2022 Strategic Roadmap for Storage

> Advanced storage technologies along with a hybrid cloud IT managed services platform are the foundation for data center modernization and enhanced IT operations. I&O leaders must implement intelligent data services infrastructure powered by software-defined storage and hybrid cloud IT operations.

Overview

Key Findings

- Use of artificial intelligence for IT operations (AIOps) transforms IT infrastructure into a more resilient, intelligent data services management platform, thereby modernizing IT operations and data centers.

- Distributed file systems and object storage features and capabilities are unifying into a single platform to address a broader set of unstructured data use cases, reducing solution complexity and storage management costs.

- Interest in and adoption of storage as a service (STaaS) and consumption pay-for-use sourcing methods have grown appreciably, gaining rapidly as a percentage of deployed enterprise storage for off-premises and hybrid cloud applications.

- The increasing risk of security breaches, exposure and extortion of sensitive data has changed organizations' behavior to a proactive data management practice as part of a broader data governance strategy.

- The adoption of public and multicloud — along with the complexities associated with backup and data management in a hybrid world, and concerns over ransomware and backup security — is forcing I&O leaders to rearchitect their backup infrastructure and explore alternative solutions.

Recommendations

I&O leaders must automate their storage systems and embrace the cloud model by taking the following actions:

- Leverage vendors' AIOps storage management tools to reduce the need for dedicated storage-related headcount and to augment hardware management and increase IT productivity.

- Avoid deploying a siloed file-and-object-storage-only solution by selecting a unified platform that combines capabilities and features that address a broad set of unstructured data use cases.

- Replace inefficient capital expenditure (capex) procurement methods and labor-intensive budgeting processes by using a consumption-based STaaS delivery model to align lifetime asset costs with usage value.

- Mitigate costly and highly disruptive data extortion events by implementing active cybersecurity defense capabilities that can detect and ensure against egregious ransomware attacks.

- Avoid information compliance and governance risks by selecting data governance and management solutions with policy-based and artificial intelligence (AI)/machine learning (ML)-enabled data classification capabilities.

Strategic Planning Assumptions

- By 2025, 40% of all enterprises will require storage products to have integrated ransomware defense mechanisms, up from 10% in 2021.

- By 2026, large enterprises will triple their unstructured data capacity stored as file or object storage on-premises, at the edge or in the public cloud, compared to 2021.

- By 2025, more than 70% of corporate, enterprise-grade storage capacity will be deployed as consumption-based offerings, which is an increase from less than 40% in 2021.

- By 2025, more than 40% of all on-premises IT storage administration, support and maintenance activities will be replaced by STaaS AIOps, up from less than 10% in 2021.

- By 2025, 35% of enterprise customers will archive workstream collaboration and meeting solutions for nonregulated requirements, an increase of more than sevenfold from 2021.

Introduction

The enterprise storage industry is entering a period of intense and rapid transformation that will leave an indelible imprint on IT operations. The most fundamental question facing I&O leaders is how to leverage the benefits of the cloud model to transform IT operations.

> Twenty-three times growth in shipped petabytes (PBs) through 2030 will reshape and redefine the data center and IT operations as we know them today.

The data center will be more physically and logically distributed across a hybrid substrate with multiple infrastructure domains, including on-premises, colocation, public cloud and edge infrastructure. This will require I&O leaders to weigh the benefits of moving mission-critical applications to the public cloud or embrace the hybrid cloud IT operations platform provided by storage and compute vendors.

The hybrid cloud IT platform model has rapidly emerged as the preferred path to cloud-native benefits because it preserves control and oversight to IT infrastructure decisions while shifting costs from capex to operating expenditure (opex). The hybrid cloud IT model allows I&O leaders to exit hardware administration, maintenance and support with vendor life cycle management capabilities. Also, I&O leaders should take advantage of platform-consumption-based deployment models, eliminating capex processes.

Figure 1 identifies the current and future state of the enterprise storage landscape. This Strategic Roadmap covers the key gaps between the current and future state, and provides short-, medium- and long-term action plans.

Figure 1: 2022 Strategic Roadmap Overview for Storage

2022 Strategic Roadmap Overview for Storage

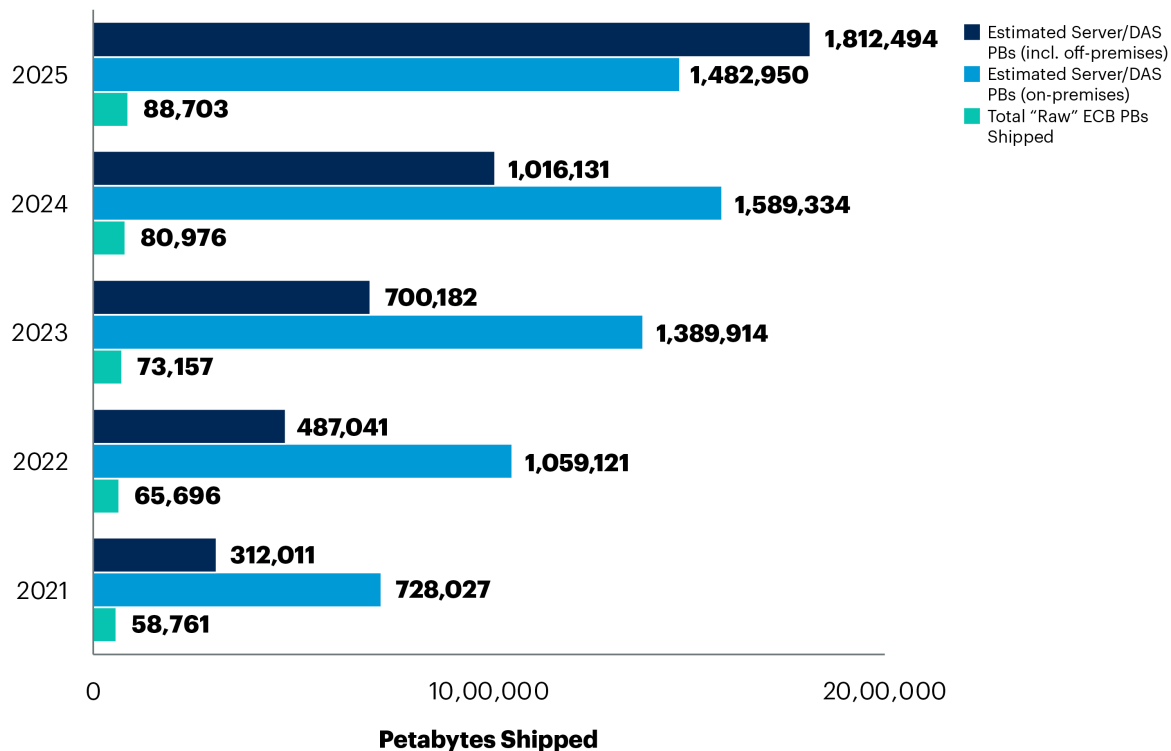| Future State	Current State	
• Self-service platform provisioning and life cycle management with centralized cloud-native control and data services capabilities. Replace product features sourcing with metric-based SLA sourcing. • Hybrid cloud IT operations and consumption-based STaaS is the primary deployment model for cloud-native storage infrastructure and data services, replacing capex financing and client-based asset financing and management. • Storage administration, maintenance and support replaced by AIOps-enabled STaaS management capabilities, along with risks and associated costs. Storage SME is reskilled for software projects and AI/ML development initiatives. • Anti-ransomware and cybersecurity solutions implement the NIST framework and advanced detection methods that reduce the threat exposure window.	• Storage appliances are complex and expensive to manage and support, and lack composability and elasticity to vary capacity and compute across a physically distributed cloud services platform. • Capex planning and budget processes are inflexible, exposed to supply chain issues, lack effective ROA metrics to assess and guide IT costs, and restrict consumption-based flexibility benefits. Over 40% of Capex storage asset value is lost over a five-year period due to underperforming asset utilization costs. • 35%-52% of storage asset capacity (TB) costs are tied up in storage administration, support and maintenance, increasing up to 70% after maintenance period expires. • Data protection solutions lack ransomware detection and exfiltration detection and prevention capabilities that can guarantee threat window exposure and recovery periods acceptable to business demands.	**Gap** • On-premises storage systems lack a platform-centric data services strategy to deliver cloud-native services to on-premises applications. • Capex financing lacks flexible IT asset management capabilities to IT priorities. • Hardware-based administration does not take full advantage of AIOps to optimize hardware maintenance and support activities. • Business priorities are largely nascent in IT priorities as a result of IT budgets tied up in legacy efforts. • Data protection lacks sufficient detection and remediation capabilities to eliminate threats. **Migration Plan** • Transition to hybrid cloud IT platform ops. Replace Capex with consumption-based pay-for-use and source metric-based SLAs. • Use vendor AIOps to stop hardware admin, support and use of life cycle management. • Implement a data services and management capability that includes IT automation. • Business outcomes and application priorities are central to IT infrastructure budget priorities.

