Microsoft

Liquid Cooling in the Cloud

Speaker : Vaidehi Oruganti

October 2023

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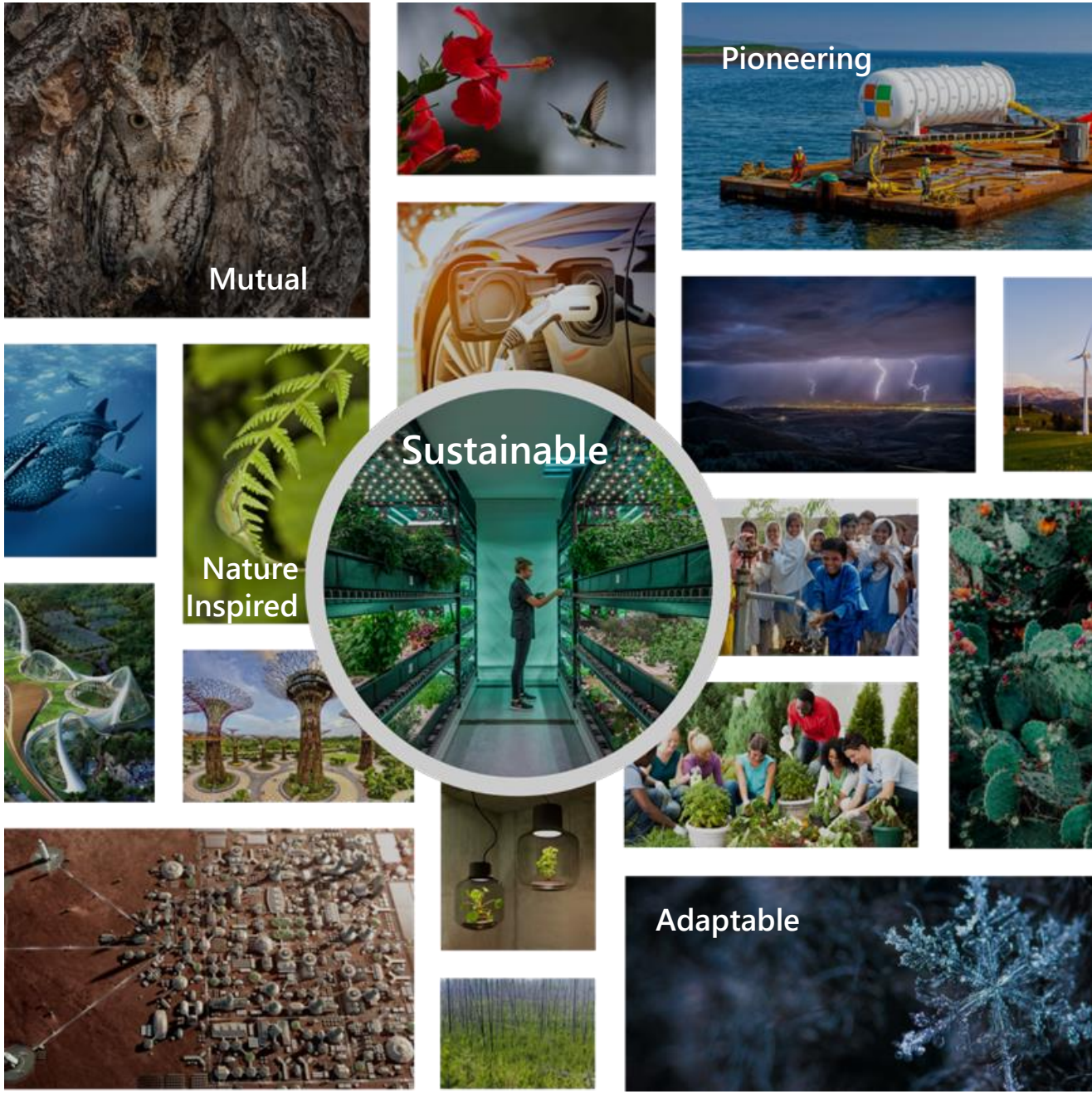
Cloud Operations And Innovation | CO+I CTO Office
Microsoft



Cloud Operations + Innovation

Microsoft's Sustainability Pledge

Microsoft | Official Microsoft Blog Microsoft On the Issues The AI Blog Transform

Microsoft will be carbon negative by 2030

Jan 16, 2020 | Brad Smith - President

Link: Microsoft will be carbon negative by 2030

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Aiming for more than just net zero

Posted on July 27, 2020

Noelle Walsh, Corporate Vice-President, Cloud Operations + Innovation

Climate experts across the globe agree: if we can't drastically reduce carbon emissions, our planet will face catastrophic consequences. Microsoft has operated carbon neutral since 2012, and in January 2020 Brad Smith announced our commitment to going carbon negative by 2030. This isn't a goal we can reach in one easy swoop—it will take time, dedication, and many small steps that coalesce into something greater.

