2020 Strategic Roadmap for Storage

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Initiatives: Data Center Infrastructure

Advanced storage technologies and consumption-based IT services provide the agility and flexibility needed to thrive in a digital economy. I&O leaders must invest in application-aware infrastructure, embrace infrastructure-led-innovation and modernize storage systems for hybrid cloud services.

Overview

Key Findings

- Organizations are focusing on continuous cost optimization and fiscal constraints in the post-COVID-19 digital economy, with I&O leaders reinvesting savings in digital business initiatives.

- Widespread use of artificial intelligence operations (AIOps) will transform IT infrastructure management into a more proactive, predictive environment, reducing administration and downtime costs.

- Most I&O leaders will replace expensive on-premises backup solutions with hybrid cloud storage services for disaster recovery (DR), cybersecurity and nondisruptive testing.

- Most I&O leaders cited increased operational efficiency and alignment with digital business initiatives as their top two reasons to modernize core IT systems.

- Organizations that have successfully implemented comprehensive and adaptive data governance increase trust in their data and improve data management process efficiencies.

Recommendations

Infrastructure and operations (I&O) leaders responsible for data center infrastructure must:

- Eliminate technical debt and underutilized capacity by implementing a culture of financially sustainable, continuous cost management that avoids shortcuts.

- Harness increasingly diverse data assets for real-time analysis by investing in AIOps to augment IT functions, support hybrid storage and deliver self-service features.

- Centralize, simplify and secure existing backup (BU) systems by implementing a hybrid cloud, IT services-based platform strategy.
- Modernize and automate legacy storage systems by proactively using advanced storage technologies to drive infrastructure-led innovation.

- Close the data governance gap by continuously controlling access to data with AI/machine learning (ML) policy-driven protection measures.

**Strategic Planning Assumptions**

By 2024, hyperconverged infrastructure’s (HCI’s) share of on-premises workloads will grow to 40% (up from 20% today), primarily by cannibalizing three-tier infrastructures.

By 2024, large enterprises will triple their unstructured data stored as file or object storage on-premises, at the edge or in the public cloud, compared to 2020.

By 2024, 40% of I&O leaders will implement at least one hybrid cloud storage architecture, up from 10% in 2020.

By 2024, 50% of the global storage capacity will be deployed as software-defined storage (SDS) on-premises or on the public cloud, up from less than 15% in 2020.

By 2024, more than 30% of enterprise storage capacity will be remotely managed outside of enterprise data centers, up from less than 5% in 2020.

**Analysis**

To strategically transform their operations, I&O leaders must understand both the status quo and emerging trends in enterprise storage. These storage trends will impact I&O services, processes, people, technologies and cost optimization best practices.

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 a short-, medium- and long-term action plan.

*Figure 1: 2020 Strategic Roadmap Overview for Storage*
### 2020 Strategic Roadmap Overview for Storage

<table>
<thead>
<tr>
<th>Future State</th>
<th>Current State</th>
<th>Gap</th>
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<tr>
<td>• Data-assets-driven culture; fully-automated AI/ML storage platform; managed hybrid IT services delivery platform with global asset orchestration, infrastructure provisioning.</td>
<td>• Lack of infrastructure-led innovation and a largely reactive (42%) IT organization have slowed the mean average time to deploy digital business model changes to 12.5 months.</td>
<td>• On-premises storage systems aren’t taking advantage of hybrid cloud storage software.</td>
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<td>• IT cloud engineering and operations staff, cross-functionally aligned to DevOps teams that complement business outcomes.</td>
<td>• 50% of IT organizations lack cloud engineering skills needed to design and manage hybrid cloud services.</td>
<td>• Enterprise IT organizations lack the skills to advance hybrid cloud services initiatives.</td>
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<td>• Software-defined storage infrastructure provides hardware independence that scales more cost-effectively with API programmability for workflow automation.</td>
<td>• Storage systems are expensive, inelastic, hardware-intensive, proprietary hardware, complex to manage — lack composability to vary capacity and performance.</td>
<td>• Hardware storage systems lack automation capabilities.</td>
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<td>• NVMe, NVMe-oF and SCM account for the vast majority of storage capacity deployed to tackle performant capacity and latency-sensitive workloads and use cases.</td>
<td>• 90% of installed external storage arrays are not designed to cost-effectively support modern storage workloads and use cases.</td>
<td>• Applications and policy-driven requirements absent from IT infrastructure budget priorities.</td>
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<td>• Global DRaaS and hybrid cloud solutions account for increasing and larger share of backup, DR and cybersecurity solutions.</td>
<td>• Data protection solutions and licenses are cost-prohibitive, manually intensive and prone to cybersecurity attacks.</td>
<td>• Current systems not architectured or automated for continuous cost optimization over time.</td>
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<td>• Consumption-based subscription licensing, template-based services catalog offerings have replaced a majority of perpetual license and capex solutions as the preferred usage method.</td>
<td>• Increasing aged data and rapidly increasing new data have increased security, compliance risk, data governance issues.</td>
<td>• Asset-intensive storage systems are costly to operate and increase technical debt.</td>
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<td>• Less than 1% of storage capacity is deployed as a service. On average, storage is depreciated over five to six years; labor-intensive asset management.</td>
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<td>• Migration Plan</td>
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<td>Source: Gartner 722078_C</td>
<td></td>
<td>• Embrace infrastructure-led innovation and hybrid cloud storage solutions.</td>
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<td>• Invest in cloud engineering and operation skills.</td>
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<td>• Invest in AI/ML to automate labor-intensive administration and harness diverse datasets.</td>
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<td>• Transition to subscription-services-based hybrid cloud IT platform.</td>
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<td>• Place business outcomes and application needs in the forefront of IT budget priorities.</td>
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<td>• Invest in resilient hybrid cloud architecture to harden workloads.</td>
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By 2025, I&O leaders must transform their IT operations and storage systems into innovation-led growth engines for policy-driven, application-aware digital commerce infrastructure. Future enterprises will be data-driven, cloud-enabled and API-centric. As such, progressive I&O leaders will embrace cutting-edge storage innovations that revitalize core legacy systems that drive revenue growth and deliver unparalleled efficiencies across the enterprise.

