BERNSTEIN
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U.S. Multi Industry & Electrical Equipment

Data Center Cooling: Accelsius on the transition from single-phase to two-phase liquid cooling



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We recently hosted John Hewitt, CEO of Accelsius, for a fireside chat at Bernstein's *The Road to Intelligence: A Data Center and AI Value Chain Investor Day*. Summarizing our key takeaways from the discussion:

1. The shift toward inference workloads should not reduce (but in fact increase) the need for liquid cooling: Heat flux (W/cm^2) and rack TDP (kW) are expected to continue rising regardless of whether GPUs are predominantly used for training or inference. Inference may (in some cases) create a more consistent thermal load because the chips can operate continuously at high utilization, while training workloads can be comparatively "bursty" (discontinued cases of heat localization or hotspots).

2. Single-phase DTC still has meaningful headroom, but accessing that headroom carries a growing system-level cost: The capacity of single-phase DTC can be extended through higher liquid flow rates and lower facility-water inlet temperatures. However, both levers consume additional power *(either through greater pumping requirements or increased chiller usage)*, thereby reducing the power available for compute.

3. Two-phase DTC is unlikely to replace single-phase overnight, but gradually: Accelsius expects a gradual transition in which both architectures coexist. The company sees commercialization developing over the next few years as upcoming chip generations / rack architectures move closer to the practical limits of single-phase DTC.

4. Higher facility-water inlet temperatures are an important system-level advantage of two-phase DTC: Accelsius' testing indicated that its two-phase DTC system could deliver comparable performance at a 54°C facility-water inlet temperature to a single-phase system operating at 45°C. The ability to operate at higher water temperatures could reduce / (potentially) eliminate chiller requirements in certain climates, thereby freeing additional power capacity for compute.

5. The remaining challenge is ecosystem deployment rather than proving the fundamental engineering: Accelsius believes it has substantially resolved core engineering issues including phase-change optimization and vapor management. The company is now focused on integrating the technology with silicon vendors, server ODMs / OEMs, and customer supply chains.

While the transition is unlikely to occur overnight, continued growth in heat flux (W/cm^2) and rack TDP (kW) would increasingly test the economic and operational limits of single-phase DTC. Accelsius expects the two architectures to coexist during a gradual transition, with two-phase DTC adoption becoming more relevant as higher flow rates, colder facility water, and greater pumping / chiller power make it increasingly difficult to extend the boundary of single-phase DTC.

See the Disclosure Appendix of this report for required disclosures, analyst certifications and other important information. Alternatively, visit our Global Research Disclosure Website.

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BERNSTEIN TICKER TABLE

			7 Oct 2026		TTM	Adjusted EPS				Adjusted P/E (x)	
Ticker	Rating	Cur	Closing Price	Price Target	Rel. Perf.	Cur	2025A	2026E	2027E	2025A	2026E	2027E
VRT (Vertiv)	O	USD	246.49	368.00	39.0%	USD	4.20	6.60	9.06	58.7	37.3	27.2
NVT (nVent)	O	USD	167.82	229.00	58.6%	USD	3.34	5.15	6.55	50.2	32.6	25.6
TT (Trane)	O	USD	467.27	575.00	(5.8)%	USD	13.06	15.28	17.79	35.8	30.6	26.3
JCI (Johnson Controls)	O	USD	155.93	190.00	27.8%	USD	3.78	5.09	6.35	41.3	30.6	24.6
CARR (Carrier)	M	USD	55.00	64.00	(23.3)%	USD	2.57	2.86	3.24	21.4	19.2	17.0
SPX			7,801.77									

O - Outperform, M - Market-Perform, U - Underperform, NR - Not Rated, CS - Coverage Suspended

Source: Bloomberg, Bernstein estimates and analysis.

INVESTMENT IMPLICATIONS

We rate VRT (TP $368), NVT (TP $229), TT (TP $575), JCI (TP $190) Outperform. We rate CARR (TP $64) Market-Perform.

RESEARCH INDEX

Primer Library

Liquid Cooling Primer: Coolant Distribution Units (CDUs)

Liquid Cooling Primer: Cold Plates

Data Center Chillers (1/3): Primer and free cooling economics

Data Center Chillers (2/3): How real is Chiller Gate risk?

Data Center Chillers (3/3): How much can "free cooling" impact chiller service revenues?

Data Center Cooling and Power: What's the $M per MW for different types of equipment

Orbital Data Centers: Content ($M/MW) Implications for Cooling Equipment Players

Other Relevant Research

Data Center Cooling Equipment: What is the service tail of a CDU (Coolant Distribution Unit)?

Liquid Cooling: What does Google's Brazos mean for the broader CDU ecosystem?

Liquid Cooling in Data Centers: What comes after single phase DTC? With CoolIT's 15kW cold plate, does anything even need to?

Data Center Cooling: Chiller killer? Quick thoughts on Accelsius' two-phase cooling at >54 degree celsius inlet temperatures.

