CASE STUDY

WHAT IS THE SOURCE OF YOUR WATER?

CONSTRUCTING AN INDUSTRIAL ATMOSPHERIC WATER GENERATOR SYSTEM TO SUPPORT A CLOSED LOOP DATA CENTER OR NETWORK OPERATIONS CENTER

GREEN TECHNOLOGY GLOBAL
Atmospheric Water Generator

BACKGROUND

A data center is the technological hub of modern enterprise operations. The data center provides the critical IT infrastructure needed to deliver resources and services to business employees, partners and customers around the world.

The sheer scale involved in enterprise computing demands a large, dedicated space that is carefully designed to support the space, power, cooling, management, reliability and security needs of the IT infrastructure.

- **Power.** There must be adequate power -- in watts, often as much as 100 megawatts -- to operate all the IT infrastructure. Power must be affordable, *clean* -meaning free of fluctuation or disruption and reliable. Renewable and supplemental/auxiliary power must be included.

- **Cooling.** The enormous amount of power delivered to a data center is converted into computing -- i.e., work -- and a lot of heat, which must be removed from the IT infrastructure using conventional HVAC systems (demanding massive quantities of non-potable water for cooling), as well as other unconventional cooling technologies

- **Security.** Considering the value of the data center and its critical importance to the business, the data center must include controlled access using a variety of tactics, ranging from employee badge access to video surveillance.
- **Management.** Modern data centers typically incorporate a building management system (BMS) designed to help IT and business leaders oversee the data center environment in real time, including oversight of temperature, humidity, power and cooling levels, as well as access and security logging. (by Stephen J. Bigelow, Senior Technology Editor, 18 May 2022)

WATER REQUIREMENTS FOR COOLING

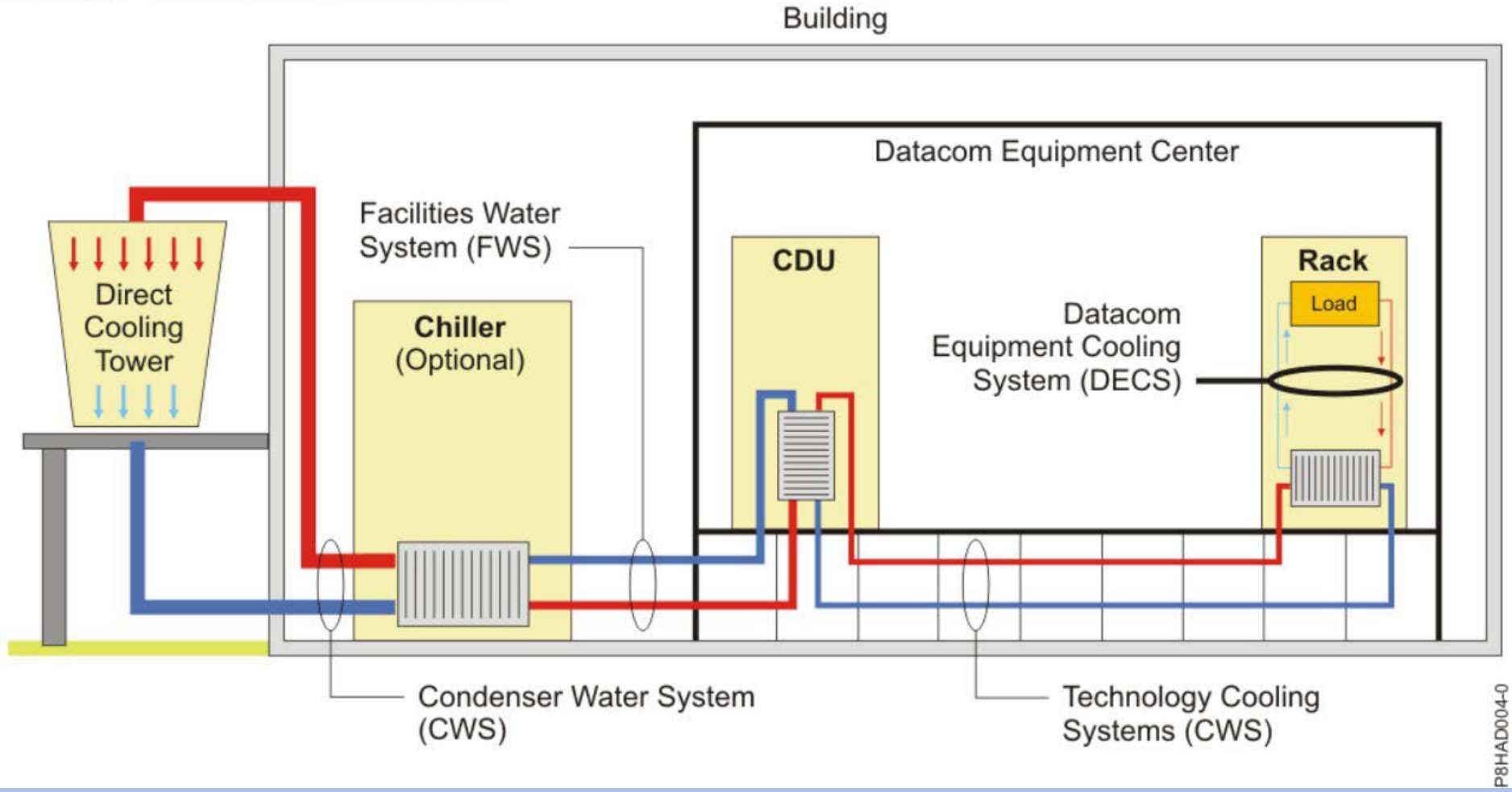
IBM specifications for water cooling systems: The datacom equipment cooling system (DECS) is a water loop in which the water comes in contact with the components to be cooled. There are cases where the DECS water is supplied by an in-rack CDU or can be supplied by an external CDU that service multiple racks. For details of potential liquid cooling systems and loops within a data center and the terminology that is used, (see Figure 1).

