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One Year of Two Phase (2P) Immersion Cooling in the Cloud: Lessons Learned

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One Year of Two Phase (2P) Immersion Cooling in the Cloud: Lessons Learned

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Microsoft's Sustainability Pledge

ADVANCED COOLING FACILITIES

ADVANCED COOLING SOLUTIONS

SUSTAINABILITY

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

Microsoft Azure Contact Sales

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Blog / Updates

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

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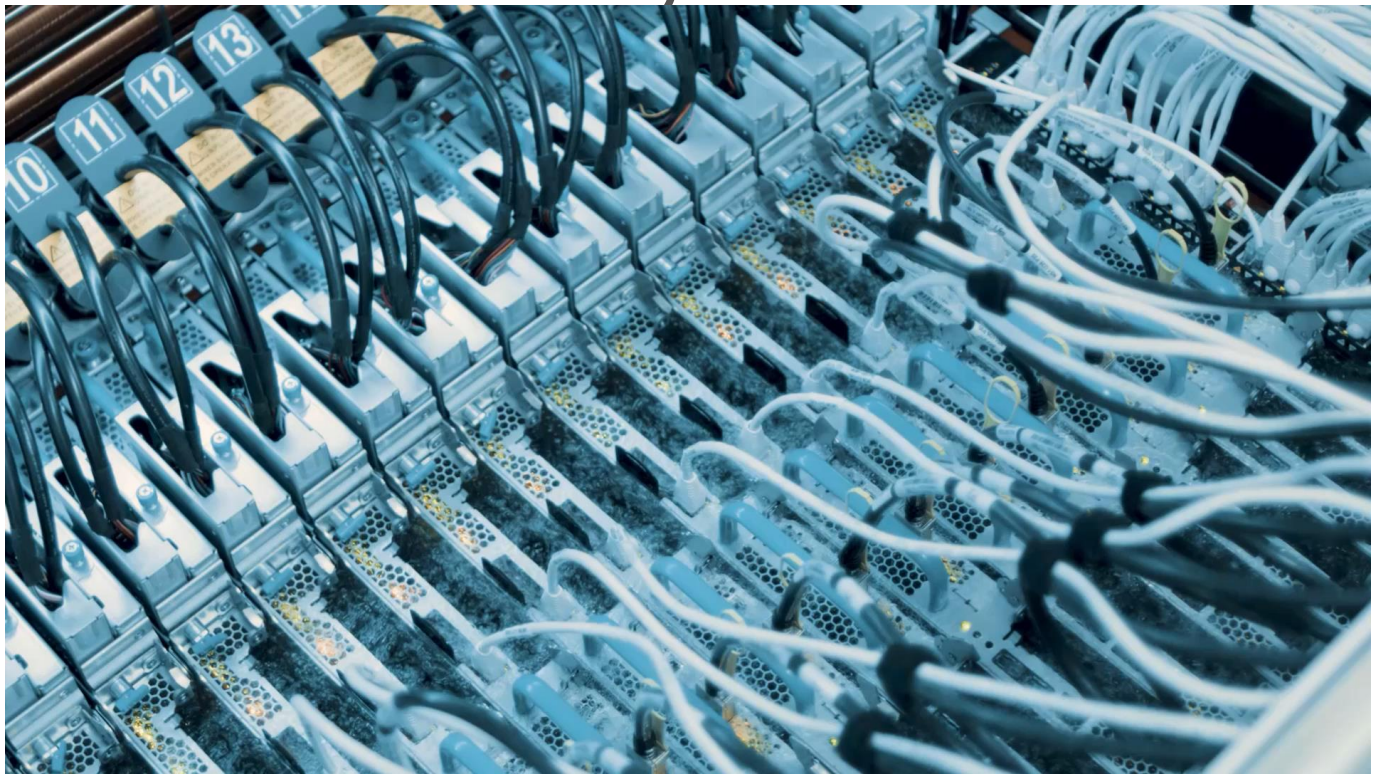
Innovation Story



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

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Immersion Tank

- 38U Tank
- 2.2m(W) x 1.2m(D) x 2m(H)
- Compatible with Olympus PMDU
- 17.4kW with 1+1 condenser redundancy
- Up to 650mm depth IT
- Serviceability and ergonomics
- Smart control and real-time monitoring
- Safety oriented design