AI Data Centers: Procurement dynamics across power and cooling components (webinar recap)

US Industrials: 30 exhibits on the state of cooling and electrical equip. procurement in North American Data Centers

US Multis: Mapping the Data Center Service Footprint for Chiller OEMs (CARR / JCI / TT)

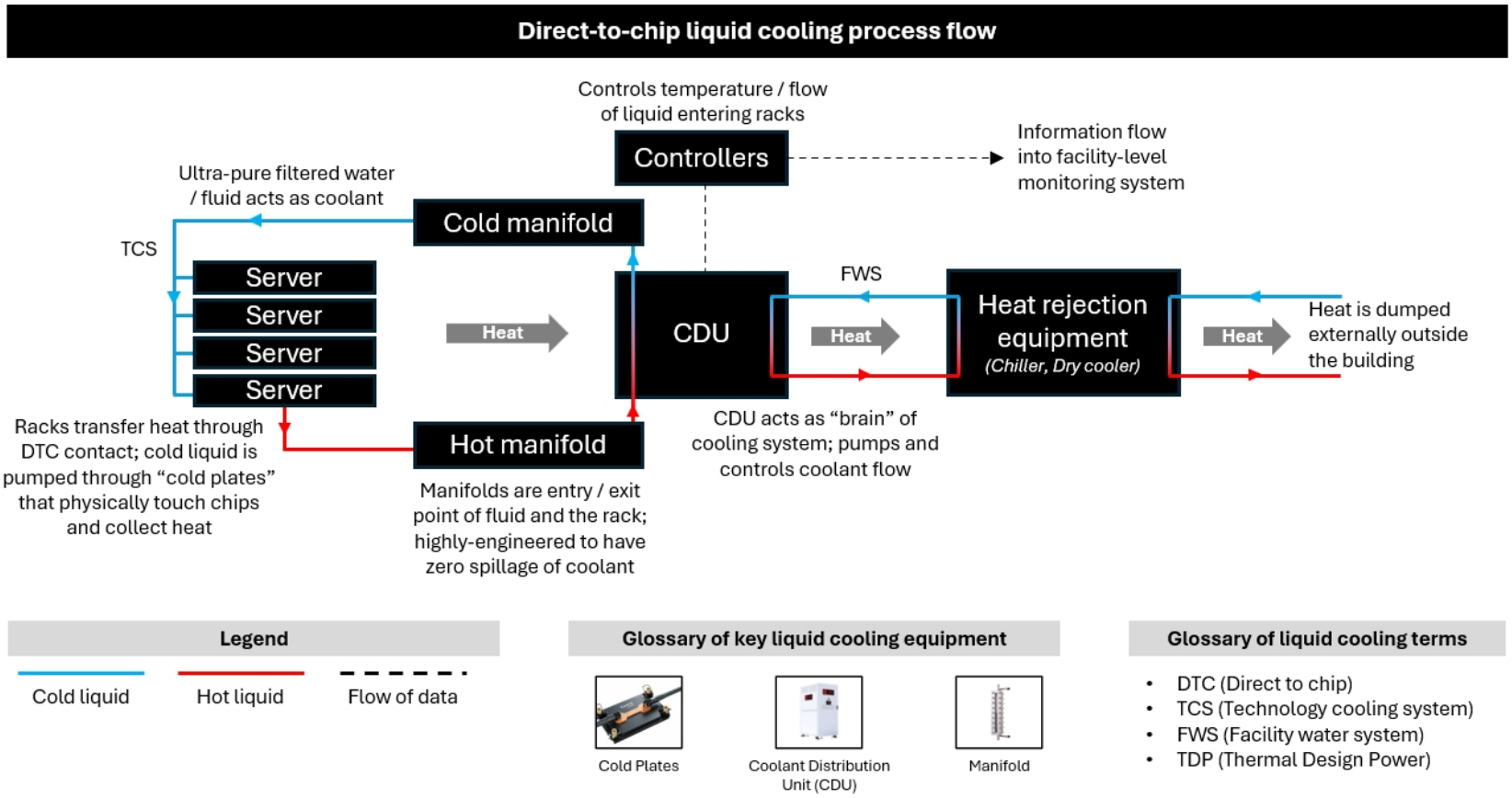
Initiations

US Multis Initiation: Thrills and Chills

US Multi Industrials: Can we (inter)connect? Initiating coverage with Outperform on Amphenol and TE Connectivity

DETAILS

EXHIBIT 1: **Recap | Direct-to-chip (DTC) liquid cooling process overview**



Source: Bernstein Analysis

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EXHIBIT 2: **Sensible vs. latent heat: what's the difference?**

Mechanics of heat transfer

$$Q = mc\Delta T + mL$$

Sensible Heat *(normal heating)* — **Latent Heat** *(Heat needed to change phase from liquid to vapor)*

- **Q** = Total heat energy absorbed by the liquid (measured in kilo-Joules)
- **m** = Mass of the liquid (measured in kg)
- **C** = Specific heat capacity (amount of heat required to raise temperature of 1kg of liquid by 1°C, measured in kilo-Joules/kg-°C)
- **ΔT** = Temperature change (measured in °C)
- **L** = Specific latent heat (amount of heat required to boil the liquid, measured in Joules/ °C)

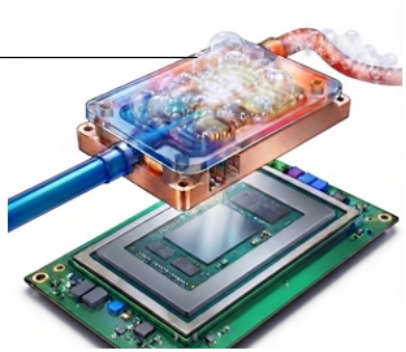
Illustration (consider water as an example)