Source: Gartner
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The widespread adoption of the cloud is forcing IT to adopt a software-defined data service platform-centric operations approach and an API-first mindset. To create value for internal customers and lay the foundation for a rapid shift in a very short time requires I&O leaders to leverage platform ecosystem partners' added value, unlocking advanced and emerging storage capabilities. Storage trends brought about as a result of the cloud will impact I&O operating models, storage and data management technologies, processes, people, and metric-based service-level agreements (SLAs) that replace traditional product-feature-centric sourcing requirements.

The distribution of on-premises versus off-premises storage (including both public and hybrid cloud) will shift markedly by 2025. The ratio of non-external-controller-based (ECB) server-based storage (SBS)/direct-attached storage (DAS) versus on-premises ECB storage arrays will transform, with ECB systems consuming less than 4% of the total enterprise PBs shipped in 2025, down from 6.6% in 2021 (see Figure 2). The implications are profound to IT operations and vendor-based architecture decisions, as hybrid cloud and hyperscale platform strategies play out through the decade, in relation to total capacity deployed/shipped. For example, server/DAS on hyperscaler is disaggregated storage-compute, which is architecturally more cost-effectively scalable on a distributed platform than ECB storage appliances.

Enterprise storage infrastructures will continue to be defined by hybrid multicloud and multidomain architectures. In 2025, the majority of enterprises will integrate some form of consumption-based pricing for data management services. This is primarily because it's easier to acquire data management services by consumption method than sourcing individually.

Figure 2: Enterprise Petabytes 2021-2025

Enterprise Petabytes 2021-2025

Legend:
- Estimated Server/DAS PBs (incl. off-premises)
- Estimated Server/DAS PBs (on-premises)
- Total "Raw" ECB PBs Shipped

Year	Estimated Server/DAS PBs (incl. off-premises)	Estimated Server/DAS PBs (on-premises)	Total "Raw" ECB PBs Shipped
2025	1,812,494	1,482,950	88,703
2024	1,016,131	1,589,334	80,976
2023	700,182	1,389,914	73,157
2022	487,041	1,059,121	65,696
2021	312,011	728,027	58,761

X-axis: Petabytes Shipped (0, 10,00,000, 20,00,000)

Source: Gartner
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Gartner

In summary, the following market forces are shaping the enterprise storage landscape:

- Advancements in storage management are integrating with three AIOps market categories: data and analytics tools, AIOps features and AIOps platforms.

- AIOps features and capabilities and consumption-based delivery models provide pathways to higher productivity and a more resilient and scalable IT services operating platform.

- Vendor financing and asset management solutions allow IT to replace capex budgeting processes, align asset costs to asset utilization value and take responsibility for life cycle management activities.

- Hybrid cloud IT platforms allow IT to tap into broad industry ecosystems to accelerate access to, and use of, third-party products and services, in return driving IT innovation on the hybrid cloud platform.

- Advancements in ransomware detection and prevention methods mitigate the threat exposure window and reduce it to a financially quantifiable event to reserve against.

- Use of consumption-based and pay-for-use subscription licenses replace capex spending on over 70% of shipped enterprise storage capacity in 2025.

- Ultra-low-latency use cases will drive demand for power-efficient, high-density edge data center infrastructure, where more than 50% of data will be generated and processed by 2025.

- IT organizations will replace or augment storage administration skills and subject matter experts with storage as a service by leveraging vendor investments in advanced AIOps capabilities.

- Use of enterprise-class storage software features and storage management tools on hybrid cloud, public cloud and edge infrastructure will modernize IT operating models with cloud-native benefits.

Future State

Over the next three years, I&O leaders will increasingly favor sourcing metric-based SLA solutions, over traditional products and features, that deliver business and IT operations outcomes. After decades of focusing solely on product attributes such as performance and capacity costs, future storage solutions will deliver a modern data center built on simplicity, agility, and operationally resilient and elastic infrastructure. STaaS SLAs will redefine the relationship between IT users and vendors, with vendors taking responsibility for hardware management, administration and support, combined with more of the asset optimization, capitalization and financing costs.

I&O leaders will shift the majority of their infrastructure management activities and continuous cost optimization responsibilities to long-term strategic partnerships with cloud-native storage and system providers and their data services platform. This change will allow I&O leaders to refocus their efforts on business initiatives and restructure their IT operating models to be more flexible, services-based and a vital ally to business partners.

Intelligent Infrastructure

Artificial Intelligent Operations

The role of the storage administrator is changing as we move toward service-based infrastructure deployments and increased automation. AIOps provides a framework and set of tools to offload the more mundane tasks of resource management, but primarily will address the challenges that simply can't be resolved by scaling human resources.