As the cloud business grows, our datacenter footprint grows. In our journey toward carbon negative, Microsoft is taking steps to roll back the effect datacenters have on the environment. Reaching this goal will take many steps, along with the implementation of innovative technologies that have yet to be developed.

Many companies are reaching for net zero emissions, but we're taking it even further. We're not just reducing our output to zero. We're committed to reducing our emissions by half, and then removing the carbon we've emitted since 1975, to truly go carbon negative.

The journey to carbon negative

A big part of going carbon negative means completely changing the way datacenters operate. Datacenters have adopted some sustainable methods around cooling, including open-air and adiabatic cooling. These methods have helped to drastically reduce the water and energy consumption of datacenters, but they're not enough. Currently, datacenters and the backup that powers them in peak load times depend on fossil fuels like diesel. Microsoft is working to change that.

Our ambitious goals to cut down our carbon footprint have necessitated exploration into various technologies. With each kind of technology, we're determining the best combination to implement based on our overall goal as well as the specific datacenter locations and their local needs.

Link: Aiming for more than just net zero

Hyperscale Aircooled Data Centers

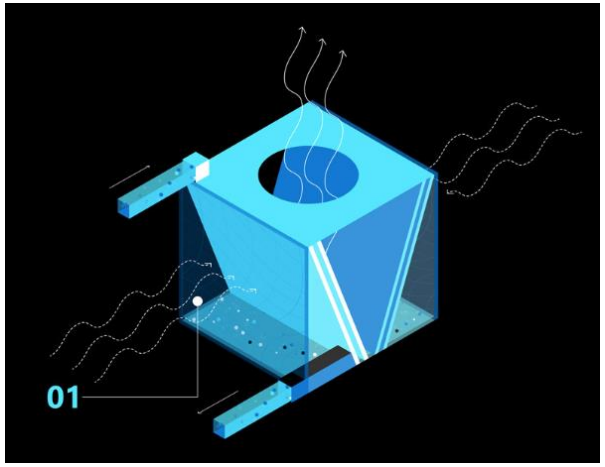
CO+I | CTO Office | VAIDEHI ORUGANTI

- Mega
- Efficient
- Scalable
- Optimized

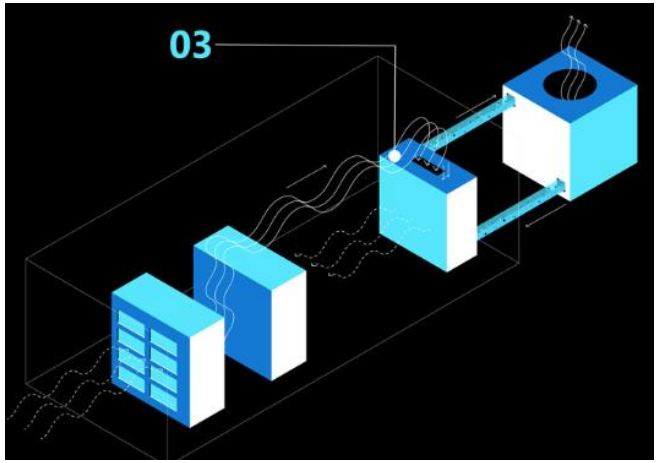
Research and Advanced Development Team, CO+I CTO Office

Microsoft Datacenter Operations

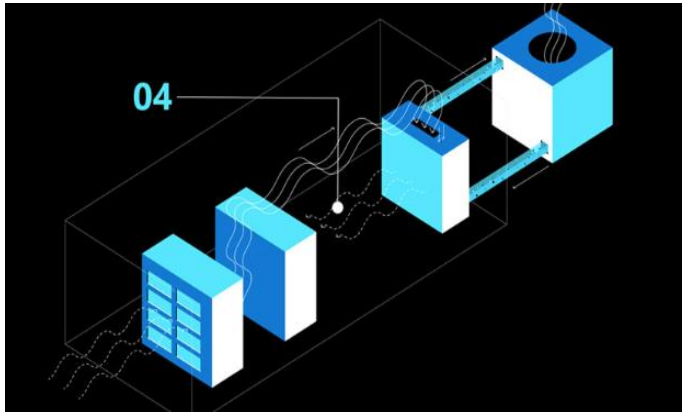
Outside air for direct free cooling.