Sensible Heat	**1 kg of water heats up by 1°C**	
	$Q = (1) \times (4.18) \times (1) = 4.18$ kJ	Core principle of single-phase DTC *(coolant just "heats" up)* – amount of heat taken out is **4.18 kJ**
Latent heat	**1 kg of water boils up (constant temperature process)**	
	$Q = (1) \times (2260) = 2260$ kJ	Core principle of two-phase DTC *(coolant "boils")* – amount of heat taken out is **2260 kJ**

Source: Bernstein Analysis and Estimates

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EXHIBIT 3: **Two-phase DTC liquid cooling mechanism (illustrative)**

	Description	Illustration
Step 1: Coolant *evaporates* upon getting heat from GPU	• Coolant is a **dielectric refrigerant** (e.g., R1233zd, R1234) unlike single-phase (water-glycol mixture) • Coolant **boils at 40 – 60^{0}C** *(below max temperatures reached by GPUs in intensive workloads)* • Evaporation process **removes much larger amounts of heat** at a nearly constant temperature (*due to the latent heat of vaporization)*, delivering higher cooling effectiveness vs. single phase • Vapor generation is naturally the **most intense over the highest-power compute regions**, **naturally concentrating heat removal** where cooling demand is the *greatest*	**Cold plate-GPU interface cross-section** *The coolant **evaporates** upon contact with the hot GPU, exiting as vapor* 
Step 2: Coolant is *condensed* back into liquid droplets	• The **hot vapor** exits the cold plate and **enters a condenser (may or may not be in the CDU)**, where heat is rejected and the vapor condenses **back into liquid droplets** • Condensation releases the latent heat absorbed at the GPU, enabling efficient transport of heat away from the server • Condensed **liquid is then recirculated back into the cold plate,** thereby creating a closed-loop cooling cycle that continuously repeats	**Condenser cross-section** *Hot vapor (upon exiting the cold plate enters a condenser*  ***Condensed liquid coolant** is now pumped back to the cold plate and the cycle repeats*

Source: Bernstein Analysis; images generated using AI to showcase representative process

We recently hosted John Hewitt, CEO of Accelsius, for a fireside chat at Bernstein's *The Road to Intelligence: A Data Center and AI Value Chain Investor Day*. During the discussion, John provided an overview of Accelsius' development into a commercial-stage provider of two-phase direct-to-chip (DTC) liquid cooling solutions, and shared his perspectives on the broader liquid-cooling landscape.

The note below summarizes our key takeaways from the fireside chat.

The data center cooling space is rapidly evolving. Each week, we see new developments emerge that bring with them real implications on who the long-term winners and losers could be. We recently put out a note on single-phase cooling and the impact CoolIT's 15kW cold plate could have on the market. Our conclusion there was that two-phase cooling may not even be required in the long run (since a 15kW cold plate creates a roughly 6x thermal headroom over current GPU TDPs). However, our perspective on this has changed slightly with Accelsius' recent white paper on two-phase cooling, on which we recently published our views.

Liquid cooling remains relevant in an inference-heavy world

The evolution of AI workloads towards increasingly inference-based *should not* weaken the structural need for liquid cooling. The primary driver of cooling architecture remain the amount of heat generated per unit area (or heat flux measured in W/cm^2) and thermal design power (TDP), both of which are expected to continue rising across both training / inference applications. However, a determinant of the cooling ecosystem could be the size of deployment site. Large training clusters are normally concentrated in major campuses and can place "bursty" loads on the silicon (larger high-density hotspot regions on the GPU). Inference capacity may be deployed across a broader mix of locations, including edge data center campuses (small capacity sites) with expected lives of ~10 -15 years. Inference results in more consistent workloads, which could lead to near full chip utilization. An inference workload is hence not necessarily easier to cool simply because it is not training a frontier model. A more consistent chip utilization profile can place a sustained thermal burden on the cooling system, even if the aggregate architecture (in terms of total system capacity) differs from that of a training cluster.

Transition from air-cooled to single-phase DTC to two-phase DTC

Air cooling historically performs well up to heat flux levels of ~40 W/cm^2 and can potentially be extended towards ~50 W/cm^2 heat flux levels (using denser fins, higher static pressure fans etc.). Beyond that level, operators generally need to depopulate racks / increase airflow or use some combination of these two parameters. Both approaches limit either compute density or system efficiency. Single-phase DTC becomes increasingly relevant beyond the practical limits of air cooling, supporting chip TDPs in the ~1.2 - 2kW range and may be pushed beyond this through higher coolant flow rates and lower inlet-water temperatures. However, extending single-phase cooling comes with its share of trade-offs:

- Raising coolant flow beyond ~1.5 liters per minute per kW requires additional pumping power. This incremental pumping power comes from the same finite power pool that could otherwise be allocated to more compute
- Lowering facility-water temperatures can improve cooling performance, but requires greater use of chillers. Additional chiller power similarly reduces the amount of utility power available for compute

CoolIT recently demonstrated a 15kW cold plate, potentially pushing adoption of two-phase DTC further out. However, heat-removal capacity alone is insufficient to determine whether the system is operationally or economically attractive. A single-phase DTC cold plate may technically dissipate a high level of heat if enough cold liquid is forced through it. However, further information about certain parameters (coolant flow rate, temperature / heat flux measurements at the die-level) are required to test the veracity of heat rejection claims at 15kW under practical operational conditions. NVIDIA's recently published 45°C facility-water inlet temperature represents one point along this progression. Upcoming chip generations, (platforms with TDPs ~2.3 - 3kW for Rubin / Rubin Ultra, and potentially higher with Feynman) could increasingly expose the practical and economic limits of single-phase DTC systems, and could prompt an industry-wide gradual shift towards two-phase DTC.

