WEIGHING THE OPTIONS: NOT ALL COOLING TECHNOLOGY SOLUTIONS ARE CREATED EQUAL

There are a lot of competing cooling technologies out there, and there are many important factors to consider before jumping in and installing a new system. We've broken down the key points you need to know about the four main types of cooling systems so you can weigh the advantages and disadvantages of each one and determine the best fit for your data center.

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SHELL LUBRICANT SOLUTIONS

Which type of cooling system is the best fit for your data center?

	AIR COOLING	LIQUID COOLING		
	Air cooling (traditional data centers)[a]	Single-phase cooling: cold plate (water)[b]	Single-phase cooling: immersion[ab]	Two-phase cooling: (High heat range applications)[b]
Cooling capacity	+	+ +	+ + +	+ + + +
Harware integration (For example, space needed)	+	+ +	+ +	+ +
Hardware reliability	+	–	+ +	+
Hardware performance	+	+ +	+ + +	+ + +
Heat recovery	+	+ +	+ + +	+ + +
Initial capital expenditure	+	–	+ +	– – –
Operating expenditure	+	+ +	+ +	+ + +

a. Infrastructure Services Group, reported in Global immersion cooling market in data centers – Growth, trends, forecast (2019–2024), Mordor Intelligence (2019)
b. Customer feedback and internal evaluation

Air Cooling

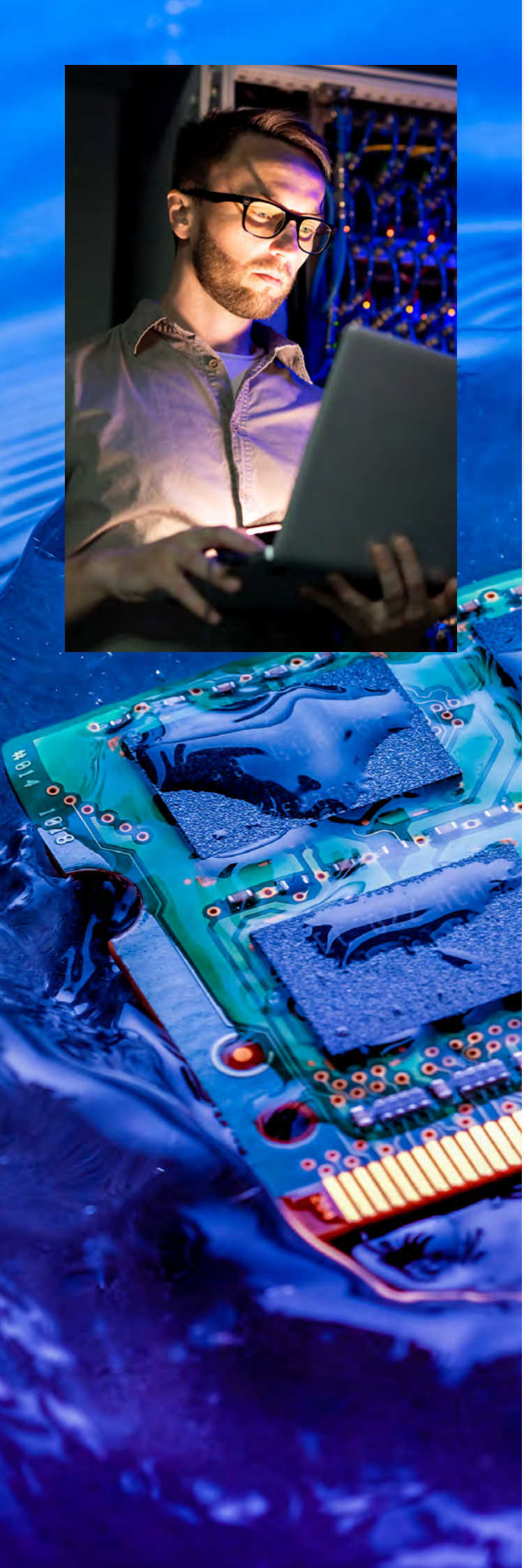
Air cooling is a well-established method that many data centers have been using for years. Air is brought in from outside and chilled by a computer room air conditioning (CRAC) unit, then pushed beneath a raised floor in the "cold aisle" and "hot aisle."

PROS	CONS
Less expensive to purchase and install	Inefficient – air is not as effective at conducting heat
Easiest option to maintain[1]	Limited location flexibility
Less expensive to purchase and install	Can create hot spots that contribute to hardware failure[2]

Single-Phase (Cold Plate, Water)

Single-phase cold plate cooling is a hybrid solution that involves both liquid and air cooling. It involves circulating cooling water internally through micro channels, which are attached to the CPUs. It is more efficient than traditional air cooling because the plate is able to absorb the heat and is cooled with liquid, which is a much better conductor of heat than air.[3]

PROS	CONS
More efficient than traditional air cooling	Potential risk of leakage and water damage to the system
Improves cooling capacity	Needs to be performed alongside air cooling to be truly effective



Single-Phase (Immersion)

Single-phase immersion cooling works well with a variety of applications, including high-performance computing. It cools IT components by submerging them in a dielectric (electrically nonconducting) fluid, which has more than thousand times the thermal capacity of air. The liquid circulates by natural convection or is pumped to remove heat from the components.

PROS	CONS
Significantly lower carbon dioxide emissions	Can require more adaption to your existing infrastructure
Better CPU performance	
Location flexibility	
Easy maintenance	

Two-Phase (High Heat Range Applications)

Two-phase immersion cooling is primarily used for high heat range applications. It is different from single-phase immersion cooling in that the coolant boils to form a gas and then condenses back to a liquid instead of staying a liquid the entire time.

PROS	CONS
Best choice for high heat range applications	High capital costs
Improves hardware performance	Uses expensive fluids with high global warming potential
High cooling capacity without requiring circulation pumps or a lot of energy	Some fluid can be lost through evaporation
	Sealed systems can make maintenance more complicated

DATA CENTERS AROUND THE WORLD PLAY A MAJOR ROLE IN THE PRODUCTION OF CARBON EMISSIONS. NO MATTER WHAT COOLING INFRASTRUCTURE YOU HAVE TODAY, IT LEADERS SHOULD BE LOOKING AT NEW WAYS TO EVOLVE AND IMPROVE EFFICIENCY, IDEALLY WHILE REDUCING THEIR CARBON EMISSIONS IN THE PROCESS.

FOOTNOTES

[1] Evans, T. (2012). The Different Technologies for Cooling Data Centers [PDF]. Schneider Electric –Data Center Science Center.

[2] 2. Varma, D. (2020, October 29). Air-Based cooling vs. Liquid-Based cooling - newly updated. Retrieved April 27, 2021, from https://www.grcooling.com/air-based-cooling-vs-liquid-based-cooling/

[3] Josh Perry, A. (2018, September 05). Cold plates in Process Cooling Applications. Retrieved April 27, 2021, from https://www.process-cooling.com/articles/89452-cold-plates-in-process-coolingapplications