capacity	0	+	++	Immersion Cooling is the best.
Hardware Integration	0	+	++	No fans in immersion Cooling.
Maintenance	0	--	-	New mechanical design.
Hardware Reliability	0	-	+	Unaffected by dust , humidity and vibration.
Hardware Performance	0	+	++	Cooling helps improving performance.
Energy Efficiency	0	+	++	No fans, chillers, CRAHs.
Heat Recovery	0	+	++	Easy to be recovered from liquid.
Noise	0	+	++	No fans, no noise.
Corrosion	0	+	++	Isolation from air, no corrosion.
Material Compatibility	0	0	?	Material compatibility needs to be tested.
Initial Capex	0	-	--	Liquid cost is temporarily high.
Opex	0	+	++	No fans, chillers, CRAHs. Low PUE.
Weight	0	-	--	Liquid is heavy.

Immersion Cooling protects IT from harsh environment

- High Temp
- Humidity
- Vibration
- Dust

Less Space…



cooling

power

compute

1 MW in 3
40’ containers

Questions?

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