White Paper

Meeting Diverse Storage Needs of Cloud Workloads: The Azure Disk Storage Portfolio

Sponsored by: Microsoft

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IDC OPINION

Innovative infrastructure technologies that fuel businesses' digital transformation — such as cloud computing, cloud storage, and management and optimization services that help enhance customer value — have moved beyond experimentation to become high-priority items on the enterprise IT road map. Enterprises have experienced the many advantages of public cloud infrastructure and IDC expects public cloud infrastructure as a service (IaaS) operational spending (opex) to surpass traditional IT capital spending (capex) by 2021.

With the expanded scope of cloud usage, workloads moving into cloud environments now have a wide range of needs, from optimizing performance, cost, and scalability in business applications to meeting low latency and high throughput for web applications. These translate to specific requirements on the disk storage service, an integral component of the cloud infrastructure delivering these applications.

Suboptimal disk storage functionality can have visibly negative business outcomes. Over-provisioning leads to high total cost of ownership (TCO), budget overruns and, potentially, dropped cloud initiatives. On the other hand, under-provisioning can result in suboptimal application performance and poor user experience. Suboptimal configuration can have a material impact on cloud service fees and the cost/performance of the application. In traditional on-premises IT, storage functionality optimization is typically delivered by active storage administration to meet the storage quality of service (QoS) needed. In public cloud, optimization comes through the selection of appropriate storage services for the application. Optimal disk storage selection delivers the desired characteristics for performance and durability, thus underscoring the importance of the disk storage portfolio available from a provider.

Microsoft Azure offers a rich range of disk storage tiers, alongside Azure virtual machines (VMs), to meet the range of customer needs previously described. This allows IT organizations to select the optimal storage tier for each workload, optimizing infrastructure on a granular level. Azure Disk Storage portfolio offers:

- Optimized disk storage offerings for a range of needs — from low cost to high performance
- Secure, reliable, and performant storage — to meet enterprise workload needs
- Ease of use, with a rich ecosystem of services and partners
- Industry-leading new capabilities on disk storage

IN THIS WHITE PAPER

Microsoft released Azure, its public cloud services platform, in February 2010, but its public cloud IaaS focus really started ramping up in 2014. Over the past few years, Microsoft has built a strong portfolio of cloud services and grown to be a dominant player in the space of cloud services, building on its dominant enterprise presence globally. At the core of this are Azure's compute and storage offerings. These are complemented by a variety of additional capabilities, including cloud-native services such as containers and functions; advanced services for databases, AI/machine learning (ML) and analytics, and IoT; management tools; and a marketplace of partner services. All these services are further supported by the global presence of Microsoft and its ecosystem of global technology and services partners.

In this white paper, IDC discusses the Microsoft Azure Disk Storage portfolio and outlines the range of capabilities that Azure's disk storage brings to enterprise IT workloads.

SITUATION OVERVIEW

Public cloud IaaS is more than just an alternative infrastructure platform option. Public cloud is now increasingly recognized as a mechanism to access new technologies and facilitate modernization of IT. And running applications on public cloud IaaS makes it easy for the customers' IT to leverage these capabilities.

Public cloud use cases have evolved from developers and start-ups to backup/recovery and broader adoption by IT for business-critical applications. New enterprise workloads are pushing the boundaries of performance capabilities, and disk storage is becoming a critical area of focus for enterprises. As they move workloads from traditional datacenter environments into public cloud, enterprises are experiencing challenges with configuring and creating the optimal infrastructure environment for each workload and in "rightsizing" the infrastructure for cloud disk storage while meeting the business requirements of the workload.

Developers and IT organizations must ensure that data is stored in a manner that allows it to securely satisfy the latency and throughput requirements of the application. Business outcomes are increasingly tied to the performance characteristics of the IT infrastructure and the underlying disk storage. In traditional datacenter environments, enterprise IT organizations have mature products and services that they are familiar with – such as all-flash array (AFA) appliances for low-latency storage, QoS tools to ensure SLAs, and data transfer protocol options – and are used to ensure that each workload operates with its required disk storage capabilities. With public cloud disk storage services, this is achieved through configuration of the following key disk storage features that determine the performance and cost of the offering:

- Disk size
- Media type – solid state drive (SSD) versus hard disk drive (HDD)
- I/O operations per second (IOPS) and throughput (measured in megabyte per second [MBps])

The availability of a wide range of storage media and management options along with these characteristics enables the infrastructure to meet application needs and optimize storage for application performance and cost. The sections that follow present the Azure Disk Storage portfolio in detail, and how it offers customers flexibility on each of the selection components previously listed.