The water quality standards that are specified pertain only to the DECS water loop that comes into contact with computer components. The ongoing monitoring and maintenance procedures are also described.

The cooling loop hardware consists mainly of corrosion resistant alloys, such as copper alloys and stainless steels. EPDM rubber must form the inner lining of all the hoses in the system. The chemistry of the cooling water must be properly maintained to avoid system disruption or shutdown due to any of the four common water-related problems of corrosion, microbiological growth, scale formation, and fouling.

The details of the water treatment depend on whether the local municipality allows the disposal of water that contains some cleaning chemicals down a sanitary drain. If the local municipality does not allow the disposal of contaminated water down a sanitary drain, a deionizing bypass can be included in the water-cooling loop to allow the cleaning of the water to purity levels corresponding to resistivity > 0.1 MΩ.cm (conductivity < 10 μS/cm) before pouring the water down the drain. You are responsible for verifying the local regulations before you dispose any water.

Figure 1. Example of liquid cooling systems and loops within a data center



Water quality requirements
Use the following requirements to plan for the water quality in your system:

- ***The water that is required to initially fill the system side cooling loop must be reasonably clean, bacteria-free water (less than 100 CFU/ml), such as demineralized water, reverse osmosis water, deionized water, or distilled water.***
- ***The water must be filtered with an in-line 50 µm filter.***

ENVIRONMENTAL IMPACT OF RELIANCE ON GROUNDWATER

"Given the predicted growth of the technology sector, however, it is perhaps particularly important for this industry (data centers) to consider its water footprint and see what changes could be made to reduce it.
Some 29.3 billion devices are expected to be online by the year 2030 and these will need to be supported and backed up by data centres all over the world, providing power for millions of servers, as well as cooling and internet access." t.ly/DS5d

“Google Data Centers’ Secret Cost: Billions of Gallons of Water

To meet surging demand for online information, internet giant taps public water supplies that are already straining from overuse.”

Drought-stricken communities push back against data centers - NBC News June 19, 2021, 5:00 AM CDT By Olivia Solon

As cash-strapped cities welcome Big Tech to build hundreds of million-dollar data centers in their backyards, critics question the environmental cost.

On May 17, the City Council of Mesa, Arizona, approved the $800 million development of an enormous data center -- a warehouse filled with computers storing all of the photos, documents and other information we store “in the cloud” -- on an arid plot of land in the eastern part of the city.

