Immersion Cooling, High Performance Cooling for HPC

HPCKP’19

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Who am I?

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Some background

\[ \frac{\Gamma, x : \sigma \vdash x : \sigma \text{ (var) }}{\Gamma \vdash M : \sigma \rightarrow \tau} \quad \frac{\Gamma \vdash N : \sigma}{\Gamma \vdash MN : \tau} \quad (\rightarrow E) \]

\[ \frac{\Gamma, x : \sigma \vdash M : \tau}{\Gamma \vdash \lambda x.M : \sigma \rightarrow \tau} \quad (\rightarrow I) \]

\[ \xi : \text{Var} \rightarrow (S \rightarrow N) \text{ then } [-]^S_\xi \]

\[ [x]^S_\xi = \xi(x) \]

\[ [n]^S_\xi = \lambda s.n \]

\[ [f(t_1, ..., t_n)]^S_\xi = \lambda s.f([t_1]^S_\xi(s), ..., [t_n]^S_\xi(s)) \]

\[ [\varphi_P(t_1, ..., t_n)]^S_\xi = \lambda s.[\varphi_P]([t_1]^S_\xi(s), ..., [t_n]^S_\xi(s), s) \]

\[ [P(t_1, ..., t_n)]^S_\xi = \lambda s.P([t_1]^S_\xi(s), ..., [t_n]^S_\xi(s)) \]

\[ [\chi_P(t_1, ..., t_n)]^S_\xi = \lambda s.[\chi_P]([t_1]^S_\xi(s), ..., [t_n]^S_\xi(s), s) \]
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By 2023, 50% of HPC deployments will be liquid cooled.
Why do computers need cooling?
“When the average per rack power density is greater than 7 kW per rack, the space utilization goes down to almost 50%. This is because almost 50% of the space is then needed by power and cooling equipment alone, and only 50% of the space can be utilized by the actual IT equipment.”

Alex Carroll
Managing Member at Lifeline Data Centers
Rack densities sky-rocketing

How to tackle this scenario?
Different types of liquid cooling

Direct-to-Chip (Direct Liquid Cooling) vs. Immersion (Liquid Immersion Cooling - LIC) vs. Active Rear-Door Extraction Cooling
Different types of liquid cooling

Direct-to-Chip cooling (generally water)
Pros:
- Same rack form factor/orientation
- Already adopted by several OEMs/ODMs
- Better dissipation capacity than air
Cons:
- Does not dissipate heat on all components uniformly
- Requires both air and water cooling infrastructure
- Danger of spillage/leak on critical components
- Can lead to vendor lock-in
Different types of liquid cooling

Immersion Cooling
Pros:
● Less HW-Failures and extended lifespan
● Reduced CAPEX and OPEX
● Silent Environment
● No vendor lock-in
Cons:
● Horizontal vs. vertical racks
● Necessity to overcome perception and mindset barrier
Different types of liquid cooling

Immersion Cooling (dielectric fluid)

Physical properties of fluids:

**Two-phase**: low-temp. evaporation dissipates heat and transfer heat out of liquid; heat-exchange cools gas to allow return flow into larger liquid volume
- Expensive to manufacture and produce
- Must be completely sealed (hazardous fumes) → higher complexity
- Aggressive on components due to micro-cavitation

**Single-phase**: no state change; circulating liquid dissipates heat; heat-exchange lowers liquid's temperature
- Simple and safe to handle
- Cheaper to produce
- Less complexity → practical solution
Submer’s Liquid Immersion Cooling solution
reduce energy consumption
increase computing density per sqm
reduce building costs
reduce latency & increase deployment speed
Reduce energy consumption

- Air Cooling Power
- IT (with Fans)
- Submer total cooling power

Conventional Data Center

Submer Data Center

50% reduction

Cooling Infrastructure Power
IT Equipment Power
Increase computing density per sqm by Leveraging High Density (e.g.: 2MW facility)

85% Less Space needed
Reduce building costs

- cooling
- power
- compute

2 MW in 3 40’ containers
Reduce latency & increase deployment speed
Benefits in budget allocation for HPC centers

Source: Intersect360
Liquid Immersion Cooling: Benefits

- **95%** Reduction in cooling OPEX
  - In comparison to direct expansion air cooling and simplified maintenance of dry-cooler systems

- **85%** Increase in computing density
  - Dissipation capacity of over 100 kW in the space of two standard racks

- **40%** Reduction in CAPEX build costs
  - Rapidly deployable in raw space without need for raised floors.
  - Minimum retrofitting required for existing DCs

- **30%** Increase in hardware life-span
  - No moving parts, no dust particles, no vibrations, less thermal and mechanical stress due to the uniformity provided by the liquid and its viscosity

- **60%** Reduction in hardware failure

**Unrivalled TCO**
Submer SmartPodX

- Over 100 kW of heat dissipation
- 45U or 22U, 19” or 21” Open Compute (OCP)
- Local and remote management interfaces
- Simplified maintenance
- Submer Cloud (remote monitoring & management)
- DCIM API - integrate with monitoring tools
- Compact form factor
- Tier III and tier IV compatible
- Vertically Stackable configurations available
- Optional IP65 (water/dust proof)

*Patent Pending*
1.03 PUE
- <85% space needed
- <95% cooling costs
- Silent operation (fanless)

1.89 PUE
- Large amount space needed
- High cooling costs
- Noisy operation

**Air cooled data center** vs. **Immersion cooled data center**

Born of HPC and made for HPC

- extensive CFD analysis
- ensure homogeneous operating environment for all components
- $3\degree C \leq \text{SmartCoolant } \Delta T \leq 5\degree C$
- uniform and protected medium for the machines to compute in
We work with these HW vendors on your behalf:
Where are SmartPods installed?

orders being fulfilled, delivered, installed until end Q1 2019
Talk to us about your liquid cooling options for your next HPC deployment!

Request more info at contact@submer.com