AZURE DISK STORAGE

Over the past few years, Microsoft has been focused on helping customers in their move to cloud through a collection of improvements and expansions to the Azure portfolio, making it possible and increasingly practical for Azure users to embrace a private or hybrid cloud strategy, start a first move to public cloud, or accelerate a movement to the Azure cloud that has already been started. Critical to successfully migrating applications and data to public cloud environments are the compute and storage characteristics of the cloud environment and matching these to the needs of the cloud workload.

Complementing its breadth of compute offerings (see *Enabling Cloud for All Compute Needs: Azure's Compute Portfolio,* available at **azure.microsoft.com/en-us/resources/idc-enabling-cloud-for-all-compute-needs/**), Azure offers a broad portfolio of disk storage options to customers through the Azure Managed Disk offerings.

IDC sees the customer benefits of the Azure Disk Storage portfolio along two dimensions:

- **Capabilities of the Azure Disk Storage portfolio:** Wide variety of Managed Disk offerings and tiers of service, including Premium SSD with volume sizes up to 32TiB offering up to 20,000 IOPS per disk and the high-performance Ultra Disk delivering sub-millisecond latency
- **Benefits from the Azure ecosystem:** Technology and services to enable adjacent and higher-layer functionalities for the organization, from both Microsoft and its ecosystem of partners

Each of these dimensions are discussed in detail in the sections that follow.

Capabilities of the Azure Disk Portfolio

Before exploring the various types of Azure SSD and HDD Managed Disk offerings, it is important to understand Azure Disk storage and the Managed Disks offering in particular.

Azure Managed Disks — Simplified Access to Virtual Disks on Azure Cloud

An Azure (unmanaged) disk is a virtual hard disk (VHD) file that is stored as an Azure page blob, all within an Azure storage account. Page blobs can also be concurrently accessed directly through REST interfaces, allowing value-added services (like Azure Backup) as well as third-party partner-provided business continuity and disaster recovery (DR) capabilities to be easily implemented against them.

The Azure Managed Disks, introduced in early 2017, encapsulates the management of the Azure storage account and page blob provisioning associated with the disk storage and allows the user to interact with the service purely at a disk storage level. This management or abstraction of disks simplifies the customer experience with the disk storage while offering the same integration and value within the Azure framework (such as the backup and DR integrations previously discussed). Microsoft has built a broad range of disk types under the Managed Disks offering umbrella and continues to extend on this portfolio.

Azure Managed Disk Offerings — Low Cost to Industry-Leading Performance

The Azure Managed Disks portfolio offers customers a rich range of offerings, allowing customers to configure cost, performance, and availability based on their application needs. Figure 1 shows an overview of these offerings. Figure 2 includes details of performance specifications for the different offerings.

FIGURE 1

Azure Managed Disk Offerings
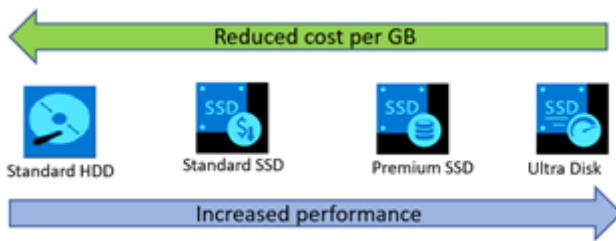
Source: Microsoft, 2019

Overview of Azure Managed Disk Offerings

Standard HDD (S series)

From the time of inception of IaaS, low-cost workloads have used spinning disk-based cloud hard disk drives for noncritical, non-I/O-intensive workloads such as backup and archive workloads or low-end file servers. The Standard HDD storage tier has a low entry-level price point and is appropriate for non-performance-sensitive data sets, experimentation, and education. The low price per gigabyte (GB) makes it ideal for use cases with large data volumes and low access frequency – use cases such as backup and disaster recovery. Standard HDD supports up to 32TiB per disk in the S80 model, with the low end S4 disk starting at 32GiB per disk. IOPS range from up to 500 IOPS in S4 to up to 2,000 IOPS per disk in the S80. Throughput ranges from up to 60MBps at the low end to up to 500MBps at the high end. As of November 2019, Azure has also introduced new sizes – S1 (4GiB), S2 (8GiB), and S3 (16GiB) – in preview.

