CoolIT systems™

# Direct Liquid Cooling: Trends, Applications and Best Practices.

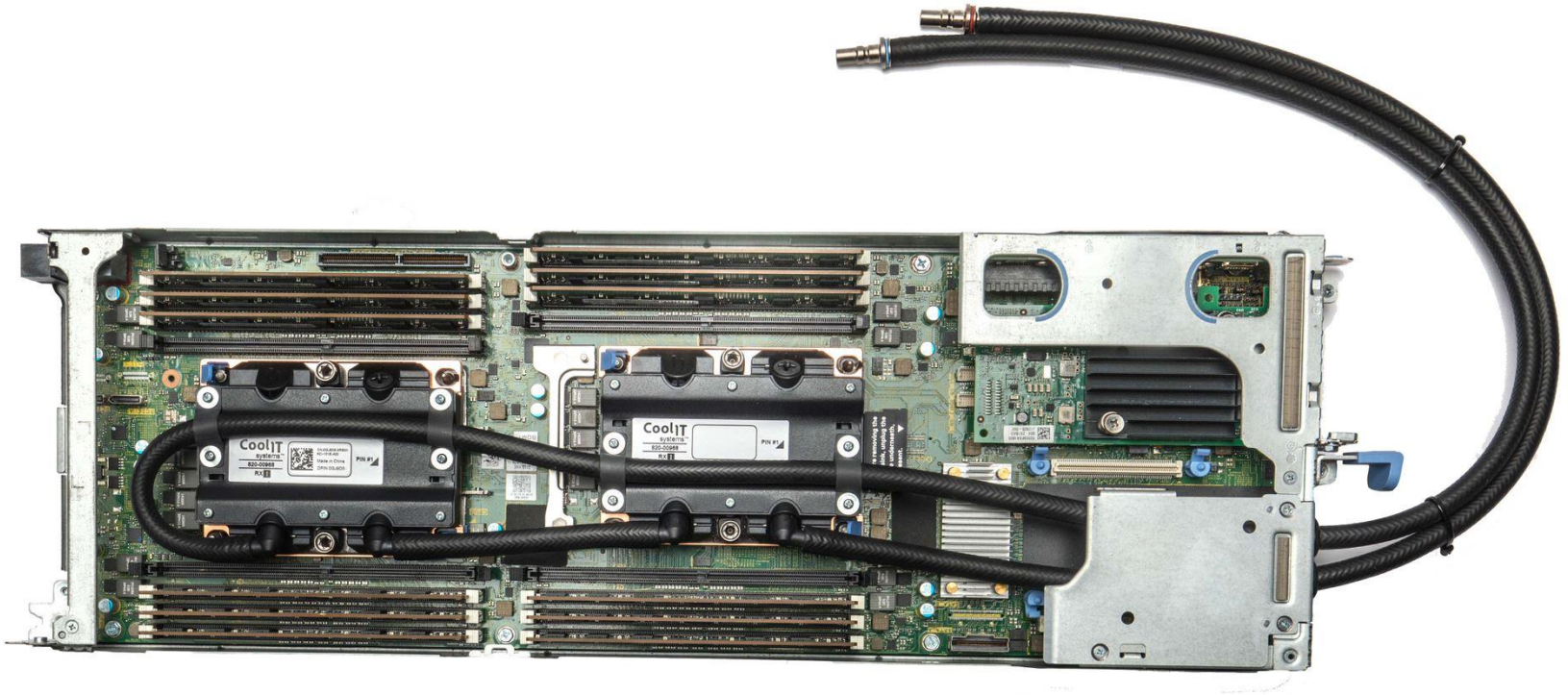
BRAD ZAKAIB • 2022-08-30

# Abstract

We continue to change the world by creating higher performing, faster, more robust technologies. However, with increasing performance comes increasing needs for thermal management. We will discuss the trends of increasing thermal design power, decreasing case temperatures, heat rejection options (air, immersion, direct liquid cooling) and at which point to consider direct liquid cooling (DLC). We will showcase different industry applications of DLC techniques to solve thermal management challenges and share our best practices in the design and validation of DLC systems to ensure quality and reliability.