The growth of new applications will drive unprecedented demand for data storage, with broad, disruptive implications for storage infrastructure, use cases and workloads. To support this increased demand, I&O leaders must harness the power of AI/ML and cloud-based IT strategies, and new consumption-based IT operating models. Technologies will enable businesses to continuously reduce operating costs and time to market for new applications, products and services.

The current state of the enterprise storage landscape today is more varied, data-intensive and geographically dispersed than ever, and will continue to accelerate at an unprecedented rate. I&O
leaders must modernize traditional IT storage administration systems to deliver the proper balance of agility, control, scale and efficiencies.

As enterprises scale digital business initiatives to leverage the massive growth in data, I&O leaders will view their enterprise storage systems as critical, strategic assets. Gartner estimates that 3.5 million petabytes (PBs) of enterprise-grade hard-disk drive (HDD), solid-state drive (SSD) and tape media will be delivered in 2025 and that shipments of enterprise-grade media will expand at a rate of more than 30% annually through at least 2030. Thus, global I&O leaders will likely have a real need for application-centric enterprise systems to store, secure, manage, protect and derive advanced, diversely analyzed value from millions of freshly generated petabytes of mostly unstructured data every year.

The distribution of on-premises versus off-premises storage (including both public and hybrid cloud) will shift markedly by 2025, with only 15% of the total enterprise PBs remaining on-premises, down from 45% in 2019. The ratio of server-based storage (SBS)/direct-attached storage (DAS) versus external controller-based (ECB) storage arrays will also transform, with ECB systems consuming less than 5% of the total enterprise PBs shipped in 2025, down from 9.2% in 2019 (see Figure 2).

Figure 2: Distribution Percentage of Enterprise Data, 2018-2030
As organizations aggressively pursue digital transformation and operational efficiencies, I&O leaders will embrace advanced, disruptive software-defined solutions and cloud-based services. In doing so, they must chart out a bold, proactive strategy to leverage storage as a competitive advantage.

The percentage of IT budget spent on cloud storage is projected to increase from 5.8% in 2017 to 11.6% in 2023. In addition, enterprises are demanding increased flexibility in response to the COVID-19 pandemic, as supply and demand fluctuate globally. This will further accelerate enterprise adoption and spending on hybrid cloud solutions.

I&O leaders must also evolve their cost management practices by using discovery and optimization tools to rightsize data infrastructure assets and increase efficiency. These tools are especially crucial for modernizing legacy storage systems, as enterprises balance cost optimization projects with investment in IT products that support business growth.
In short, the following forces are shaping the enterprise storage landscape:

- Automation, orchestration and AI/ML technologies are the primary levers for reducing operating expenses and complexity, while optimizing resource utilization.
- Cybersecurity threats and ransomware attacks will impact 95% of I&O leaders through 2024.
- Use of consumption-based, pay-as-you-grow subscriptions for both on-premises and hybrid cloud storage will increase rapidly through 2024.
- Ultra-low-latency requirements will drive demand for edge data center infrastructure, where more than 50% of data will be generated and processed.
- Most IT organizations will experience significant delays when migrating to a hybrid cloud architecture as a result of a lack of engineering and program management talent and skills.
- COVID-19 has permanently shifted a large percentage of IT workloads to remote locations.
- Hybrid and multicloud service providers will continue to replace on-premises ECB storage with more durable, service-based, scalable platforms that support a wide variety of applications.
- There will be increasing use of enterprise-class storage software features on public and hybrid cloud infrastructure.