Gartner projects that by 2024, 30% of business leaders will rely on AIOps for automated insights to drive business-related decisions.

AIOps address I&O leaders' need for operations efficiency and improved support by combining architecture or platform knowledge and workloads' telemetry insights and analytics to improve operations by delivering timely and relevant operations information.

AIOps is central to the shift to a results-oriented and continuous improvement SLA-based delivery model where humans focus on observable insights. I&O leaders can now redirect IT hardware administration and support budgets to other business priorities and growth initiatives. Investments in AIOps, integrated with STaaS platform SLA life cycle commitments over the next few years, will replace IT storage administration, maintenance and support activities. Storage vendors are investing heavily in AIOps and consumption-based deployment offerings that provide a seamless path to a more productive and resilient IT operating model.

A Gartner survey shows that 58% of I&O leaders cited increased operational efficiency and support for digital transformation as their top two reasons to modernize core IT systems.

The AIOps platform correlates events across telemetry-monitored domains or sources, reducing unnecessary human intervention that constrains operations. Today, AIOps might offer a recommendation, automate a response or trigger an external automation system. In the future, capabilities such as workload automigration, based on SLA threshold conditions, will become mainstream. Use of synthetic data with accelerated computational power, along with deep learning algorithms aimed at cyber behavior, are able to self-learn hidden patterns within data to make predictions. Over the next few years, AIOps platforms will be able to detect, predict and automate remedial action in real time across a fleet of vendor and client platform storage assets using a broad and diverse dataset. Future storage management systems will have to provide increased telemetry and interoperability with AIOPs features and platforms in order to participate in an enterprise AI-augmented DevOps environment.

Data Classification

AI/ML is powering next-generation data discovery and archiving tools that support regulated risk-compliant enterprise digital communications — email and collaboration platforms — that enable highly regulated enterprises to collect and analyze communications data at scale, quickly identify risks, recognize business insight, and improve operational systems. Communications contain compliance risks, costly operational errors, security threats, real-time cultural and social indicators, and untapped revenue opportunities. Most companies have no systematic way to surface these signals or to illuminate risks or insights across petabytes of retained data. At the heart of these systems are data classification algorithms that are used to classify data into a class or category for the purpose of assigning a probability score for determining an outcome or for protection or retention purposes. There are various types of classifications, depending on the intent of the ML algorithm, including trainable classifiers used for identifying various types of content such as legal agreements and project documents.

Primary Storage

Next-generation primary storage strategies are shaped by hybrid cloud IT operations models, artificial intelligence for IT operations, software-defined storage (SDS) and consumption models. Over 33,000PB of ECB primary storage was shipped in 2021 for on-premises mission-critical application use. However, a growing percentage of total enterprise-class primary storage capacity is deployed on hyperscale platforms because public cloud storage options have become a viable alternative to on-premises mission-critical ECB appliances. If left unchallenged, by 2025, over 70% of enterprise storage capacity will be off-premises on hyperscale platforms and as pay-for-use consumption-based subscriptions.

The single biggest development to on-premises storage in 2021, driven by interest in public cloud pay-for-use consumption plans, was the emergence of hybrid cloud IT as an operational deployment model for on-premises STaaS. At the beginning of 2020, there were no major storage vendors offering STaaS. At the end of 2021, every major primary storage vendor minimally offered block STaaS to compete against hyperscale cloud providers.

> **By 2025, Gartner projects roughly 15% of enterprise storage capacity will be deployed as hybrid cloud IT STaaS, reaching 50% of total capacity by 2030.**

Over the balance of this decade, hundreds of billions of dollars in storage infrastructure and data services transaction value will pass through the STaaS model. The battle between hyperscale and hybrid cloud IT platform strategies is underway for the millions of enterprise PBs.

As evident in Figure 3, 2021 consumption-based STaaS was No. 2 behind containers in a recent Gartner survey of IT professionals. To gain the benefits of cloud-native IT infrastructure deployments, I&O leaders are looking to hybrid cloud IT operations and STaaS as a viable alternative to public cloud. Their goal is to take advantage of cloud benefits while mitigating risk management issues and cost liabilities associated with capex acquisition models.

Figure 3: Primary Storage — Top-of-Mind Issues

Inquiry Graph
Primary Storage Top-of-Mind Issues
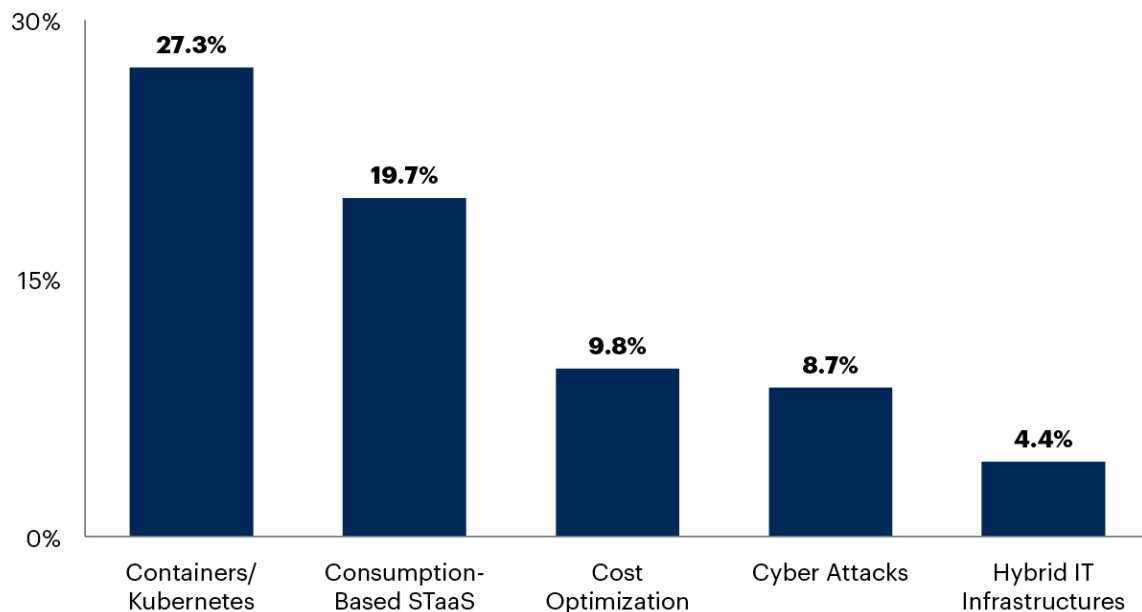
n = 183

Source: Gartner (June 2021)
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Unstructured Data — File and Object

The unstructured data storage market is rapidly evolving into an intelligent data infrastructure platform. New capabilities are needed to address the growing challenges of exponential data growth, new workloads, edge computing, rapid digitalization, ransomware and data exfiltration, and the globalization of business. Distributed file systems and object storage are the platform of choice to address the growth of unstructured data in global data centers, leading to rapid increases in both volume and capacity of deployments.