When outside air gets too warm, evaporative cooling is used



Cold water cools DC air. Once heated, the warm liquid is cooled by externally located heat exchangers



The cold air blown through cold aisles cools server racks. Once heated, the warm air from hot aisles is re-directed to be adiabatically cooled

As this cycle continues, Microsoft gets closer to meet its sustainability goals.

https://news.microsoft.com/stories/microsoft-datacenter-tour/

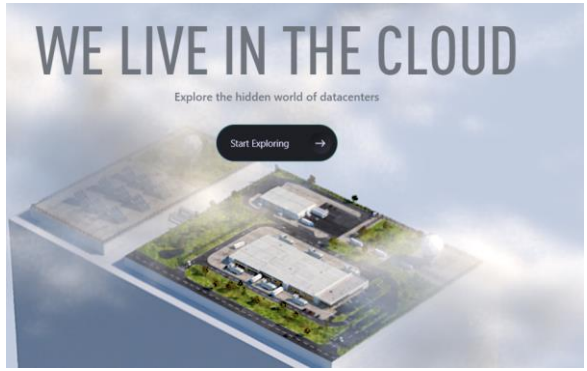
Microsoft Datacenter Operations

Used since 2017, these general-purpose compute blades offer higher core counts, memory, storage and excel as multipurpose server

These blades provide fastest GPU cores for the rapidly growing Artificial Intelligence and Machine learning workloads in Microsoft's Cloud

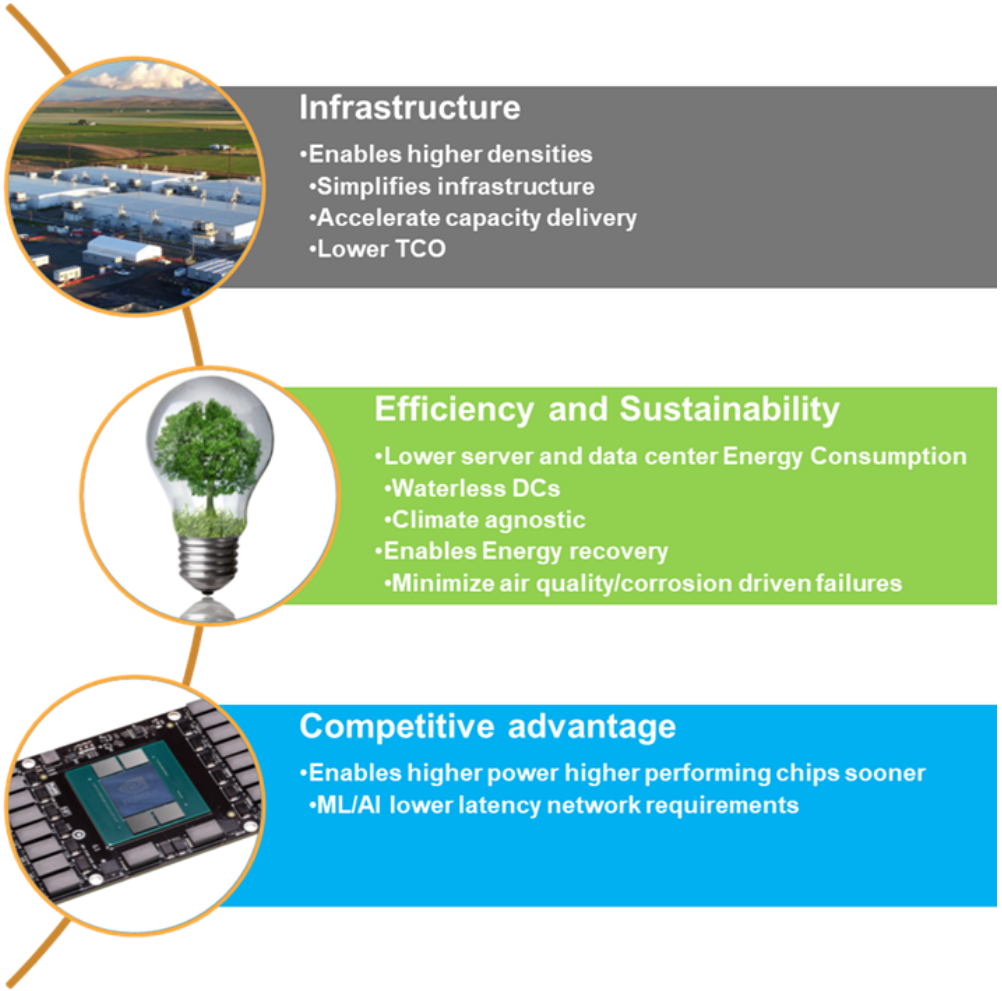
To get a virtual tour of Microsoft's datacenters from electrical rooms, to cooler, circular centers and networks, start exploring at