Future State

I&O leaders will combine new storage solutions with operational initiatives to improve alignment between business and IT. After decades of focusing solely on performance and cost, future storage innovations will target infrastructure simplicity, automation, operationally resilient platforms and flexible, cloud-based IT service models.

In the most successful IT organizations, storage solutions will optimally balance operational, technological and continuous cost optimization requirements. I&O leaders will embrace a culture of infrastructure-led innovation by demonstrating business-outcome-driven leadership. To build a service-based storage delivery platform that meets digital business needs, 80% of enterprises will transform their culture to emphasize business outcomes and align with digital business requirements. I&O leaders will expand beyond their traditional role of choosing and implementing the right storage solutions. Rather, they will serve as a vital ally and enabler of business value who steers their organization through this disruptive period.

Intelligent Infrastructure Solutions

I&O leaders must reevaluate their storage and data management strategies by rapidly adopting a new cloud-based operating model built on AI/ML technologies. The power of ML and analytics will enable an application-driven infrastructure deployment model that will turn the overwhelming volume of system and operational logs for both real-time and historical data into proactive...
administration and prescriptive services. Further, AI/ML significantly improves productivity while providing maximum flexibility in a rapidly changing environment. These insights will enable I&O leaders to provide unprecedented levels of availability and continuous efficiency and optimization to deliver better digital experiences for customers, at much lower costs.

AIOps will transform storage management into intelligent infrastructure, enabling a full view of infrastructure at the application, virtual machine (VM) or container layer. AIOps will accelerate automation to drive continuous cost optimization by increasing storage asset utilization efficiency. AIOps provides infrastructure visibility to discover complex patterns in IT storage system data. AIOps will provide an automated inference capability not available in existing monitoring tools. Automation will also drive down costs for support and vendor development.

Storage systems will use globally trained ML models to analyze and deliver predictions into user and application behavior, allowing performance adjustments based on quality of service (QoS) levels and activity patterns in real time. Built-in intelligence will allow administrators to optimize data layouts and caching behaviors, and establish tiering to reduce storage costs.

**Data Classification**

Data classification will continue to be essential for building a storage tiering strategy that delivers long-term operational cost savings and maintains control. I&O leaders will face the challenge of tiering and maintaining both active and inactive data at optimal utilization levels. Two-thirds of storage administrators report that half of their total data stored is inactive. I&O leaders will likely need to archive or migrate this data to a lower-cost tier.

Without first classifying data, I&O leaders will find it challenging to optimize or rightsize data in the appropriate storage tier or storage capability. Data must be classified in order to reduce manual-intensive, inefficient practices. Automated data classification empowers organizations to identify, classify and move data between heterogeneous storage systems and the cloud by using SRM and file analysis tools to provide unique insights into data usage and storage capacity.

**Primary Storage**

Modern, high-performance enterprise storage arrays will increasingly be based on scale-out, multinode architectures that leverage solid-state array (SSA), nonvolatile memory express (NVMe) technology and critical attributes depicted in Figure 3.

**Figure 3: The Critical Attributes of an External Primary Storage Product**
NVMe-based technologies emphasize high performance and QoS to meet the demand for low latency and greater bandwidth, and input/output operations per second (IOPS) associated with leading primary storage workloads. I&O leaders must investigate and benchmark massively parallel processing (MPP), multinode, all-active architectures to achieve consistent, predictable performance during the measured period.

Although FC will continue to be an important protocol for consistent high performance and reliability, TCP/IP will likely evolve to be an important data center transport for NVMe-oF for distributed systems. NVMe-oF leverages high-speed networks and will accelerate adoption of next-generation storage architectures. NVMe-oF will take time to evolve, so investigate the Gartner Hype Cycle for adoption guidelines.

Advancements in SBS technologies and flexible modular architectures, such as HCI and SDS, have brought SBS to the forefront. Enterprises will implement SBS methods at a rapid pace to optimize utilization of storage capacity by simplifying implementation and upgrades.

Unstructured Data Growth

As unstructured data continues to grow by 30% to 60% annually, enterprises must support diverse use cases and reduce costs by adopting extensible, on-premises, edge and public cloud integrated storage products. The distributed file system (DFS) and object storage market is growing faster than ever, both in the number and capacity of deployments. These platforms will become the best solution for addressing massive unstructured data growth. Many storage architecture systems in this market can be deployed on off-the-shelf commodity systems, providing flexibility and significant savings.