Gartner clients report that unstructured data is growing 30% to 60% year over year. Thus, I&O leaders are looking for extensible on-premises storage products that can address an increasing number of digital business use cases with lower acquisition, operational and management costs. I&O leaders are demanding hybrid cloud integration, scalability, flexibility, life cycle management, ease of management and analytics insights into data. In recent years, Gartner clients are also asking for cyber-resilient unstructured data solutions to prevent, detect and recover from ransomware attacks.

The steep growth of unstructured data for emerging and established workloads requires new types of products and cost-efficiencies. Modern products in this market are driven by SDS, which is capable of delivering tens of petabytes of storage. SDS can also potentially leverage hybrid cloud workflows with public cloud infrastructure as a service (IaaS) to lower total cost of ownership (TCO) and improve data mobility. New and established storage vendors continue to develop clustered file systems and object storage products to address cost, agility and scalability limitations in traditional, scale-up storage environments.

However, the markets for distributed file systems and object storage have been merging (see Magic Quadrant for Distributed File Systems and Object Storage). The distinctions between the two segments are blurring, and buyers are already treating it as one market and requiring both file and object access for unstructured datasets. Moreover, the most innovative vendors now offer both object and file access to their unstructured data products.

IT leaders often decide between public cloud and on-premises infrastructure for given workloads. Organizational culture and sensitivity to security and governance mandates are typically the leading factors that enterprises consider when deciding whether to move applications and data to the public cloud or to keep them on-premises. Other factors include legacy applications unsuited for public cloud, along with latency and data sovereignty.

Hybrid Cloud IT Operations — Storage as a Service

To maintain a competitive edge throughout the next wave of digital services, I&O leaders must implement a hybrid cloud IT operating model that is standardized on cloud-native platform as a service (PaaS) architecture and DevOps principles. Hybrid cloud IT spans across on-premises, colocation, public cloud and edge storage infrastructure.

An Application-Rich and Agile Platform for Workloads

To provide an application-rich and agile platform for workloads, I&O leaders must:

- Embrace a cloud-native IT services platform operating model, and shift storage assets management to vendors and their partners.

- Replace inefficient capex sourcing and product financing with platform-services-based SLA metrics.

- Avoid supply chain variability and logistics issues from massive data growth that could impede IT initiatives by shifting responsibility to vendor STaaS platforms.

For the remainder of the 2020s, various enterprise PB growth scenarios ranging from 25% to 50% have the potential to distort budget priorities. I&O leaders must collaborate with finance leaders to develop a cloud-native sourcing and asset capitalization strategy that is financed by the vendor.

Despite the flexibility and elastic options offered by public cloud storage, I&O leaders have been hesitant to rely solely on the public cloud for mission-critical applications. It can be operationally challenging to replace multigenerational enterprise-class storage capabilities and tools that I&O leaders have depended on. Instead, I&O leaders are embracing vendor-managed cloud-based STaaS and its benefits as a replacement for owned, on-premises storage infrastructure. Hybrid cloud IT STaaS provides a viable option for cloud-native benefits, along with hardware life cycle management from which IT can centrally manage. Vendors take responsibility for administration, maintenance and support. Figure 4 illustrates this rapid transition from on-premises enterprise PB storage capacity to off-premises corporate hyperscale consumption (dark blue bars) and hybrid cloud STaaS (green line).

Projected Adoption Rates of Corporate Enterprise Storage as a Service, 2019-2030
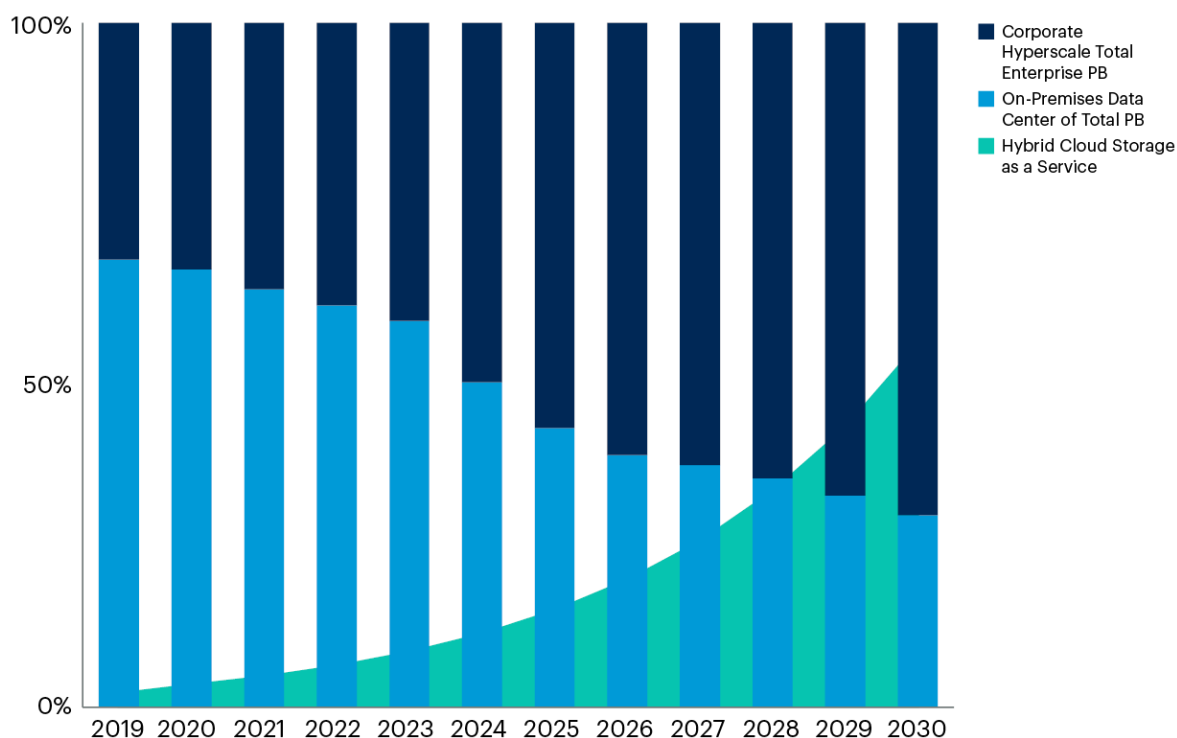
Source: Gartner
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Cyberstorage

Cybersecurity threats dominated IT concerns in 2021 and are growing in occurrence and magnitude. The effect of ransomware is enormous and destructive, impacting areas such as loss of business and recovery costs. Ransomware climbed an unprecedented 105% in 2021 over 2020 to 623.3 million attacks worldwide. [1] Explosive growth of strategies such as double and even triple extortion ensured that these attacks were more successful than ever. Double extortion is a scam in which ransomware groups exfiltrate data prior to issuing a ransom note and encrypting the system, then use that data as leverage to increase the odds of securing payment. Triple extortionists filter through the data to see who has the most to lose, then use the data as leverage to increase the odds of securing payment. IT operations often incur significant labor expense to mitigate and restore IT operations.