The transition to two-phase DTC is thus expected to be a gradual one, and not an overnight flip (like the shift from air cooled to single phase DTC). It is therefore expected that single-phase DTC and two-phase DTC will coexist in the end state.

Views on technical / engineering challenges (and developments) for two-phase DTC

1. **Implications on CDU design**

   Two-phase cooling introduces phase change within the fluid loop, shifting part of the engineering complexity *inside* the CDU. The CDU must manage the refrigerant as it transitions from liquid to vapor, maintain stable flow, control pressure, and ensure consistent heat removal across the system. Accelsius acknowledged that a two-phase CDU is inherently more complicated (by design) than a conventional single-phase CDU. The company has leveraged a universal cold-plate design (similar to one currently widely used and deployed in single-phase DTC setups which would enable easier retrofits). This cold plate was then connected to their two-phase CDU. Quick disconnects (and certain wetted components) require minor structural modifications because the material compatibility requirements differ between PG25 water-glycol mixtures (used in single-phase DTC) and refrigerants such as R515B (used in two-phase DTC). The broader server footprint and layout do not necessarily need to change materially.

   Accelsius' current CDU platform is rated at ~250kW, compared with single-phase CDUs that can reach ~2MW. The company attributes much of the gap to maturity. Single-phase DTC has benefited from ~20 years of engineering and product development, while Accelsius has developed its two-phase CDU over ~4 years. The company expects to offer multi-MW CDU configurations by next year. If achieved, this would narrow one of the more visible differences between two-phase and single-phase DTC and make the technology more applicable to large-scale hyperscaler data center campuses.

   Overall, the company's objective is to contain that complexity within an integrated system so that the operating experience for the end customer remains familiar (and unchanged) to current systems

2. **Refrigerant (R515B)**

   Accelsius uses R515B as the refrigerant in its two-phase architecture, compared with the PG25 water-glycol mixture commonly used in single-phase DTC systems. Benefits of using R515B include low global-warming potential (GWP), safety for human exposure (compared to alternative refrigerants), low damage to server components in the event of a leak (unlike water) and the fact that it is **already used within conventional chiller environments**. The HVAC / cooling industry therefore has experience handling, deploying, and maintaining R515B, thereby enabling a seamless transition from PG25 (in single-phase) to R515B (in two-phase). The comparison with chillers is also operationally relevant. A chiller already operates as 'technically' a two-phase system internally, meaning that the underlying refrigerant-handling concepts are not entirely new to the broader cooling / HVAC ecosystem. The novelty lies primarily in bringing that phase-change process closer to the chip (by integrating i into the CDU).

   However, refrigerant availability and broader supply chain readiness concerns remain important. Customers need confidence not only in the thermodynamics, but also in the long-term availability of refrigerant, and associated connectors, / pumps / heat exchangers / controls, and available services support.

3. **The most challenging technical / engineering problems appear to be resolved**

   Accelsius characterized its first two years as being focused primarily on establishing a robust technical foundation and resolving fundamental engineering issues with two-phase DTC (such as vapor lock and phase-change / vapor management). According to the company, the most difficult underlying engineering problems have now been addressed. The current focus is less on whether phase change can be controlled and more on whether the system can be deployed reliably across MW-scale deployments.

4. **Potential headwind for chillers**

   Accelsius recently tested its two-phase architecture on a Dell server platform that had initially been configured for single-phase DTC. The company collected ~40,000 operating data points while varying facility-water inlet temperatures. *The central finding was that the two-phase DTC could achieve similar cooling performance with 54°C facility-water inlet temperatures to that of the single-phase setup operating at 45°C.* This difference is significant because the temperature at which facility water must be supplied helps determine whether a site requires chiller support (chillers cool down or "chill" the facility water from ambient temperature to a low temperature; this cooled water then flows towards the CDU in order to absorb heat from the high temperature coolant on the TCS side; chillers also help reject heat from the hot water to the ambient environment once the iquid comes back from the CDU). Also, at higher inlet water temperatures, a facility can reject heat through dry coolers across a much broader range of ambient conditions.

Avoiding or reducing chiller use can thus lower both initial capex costs and power consumption, potentially allowing more of the site's power capacity to be directed towards compute. The broader implication is that two-phase DTC could expand the geographic and climatic range in which data centers can operate with dry coolers alone, and without chillers. This could become particularly valuable for power-constrained data center campuses, where every MW consumed by DTC is a MW unavailable to GPUs.

5. **Cost parity with single-phase DTC**

   A common perception is that two-phase DTC is more expensive (and harder to deploy) than single-phase DTC. Accelsius and Jacobs Engineering ran a joint study that evaluated single-phase and two-phase DTC setups for a 10MW data center design. According to Accelsius, the analysis indicated broad capital-cost parity between the two architectures on a dollar-per-megawatt basis. Eliminating some chiller content (for dry coolers) would lead to 10-15% lower power consumption, and could deliver up to ~35% lower annual opex and ~12% lower TCO over a five-year period. The resulting power headroom could potentially allow a facility to install *~5% more GPUs (*than a standard single-phase DTC setup) within the same overall power envelope.