Distributed File Systems

I&O leaders must evaluate DFS products for storing and analyzing large-scale, unstructured file data. DFS will continue to bring distributed scale-out storage architectures to the forefront of infrastructure planning. Storage vendors will develop DFS to overcome the limitations of dual-controller NAS storage design for BU and archiving. DFSs are suitable for batch, transactional, interactive processing and other high-bandwidth workloads. In addition to academic, high-
performance computing (HPC) environments, DFSs will become increasingly common for rich media streaming, analytics, content distribution, collaboration, BU and archiving. Verticals that require highly scalable file bandwidth for applications, such as financial services, media and entertainment, and life sciences, will be leading adopters of DFSs.

**Object Storage**

The market for object storage will continue to increase as enterprises seek PB-scale storage infrastructure at a lower total cost of ownership (TCO). On-premises deployments of object storage platforms will grow less rapidly compared to public cloud storage.

Application developers and DevOps team members increasingly prefer object storage implemented on lower TCO commodity systems over ECB storage (where large amounts of data are stored and extended to the public cloud). Object storage vendors will offer a variety of deployment options (such as software-only, packaged appliances and managed hosting) and both perpetual and subscription-based licensing models. Object storage products will support large-scale capacity and are best-suited for workloads that require high bandwidth (as opposed to transactional workloads that demand high IOPS and low latency).

**Storage Acceleration**

**Storage Class Memory (SCM)**

Next-generation storage systems will include storage-class memory (SCM) technologies. SCM takes the form of either SSAs or directly addressable, nonvolatile dynamic random-access memory (DRAM) in the form of persistent memory dual in-line memory modules (DIMMs). The opportunity for a new nonvolatile memory technology between DRAM and NAND flash (in terms of performance, price and capacity) will continue to grow and better align with the workload demand of leading applications. I&O leaders will use SCM in super-fast NVMe SSAs, but this use case comes at a premium (about 10 times the cost of leading auxiliary storage pool [ASP]/GB flash technology). Alternative small-block, low-latency NAND technologies (referred to as “FastNAND”) are just coming to market.

To exploit the performance benefits of these technologies, I&O leaders will use SCM as directly addressable persistent memory (PMEM). PMEM can achieve large memory capacity that is persistent and is about half the price of server DRAM ASP/GB. PMEM will not replace DRAM, but will complement PMEM to deliver acceptable performance. PMEM will become a more viable, higher-performance storage tier in the long term, providing higher volume at lower cost.

**Quad-Level Cell (QLC)**

3D NAND flash will reduce costs through higher layer count transitions (increasing to 128 layers for most vendors) and by migrating to QLC NAND flash technology. While QLC technology targets a 15% to 20% cost reduction from mainstream triple-level cell (TLC) technology, it is less reliable with lower sequential write performance. Depending on application workload demands, I&O leaders will
use QLC technology as a tier of capacity flash storage or to complement existing TLC NAND flash or SCM.

QLC is already available in several vendor storage arrays, but adoption in storage environments is nascent. Adoption will accelerate to more than 50% by 2025. I&O leaders must understand the attributes of their application workloads and invest in QLC storage arrays based on price/performance needs.

Figure 4 illustrates the hierarchy of NAND flash technologies based on price, capacity, reliability and performance.

Figure 4: 2020 Flash Technology Hierarchy

2020 Flash Technology Hierarchy

Computational Storage
Computational storage (CS) will bring computing power closer to storage, reducing performance inefficiencies and latency issues that occur when moving data between storage and compute resources. As data volumes increase, movement of data will become a bottleneck. As storage size normally vastly exceeds memory, the data will have to be read in from the storage media. This impedes application performance, undermining real-time analysis for most datasets.

Data-intensive, latency-sensitive applications will benefit the most from removing the bottleneck with CS, including AI/ML, HPC, analytics, high-frequency trading, and immersive and mixed-reality streaming. Edge computing will remain a strategic opportunity for I&O leaders, 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, but must carefully weigh the trade-off between cost and performance. Workloads that are highly I/O bound will benefit greatly from processing in storage.

BU, Archive and DR

By 2022, 40% of organizations will supplement or completely replace BU applications with cloud-based solutions. Cloud BU and DR are already available at much lower costs than in-house on-premises and secondary site solutions. However, cloud solutions may not fit every use case. I&O leaders will need to select and tier different approaches to find the best match in a hybrid cloud environment.