In the near future, ransomware attacks will become so common that I&O leaders will have to assume data cybersecurity responsibility and adopt new approaches for active defense. While storage infrastructure can be one of the most impacted solutions attacked by ransomware, it initially receives limited attention by security and storage leaders. To address this potential gap, the National Institute of Standards and Technology (NIST) created the Cybersecurity Framework (CSF) to provide organizations with guidance on how to prevent, detect and respond to cyberattacks. In October 2020, it released Special Publication (SP) 800-209, Security Guidelines for Storage Infrastructure, which includes comprehensive security recommendations for storage infrastructures. [1] As a result of the increased focus in storage security, there has been an emergence of new cyberstorage products and capabilities that are designed to identify, detect, protect, respond to and recover from ransomware attacks.

Unstructured data platforms such as network-attached storage, scale-out file systems and object storage provide inadequate protection from malicious deletion, encryption and data exfiltration, making them attractive targets. Some vendors position traditional storage technologies like snapshots, as a single answer for ransomware protection, which is inadequate to meet the new challenges ransomware brings. Cyberstorage products differentiate their advanced cyberstorage features by offering one or more of the capabilities that align with the NIST framework.

Data Protection Software

The move toward public and multicloud, along with complexities associated with the governance and protection of backup and data management, are forcing I&O leaders to rearchitect their backup infrastructure and explore alternative solutions.

Recovery at scale from large-scale data loss scenarios, as a result of ransomware, is a key driver for many clients considering replacement of existing backup and recovery platforms. Gartner anticipates further advancements in a comprehensive ransomware protection and recovery solution such as new security features, multiple options for air gap separation, immutable storage for backup, and anomaly and malware detection and instant recovery.

The broad adoption of SaaS applications, the adoption of application modernization by containerization of applications and the adoption of edge solutions are additional factors that customers should be looking at when selecting new data backup solutions.

Native backup functionality offered by cloud vendors is now being supplanted by enterprise backup solutions to improve data protection. These solutions also make cloud and multicloud data protection consistent with on-premises capabilities and user expectations.

Centralized and simplified backup management often delivered and consumed as backup as a service (BaaS) solutions are gaining more traction. The convergence of BaaS for cloud-based applications together with the backup management integration for on-premises deployments is a new trend offering the best of both worlds.

Hybrid Cloud Storage

Enterprise storage solutions are evolving to leverage cloud infrastructure and platform services (CIPS). These solutions enable I&O leaders to deliver agility, mobility, resiliency and operational efficiency. Integration of data services to the hybrid cloud platform is among the top enterprise challenges to address the need for seamless data services across the edge, the core data center and public clouds. Hybrid cloud storage is being delivered by vendors across many technologies and deployment categories (e.g., storage arrays, SDS, CIPS, hyper-converged infrastructure [HCI], backup and data management).

A new generation of hybrid cloud storage products aims to enable seamless data services among disparate data centers, edge locations and the public cloud infrastructure. The hybrid cloud storage market is evolving to leverage public cloud infrastructure and platform services that span solutions for many application needs. Currently, it includes support for block, file and object storage protocols as well as support for Kubernetes persistent storage requirements.

Gartner identified six hybrid cloud storage use cases: disaster recovery, burst for capacity, burst for processing, data orchestration, data transport and edge computing, and storage standardization (see Market Guide for Hybrid Cloud Storage). Hybrid cloud storage can deliver on multiple use cases, however disaster recovery (DR) and burst for capacity are the most understood and funded by I&O leaders today.

Software-Defined Storage

SDS abstracts the underlying physical storage hardware infrastructure to allow more flexibility to new demands and to enable a cloud-native, predictive analytics platform for STaaS. By abstracting resources from the hardware, businesses enjoy improved flexibility, performance efficiency and easier scalability without hardware lock-in. True hybrid cloud-native IT infrastructure platform architectures require hardware-neutral SDS offerings that enable applications to be deployed, managed and supported anywhere on the multidomain hybrid substrate with common management tools and data services functions. The software-independent nature of this deployment model is required to facilitate STaaS SLAs and to prevent proprietary hardware lock-in. Benefits include a more efficient use of hardware assets and accelerated IT innovation through access to and use of a broad ecosystem of APIs that welcomes collaboration over competition.

SDS capabilities are needed to augment and, over time, replace monolithic controller-based multinode appliance architectures with a more elastically flexible and cost-effective scalable compute-storage architecture. Hybrid cloud requires STaaS solutions that include SDS options on third-party hardware systems that provide the ability to scale capacity and compute independently to ensure optimum use of both across the hybrid cloud platform. SDS should be available to run on multiple different servers with direct access storage (DAS) or just a bunch of disks or flash (JBOD/JBOF) — effectively separating compute and storage or nonvolatile memory express (NVMe) capacity by a TCP network. In addition, SDS that can run on bare-metal servers should be preferred over SDS that can only run on hypervisors to avoid the hypervisor tax.

SDS solutions are diverse in design in terms of scale-up and scale-out. Some SDS solutions are composite elements of existing storage OSs, while others are new architectures designed from the ground up with cloud-native scale out attributes that can be combined with public cloud infrastructure. However, I&O leaders need to be prudent with SDS solutions to ensure that any trade-offs that are made in costs, scale, performance and management capabilities continue to adequately support the workload requirements supported by appliances. SDS should be capable of nondisruptively recovering from a hardware failure with the cluster seamlessly redirecting input/output (I/O). Appliances are limited to vendor-specific proprietary hardware that address workload performance and or configurations that can be supported, in effect constraining life cycle management efforts to maintain optimal asset life infrastructure.

Computational Storage

Computational storage device (CSD) combines processing and storage to reduce performance inefficiencies in the movement of data between storage and compute resources to address latency-sensitive application issues. CS offloads host processing from the main memory of the CPU to the storage device.

Data-intensive, latency-sensitive applications will benefit the most from removing the data movement bottleneck with CS. Examples of such applications include AI/ML, high-performance computing (HPC), analytics, high-frequency trading, and immersive and mixed-reality streaming. CS can also be a viable option to workloads that benefit from compression but can't afford the trade-offs in performance. For select applications, CS may be a better cost-performance option compared to the use of solid-state drives (SSDs). Edge computing will remain a strategic opportunity for CS, along with applications that favor distributed processing, higher performance per watt and container-based architecture.

I&O leaders will need to explore the benefits of CS for specific use cases and workloads, but should carefully weigh the trade-offs between cost and performance. Workloads that are highly I/O-bound may prove to be an excellent use case for CS, but other factors such as changes to application and vendor-related issues will need to be considered in the cost-performance benefit analysis.