6. **Serviceability / reliability concerns (vs. single-phase DTC)**

   Accelsius expects the useful life of a two-phase DTC system to be longer than that of a comparable single-phase system, although the claim will require validation through scaled field deployment. The company highlighted several durability challenges associated with single-phase DTC systems, such as microbial growth, fluid contamination, ongoing filtration requirements, erosion caused by increasing flow rates etc. Accelsius two-phase DTC system is designed with redundancy and field serviceability in mind. ~90% of the components are intended to be "hot-swappable", allowing technicians to replace a component without taking down the entire server stack. This is meant to address a meaningful customer concern. Accelsius noted that servicing a failed single-phase CDU can sometimes take as long as ~1 month. The service proposition must therefore extend beyond repairing failed equipment. Customers will require preventative maintenance, trained technicians, spare-parts availability, real-time monitoring, commissioning support, and sufficiently redundant designs to maintain operations while individual components are serviced.

Proactive engagement with customers is essential towards accelerated two-phase DTC adoption

Accelsius has been in business for ~4 years. The company described its development in three broad phases: Years one and two were focused upon establishing the core technical architecture, validating the underlying thermodynamics, and addressing engineering challenges including vapor lock and flow stability. Years three and four were about understanding system-level implications for data center power, cooling infrastructure, server design, and operating architectures. Current and future focus includes co-engineering deployment with silicon vendors, OEMs, / ODMs, hyperscalers, and other customers to determine how the technology fits into real data centers, followed by field deployment.

Accelsius expects commercial activity to develop over the next several years as chip TDPs continue to rise and single-phase systems move closer to their practical limits. The company does not expect the market to flip abruptly from one architecture to the other. Instead, it anticipates a transition period during which customers deploy two-phase cooling selectively, while continuing to use single-phase systems for less thermally demanding workloads. Early technology adoption often begins with smaller, more flexible customers seeking a competitive advantage. In liquid cooling, neoclouds may be willing to test and validate new architectures more quickly, particularly as they compete for scarce GPU and power allocations. However, neocloud growth can be constrained by access to GPUs, power, and financing. In some cases, securing financing may itself depend upon winning a hyperscaler / another long-tenured high-quality tenant. Most leading-edge GPUs continue to be allocated to hyperscalers and frontier AI labs. Hyperscaler engagement tends to progress through several stages:

1. Validate whether the technology performs as claimed
2. Determine how the system will be operated, monitored, and maintained
3. Incorporate the architecture into a hyperscaler-specific data-center design
4. Integrate the solution with existing development and procurement plans
5. Conduct proofs of concept before broader field deployment

Hyperscaler engagement cycles are hence longer than those of neocloud customers, but the eventual opportunity is substantially larger. Hyperscalers also place greater emphasis on operational reliability, vendor redundancy, service coverage, and multiple sources of supply. Accelsius is therefore concentrating its efforts where it expects the largest and most durable demand to reside.

Reduced supply chain concerns on account of US-dominated BOM

The most visible pieces of a liquid-cooling system are the CDU, pumps, and heat exchangers. However, Accelsius emphasized that deployment readiness also depends upon securing adequate supplies of smaller components, including low-value components such as quick disconnects and specialized connectors. These parts require design work despite their relatively small size / value. They affect leak prevention, installation time, serviceability, reliability, and the ease with which systems can be deployed across thousands of servers. Accelsius currently sources its bill of materials (BOM) primarily in the United States, limiting its direct exposure to tariffs on components imported from Asia. Management does not view long-term component availability as its principal concern. It is more focused on establishing a scalable deployment and service ecosystem.

Strategic corporate partnerships can help accelerate deployment

Accelsius' corporate investors include Legrand and Johnson Controls, which support different parts of the data center cooling stack. **Legrand** is more closely aligned with products and systems *inside the data center*, including the interface between the CDU and the broader white-space infrastructure. The collaboration is focused on making deployment more effective for the end customer and supporting the integration of two-phase CDUs into existing data-center campuses **Johnson Controls** is more focused on the facility-infrastructure side. The relationship centers on how chillers / dry coolers may evolve as data centers transition toward higher facility-water inlet temperatures and (gradually) towards two-phase DTC

RECAP: SINGLE PHASE VS. TWO-PHASE DTC COOLING

Before we get into the details. a quick recap on single-phase vs. two-phase cooling and how they differ.

Single-phase direct-to-chip (DTC) liquid cooling

The predominant format of liquid cooling today is single-phase DTC. DTC stands for Direct-To-Chip. It involves cold plates (which are aptly named slabs of metal that have reduced temperature due to refrigerant that circulates inside them) coming into contact with GPUs to extract heat. Inside the cold plates, liquid flows through arrays and flow loops with the intent of maximizing the amount of heat they are able to extract from the GPU. Coolant Distribution Units (CDUs) pump low temperature coolant (usually a water - propylene glycol mix in single-phase setups) through the cold plates and recollect the spent liquid once they have extracted heat from the server.

The heat is then extracted from the coolant (making it cold again) and the process repeats. It is called single phase because the coolant stays in a single phase (liquid) and does not change phases from to gas via evaporation. This loop (i.e., circulating from the CDU through cold plates in the server) is called the TCS or technology cooling system. Once spent coolant reaches the CDU, it passes through a heat exchanger where it transfers heat to another cooling loop called the FWS or Facility Water System. The FWS connects to a chiller or dry cooler to reject this heat outside a data center. However, as rack power densities continue to increase, the public narrative is that single phase DTC is reaching the theoretical limit of how much heat it can extract.