Modernized, cloud BU and/or DR solutions radically simplify data management and reduce recovery times. These tools will better protect and recover data from cybersecurity threats such as ransomware. BU vendors offer global, single-pane-of-glass management tools, running either as SaaS or as self-deployed solutions. I&O leaders should also invest in continuous, active DR capabilities and nondisruptive testing.

Anti-Ransomware

I&O leaders will transform their approach to BU and DR by 2024 to combat the rampant rise of cybersecurity threats. Ransomware attacks are costly and can force businesses offline. Half of all security breaches go undetected for multiple months, impacting the integrity of BU and recovery data and increasing risk levels beyond affordable solution costs.

In response to ransomware attacks, vendors will continue developing capabilities to analyze their presence, mitigate their impact and expedite recovery. BU/DR vendors will add new ransomware-specific features and packaged recovery solutions that can scan repositories for malware. These features will eliminate unrecognized malware that is captured in BU operations during the restore. As a result, recovery from a malware attack will not reseed the infrastructure with the malware that caused the outage. I&O teams must evaluate new ransomware products and determine which approaches and features will best mitigate risk (see “Avoid Ransomware Disasters With a Better Backup and Recovery Strategy”).

Highly Available and Resilient Data Services

To guarantee an acceptable level of operational continuity, I&O leaders must eliminate a single point of failure by planning and designing their processes and systems around multiple service delivery methods. By removing single points of failure, they will achieve sustainable, cost-effective redundancy and resilience. Data mirroring, storage clustering, erasure coding and data replication will remain the principal default technologies for providing resiliency. These technologies will be leveraged both on-premises and in the cloud to provide local, hybrid, in-cloud or cloud-to-cloud resiliency. SDS architectures will serve as the foundational layer for these services. More storage
vendors will begin offering 100% guaranteed data availability with automatic failover and multisite replication, including to the cloud.

Data Governance and Management

Regulations will present a new series of use cases, and organizations must proactively mitigate risks in unstructured, structured and semistructured data. The scope of regulations will expand even further in highly regulated industries, such as financial services and healthcare. IT organizations will deploy a combination of data protection, archiving, e-discovery and file analytics solutions to identify and mitigate regulatory compliance risks.

An expanding number of BU/DR solutions will extend new data reuse capabilities to apply information governance, automated data management policies and file analysis to BU data. Enterprise information archiving (EIA) and e-discovery solutions will continue to expand their models to cover unstructured forms of media, including social media and collaboration platforms. These solutions will provide improved accessibility and management of a growing number of data sources.

Hybrid Cloud Storage

Hybrid cloud storage (HCS) solutions will evolve to leverage public cloud infrastructure and platform services that span solutions for most application needs. This includes support for block, file and object storage protocols. More than one-third of I&O leaders will implement HCS infrastructure to support cloud storage solution initiatives to deliver agility, mobility and improved operational efficiency and resiliency. However, due to the fragmented nature of this market and integration challenges with cloud, I&O leaders must thoroughly examine use-case-specific HCS product capabilities before implementing solutions.

The market for HCS is rapidly evolving, with many prominent and small vendors tackling varied use cases and adoption patterns (see "Market Guide for Hybrid Cloud Storage"). The five leading use cases for HCS will be:

1. **BU/DR.** Snapshotting, replicating and copying structured or unstructured datasets from on-premises or edge storage to the public cloud IaaS.

2. **Burst for capacity.** Expanding on-premises storage capacity without deploying additional on-premises or edge storage infrastructure by tiering structured or unstructured data to the public cloud.

3. **Burst for compute.** Moving or accessing data for processing, or rendering it in different locations from where it is stored. This addresses scenarios where data and application processing are not collocated.

4. **Data orchestration.** Abstracting underlying storage and orchestration of data across hybrid cloud deployment scenarios.
Storage standardization. Standardizing of storage platforms for deployment scenarios to improve operational consistency of storage services.

Figure 5 outlines these emerging HCS use cases and associated deployment technologies.

**Figure 5: Hybrid Cloud Storage Deployment Technologies and Use Cases**

<table>
<thead>
<tr>
<th>Business Priorities</th>
<th>Seamless bridge between disparate data centers, edge locations and public cloud infrastructure and platform services</th>
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<td><strong>Use Cases</strong></td>
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<tr>
<td>Disaster Recovery</td>
<td>Burst for Capacity</td>
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<td>Burst for Processing</td>
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<td>Storage Standardization</td>
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<tr>
<td><strong>Deployment Technologies</strong></td>
<td>Storage Arrays</td>
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Source: Gartner 722078_C

**Edge Storage**

I&O leaders will develop hybrid cloud strategies that include deployment of next-generation edge or “outside of enterprise data center” storage platforms to support ultra-latency-sensitive applications. The variety of use cases and requirements will lead to a vast platform to be operated in a geodistributed topology, with compute infrastructure distributed across tens of thousands of physical sites. Also, the scale of distributed computing and storage required by edge computing — especially at deployment locations that have no IT staff — will create new management challenges. Edge computing also creates new security challenges, as much of the processing and storage is located outside of traditional information security visibility and control. This significantly enlarges enterprise attack surfaces.