To handle very-high-performance storage workloads, there are emerging technologies such as the data processing unit (DPU) or a storage processing unit (SPU) with special-purpose networking processors and dedicated storage. A DPU is either a system-on-a-chip (SOC) or an ASIC or an FPGA that includes CPU, network interface and onboard acceleration engines.The DPU is incorporated into a smart network interface controller to offload CPU cycles for storage traffic. An SPU provides common storage services like compression, encryption, quality of service (QoS) including redundant array of independent disks (RAID) or erasure coding, connecting server SSDs and presenting local or shared volumes.

Data Management and Governance Services

Data Management

Data management services will address one of the fundamental I&O challenges with storage this decade: managing exponential storage capacity and data growth in primary, unstructured and secondary storage. I&O leaders are faced with massive data volumes (billions of files and objects) and increasing growth in databases. Data is piling up in silos across on-premises, cloud and edge environments. Unifying data visibility, lineage and workload demands across the hybrid cloud, along with data mobility for automated optimization initiatives, will provide I&O leaders with the platform capabilities needed to gain control over their data estate.

A universal metadata platform methodology that supports both structured and unstructured data is required to provide increasing levels of data efficacy, improved protection and nondisruptive workload mobility across the hybrid cloud data estate. Also, a centralized approach to the entire data estate is required to eliminate fragmentation, ineffective data protection and potential security issues. The use of machine learning and analytics can leverage metadata for both value-added data services and integrated AIOps' feature enhancements for improved IT operations.

I&O leaders should expect vendors to deliver a comprehensive data management and services portfolio, including current and emerging technologies, as part of an integrated as-a-service hybrid cloud platform offering to include:

- Data migration (bidirectional):

    - Data protection — providing operational, disaster and cyber recovery services

    - Analytics — both near-time and real-time collation for value-added and operational efficiencies

    - Fine-grained policy management and access control

    - Dataset correlation across hybrid cloud platforms

    - Data classification for appropriate tiering, access, sensitivity analysis and protection schemes

    - Archiving, including policy-aware retention; proactive compliance; and support of centralize search across content and API-linked sources

    - Distributed ledger, catalog, journaling for shared data resources and modeling

Data Governance

To manage the constant and often-uncontrolled expansion of unstructured and structured data and align to the demands of regulatory and/or corporate governance, privacy and security risks, I&O leaders must establish a framework of proactive data governance and management initiatives. The scope of this framework and the technologies to address must include all forms of on-premises and cloud-based digital communications and user-/application-generated data. The inclusion of AI/ML in data governance and management tools, such as data analysis, data discovery and archiving, will have several benefits. It will simplify the deployment process, improve the accuracy of data categorization and classification efforts, and accelerate the timeline to actionable insights for continuous data cleanup and curation.

As a first step, data analysis and discovery tools assist organizations in better understanding the data landscape by increasing visibility to disparate, unorganized sources of information. This allows IT teams to identify opportunities to gain operational efficiencies, gives compliance teams a view into the application of retention policies and insight to sensitive information, including personal information (PI), and heightens the security team's awareness to areas of data access risk. These tools are delivered as stand-alone products or integrated with data classification, e-discovery and a growing number of backup/recovery solutions.

Once an organization's data is better understood, specific information life cycle management and governance requirements can be addressed by use of structured data archiving and enterprise information archiving (EIA) solutions. Designed for archiving data sources to a centralized platform, they play a critical role in retiring decommissioned applications, improving data accessibility, surfacing new data insights, standardizing governance practices and gaining operational efficiencies. Also, they prevent the growth of storage requirements in backup systems, which tend to get repurposed for data archiving use cases.

Drive Technologies and Transport Protocols

The media technology and transport protocols continue to evolve to accommodate the growing demands from performant workloads such as AI/ML, HPC, in-memory computing and analytics, but also the increasing demand for microsecond-latency database applications powering retail websites. On the performance side, flash technology cost reductions through higher layer counts, scalable to over 500 layers, will be able to sustain 15% year-over-year cost reductions into 2030. SSDs, employing flash technology, continue to see growing performance gains, given the transition to NVMe PCIe Gen3 to Gen4 (now) and Gen5 coming in 2023 or beyond. The lower latency and greater bandwidth at the drive level demands greater storage network connectivity by means of NVMe-oF.

NVMe-oF adoption remains nascent at under 10% of customers today. This is due to high cost and complexity that requires updates to storage networks but also operating systems and at the application layer. NVMe-oF over Fibre Channel (FC-NVMe) and to a lesser extent Ethernet (RoCEv2) are the existing approaches. However, NVMe-TCP holds promise in the future by limiting infrastructure changes or abstracting hardware deployment complexity, although it still requires broad ecosystem support. NVMe-oF is critical to truly exploit the performance advantages of storage class memory (SCM), which offers low-latency NVMe PCIe SSD storage. While SCM SSDs based on Optane technology and also on specialized low-latency NAND flash technology have been available in the market, their high price points and limited awareness have impeded adoption for all but the most extreme performance-demanding workloads.

On the capacity/low-cost side of storage demands, nearline hard-disk drive (HDD) technology continues to see slow but steady cost declines leveraging heat-assisted magnetic recording (HAMR) and microwave-assisted magnetic recording (MAMR). technology. Capacities are expected to push past the current 20 terabytes limit to 40TB and higher in the years ahead. In addition, nearline HDD technology has announced plans to support NVMe interfaces as well as a flash cache in order to provide better interoperability with SSDs and access speeds and rebuild times at large capacities. SSD technology is also increasingly trying to penetrate the backup and recovery markets, but will not see widespread deployment due to its average selling price per gigabyte (ASP/GB) that will remain at least two to three times higher than HDD ASP/GB by 2030. Lower-cost and lower-quality quad-level cell (QLC) 3D NAND technology is increasingly being deployed across all workloads. Its lower cost structure is best positioned to challenge nearline HDD technology in the near future from a TCO perspective.

Container-Native Storage

Containerized workloads are on the rise, and there is growing pressure on IT leaders to modernize their IT infrastructures. The number of stateful workloads being deployed in containers and the number of pulls from container registries of popular databases, such as MongoDB, MySQL and PostgreSQL, is rapidly increasing.

IT leaders are rethinking their approaches to container storage for several reasons:

- Support for stateful applications (such as databases)

- Requirements for prolonged container runtime (days versus minutes)

- The ability to share application data

- The ability to provide advanced data services (e.g., encryption, data reduction and data protection)

As a result, many container-based applications in enterprise production environments now require support from a persistent storage platform, including advanced data services.

Container-native storage is specifically designed to support container workloads and focus on addressing unique cloud-native scale, granularity and performance demands while providing deep integration with the Kubernetes container management systems. Container-native storage is designed to be aligned with microservices architecture principles and adhere to the requirements of cloud-native data services.