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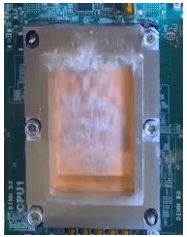
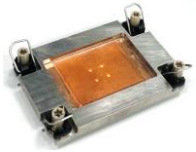
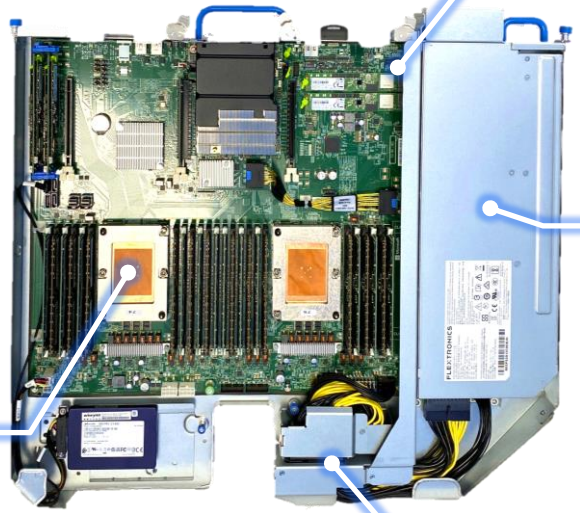
Immersion Server

- FW Modification
  - ✓ Fan detection removal
  - ✓ Immersion temperature threshold





Boiling Enhancement Plate



Vertical Service

PSU

Blind Mate Connector

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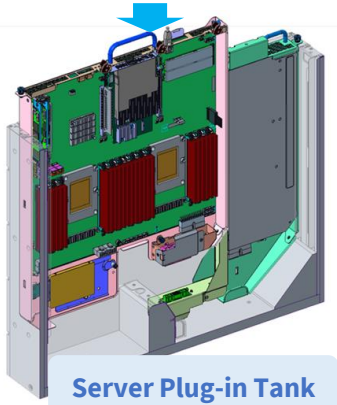
SUSTAINABILITY



Server Plug-in Tank

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Integration in DC

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SUSTAINABILITY

Tank Positioning

Tank Inspection

Tank Manager Power on

Tank Functional Check

Water Loop Connection/ Start Pumping

Cooling Water Quick Connection

Water Loop Inspection

Dielectric Fluid Injection

Power On IT Gears

Functional Check

IT Gears Operating

- Network Communication
- Monitoring

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Tank/server Operation

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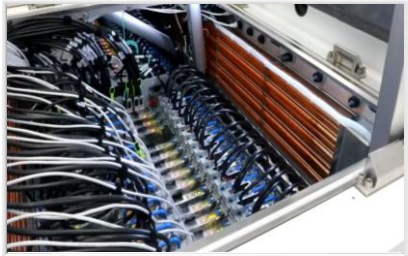
SUSTAINABILITY

Power/ Water Connection

Automatic Lid Anti-Pinch

Serviceability

Boiling



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Contamination in 2-Phase Immersion

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SUSTAINABILITY

What are the contaminants of concern in 2-phase immersion?

- Hydrocarbon oils: phthalate esters, silicones, solder flux, etc. Most 200<M<600 g/mol
- Solubility in immersion fluid varies from ~1-1,000 parts per million (ppm)

Where do these contaminants come from?

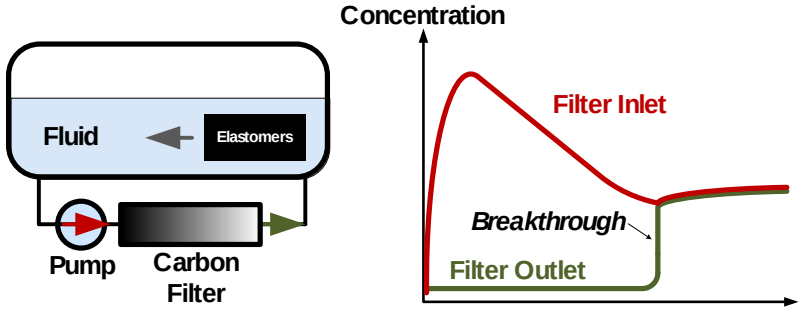
- Extracted from elastomeric materials placed in or on electronics:

Material Source of Contaminant	rectifier	server	cabling	tank	Example of Component Containing Contaminant	Mitigation/Comment
PVC insulation	●	●	●		wiring: communication and power cables, etc.	use cleaner alternative
silicone RTV	●				transistor potting, vibration dampening capacitors	*
hot melt adhesive	●				wire retention	*
thermal interface grease		●			transistor and diode heatsinks	*
thermal interface grease		●			heat sink attach to processors	OK to use but alternatives exist
thermal interface pads	●	●			attach heat sinks for voltage regulators, diodes, etc.	*
conformal coatings	●				often applied to power supply circuit board	*
electrical isolation pads	●				power supply transistors and diodes	*
solder flux	●	●			PCBs	clean if possible
heat shrink tubing	●				wiring, cable assemblies	minimize
elastomers				●	tank O-rings, seals, etc.	minimize, use cleanest option
foam rubber		●			airflow guides or vibration dampeners	*

* can likely be eliminated in 2-phase immersion

How to mitigate the effects of contamination?

- Elimination of the contaminant or its source
  - Many elastomers can be eliminated outright.
  - Clean alternatives exist for others (e.g. LSZH vs PVC).
- Filtration of contaminant with activated carbon



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Fluid Contamination and Thermal Impact

- Continuously filtering the fluid could mitigate the contamination level significantly
- Reducing the contamination provides higher cooling capability
- Selecting the materials with low contamination is key point

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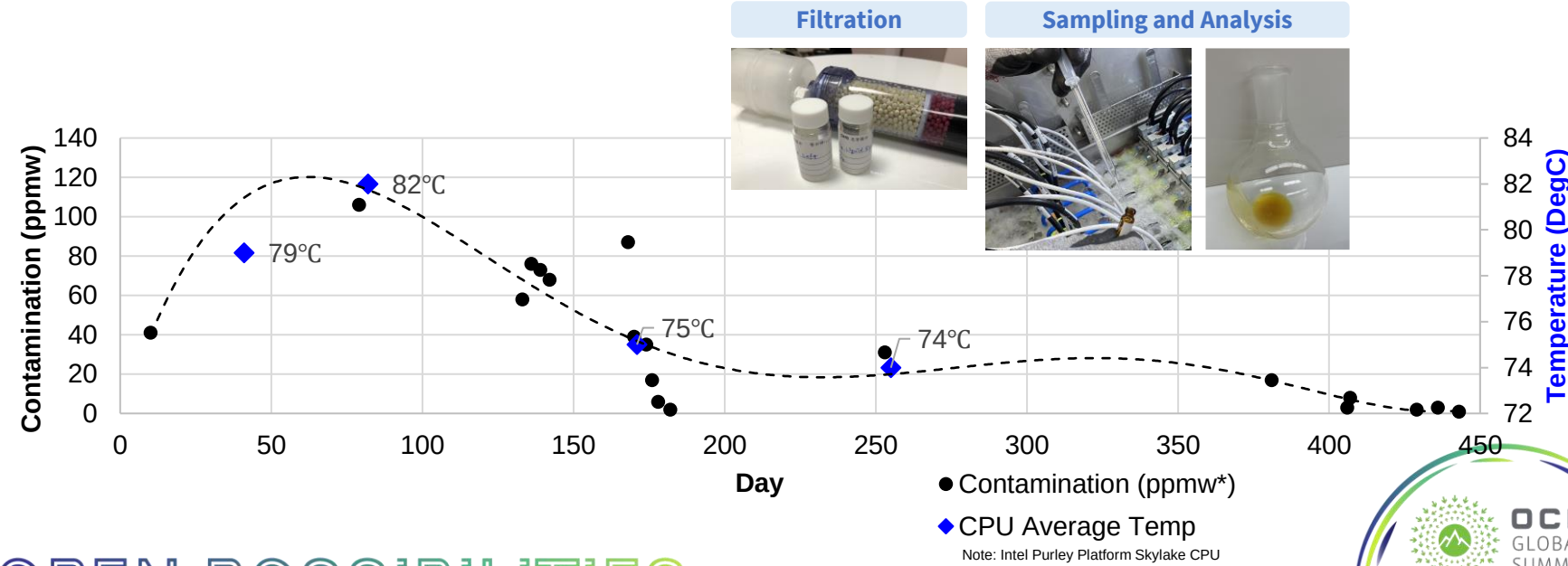
SUSTAINABILITY