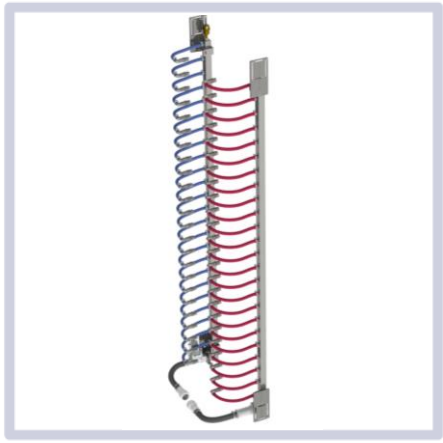
# What is Direct Liquid Cooling (DLC)?

A cooling system where circulating cooling fluid (coolant) is contained within a loop that routes to heat exchange components (coldplates) that contact heat generating components directly through thermal interface materials.



# CoolIT's Rack DLC: Four Adaptable Modules

PASSIVE COLDPLATE LOOP



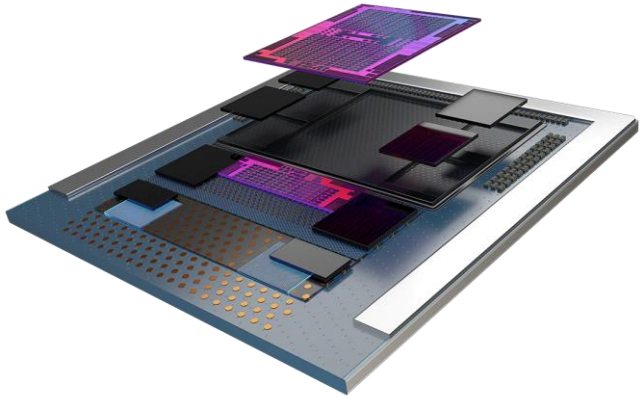
RACK MANIFOLD

COOLANT DISTRIBUTION UNIT

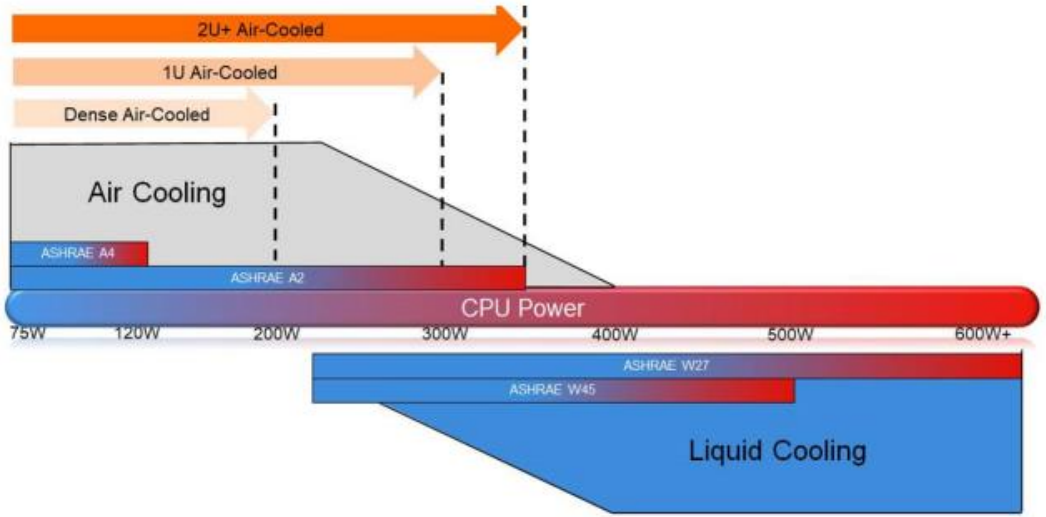

SECONDARY FLUID NETWORK

# Thermal Management Trends

- Increased rack and server board density
- Increasing thermal design power (TDP) and heat density
- Decreasing package surface (case) temperature limits
- Widespread use of GPUs/Accelerators
- Multi-chip packages (2D & 3D)