Standard SSD (E series)

Organizations are often forced to make a trade-off between performance consistency and cost, even at low levels of IOPS requirements. With the general availability of new Azure Standard SSD Managed Disks announced at Ignite in September 2018, Standard SSDs provide a cost-effective storage option optimized for consistent latency performance at lower IOPS levels, without the high cost of premium high IOPS offerings. Standard SSDs support from up to120 IOPS at the low end to up to 6,000 IOPS at the high end, with the E80. Performance ranges from up to 25MBps for the E4 to up to 750MBps per disk in the E80. As of November 2019, Azure has also introduced new sizes – E1 (4GiB), E2 (8GiB), and E3 (16GiB) – in preview. This tier offers predictable SSD performance for cost-sensitive workloads.

The Standard SSD storage offers consistency in latency performance over Standard HDD disks and is designed for low I/O applications such as entry-level production applications and scale-out web applications that require predictable performance. Typical workloads ideal for Standard SSD include general-purpose web applications and entry-level web servers.

Premium SSD (P series)

For workloads with lower-latency and higher-performance requirements than Standard SSD, Azure Disk Storage offers Premium SSD for I/O-intensive applications, business-critical database deployments (e.g., Oracle, SQL Server, Mongo DB, Cassandra), and high-performance workloads.

Premium SSD provides single-digit millisecond latency at the high end, with up to 20,000 IOPS and 900MBps per disk in the P80. As of November 2019, Azure has also introduced of new sizes – P1 (4GiB), P2 (8GiB), and P3 (16GiB) – in preview. Premium SSD offers consistent provisioned performance for I/O-intensive use cases and is designed for a broad range of enterprise production or performance-sensitive workloads such as databases and data analytics.

Ultra Disk

Ultra Disks, announced at Ignite 2018, push at the boundaries of current disk storage capabilities available in public cloud and are designed for the highest tier of business applications such as SAP HANA, SAN, and enterprise production workloads, characterized by low latency and high IOPS needs.

Ultra Disk storage volumes are capable of up to 160,000 IOPS and 2GBps throughput per disk and provide sub-millisecond latency and up to 64TiB volume size. In addition, Ultra Disk allows flexible configuration of IOPS independent of disk sizes, allowing for high IOPS with smaller disk sizes as needed for certain cloud-native use cases, such as stateful Kubernetes applications. Through these capabilities, Ultra Disk provides high-throughput performance to applications without disk striping or caching.

Ultra Disk represents the leading edge in today's public cloud disk storage offerings and is expected to continue to evolve to support more advanced capabilities. Key upcoming features for Ultra Disk include a shared disk mode for custom high-performance shared storage workloads such as massively parallel computing clusters with shared data back ends and failover clustering such as Windows Server Failover Clustering (WSFC) and SQL Server Failover Cluster Instances (FCI). In today's world of cloud computing, continuous improvement and continuous development of features goes on all the way around the calendar. Ultra Disk and its road map highlight that the race to deliver new features and services is taking no breaks at Microsoft Azure.

IDC Opinion

This portfolio of managed SSD and HDD virtual hard disk services provides disk storage options across diverse workloads to optimize across cost, performance, and size as needed for each application, enabling trade-offs across performance, size, and cost. With the portfolio of Standard HDD, Standard and Premium SSD, and Ultra Disk storage options shown in Figure 2, Azure users have the ability to optimize their cloud compute and storage configurations to match workload needs. Microsoft helps customers map their application needs across Azure Disk types to optimize storage by understanding the application characteristics, considering I/O intensiveness and level of latency, and at what level. These decisions guide users to the appropriate Azure Disk Storage offering.

FIGURE 2

Range of Disk Storage Configurations Available with Managed Disks

General Availability				
	Standard HDD	Standard SSD	Premium SSD	Ultra Disk
Single disk max value	Low-cost storage	Consistent performance	High performance	Sub-millisecond latency
Size	32 TiB	32 TiB	32 TiB	8X	64 TiB
IOPS	2,000	6,000	20,000		160,000
Bandwidth	500 MBps	750 MBps	900 MBps	3-4X	2,000 MBps

Source: Microsoft, 2019

Azure Managed Disks — Designed for High Availability

Azure Managed Disks are architecturally designed to deliver high availability (99.999% availability). Managed Disks also offer multiple availability options in conjunction with Azure virtual machines. This enables Azure to offer the industry's only single-instance SLA of 99.9% and fault domain alignment with compute resources for availability sets and availability zone deployments, covered in detail in the section that follows. In addition, all Managed Disks come with triple redundant replication to enable hardware fault tolerance for customer workloads. These enable Azure to claim a 0% annualized failure rate (AFR) durability guarantee, with no customer data loss.