Two-phase direct-to-chip (DTC) liquid cooling

As the name suggests, two-phase DTC cooling involves two phases of matter in the cooling process. In single-phase DTC, the TCS coolant (a water glycol mix) remains in a liquid state through the entire heat transfer process as it passes through the cold plate. However, in two-phase DTC, the coolant (another compound, not water-based) evaporates into a gaseous state in the cold plate before being cooled again into a liquid and repeating the cycle. The process of evaporation is able to capture a large amount of heat without a significant change in the underlying temperature of a refrigerant.

To understand how this works, we need to define a few scientific terms; sensible heat and latent heat. Sensible heat refers to the amount of heat needed to increase the temperature of a substance without a phase change. Latent heat refers to the amount of heat needed to cause a phase change (e.g., liquid to gas via evaporation) while maintaining the temperature of the matter undergoing a phase change.

$Q_{sensible\ heat} = m * c * \Delta T$ where m is the mass of the substance, c is it's specific heat (i.e., the amount of heat needed to increase temperature of 1 kilogram of material by 10C), and ΔT is the change in temperature.

$Q_{latent\ heat} = m * L$ where m is still the mass of the substance while L is the specific "latent" heat (i.e., the amount of heat needed to cause a phase change of 1 kg of material). Notice how the temperature change doesn't matter like with sensible heat; this is because when a phase change takes place, it happens at constant temperatures. If a coolant or refrigerant has a large enough latent heat, it can essentially capture a lot more thermal load while maintaining relatively constant temperatures vs. sensible heat transfer. This is the same principle applied in a refrigerant compression cycle, where refrigerant evaporates when it captures heat and condenses before cycling back into the system.

EXHIBIT 4: **Two-phase DTC enables much higher heat transfer compared to single-phase DTC**

Mechanics of heat transfer

$$Q = mc\Delta T + mL$$

Sensible Heat *(normal heating)* — **Latent Heat** *(Heat needed to change phase from liquid to vapor)*

Q	=	Total heat energy absorbed by the liquid (measured in kilo-Joules)
m	=	Mass of the liquid (measured in kg)
C	=	Specific heat capacity (amount of heat required to raise temperature of 1kg of liquid by 1°C, measured in kilo-Joules/kg-°C)
ΔT	=	Temperature change (measured in °C)
L	=	Specific latent heat (amount of heat required to boil the liquid, measured in Joules/ °C)

Illustration (consider water as an example)

Sensible Heat	**1 kg of water heats up by 1°C**	
	Q = (1) X (4.18) X (1) = 4.18 kJ	Core principle of single-phase DTC *(coolant just "heats" up)* – amount of heat taken out is **4.18 kJ**
Latent heat	**1 kg of water boils up (constant temperature process)**	
	Q = (1) X (2260) = 2260 kJ	Core principle of two-phase DTC *(coolant "boils")* – amount of heat taken out is **2260 kJ**

The authors would like to thank Sakansh Mittal for his help in preparing this report.

I. REQUIRED DISCLOSURES

References to "Bernstein" or the “Firm” in these disclosures relate to the following entities: Bernstein Institutional Services LLC (April 1, 2024 onwards), Sanford C. Bernstein & Co., LLC (pre April 1, 2024), Bernstein Autonomous LLP, BSG France S.A. (April 1, 2024 onwards), Sanford C. Bernstein (Hong Kong) Limited 盛博香港有限公司, Sanford C. Bernstein (Canada) Limited, Sanford C. Bernstein (India) Private Limited (SEBI registration no. INH000006378), Sanford C. Bernstein (Singapore) Private Limited, Sanford C. Bernstein Japan KK（サンフォード・C・バーンスタイン株式会社）and analysts employed by Société Générale Africa Technologies & Services to produce Bernstein research under a Global Services Agreement in place between Bernstein and Société Générale.

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VALUATION METHODOLOGY

Vertiv Holdings Co

We value Vertiv at 27x NTM + 1 EBITDA of $5.3B to reach our target price of $368.

nVent Electric PLC

We used a SOTP approach to value NVT. For the EC business, we used NTM + 1 EBITDA of $444M and an EV/EBITDA multiple of 17x. For the SP business, we use an NTM + 1 EBITDA of $1,194M and an EV/EBITDA multiple of 26x. Based on these assumptions, we arrive at a fair value per share of $229.

Trane Technologies PLC

We value Trane at 22x NTM + 1 EBITDA of $5.9B to reach our target price of $575.

Johnson Controls International PLC

We value JCI using a 20x EV/EBITDA ratio and an NTM + 1 EBITDA estimate of $5.3B to reach our target price of $190.

Carrier Global Corporation

We value Carrier using a 15.3x EV/EBIT ratio and an NTM + 1 EBIT estimate of $3.98 B to reach our target price of $64.