Source: AMD



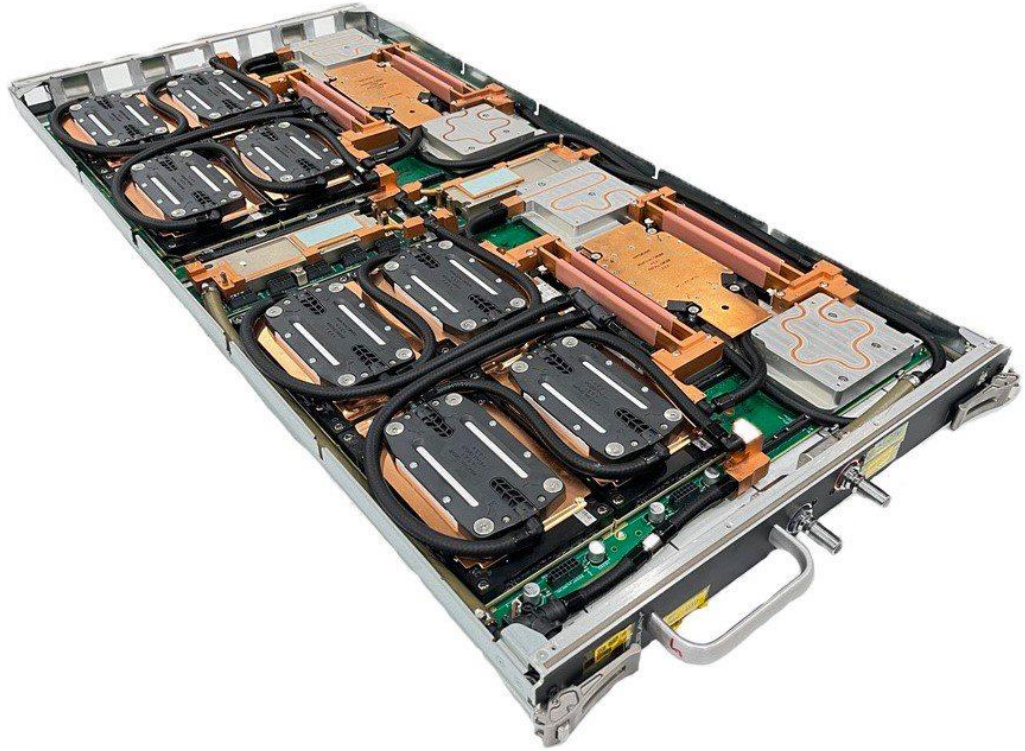

Source: ASHRAE TC 9.9

# Liquid Cooling Market Trends

- Continued adoption in Supercomputers and HPC
- Uptick in interest from Enterprise, Colo, and Hyperscale datacenters
- Increased need for energy savings and environmental sustainability
- Emergence of a range of commercially available liquid cooling technologies

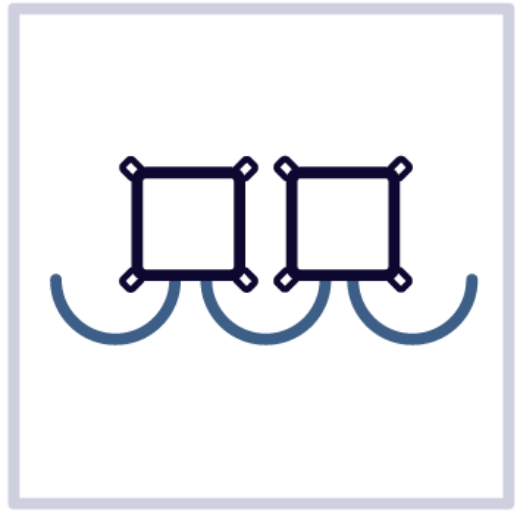
# Why Direct Liquid Cooling?

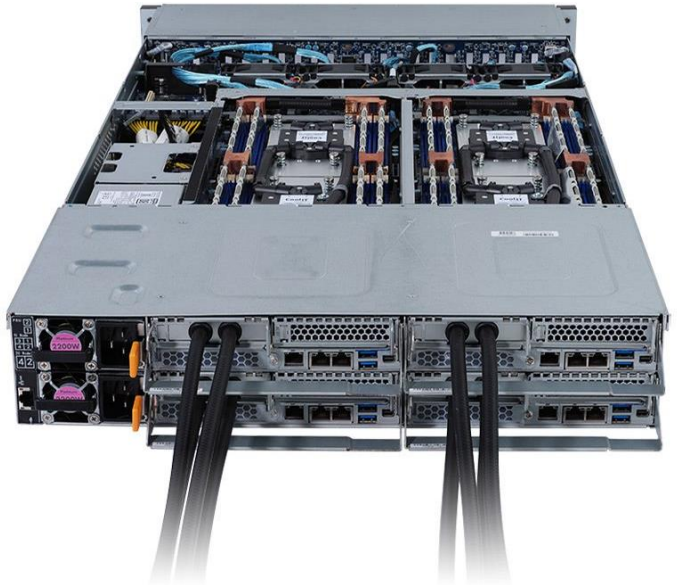
- High Performance
- Energy Efficient
- Configurable: 60-100% Heat Capture
- Datacenter Architecture
- Plug and Play
- Retrofittable
- Environmentally Friendly
- Safe & Reliable
- Beyond Datacenter…