https://news.microsoft.com/stories/microsoft-datacenter-tour/



Aiming for more than just net zero

Holistic Overview For Liquid Cooling

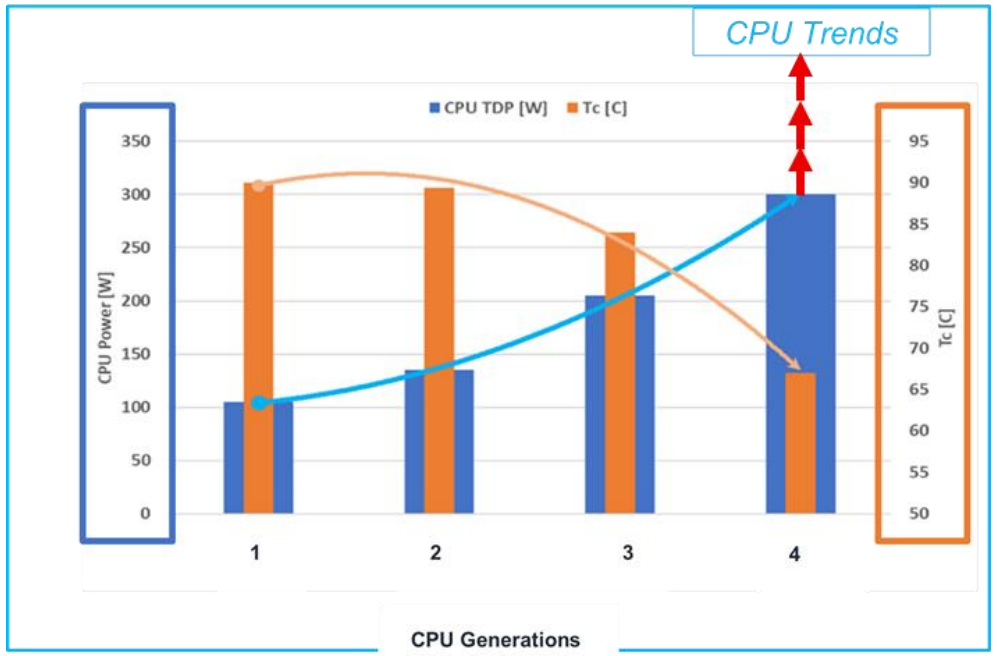


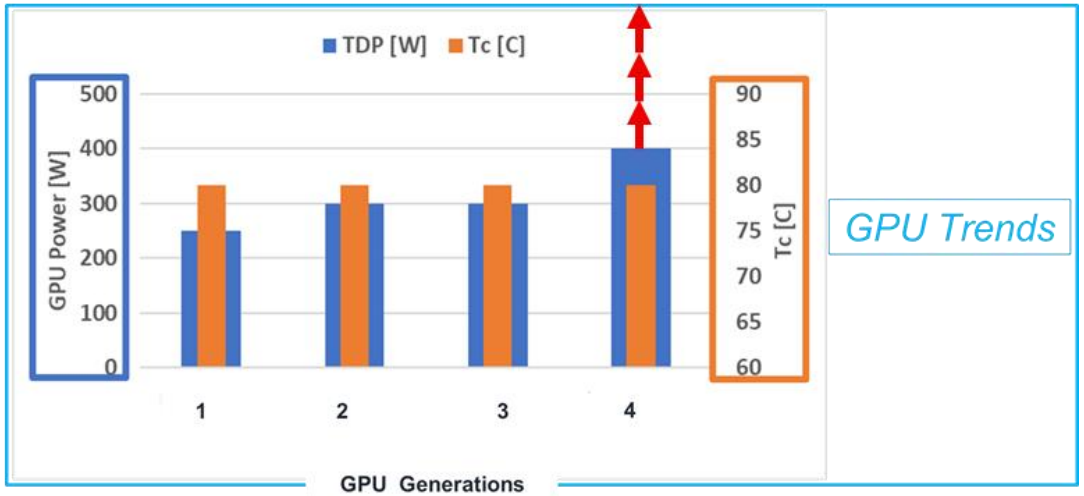
Microsoft

Cloud Operations + Innovation

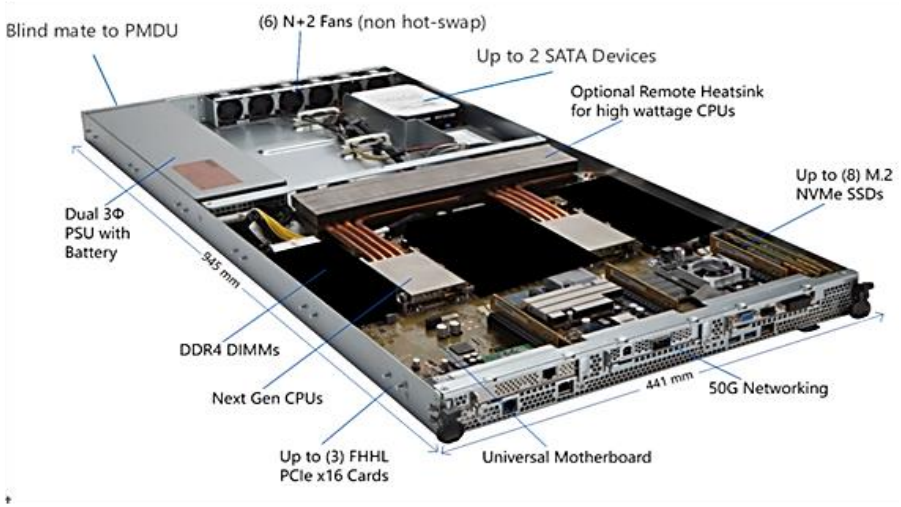
Cooling Challenges

Chip Power and Temperature Requirements Trends



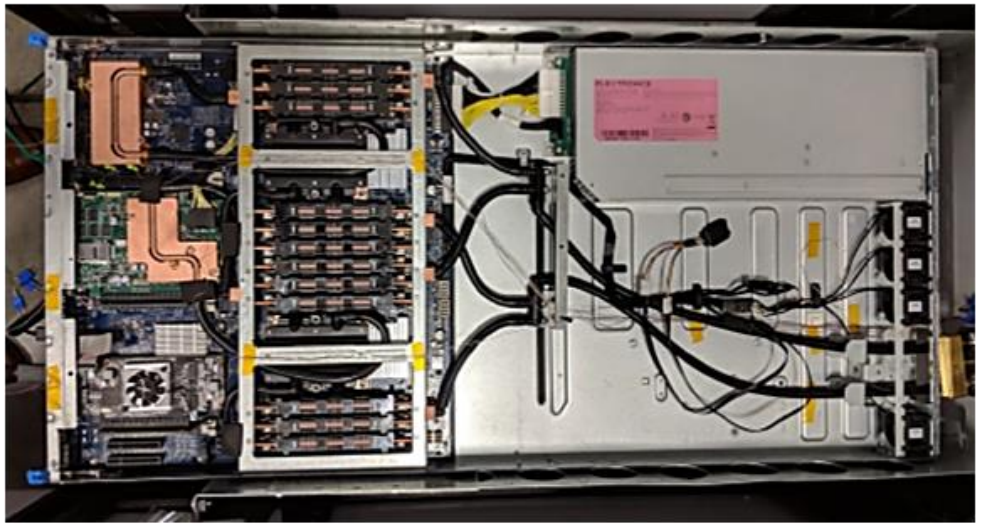