RISKS

Vertiv Holdings Co

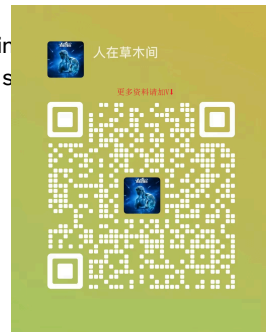
Downside: (i) Efficiency increasing to the point where less cooling needed, (ii) Unexpected slowing of data center expansion, (iii) Faster than expected shift away from NVIDIA chips to custom silicon (impacts Vertiv because of strong relationships), (iv) Tech. shift away from DTC / 800 VDC if Vertiv can’t react fast enough

nVent Electric PLC

Downside: (i) Faster than expected commoditization of CDUs / OCP makes them a commodity, (ii) Production line weakness for CDUs (given NVT is ramping), (iii) Longer than expected lead time to hire for key roles (e.g., open supply chain VP position)

Trane Technologies PLC

Downside: (i) Price fixing lawsuit escalates for Trane, (ii) More players achieve similar level of product innovation in liquid cooling, (iii) Residential / transport numbers deteriorate further than expected, (iv) Chiller headwinds (both s outweigh liquid cooling tailwind



Johnson Controls International PLC

Downside: Lean transformation does not successfully cascade through org., Data center weakness from chiller headwinds, Operating leverage <50% based on management guidance

Carrier Global Corporation

Upside: (i) Resi / light commercial cycle turns in the US (we think this is easily the biggest driver for Carrier looking ahead), (ii) Continued growth in data centers (we'd be especially impressed if this came from CDUs) (iii) Policy changes in the UK / Germany driving heat pump uptake

Downside: (i) Escalation of price fixing lawsuit (Carrier uniquely exposed, (ii) Slowing of data center CapEx by hyperscalers, (iii) Supply of R-410A does not tighten as expected / drags out for longer

RATINGS DEFINITIONS, BENCHMARKS AND DISTRIBUTION

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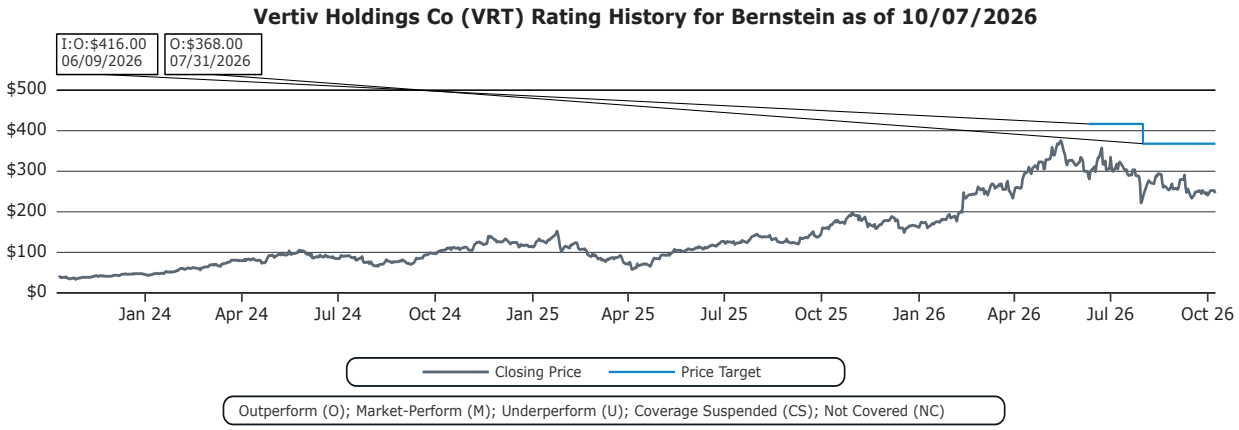
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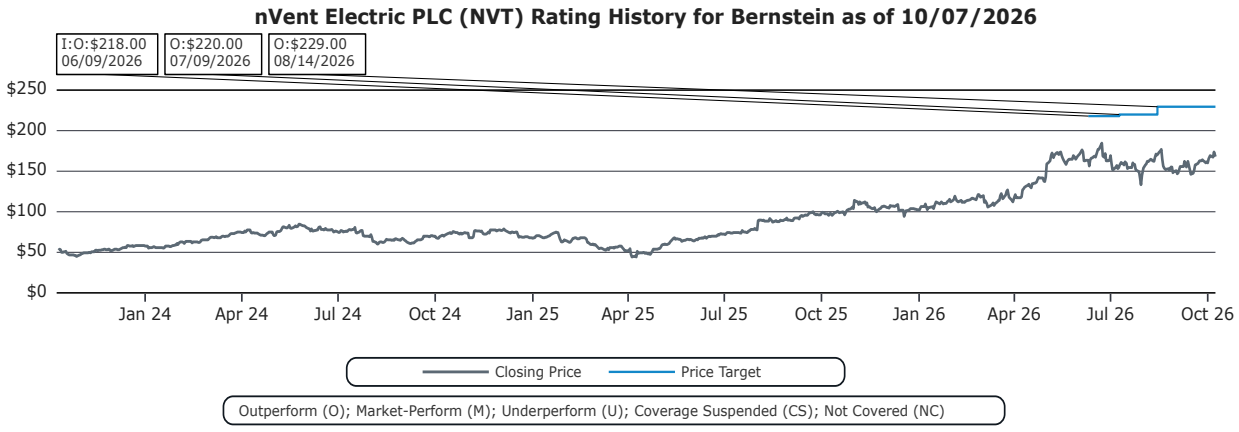
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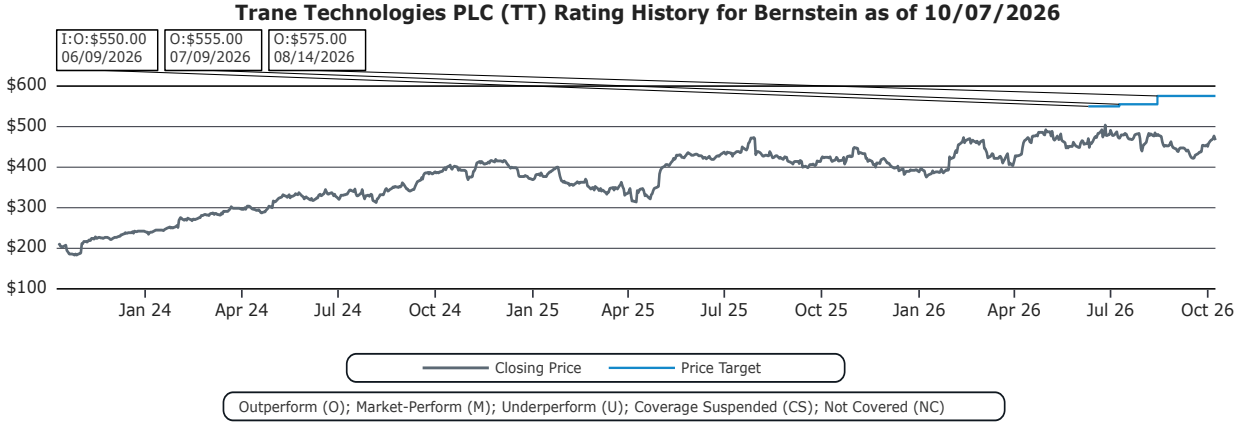
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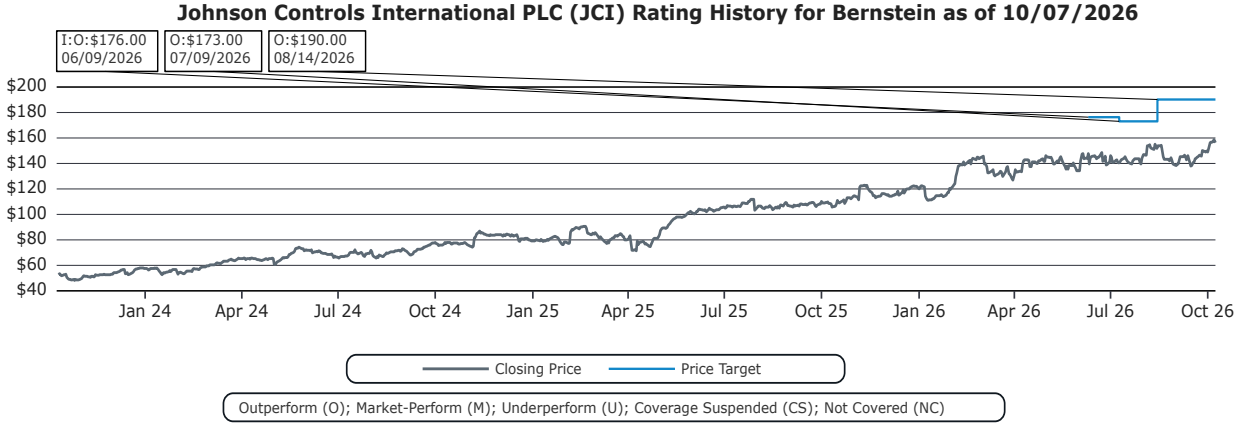