But keeping the rows of powerful computers inside the data center from overheating will require up to 1.25 million gallons of water each day, a price that Vice Mayor Jenn Duff believes is too high. “This has been the driest 12 months in 126 years,” she said, citing data from the National Oceanic and Atmospheric Administration. *“We are on red alert, and I think data centers are an irresponsible use of our water.”*

AI has major impact on daily water usage

More data centers are being built every day by some of America's largest technology companies, including Amazon, Microsoft and Google and used by millions of customers. According to the Synergy Research Group, there were about 600 "hyperscale" data centers, massive operations designed and operated by a single company that then rents access to cloud services, globally by the end of 2020.

That's double the number there were in 2015. Almost 40 percent of them are in the United States, and Amazon, Google and Microsoft account for more than half of the total.

The system used to cool servers inside the Apple Data Center in Mesa, Ariz.

Tom Tingle / The Republic / USA Today Network

"The typical data center uses about 3-5 million gallons of water per day -- the same amount of water as a city of 30,000-50,000 people," said Venkatesh Uddameri, professor and director of the Water Resources Center at Texas Tech University."

Amazon Water Sustainability & Water Stewardship

“Water Positive by 2030: In 2022, we announced Water+, our commitment to being water positive by 2030. That means we’ll return more water to communities and the environment than we use in our data center operations.

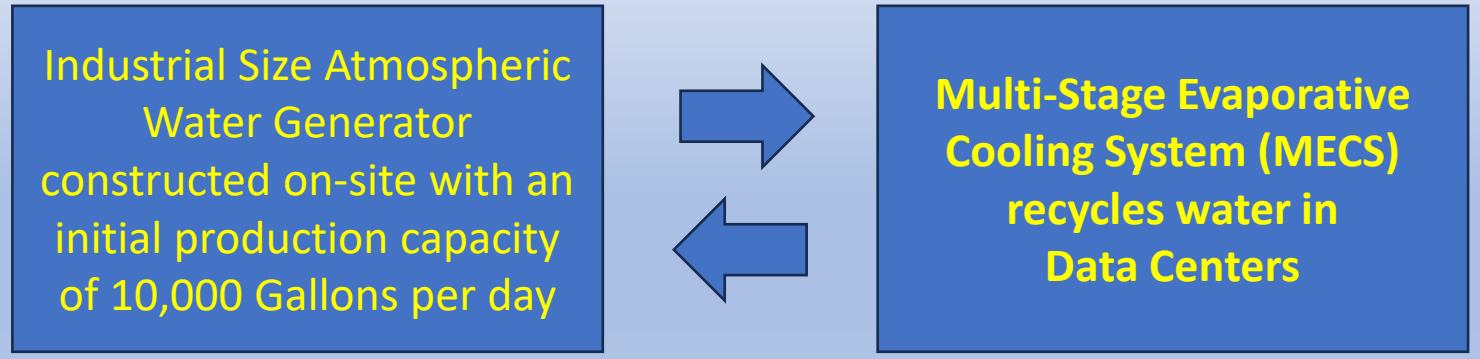
To do this, we’re increasing the use of sustainable water sources, improving water use efficiency across our operations, reusing water as much as possible, and supporting water replenishment projects for communities and the environment around the world.” (source Amazon Sustainability website t.ly/Sa1i)

Comment: Amazon’s response is a bit disingenuous as it has not addressed the current issue; What is the source of their water for current operations? What is the current impact on the environment? What effect of their drawing existing water resources for the next eight years until they achieve their goal? Reads like hyperbole and an attempt to garner positive press.

THE CASE FOR CONSIDERING ALTERNATIVE POINT OF USE DELIVERY OF WATER FROM THE AIR PRODUCED BY ATMOSPHERIC WATER GENERATORS THAT HAVE ZERO IMPACT ON THE ENVIRONMENT AND ARE 100% INDEPENDENT OF EXISTING GROUNDWATER RESOURCES

Industrial Atmospheric Water Generator Systems constructed on-site in tandem with data centers provides a long-term solution that relieves the burden of current dependence on existing and diminishing water supplies. AWGs provide a sustainable solution relying upon the billions of water particles present in moisture in the atmosphere, free from pollutants, that can be moved through a multi-stage filtration process to produce fresh drinking water quality water that meets or exceeds World Health Organization Standards, fully in compliance with the IBM water purity standards noted above that will not be harmful to sensitive electronic equipment.