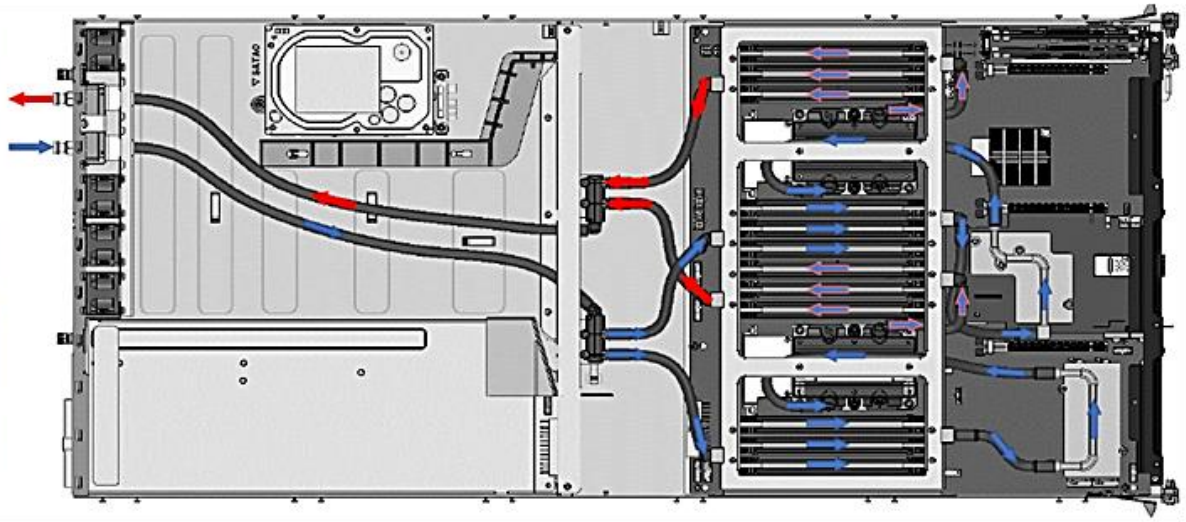
Olympus Server Implementations

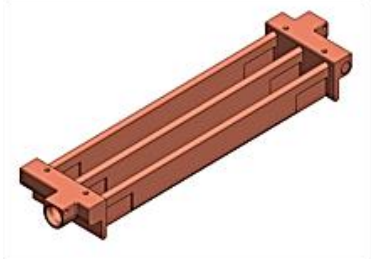


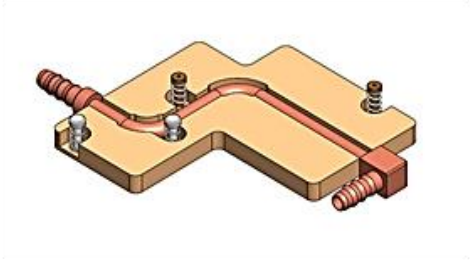
- Front to Rear Forced Convection Air Cooled
  - Air Cooled Power Supplies
- Remote Heatsink with Heat Transport through Heat Pipes
- Capable of cooling over +1kW in 1RU
- Power density of the chips and/or fan power consumption present limitations to the thermal solution.