HCI platforms are currently one of the most popular on-premises solutions for general-purpose virtualized edge and remote office/branch office (ROBO) use cases. These systems provide simplified operations and licensing. By 2023, most HCI vendors will provide edge-oriented products with adequate resiliency built into the system.

**Software-Defined Storage**

SDS provides data storage services to replace or augment traditional storage arrays. SDS will be deployed as a VM, container or storage software on a bare-metal industry standard server. SDS will allow organizations to deploy storage-as-a-service software on-premises, at the edge or in the
public cloud. I&O leaders will leverage SDS to create resilient storage infrastructure platforms based on industry-standard hardware for file, block or object protocols.

SDS changes delivery models — and potentially substantial savings — of enterprise storage infrastructure for a broad array of workloads, including analytics, HPC, AI/ML and application consolidation. SDS provides hardware independence that scales cost-effectively. It provides API programmability for workflow automation. SDS allows for separating the control plane from the data plane, enabling centralized orchestration. Proprietary hardware will no longer be a key differentiator due to the power of multicore Intel x86 processors, high-throughput networking, and use of software-based RAID or erasure coding and flash. Thus, I&O leaders must leverage software-based advances to deliver differentiated value.

I&O leaders must also identify TCO savings from both capital expenditure (capex) and operating expenditure (opex), including administration, certification, deployment and ongoing management, maintenance, and support.

**Infrastructure as Code**

Digital transformation requires cloud-enabled IT infrastructure that scales reliably to meet rapidly changing business needs. I&O leaders will deploy infrastructure as code (IaC) to enable infrastructure provisioning and configuration to be handled in the same way as application code. IaC leverages versioning and auditing capabilities that use descriptive language to orchestrate and provision infrastructure. Because it is in a code repository, I&O leaders will use IaC as part of continuous integration/continuous deployment (CI/CD) pipelines. IaC will also enable simplified testing and provisioning, and hardening of the change management process with storage infrastructure.

By removing manual steps from infrastructure provisioning, IaC will minimize human error and improve the consistency and reproducibility of the environment. Also, it will enhance product team agility by simplifying the application development and operations effort, increasing the resilience of applications. The primary benefits are fewer infrastructure failures, elimination of infrastructure drift, reduced cost, improved efficiency and accelerated application time to market.

**Storage Security**

Most data breaches are ultimately caused by a failure in data storage security. Well-designed data storage security is also mandated by various compliance regulations, adding legal implications to storage security demands. Global digital data volume growth will drive a 41.2% increase in security spending. AI/ML algorithms that analyze data and management systems in real time, along with rule-based engines for targeted security policies, will help detect anomalous data access and movement patterns for closer investigation. Use of key management solutions and self-encrypting drives further strengthens the ability to secure critical enterprise data assets. I&O leaders will increasingly need to prove that their data is secure and reliable, and that it has been gathered, stored and processed with integrity.
Current State

Storage array vendors have spent the past year consolidating and updating their product offerings with richer features, common operating systems for high-end to midrange systems, software automation capabilities and hybrid cloud services offerings. The industry continues its transition to SSAs with a comprehensive set of storage management features and data services. Other major themes of the current state of enterprise storage include:

- In the installed base, 90% of the external dual-controller architecture storage arrays are not designed to cost-effectively support NVMe-based, high-performance storage workloads.

- Eighty-nine percent of I&O organizations are optimized for technology projects that have a clearly defined beginning and end. However, organizations are now beginning to align funding, development resources and ongoing management support with a strategic roadmap of IT services targeted at continuous business value streams.

- AI/ML technologies in IT storage operations are deployed for event correlation and anomaly detection, with root causation and automatic remediation. ML simplifies performance anomaly detection and impact analysis while continuously optimizing costs and increasing utilization.

- SDS solutions deployed on commodity hardware, public clouds or as a hybrid architecture can scale to multiple petabytes with good performance. DFS/OS storage architectures are converging as vendors offer a single platform that supports both architectures.

- Hybrid cloud storage is among the top three I&O challenges when deploying storage solutions to deliver seamless storage across a hybrid cloud environment.

- HCI systems are replacing midrange storage systems in large enterprises. All leading storage vendors offer at least one HCI product line alongside their midrange and high-end storage arrays. HCI systems are preferable to consolidated, general-purpose, virtualized workloads and ROBO workloads due to their simplified operations and licensing.