Azure Managed Disks — Integration with Azure Compute

Managed Disks are designed to be used alongside Azure Compute virtual machines. To facilitate easy scalability and availability management, Azure Managed Disks also support planned placement and/or logical configuration in Availability Sets, Availability Zones, and Scaling Sets.

Availability Sets are groups of resources that are placed to ensure physical isolation among the resources within them and ensure high availability for the logical group as a whole. They are placed on multiple physical servers, storage units, and network switches. Managed Disks attached to virtual machines in an Availability Set are automatically placed in physically separated physical devices to ensure that the disk storage meets the fault tolerance and availability needs of the Availability Set.

Availability Zones are physically isolated groups of resources within an Azure region, enabling applications within a region to be architected for high availability and tolerance to physical faults at a datacenter level. Within a geographic region, Azure provides redundancy with three or more separate zones, where each zone has one or more datacenters. Azure Managed Disks support physical placement and isolation through Availability Zones, protecting the user's infrastructure from single points of failure.

Azure virtual machine Scale Sets are sets of identical, load-balanced VMs that are autoscaled up and down based on certain preconfigured criteria. Managed Disks can be included into these VM Scale Sets to easily scale the disk storage resources proportionately with the VMs scaled in the Scale Set. Coupling these resources allows management and scaling of the compute and storage resources together in a seamless manner.

These integrations with Azure Compute VM concepts enable applications to be easily designed for scalability according to the demands of the application environment while maintaining latency, availability, and durability needs for the business scenario.

Azure Managed Disks — Built-In Encryption Capability

Azure Managed Disks support two levels of encryption to protect customer data: the Storage Service Encryption, which protects data at rest in disk storage, and the Azure Disk Encryption, which uses BitLocker with Windows and DM-Crypt with Linux to provide volume-level encryption of disk storage data from Windows and Linux OSs, respectively. The Storage Service Encryption for data at rest encryption is enabled by default in all Managed Disks. Encryption can be set up with Microsoft Managed Keys (MMK). As of November 2019, Azure has also introduced the preview of Customer Managed Keys (CMK) with keys managed through Azure Key Vault. Azure Disk Encryption can be optionally turned on by the customer, and keys can be managed through the Azure Key Vault service.

Benefits of the Broader Microsoft Azure Ecosystem

In addition to the disk types that are available in the Azure Disk Storage portfolio previously described, the Azure environment brings a variety of additional benefits to Azure users. IDC's surveys of the public cloud IaaS market has shown that the access to value-added services and higher-layer technologies is a key driver of public cloud adoption by enterprises.

The Azure ecosystem includes both value-added infrastructure management services available alongside the Azure Managed Disks and higher-layer PaaS, SaaS, and partners available through the Microsoft Ecosystem (see Figure 3).