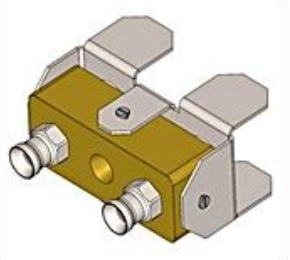
Direct Attach Micro-Channel Cold Plates

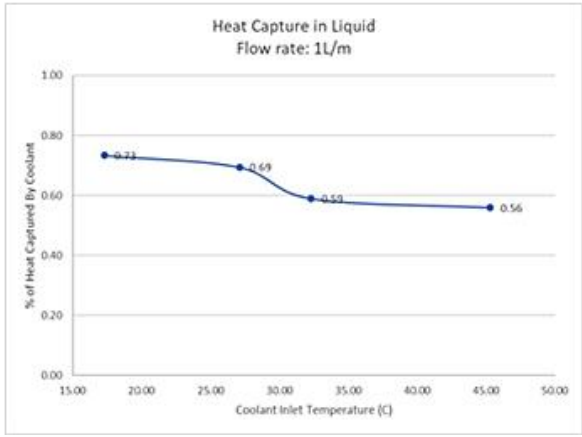




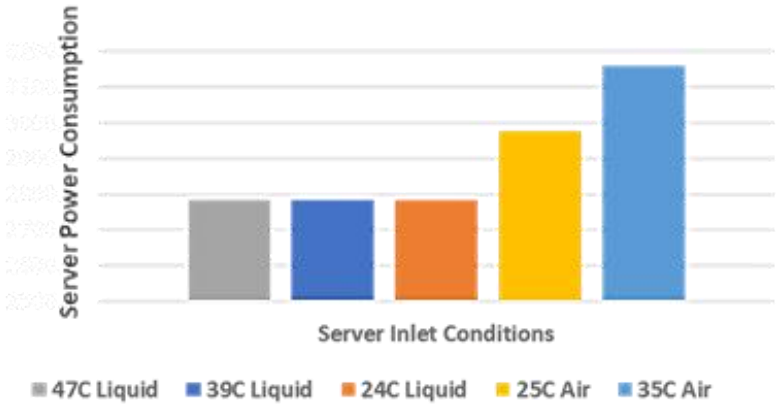


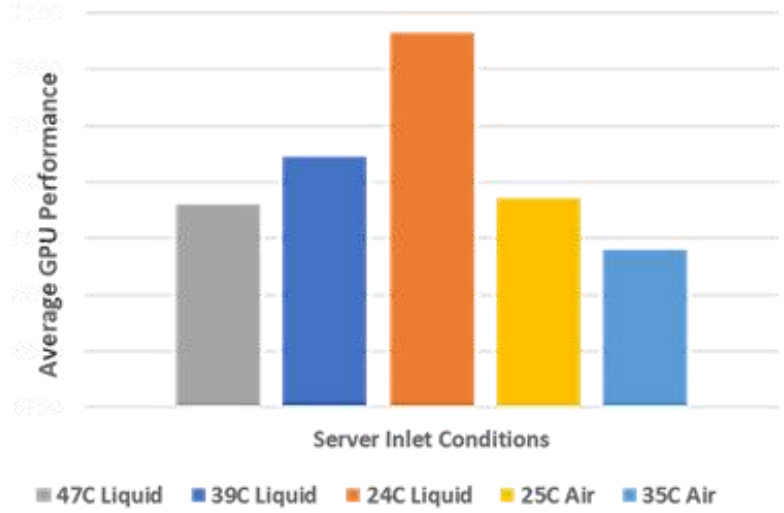






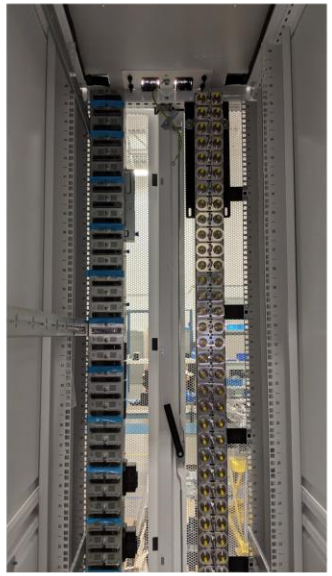
Microsoft’s GPU server with air cooled HS and Cold Plates





Air-Assisted (L-A) Cold Plate cooling

- Solution for high flux/power chips
- Compatible with aircooled/adiabatic DCs