Container-native storage is different from traditional storage by having the following characteristics:

- Hardware agnostic

- Designed for containers; deployed as containers

- Simplified licensing

- API driven; based on distributed architecture

- Supports on-premises, edge or public cloud deployments

- Multidistribution integration

- Data services and I/O operations at container granularity versus virtual or physical volume granularity

- Integrated backup and DR

Green Storage

Energy conservation is a key driver for data center modernization. Environmental and sustainability requirements are forcing I&O leaders to implement plans to achieve carbon neutrality. On average, the energy cost to power a single server rack in a data center in the U.S. can be as high as $30,000 a year depending on its configuration of storage and compute capabilities. On average, storage can account for 11% of the energy or roughly $3,300 per rack.

Compute-intensive applications, like AI in particular, will begin to outpace the efficiency gains that have historically kept data center energy use in check. Investments in next-generation storage technologies and heat-removal technologies will be required to avoid a corresponding growth in energy use with growth in data. A 23-fold increase in enterprise storage capacity through 2030 will require I&O leaders to adopt energy conservation initiatives to reduce energy costs.

There are many energy conservation strategies available to mitigate the impact of storage on data center power and cooling budgets, thereby lowering energy usage and emissions. Below is a sample list of best practices.

Environmental, sustainability and governance (ESG) assessment:

- Require storage/infrastructure providers to benchmark their capabilities to ESG standards and capabilities in support of green initiatives.

- Determine sustainability goals (netzero) and timelines to determine whether/if offsetting carbon credits would be required to achieve goals.

Storage application efficiency:

- Identify application consolidation opportunities, and calculate their impact on your power, space and cooling footprint:

    - Consider architectural changes that promote favorable TCO, and explore high-capacity media.

    - Leverage the power efficiencies, scale and economics of cloud and STaaS as this may be a viable means to achieving sustainability goals.

- Employ data management strategies such as data reduction, lean backup/recovery copies and tiering strategies that are predicated on automation for optimal data management and placement for maximum efficiency. This includes policy-aware data classification strategies and fleet management.

- Ensure AIOPs platform has analytics that can quantify energy consumption, can provide simulation modeling, and has environmental and sustainability metrics that will be critical to assessing impact and to meet future goals.

Life cycle management:

- Ensure suppliers have a certified "green" supply chain from cradle to grave.

- Reclaim older storage system assets — to refurbish and repurpose may lower energy usage costs and energy costs associated with producing new storage systems.

- Replace obsolete assets to recertify through recycling programs.

Current State

Storage vendors have spent the past year launching or building out their STaaS offerings and investing in AIOps tools with new prescriptive features and proactive capabilities to underpin their offerings. Recent hybrid cloud SDS product offerings include software that can be deployed in the public cloud, extending on-premises capabilities to lead the shift to a hybrid cloud storage and IT services platform for cloud-native benefits.

Other major themes of the current state of enterprise storage include:

- Pandemic driving remote and hybrid cloud edge workload solutions.

- Impact of cloud-native model to on-premises appliances and platform architectures.

- Artificial intelligence and machine learning algorithms augmenting hardware administration activities and related costs.

- On average, 65% of businesses recover their data as a result of ransomware, data exfiltration and extortion, and less than 10% recover all of their data.

- Collaboration communication tools drive archival compliance solutions beyond regulated industries.

- IT sourcing strategies shift from product features to platform-metrics-based SLA outcomes for both IT (e.g., replace storage subject matter experts and administration) and business (e.g., remote workforce) that drive IT operating model improvements that replace storage administration and support.

Gap Analysis and Interdependencies

Operational Innovation

I&O leaders must:

- Plan and migrate workloads to a hybrid cloud IT services-based platform to take advantage of cloud-native capabilities and benefits.

- Operationalize cloud-native principles as new cultural norms to focus on PaaS consumption offerings.

- Shift asset capitalization and sourcing product features to SLA-based demands, and hold vendors accountable for delivering committed operational efficiencies.

- Upskill IT teams with cloud operations roles, including software development capabilities that pave a path toward productivity gains possible through cloud-based automation.

- Leverage AIOps to replace or significantly augment storage life cycle administrative, maintenance and support activities.

- Replace capex-intensive asset management and financing with consumption-based subscription plans that align asset costs to value delivered over the life of the asset with measured returns against the assets (ROA).

Technological Innovation

Legacy storage systems are complex to manage, expensive to maintain, elastically inflexible to scale storage capacity and compute independently, and struggle to meet cloud-native services-based hybrid cloud platform needs.

Further, legacy storage systems lack the full-spectrum hybrid cloud software-defined capabilities that support cloud-native life cycle management capabilities such as orchestration, provisioning, workload optimization and data protection, independent of the physical hardware. I&O leaders must replace legacy storage architectures with services-capable platforms that leverage cloud-native software features that provide access to a rich ecosystem of technological innovation. The volume of enterprise capacity coming online this decade requires I&O leaders to lean on technology partners' investments in platforms designed for cloud-native services.

Cost Optimization Innovation

I&O leaders are increasingly challenged to continuously optimize resources and asset costs — from data centers to labor to infrastructure assets and sourcing strategies — without investment in AIOps tools. I&O leaders must adopt a plan that executes a continuous infrastructure cost savings platform strategy and assign IT personnel to develop and implement an AIOps platform initiative to shift IT resources away from managing and supporting hardware. IT organizations must balance these priorities with continuous investment in cloud-native and intelligent infrastructure, increasingly software-defined, to substantially reduce inherent risks and operational costs over time.