FIGURE 3

The Broader Microsoft Azure Ecosystem of Technologies and Partners
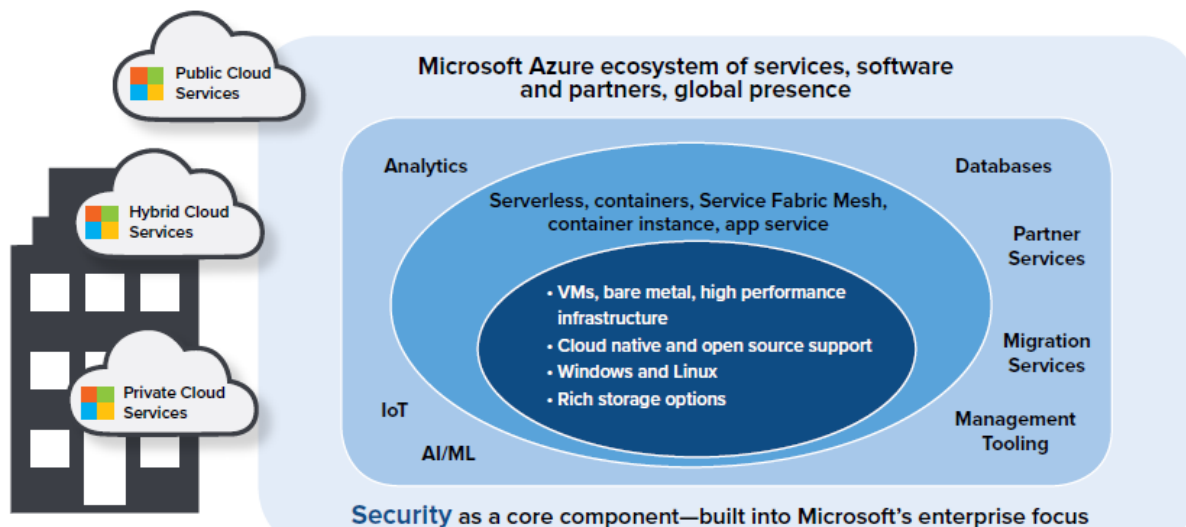
Source: Microsoft, 2019

The capabilities listed in this document are not exhaustive but are intended to represent the range of services and benefits available to Azure customers through the Azure and Microsoft ecosystem.

Azure Storage Management Capabilities — Ease of Management and Protection

Performance Monitoring Through Azure Monitor

Azure Monitor is an Azure service that allows collection and analyses of operational metrics on the customers' Azure resources – to troubleshoot and maximize productivity of the deployment. Azure Monitor includes the ability to monitor a variety of individual Azure Managed Disk metrics (by operating system [OS] or data disk, read or write ops/second, bytes/second, queue depth, etc.). Users can link this data with third-party tools to create dashboard displays. Azure Monitor also provides alerts – set either statically or dynamically by machine learning.

Azure Monitor capabilities continue to evolve with technology, with new announcements and capabilities built on the latest Azure technologies. Early in 2019, Azure Monitor announced Dynamic Thresholds, using machine learning to identify patterns in disk metrics – to allow developers to enable unique alert thresholds for different usage patterns.

Azure Cost Management

As businesses continue to move workloads to the public cloud, there is a general expectation that they will achieve cost savings. At the same time cost is a top concern with public cloud adoption and selection. In response, cost analytics has become a vital part of a cloud management strategy. Azure Cost Management, included at no cost in the Azure portal, offers a variety of tools to do just this. Users can monitor cloud spend through dashboards or download raw data – to review accumulated costs. Users can customize the views to monitor cost over time and tag and group resources (such as servers, storage, availability sets, scale sets, disks, batch, cognitive services) as they relate to

functions within their organization (e.g., development, production, finance). To plan costs, Azure Cost Management includes the ability to create cost budgets and set notifications, such as sending an email when a resource is within 90% of budget. IT organizations can use this cost data to drive team accountability for budgets and tracking cloud expenses to these.

Aside from presenting cloud usage data, Azure Cost Management helps optimize cloud spend not only by analyzing usage data but also by providing recommendations on cloud resources based on usage. Examples include disk drives that are not attached to a VM and oversized VMs (the Azure Storage portfolio has a breadth of offerings that can be optimized for each workload). This Azure capability helps Azure users get the most effective usage of their IT spending.

Azure Backup and Managed Disk Snapshots

IDC research shows that backup of resources running in public cloud IaaS continues to be a top area of concern for enterprises running their workloads on a public cloud. While backup and DR offerings and capabilities on-premises are a well-defined and understood domain, backup in public cloud is an area where enterprises are still building familiarity and understanding. Azure Backup is an Azure native backup service providing backup and recovery services using the Azure cloud. Azure Backup can be enabled for an Azure VM on creation (provided it is running a supported operating system) – to back up the volume data and system state for protection. This allows an easy way for customers to ensure protection against failures and provides a recovery plan against both internal and external errors.

Another data protection service available with Azure Managed Disks is the Managed Disk Snapshots, a point in time copy of the Managed Disk that can be used as a reference for a recovery point. These snapshots contain only the used data on a single disk and does not include unused disk space. As of September 2019, Azure has also introduced the preview of incremental snapshots, which allow creating snapshots using the differential data when taking a sequence of snapshots. These optimizations provide cost savings along with the backup and point in time restoration capabilities.

