White Paper

All-Flash Storage: Improving How Physicians Deliver Patient Care

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IN THIS WHITE PAPER

This IDC White Paper, sponsored by Pure Storage, discusses important healthcare IT storage needs for the growing provider market, focusing on how all-flash storage solutions can be used to provide faster access to patient data. Patient data includes both structured and unstructured data, including high-definition and 3D medical images and videos. This White Paper also covers key flash storage use cases in healthcare and provides essential guidance for providers regarding the return on investment (ROI) and TCO benefits of moving to an all-flash storage data platform.

PROVIDER DATA VOLUMES ARE RAPIDLY EXPANDING

The shift from fee-for-service to value-based reimbursement is driving investment in data aggregation, analytics, and health information exchange technologies to achieve the Triple Aim objectives of reducing healthcare costs by improving quality and consumer engagement. Consequently, the volume of electronic health information being collected and stored by health systems has grown exponentially over the past decade. Healthcare organizations are more reliant on real-time access to healthcare data than ever before to influence clinical process improvements and create revenue-generating business models.

Data needs to be available at the point of decision making by both healthcare professionals and executives to address the following scenarios:

- Pressure to consolidate to achieve economies of scale and strengthen negotiation position through market reach
- Need for better care coordination and collaboration across provider networks (especially if ownership models range from closely affiliated to owned entities)
- Enhance care collaboration between a mobile workforce by sharing clinical data including images
- Ensure profitability under value-based care

Organizations that successfully make this shift to value-based healthcare will recognize data as a strategic asset to be acquired, aggregated, and analyzed to optimize clinical, financial, and technical operations. Organizations also understand the importance of creating a 360-degree view of the patient that includes data generated between office visits and inpatient admissions. These data include biometric readings from consumer-grade medical devices or wearable activity trackers, social determinants of care, and other environment data such as weather and pollen counts.

IDC estimates that the lifetime data volume for a typical patient is approximately 1,100TB. Progress in high-definition and 3D medical imaging and videos; continuous advances in bioinformatics, as in the case of genomic sequencing; and the increasing adoption of technologies such as picture archiving and communication systems (PACSs), radiology information systems, and digital pathology systems are among the key causes of this volume explosion. In turn, healthcare organizations are not only investing in big data and analytics but also looking to cognitive computing, artificial intelligence (AI), and machine learning to glean insights from all this data and support clinical decision making at the point of care.

Variety is a dimension that makes healthcare data management both interesting and challenging. Today, IDC estimates that only about 20% of patient data produced in a typical healthcare organization is structured. Structured data, such as information in patient administration systems, traditional electronic health records (EHRs), and billing systems, can be easily stored, queried, recalled, analyzed, and manipulated by computer systems to support care processes. The remaining 80% that is unstructured (and semistructured) often lags behind structured data in its ability to be inappropriately captured, stored, and organized so that it can be used in analytics and leveraged across the organization. Unstructured data holds valuable patient information (e.g., nursing and physician notes, visible light images, videos, and information from monitoring devices and sensors). Nevertheless, this value is often limited to a single episode of care and remains with the department or the professionals who created it because of limitations that prevent the data from being fully utilized.

Increasingly healthcare organizations want to create a 360-degree patient view for individual patients and specific populations to better manage their care under value-based care delivery and reimbursement models. A longitudinal patient record is essential not only to document the patient journey but also to provide a flexible information platform that supports all healthcare providers involved in the process of care delivery. Aggregating this data, in addition to unstructured data and the data from the growing adoption of social, mobile, and Internet of Things (IoT) devices, into a 360-degree view for consumption by healthcare professionals and patients is not a trivial task.

Healthcare providers need to address the complexity of patient health information management by adopting a new approach to storage. They need a simplified storage architecture flexible enough to manage a wide variety and volume of structured and unstructured data while offering rapid access to this data.

FLASH STORAGE PLATFORM IS CHANGING TO MEET INTENSIFYING DATA CHALLENGES

New all-flash array (AFA) designs promise to address storage issues across all industries and are rapidly taking over from legacy designs that were originally built around spinning hard disk drive (HDD) technology. All-flash arrays are entirely solid state. There is no spinning disk, dramatically reducing read/write time latency. Thus data processing is available at wire speed. Increasing read/write time by tenfold greatly improves users' efficiency and productivity. Purpose-built all-flash arrays are faster than hybrid arrays, which are traditional arrays retrofitted with flash memory, and don't require the complex configuration needed to optimize combinations of flash and disk.