Gap Analysis and Interdependencies

Operational Innovation

I&O leaders must embrace infrastructure-led innovation by building a cloud-enabled operating model and leveraging advanced technologies and realigning cultural norms to focus on platform as a service (PaaS) consumption offerings that support applications and business outcomes. They must upskill I&O teams with cloud architecture and cloud operations roles and responsibilities to enable the productivity gains possible through cloud-based automation. IT organizations must also develop automation capabilities by leveraging software AI/ML to replace or complement administrative and manual-intensive infrastructure management tasks.
Organizations must start the process of transitioning their capex-intensive environments to consumption-based subscription plans that offer increased flexibility and agility by increasing software utilization.

Technological Innovation

Legacy storage systems are often too expensive and fail to meet performance standards. These systems do not leverage hybrid cloud-based technologies and are inflexible or slow to adapt to sudden changes in business demands or rapid data growth.

Hybrid cloud storage solutions are key enabling technologies to support the scale, intelligence and agility required by diverse users across the business-IT continuum. Intelligent platform services are in demand and are becoming a prerequisite to business success. Intelligent platform services provide innovative features, including real-time analysis of business situations in context, AI-assisted decision making, development automation and augmented user experience. I&O leaders must start investing in software-defined technologies and rapidly shift away from monolithic hardware-based systems that are inflexible and difficult to manage. They should also incorporate composable infrastructure and open-source software (OSS) technologies into their storage ecosystem.

Cost Optimization Innovation

Without advanced software-based AIOps tools, I&O leaders find it difficult to continuously optimize resource utilization. IT organizations must transition to a planned, continuous cost savings roadmap and eliminate resource-intensive, unplanned cost savings projects. IT organizations must balance these priorities with continuous investment in cloud solutions to reduce operational costs.

Migration Plan

Figure 6 illustrates our recommended migration plan for enterprise storage. This plan will help I&O leaders to invest in automation and software that simplify storage management, improve administrative agility, and deliver continuous cost optimization and infrastructure-led innovation. I&O leaders must use this plan to design and implement a hybrid cloud IT services platform to align business and IT around shared, application-specific goals that enhance business value.

Figure 6: 2020 Strategic Roadmap Timeline for Storage
This plan is divided into short-term (higher priority), midterm (medium priority) and long-term (lower priority) projects. The priority level corresponds to the timeline for each project, with the high-priority projects getting underway in 2020.

**Higher Priority**

**Proactively Embrace Infrastructure-Led Innovation**

- Proactively embrace advanced technologies, architectures and vendors to enable a hybrid cloud service platform that can provide IT infrastructure consumption offerings.

- Balance financial and operational benefits of innovations with the risks.

- Deliver agile, cost-effective and automated application-aware infrastructure services to business units and benchmark deliverables with best-in-class alternatives.

**Reskill I&O Teams and Transform the Organization**

- Hire and develop cloud architecture, development and operational skills.
Position I&O as an infrastructure service broker for digital initiatives.

Design for agility, automation, scalability and business outcomes.

Measure and reward I&O teams based on their delivery of business-value-aligned storage outcomes.

Collaborate with application leaders to create application-to-infrastructure roadmaps.

Design a service-based storage and data protection strategy that aligns with application roadmaps and organizational budget priorities.

### Automate Manual Processes and Implement AIOps

- Fast-track support for data and application pipelines.
- Automate and simplify infrastructure and policy management.
- Use storage vendor's AI/ML tools to automate the entire storage management and support process, including proactive planning tools to advise on capacity and utilization levels.

### Rearchitect Storage Into a Platform as a Hybrid IT Cloud for Applications

- Adopt a cloud-first IT sourcing strategy to lay the foundation for reducing the on-premises data center infrastructure footprint by 2025.
- Transform the data center with next-generation technology enabled by cloud and multicloud services.
- Shift focus from infrastructure plumbing and asset management to instead provide data services for application teams.
- Create an economies-of-scale platform that can rapidly deploy new applications.
- Devise a hybrid cloud strategy and identify the infrastructure platform building blocks needed to orchestrate and provision IT services-oriented capabilities.
- Implement consumption-based pricing or subscription models with high levels of transparency that can be billed by business unit or application. Benchmark pricing against vendor capex and utility models to track software TCO over the next five to 10 years.

### Medium Priority

**Optimize Data Center Storage to Improve Resiliency, Agility, Uptime and Performance**
Select NVMe back-end SSAs with at least 32GB FC or 25GB Ethernet interconnects for critical scale-up workloads that require low latency.