The Broader Microsoft Azure Ecosystem — Access to Technologies and Partners

New Technologies and Services

Public cloud is increasingly seen as a source of access to new technologies and higher-layer services for modernization of applications, not just as a functional solution for infrastructure or IT. A vibrant ecosystem is a growing component of cloud adoption and usage. Microsoft Azure offers access to a rich ecosystem of higher-layer services and partners. These include cloud-native capabilities, such as Azure Kubernetes Services (AKS) integration for Kubernetes-based workloads, and built-in developer extensibility. Azure Managed Disks are designed to be easily used alongside AKS – to meet persistent storage needs for containerized applications. Other new technologies and software capabilities include new AI/ML, data management, and edge delivery mechanisms.

Azure's investments and momentum in expanding this ecosystem are evident through the new services introduced in these domains – including Azure Machine Learning Studio, Azure Cosmos DB, and the 2019 announcements around Azure Data Box Edge. While a number of these are not technologies that typical enterprise IT organizations start using in the early stage of cloud adoption, they are important considerations because of the recognition that access to these capabilities will speed up upcoming investments and initiatives to drive digital transformation through the organization.

The Microsoft Partner Network

Azure also provides customers access to services and technologies from the broad ecosystem of Microsoft partners through the Microsoft Partner Network (see Figure 4). These include targeted solutions for every stage of cloud maturity and cloud adoption. The Microsoft Partner Network and the investment to build a healthy network of partners to service customer needs is an acknowledgement of diverse enterprise customer needs and a commitment to support these directly or indirectly as needed.

Microsoft partners provide access to several common data storage and migration scenarios, such as replication and migration (Zerto), backup and disaster recovery (Commvault, Actifio, Rubrik, Veritas, Zerto), databases and data analytics (Cloudera, SAP, Teradata, Datastax), container storage (Portworx, StorageOS, Kasten), and NAS storage (SoftNAS, NetApp).

FIGURE 4

Access to Capabilities Through the Microsoft Partner Network

Source: Microsoft, 2019

ESSENTIAL GUIDANCE

The growth in public cloud infrastructure acceptance into the enterprise environment has resulted in an explosion of usage of public cloud for IT infrastructure needs. Public cloud allows granular selection and configuration of infrastructure services to meet each workload and use case in an optimized manner. This is particularly important for core infrastructure compute and storage services, including

disk storage, where over- and under-provisioning of resources can result in missed business goals. Public cloud buyers and evaluators must explore their potential public cloud service provider partners to make sure that the range of capabilities available can meet their workload needs.

Public cloud is also increasingly seen as a source of new technologies and services, particularly in terms of new capabilities that can act as catalysts to the enterprise's digital transformation progress. The strength of the cloud provider's ecosystem of technology services and partners must be a key consideration for customers when evaluating public cloud providers.

The Azure Managed Disk portfolio offers customers a rich range of offerings, from low-cost entry-level HDD- and SSD-based storage to industry-leading low-latency cloud disk storage. These are accompanied by the comprehensive Azure Compute portfolio and the deep integration across broader Azure cloud services. The core infrastructure services are complemented by a rich layer of management and productivity solutions, as well as higher-layer services and new technology frameworks such as advanced data management, IoT solutions, and AI/ML. Last, but not least, is the strong Microsoft Partner Network providing customers easy access to technologies and services from a validated global cohort of partners. Cumulatively, these are a compelling set of reasons to consider Azure as a cloud platform partner on the enterprise cloud adoption journey.

LEARN MORE

- *Microsoft Build 2019: Tying the Portfolio Together* (IDC #US45090919, June 2019)
- *Microsoft Ignite and Envision 2018: Continued Heavy Investment in Cloud Products* (IDC #US44376818, October 2018)
- *Worldwide Public Cloud Infrastructure as a Service Forecast, 2018-2022* (IDC #US44232218, August 2018)
- *Worldwide Software as a Service and Cloud Software Market Shares, 2017: A Year of Expanding Platforms* (IDC #US43821218, August 2018)
- *Growth of File Storage Services in the Public Cloud* (IDC #US44002318, June 2018)
- *Microsoft Acquires Cloud Storage Gateway Company Avere Systems* (IDC #lcCEMA43499018, January 2018)
- *IDC MarketScape: Worldwide Infrastructure as a Service 2017 Vendor Assessment* (IDC #US43073916, September 2017)

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