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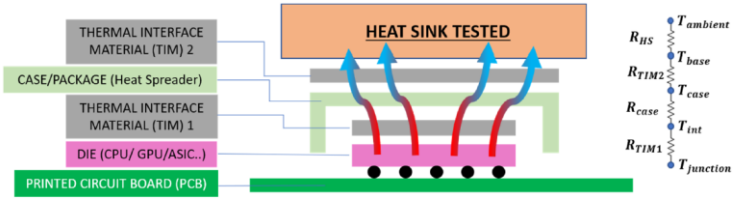
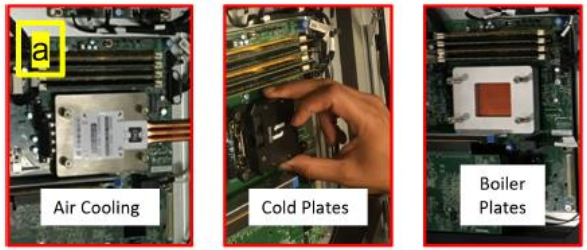
Sustainable & Efficient Computing

- 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 Blue 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

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Sustainable & Efficient Computing

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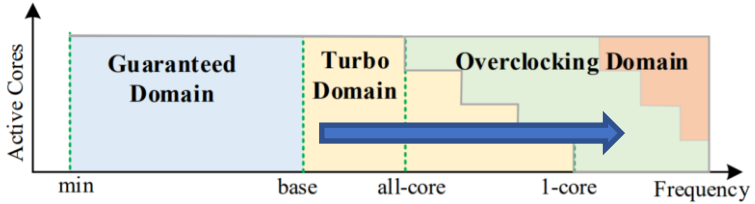
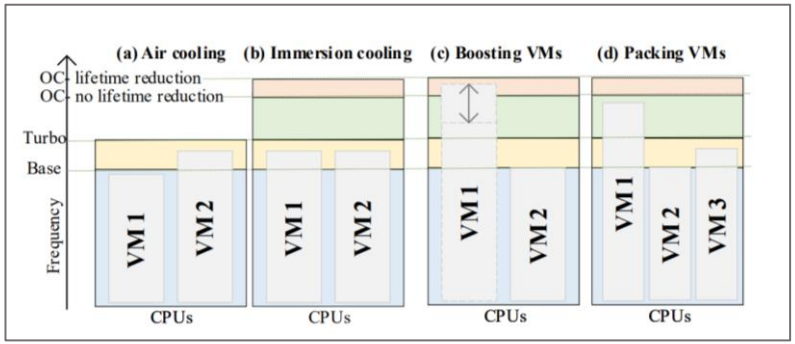
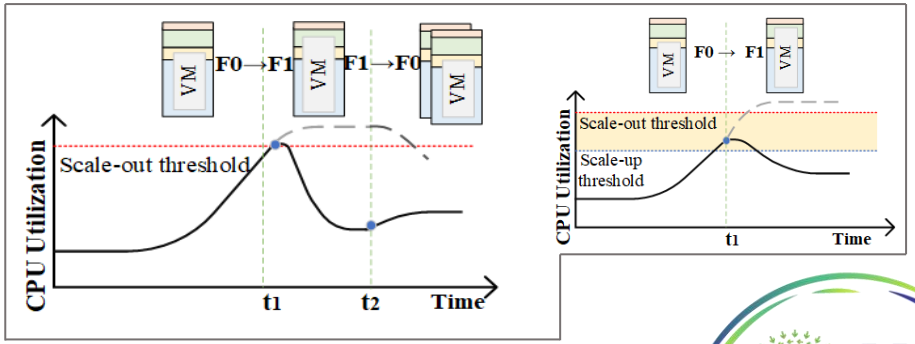
USTAINABILITY

COMPARISON OF THE MAIN DATACENTER COOLING TECHNOLOGIES.

	Average PUE	Peak PUE	Server fan overhead	Max server cooling
Chillers [12]	1.70	2.00	5%	700 W
Water-side [41]	1.19	1.25	6%	700 W
Direct evaporative [41]	1.12	1.20	6%	700 W
CPU cold plates [15]	1.08	1.13	3%	2 kW
1PIC [5]	1.05	1.07	0%	2 kW
2PIC [2]	1.02	1.03	0%	>4kW







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Call to Action

Immersion Fluid Investigations

- Different fluids to choose from
- Compatibility and effect of contaminants

Tank & Servers

- Pumps and Filtration
- Design optimization for use in fluids

Microsoft Contributions

- Immersion Server Lift specification (ongoing)
- Operational learnings
- Whitepaper (TBD) + OC Articles

Join the immersion cooling efforts

- https://www.opencompute.org/projects/acs-immersion

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Thank you!