Ensure storage platforms offer seamless migration to NVMe-oF-based architectures and seek out solutions that incorporate QLC media for read-intensive workloads to reduce costs and enable scalability, without sacrificing durability or endurance where it’s needed.

Use HCI to consolidate highly virtualized environments, hosting web applications and midsize databases. Choose software-only HCI to provide better flexibility with the choice of hardware; choose HCI appliances for operational simplicity and easy vendor management.

Select systems that are cloud-integrated and support container management.

Invest in SDS tools that support multicloud storage management.

Engage with business and IT partners to understand their roadmaps for supporting multicloud environments that simplify data mobility and storage management.

Build Hybrid Cloud Capabilities to Enhance BU, DR and Cybersecurity

Proactively embrace third-party IT resiliency and orchestration platforms that enable end-to-end visibility and management of the BU and DR environment.

Invest in file analytics tools to analyze, index, search, track and report file content. Choose file analytics software based on its visualization capabilities and support for metadata and content analysis.

For unstructured data, evaluate SDS-based DFS software that offers both file and object protocols. Choose solutions that integrate with a public cloud that scales to multiple petabytes.

Build an Enterprise IT Storage Service Offerings Catalog

Create and publish a catalog of billable storage services for business users.

Prioritize listing services that are more in demand, well-defined and standardized.

Add forward-looking services to anticipate future demand, rather than simply fulfilling requests.

Provide formal descriptions of each service, including its key deliverables, attributes, purpose and SLAs.

Use a standardized storage RFP toolkit for routinely assisting and benchmarking application requirements by setting proper expectations in advance of budgeting (see “Tool: RFP for Primary Storage and Distributed File Systems and Object Storage”).

Include key performance metrics to monitor and report on utilization and QoS.
Incorporate Edge Compute Workloads

- Identify which workloads and use cases belong in edge data centers.
- Bring compute resources closer to the edge to support the bandwidth and latency required by IoT devices and applications.
- Build a distributed storage architecture with compute resources at increasingly decentralized locations across the data center, private cloud and public cloud.
- Consolidate ROBO and edge workloads on resilient, single-node or two-node HCI platforms.
- Track the acquisition and maintenance costs of these appliances for the next seven years, as ROBO systems always have a longer refresh cycle.

Favor Open-Source Storage Standards Over Proprietary Solutions

- Leverage the cost and performance advantages of API-based OSS for commodity-based functions where there is minimal differentiation with branded solutions.
- Prepare the organization for OSS adoption by actively deploying pilot projects, identifying internal champions and training storage teams.
- When deploying OSS, use a commercial distribution and work with a vendor to install, maintain and support the software.
- When deploying open-core or freemium storage products, evaluate any downsides of lock-in against the potential benefits. Avoid proprietary software versions where possible, as they add potential costs and support issues.

Lower Priority

Assess Container-Native Storage for Elastic Scalability

- Evaluate container-native storage systems with high levels of granularity for cloud-native applications.
- Choose storage solutions that align with microservices architecture principles and adhere to the requirements of container-native data services. Storage solutions should be hardware-agnostic, API-driven, deployed as containers and designed for container granularity, based on distributed architecture and capable of being deployed at the edge, core or public cloud.
- Assess vendors’ delivery of quality customer support and consistent pricing models, given that the container ecosystem is rapidly evolving with unproven vendor business models.

Computational Storage
Explore possible benefits of using CS in specific use cases, including ML processing, real-time data analytics, high-frequency trading, multimedia production and HPC. CS is especially beneficial for workloads that are highly I/O bound.

Weigh the trade-off between cost and performance gains when evaluating CS. Applications that work across multiple CS nodes will perform best and offer the greatest benefits.

**Evidence**

This research is based on Gartner client inquiries and Gartner surveys.


**Recommended by the Authors**

*IT Key Metrics Data 2020: Industry Measures — Executive Summary*

*Market Trends: The Velocity and Distribution of Enterprise Data, 2010-2030*

*ClOIs Can Use the Run-Grow-Transform Model to Align IT Functions and Roles to Strategic Business Priorities*

*Drive Administration, Application and Automation Capabilities of Infrastructure-Led Disruption*

*Gartner Market Databook, April 2020 Update*


*How to Lead Digital Disruption With Programmable Infrastructure*

**Recommended For You**

*Make Your Strategy More Adaptive for an Uncertain Environment*

*Best Practices for Major IT Integration Planning During Healthcare Provider M&A*

*Healthcare ClOIs: Assess Your Own Ability to Be a Digital Partner*

*Healthcare Provider ClOIs: Use Scenario Planning to Determine the Durability of Your EHR Megasuite Relationship*
Outsourcing Best Practices and Innovation Incentives for Healthcare Payer CIOs

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