# Best Practices: Design

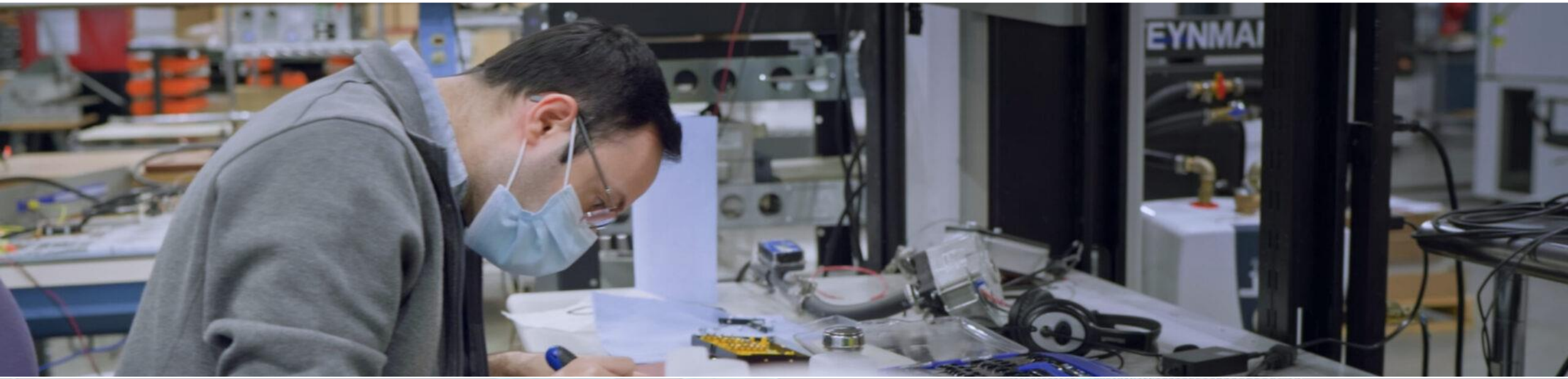
- Consider cooling early on
  - Optimized motherboard layouts minimize complexity and cost
  - Cooling structures require mounting features
- Consider coolant chemistry
  - Biological growth, corrosion, & polymer compatibility should be top of mind
  - Aluminum CAN be used in liquid cooling systems (under certain conditions)
- Consider serviceability requirements
  - Impacts decision-making on inclusion and placement of flexible hosing
  - Blind mate or manual mate fluid connectors
- Identify thermal interface points
  - Selection of thermal interface materials based on component height tolerances & flatness
  - Monolithic vs. discrete coldplates





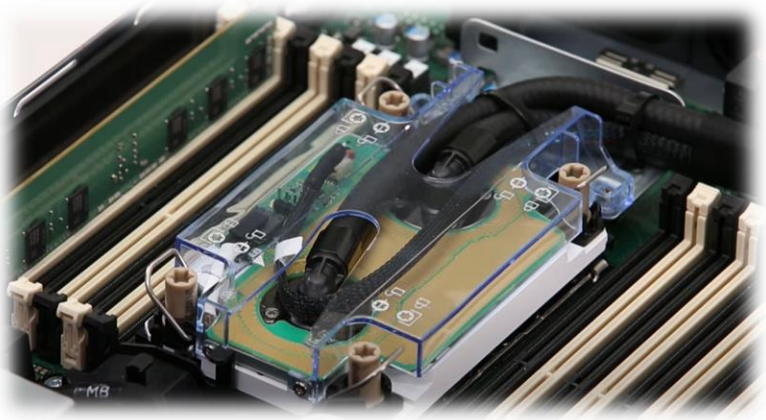
# Best Practices: Validation

- Accelerated life testing
- Controlled environment performance testing
- Regulatory certifications – a new industry
- A lab built for Direct Liquid Cooling



# Best Practices: Quality & Reliability

- Consider: these products are designed to run 24/7, 365, for 5+ years, at elevated temperature without failures
  - Compared to: cars, rockets
- Coolant health monitoring and maintenance
  - Planned preventative maintenance plans & authorized service providers
- Leak detection & mitigation
  - Predictive failure modelling (Weibull)



Source: Dell YouTube

# Leaders in liquid cooling.

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