360° Closed-Loop Water Recovery System 100% independent of groundwater



MECS Solution

- **The Multistage Evaporative Cooling System (MECS) and Water Vapor Recovery System is a disruptive green…clean tech…sustainable cooling technology solutions combining well known "off the shelf" cooling system components (cooling towers, cooling coils, pumps, air handling units, etc.) in a series and sequence that maximizes energy efficiency, sustainability, and is friendly to the environment.**
- **Our packaged / integrated MECS cooling solution has a first cost ±10% of mechanical refrigeration systems (chillers, can save 40 to 85% on cooling energy use/costs by eliminating high energy consuming compressors common in chillers), and will recover ~95% of the water evaporated by main component cooling towers via our Water Vapor Recovery System (WVRS) making the MECS a nearly net zero water usage cooling solution**
- **MECS is environmentally friendly as it does not use any harmful refrigerants … environmentally harmful chlorofluorocarbons (CFCs) or hydrofluorocarbons (HFCs) that is used in chillers by using water as our refrigerant in the cooling towers**
- **A means to recover the water being evaporated by MECS is being developed incorporating existing water recovery technology from GTG Atmospheric Water Generators (AWG)**

Comparison VERSUS Competitor Technologies

Energy Usage Comparison of Traditional Data Center Cooling Systems to the RTDCCS

		Trad'l Mechanical Cooling KW / Ton	RTDCCS KW / Ton	KW / Ton Savings	% Energy Savings
System 1	CRAC Cooled System	2.88	0.69	2.19	**76.0%**
System 2	CRAH Cooled Systems – Chilled Water Based	2.73	0.69	2.04	**74.7%**
System 3	CRAC Cooled System w Containment	2.67	0.69	1.98	**74.2%**
System 4	CRAH Cooled System w Containment	2.54	0.69	1.85	**72.8%**
System 5	Liquid Cooled Racks Unoptimized	2.37	0.69	1.68	**70.9%**
System 6	Liquid Cooled Racks Chilled Water Temperatures Optimized	1.72	0.69	1.03	**59.9%**
System 7	Liquid Cooled Racks Chilled Water Temperatures Optimized and Free Cooling Systems	1.39	0.69	0.70	**50.4%**
System 8	Liquid Cooled Racks Chilled Water Temperatures Optimized and **Evaporative** Free Cooling Systems	1.21	0.69	0.52	**43.0%**
System 9	Active Liquid Cooled Doors, Chilled Water Temp Optimized, & Evaporative Free Cooling Systems	1.17	0.69	0.48	**41.0%**
System 10	Passive Liquid Cooled Doors Chilled Water Temp Optimized & Evaporative Free Cooling Systems	0.93	0.69	0.24	**25.8%**
System 11	Pumped Refrigerant Systems	1.74	0.69	1.05	**60.3%**
System 12	Air Side Economizing	1.41	0.69	0.72	**51.1%**
	Average kW usage per ton	**1.90**	**0.69**	**1.21**	**63.6%**

Market Size

- **Cooling Tower Market worth $5.355 Billion per year USD by 2031**
- **Chiller Market worth $14.5 Billion per year USD by 2032**
- **Data Center Cooling System Market Size Worldwide - The global data center cooling market size was valued at $13.51 billion in 2022 & is projected to grow from $14.85 billion in 2023 to $30.31 billion by 2030**
- **The Global Atmospheric Water Generator market is valued at $299 million per year USD in 2022 is expected to reach $1611 million USD by the end of 2028, growing at a CAGR of 40.0% during 2023-2028.**

Temperature of the cooling water produced by the MECS (depending on ambient air conditions) is close to the temperatures of cooling water produced by a chiller (normally ~ 48°F) opening the Billion$ Chiller Market to MECS

Not all chilled water produced by Chillers and used in many applications require such a low temperature of cooled water (normally ~ 48°F) and could be served by MECS which can produce cooled water of 55°F to 65°F, opening over 25 to 35% of the Billion$ Chiller Market to MECS

Data center storage plays a crucial role in the IT infrastructure of today's enterprises, with demand for it growing rapidly and continuously. To meet this demand, organizations must manage an increasing volume of data generated by new applications, ensure fast transfer rates and low-latency access by using suitable storage technologies, and address issues related to redundancy, uptime, and resilience against various types of failures.