Facility water (L-L) cold plate cooling

- Solution for high flux/power chips
- Supports higher power racks
- Requires CDUs and liquid cooled data center

CDU: Rack DCLC™ CHx750

CoolIT systems™

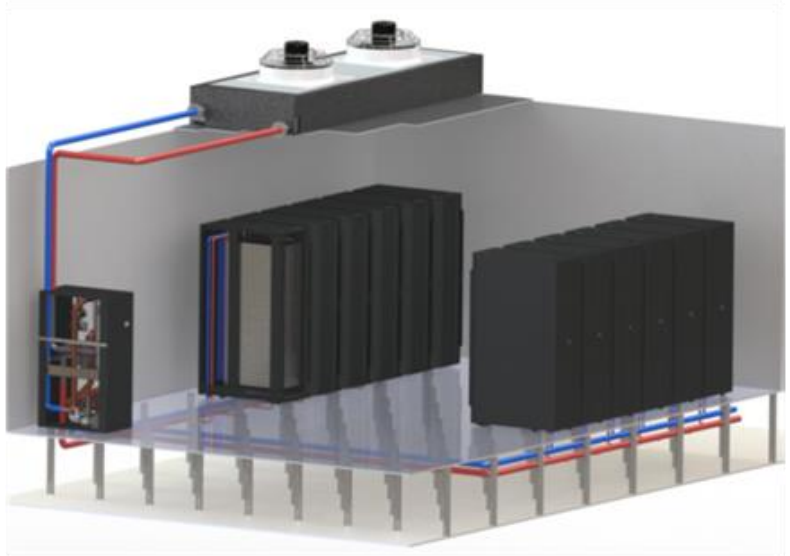
Features

- Manages 750 kW heat load per network
- ASHRAE W4 warm Direct Liquid Cooling
- Redundant centralized pumps
- Control System with remote monitoring
- High flow and heat transfer capability
- 50 micron filtration to secondary loop