By 2025, Gartner believes that 60% of I&O teams will use AI-augmented automation to enable greater IT productivity, ability and scalability.
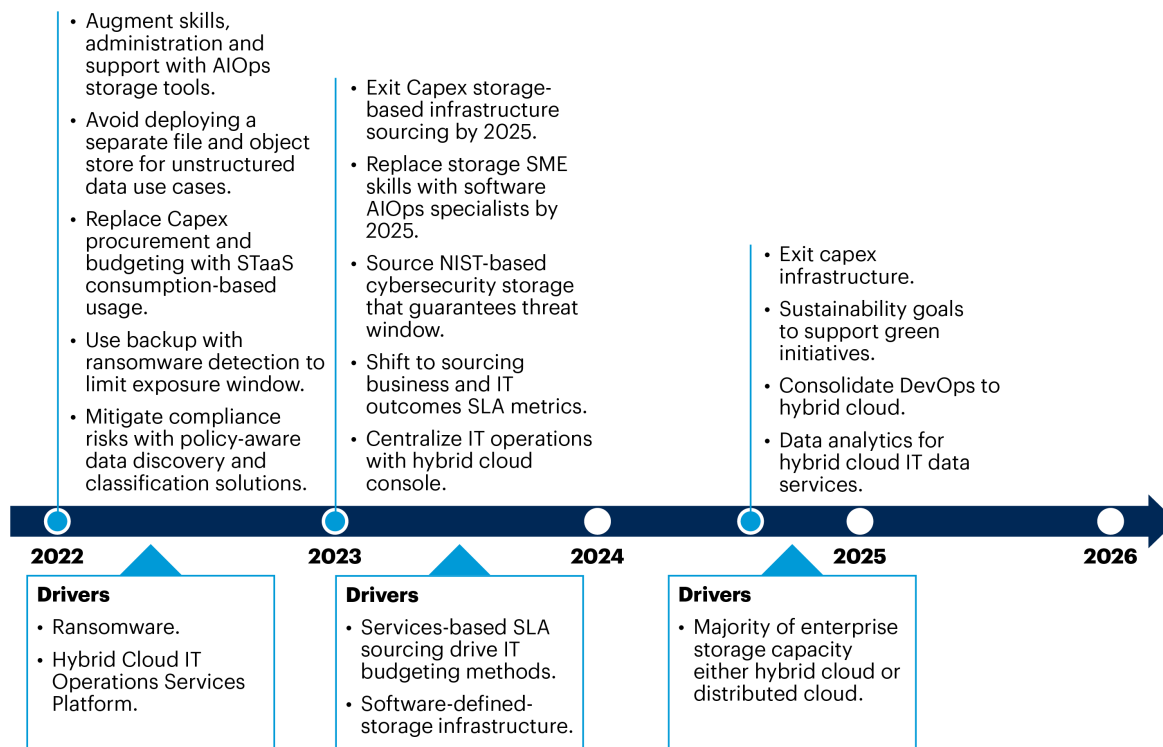
Migration Plan

Figure 5 illustrates our recommended migration plan for enterprise storage. This plan will help I&O leaders to develop an agile services-based, cloud-native IT operating model that will scale with business demands, accelerate IT innovation and remove technological barriers. In return, I&O leaders will see a significant improvement in higher levels of productivity, a more efficient use of IT budget and a more resilient infrastructure to withstand the critical issues, such as ransomware, businesses face.

I&O should plan to exit hardware administration, support and maintenance activities by partnering with cloud-native platform storage vendors that will provide life cycle management that continuously optimizes asset value to costs over the life of the asset. Consumption-based pricing (CBP) for on-premises data center infrastructure and hybrid cloud IT operations is available for cloud-native benefits. CBP consists of hardware and software vendors offering an asset financing and acquisition model as part of a metric-based services platform. Update all security capabilities to mitigate cybersecurity threats while diminishing the window of exposure. I&O leaders must use this plan to implement a hybrid cloud IT services platform to align business and IT around shared, application-specific goals that enhance business value.

Figure 5: 2022 Strategic Roadmap Timeline for Storage

2022 Strategic Roadmap Timeline for Storage

2022
- Augment skills, administration and support with AIOps storage tools.
- Avoid deploying a separate file and object store for unstructured data use cases.
- Replace Capex procurement and budgeting with STaaS consumption-based usage.
- Use backup with ransomware detection to limit exposure window.
- Mitigate compliance risks with policy-aware data discovery and classification solutions.

2023
- Exit Capex storage-based infrastructure sourcing by 2025.
- Replace storage SME skills with software AIOps specialists by 2025.
- Source NIST-based cybersecurity storage that guarantees threat window.
- Shift to sourcing business and IT outcomes SLA metrics.
- Centralize IT operations with hybrid cloud console.

2025
- Exit capex infrastructure.
- Sustainability goals to support green initiatives.
- Consolidate DevOps to hybrid cloud.
- Data analytics for hybrid cloud IT data services.

2022 Drivers
- Ransomware.
- Hybrid Cloud IT Operations Services Platform.

2023 Drivers
- Services-based SLA sourcing drive IT budgeting methods.
- Software-defined-storage infrastructure.

2025 Drivers
- Majority of enterprise storage capacity either hybrid cloud or distributed cloud.

Timeline indicates when to begin.

Source: Gartner

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Gartner

Higher Priority

Plan and implement hybrid cloud IT operations:

- Augment SME skills, hardware administration and support with vendor AIOps storage tools.

- Avoid deploying a separate file-and-object-store-only solution for most unstructured data use cases.

- Develop a plan and timeline to migrate to a services- and consumption-based platform with vendor financing and pay-for-use asset management capabilities to eliminate capex.

- Migrate workloads that require flexibility in scaling capacity and processing for cost reasons to cloudlike distributed storage and compute architectures.

- Identify and source the five most important SLA-based consumption metrics, and contractually hold vendors accountable to deliver with shared risks by integrating with vendor AIOps tools.

- Source a cybersecurity solution that maps to application costs, mitigates the threat window and guarantees remediation within a defined period of time to business-justified conditions.

- Mitigate compliance risks by selecting policy-aware, AI/ML-enabled data classification solutions.

Medium Priority

Reskill and transform IT operations model:

- Create fusion teams based on delivery of business-value-aligned storage outcomes and align with business and application development priorities.

- Staff up IT ops AI/ML engineering, cloud operations and data scientists to develop and oversee a plan to leverage the data analytics backplane as a means to govern data services and SLAs.

- Appoint "data champions" to develop policy-aware data classification and retention strategies for business-critical applications and compliance and privacy issues.

- Work with storage vendors to identify third-party ecosystem IP and technologies required to deliver advanced SLA capabilities and data services as part of the integrated services platform.

- Identify future edge applications, and develop an infrastructure plan that takes into consideration green technologies to support requirements remotely as part of the hybrid cloud platform.

Lower Priority

Identify possible near-term and future technologies and deployment methods for workloads:

- Disaggregated storage-compute NVMe-TCP architecture

- SmartNIC

- Storage as code

- Hybrid cloud PaaS solutions including database as service, analytics, MLOps

- Composable infrastructure as a consumable service (CICS)

- Ethernet drive

- Optical disk systems

- Use of deep learning and ML data classification tools to prevent ransomware, data exfiltration and extortion events

- GPUDirect remote direct memory access (RDMA) for very low-latency workloads — such as ML training and analytics

- Data processors devices

Evidence

Client inquiries.

[1] 2022 Sonicwall Cyber Threat Report

Recommended by the Authors

Some documents may not be available as part of your current Gartner subscription.

Magic Quadrant for Primary Storage

Magic Quadrant for Distributed File Systems and Object Storage

Magic Quadrant for Enterprise Backup and Recovery Software Solutions

Magic Quadrant for Enterprise Information Archiving

Market Guide for Hybrid Cloud Storage

Enterprise Storage as a Service Is Transforming IT Operating Models

Hyperscaler Public Cloud Providers Reshape the On-Premises External Storage Competitive Landscape

Invest Implications: The Importance of Software-Defined Storage for Virtualized Hybrid Cloud Infrastructures

Forecast Analysis: External Controller-Based Storage, Worldwide