Data center storage comprises the integrated hardware, software, and processes used for storing, managing, and distributing digital data in a centralized location. It includes storage devices such as HDDs, SSDs, and tape drives, arranged in racks and clusters for optimized operation and efficiency.

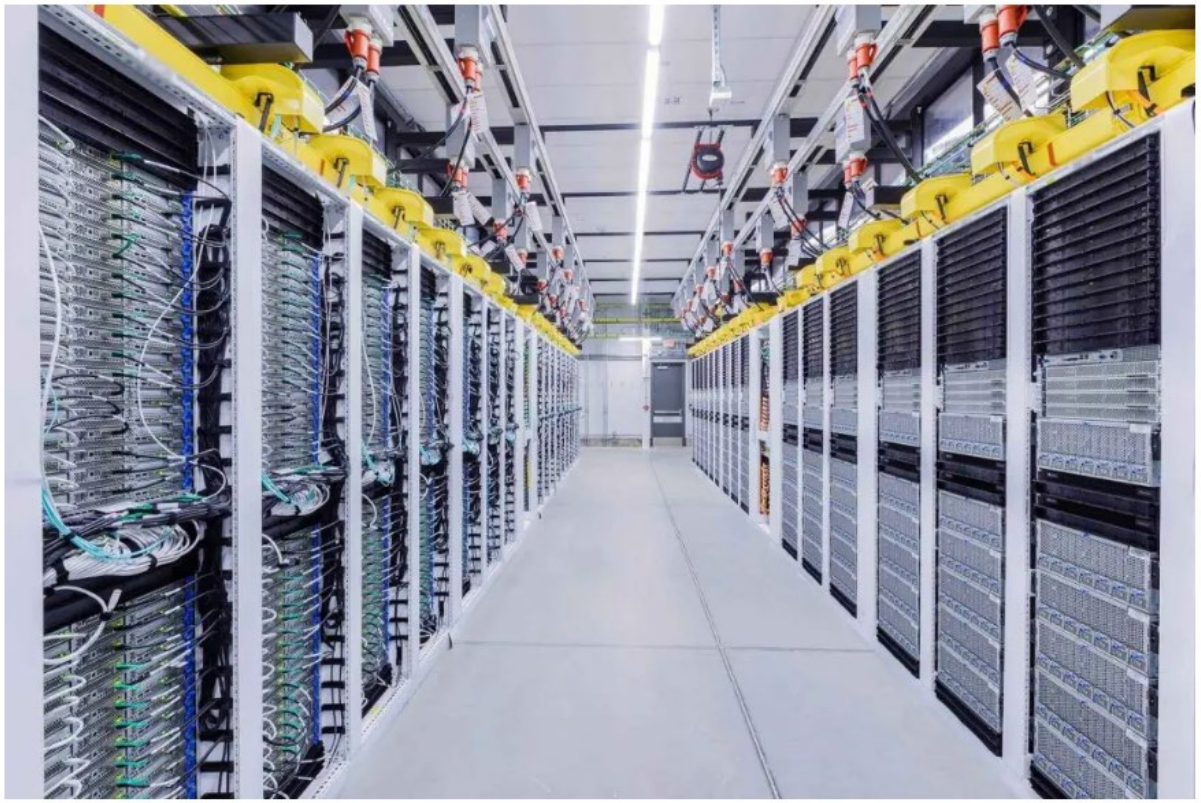
Dgtl Infra explores the intricacies of data center storage, offering insights from the types of storage solutions (DAS, NAS, and SAN) to the next-generation technologies. Whether you're focused on the different kinds of information stored in data centers, the importance of these storage systems, or looking into how the cloud impacts storage technologies, we provide a wealth of information that comprehensively covers the topic. Keep reading to explore the capacity and cost considerations of data center storage, and get familiar with leading companies driving innovation in this space.