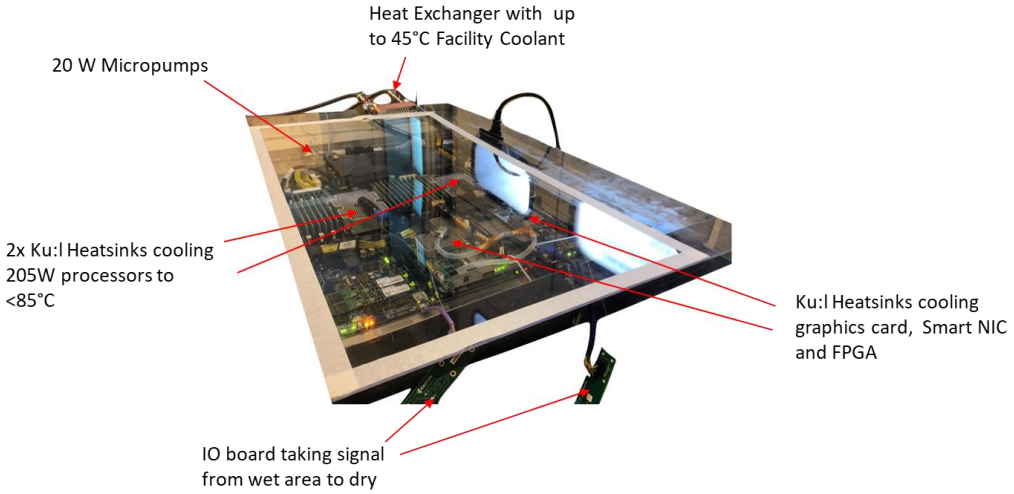
Benefits

- Reduces need for chillers and CRACs
- Significantly reduces OPEX
- Isolates high pressure facility water from racks
- Serviceable onsite – no downtime
- High temperature return water can be used for heat re-use

CHx750	
kW Capacity (@ 30°C facility water)	750 kW
Racks per system	5-20
Power Consumption (Max.)	7.4 kW
Centralized Pump Capacity (Max.)	450 lpm



Single Phase bath Immersion

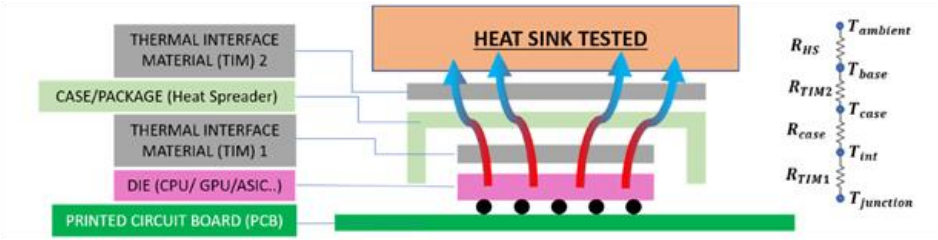


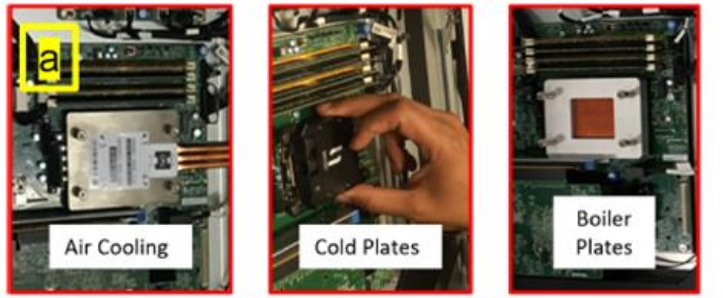
Two-Phase Bath Immersion

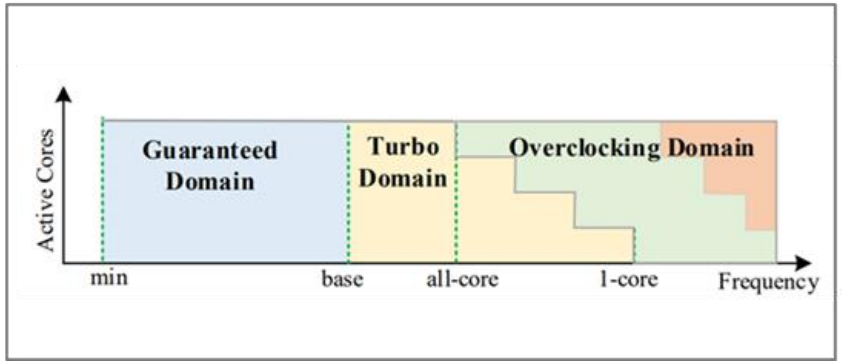
Link: To cool datacenter servers, Microsoft turns to boiling liquid – Innovation Stories

Sustainable and Efficient computing

- How to perform efficient high performance computing using Overclocking in liquid cooling?
- Two recent Microsoft (MSR, CO+I, and Azure) studies showed how liquid cooling can be used to produce higher performing and more scalable VMs with less data center resources (eCO2, energy, and water) leading to more sustainable computing







[1] Cost-Efficient Overclocking in Immersion-Cooled Datacenters
[2] CPU Overclocking: A Performance Assessment of Air, Cold Plates, and Two-Phase Immersion Cooling

Looking into the future

Embedded Microfluidics Cooling

- Embedded Microfluidics Cooling has a potential to offer significantly higher performance compared to cold plates
- Since 2021, we have been working on improving the reliability, robustness of packaging and advancing this technology further
- With the recent growth of GPU and AI, this cooling technology can offer interlayer cooling in 3D stacked dies, targeted cooling of SOC and HBM for GPU servers.

Microsoft's Embedded Microfluidics Cooling in 2021