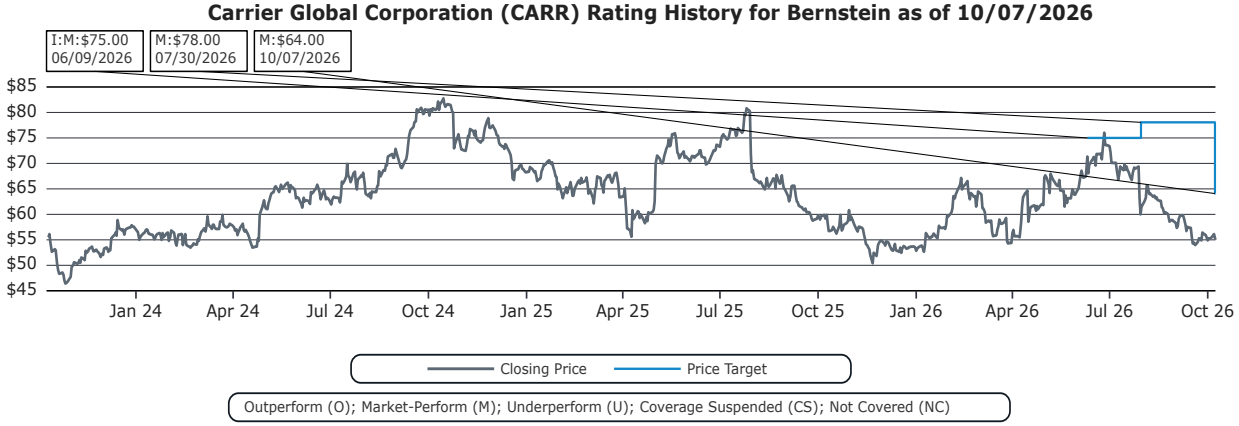
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