What is Data Center Storage?

Data center storage is the collective hardware, software, systems, and processes used to store, manage, and distribute large amounts of digital information in a centralized computing environment. This storage infrastructure consists of different types of hardware like hard disk drives (HDDs), solid-state drives (SSDs), and tape drives, as well as software for data management and backup.

The storage hardware is mounted in dedicated storage trays, which are then placed within racks, cabinets, or chassis. These are organized into rack units (U) and arranged in rows within the data center. For enhanced organization and efficiency, racks and cabinets can be further assembled into clusters. These clusters are interconnected, allowing the storage hardware to operate as a unified system within the data center.

For example, in Microsoft's data center in Washington state, the racks on the right side *(as shown in the image below)* house HDD JBODs (Just a Bunch Of Disks), demonstrating a specific arrangement of storage hardware within the facility.



Source: Microsoft.

Additionally, data center storage involves a set of policies and procedures designed to manage the storage and retrieval of data effectively. This includes detailing methods for data collection, ensuring the security of stored data, implementing access control measures, maintaining data availability, setting storage quotas, and establishing regular backup schedules.

What Data is Stored in Data Centers?

Data centers store a wide range of digital information for various organizations and services, including:

1. **Web Content:** Comprises websites, online applications, and services, along with their related data such as HTML files, scripts, multimedia content (including text, audio, images, and video), and databases
2. **Business Data:** Companies rely on data centers for storing essential internal data. This includes customer records, transaction histories, employee information, financial records, and proprietary research. Many organizations also host their databases within data centers, utilizing SQL and NoSQL technologies
3. **Email and Communication Records:** Data centers are crucial for storing email data, which includes attachments and metadata. They also store logs and content from communication platforms like Slack and Microsoft Teams
4. **Application and User Data:** Information generated from software applications and social media platforms fall under this category, including personal profiles, communication history, usage metrics, and purchase records
5. **Big Data and Analytics:** Data centers hold large datasets used for analytics, training machine learning models, and research purposes. This can involve data sourced from IoT devices, sensors, and user interactions

Data center storage is important for modern computing and information management for several reasons:

1.Data Accessibility and Availability: Data centers are crucial for ensuring data is readily accessible and available for users and applications, facilitating efficient data retrieval and storage. This capability is vital for the smooth and continuous operation of organizations, especially for the online services and applications of online retailers, financial services, and healthcare providers, which require constant data access

2.Data Security and Protection: Data centers provide security measures to protect sensitive data against unauthorized access, breaches, and cyberattacks through physical security, network security protocols, firewalls, and data encryption. They also feature backup and disaster recovery systems to safeguard data from loss due to hardware failure or natural disasters

3.Scalability and Flexibility: Data centers provide scalable storage solutions that accommodate the growing data storage needs of expanding organizations, without requiring significant upfront investments in hardware and facilities. This scalability allows organizations to manage increasing data volumes efficiently, avoiding performance bottlenecks or downtime

4.Cost Efficiency: Centralizing data storage in data centers allows organizations to achieve economies of scale, thereby reducing the costs associated with data management. These savings arise from reduced expenditures on hardware, maintenance, and energy. Data centers also implement technologies like data deduplication and compression to further enhance storage efficiency and lower costs

5.Performance and Reliability: Utilizing high-speed storage networking technologies such as Fibre Channel, data centers process data efficiently and maintain redundant systems to offer high-performance and reliable storage solutions. This reliability is crucial for data center operations and services that depend on high-speed data retrieval and real-time processing, including big data analytics, artificial intelligence, and machine learning algorithms

6.Compliance and Regulatory Requirements: Many industries are subject to strict regulations regarding data handling, privacy, and retention, such as the Health Insurance Portability and Accountability Act (HIPAA) in healthcare. Data centers support organizations in complying with these regulations by providing measures such as encryption for data at rest and in transit, implementing strong authentication mechanisms and role-based access controls (RBAC), and maintaining detailed audit trails of data access