Advantages of All-Flash Storage in Healthcare

Highly flash-optimized storage platforms offer compelling advantages in performance, efficiency, economics, and availability relative to disk and hybrid storage platforms and overcome many of their

shortfalls, namely complexity and IOPS performance bottlenecks. While HDD capacity has increased over the years, the mechanical nature of HDDs imposes an upper limit on performance, and the technical workarounds needed to achieve large capacity requirements add complexity. Unlike disk technology, flash technology continues to advance at a rapid pace, resulting in even denser flash media, more cost-effective options, and greater technical performance in datacenters.

Enhance IT Efficiency

All-flash arrays provide a number of benefits that add value to the IT organization. Many healthcare organizations have been able to quantify a return on investment that justifies investing in flash storage for additional workloads beyond the mission-critical, performance-sensitive applications such as electronic health records or analytics systems. Healthcare organizations do not have to sacrifice performance for price as evidenced by when primary and secondary benefits are included in ROI and TCO calculations. These benefits include:

- **Simplicity.** All-flash array storage enables IT organizations to leverage a unified data platform for structured and unstructured data across all workloads. Eliminating dedicated, siloed storage hardware for specific workloads simplifies performance monitoring by reducing potential bottlenecks that take IT staff time to discover and remediate. A simplified data storage architecture also provides benefits to end users in that access to data from core clinical applications and analytics solutions is faster.
- **Resiliency.** Automation, self-configuration, and self-optimization not only speed up provisioning but also reduce the risk of human error that could require systems to be brought offline before they can be restored. All-flash arrays that support full redundancy and feature components that can be hot-swapped in production without downtime support nondisruptive maintenance and improve availability and resiliency. All-flash arrays can demonstrate availability extending to six- or even seven-nines, which translates to less than 32 seconds a year. This high level of uptime allows IT organizations to proactively focus on business priorities rather than having to allocate more of their time to maintenance and disaster recovery tasks.
- **Durability**. While SSDs will over time experience wear and tear because of constant read/write requests, the lack of moving parts found in HDDs means that all-flash storage is less likely to have spontaneous breakdowns such as disc scratches or a drive head crashing.
- **Optimized virtualization**. Virtual machines run a variety of mixed workloads, which result in high levels of random I/O that are difficult for spinning disks to handle. Hard disk drives constantly spinning to look for data add milliseconds to read/write processes. This scenario is often called the blender effect, and performance degrades as a result. Flash enables the addition of more virtual machines per server that also optimizes physical storage capacity.
- **Lower datacenter costs.** Replacing conventional hard disk drive storage with all-flash storage will lower datacenter costs when it comes to power, cooling, and physical space. It is not uncommon for power and cooling costs to exceed conventional infrastructure costs. The deduplication capabilities of flash storage also greatly reduce storage space requirements. Thus flash storage's smaller footprint and lower power and cooling requirements can result in significant savings when conventional storage is replaced by flash storage. For hospitals whose datacenters have power or space constraints, moving to all flash can extend the life of a facility while allowing IT to provide more services on-premise.

The Buying Model for Storage Changes with All Flash

Increasing the capacity of conventional data storage requires upgrading to new servers and migrating data. In contrast, adding capacity in an all-flash environment is as simple as adding additional flash blades (the printed circuit boards that house the flash media) or upgrading to higher-density flash blades. Scale-out architecture, therefore, offers multiple options for simple, online, and nondisruptive performance and capacity upgrades, enabling IT organizations to deliver greater capacity and performance on demand. IT organizations can acquire capacity as they need it rather than investing in a server that they may not use to capacity for several months or longer.

Flash Storage Changes How Physicians Practice

New care delivery and reimbursement models are changing how physicians practice medicine and care for their patients in profound ways. To be successful delivering value-based care, clinicians must collaborate more closely across the continuum of care, which requires the ability to securely exchange large volumes of patient health information, including medical images. The new business model also requires that healthcare organizations have a good handle on their operational, clinical, and financial performance as they make the shift from fee-for-service to value-based care. These changes are thus accelerating the deployment of a variety of analytics solutions.

All-flash storage provides clinicians faster access to clinical data in EHRs and images — in many cases even before the radiology reports are turned around — no matter where the physicians are located. Clinical workflows benefit from lower latency and higher throughput and bandwidth, especially when clinicians are handling massive data sets in near real time. Faster access to clinical data and images improves clinical workflow and decision making, thus improving patient outcomes. All-flash arrays also speed up analytics engines providing faster or even real-time access to relevant clinical insights. Faster technology improves clinician productivity and efficiency, enabling clinicians to not only see more patients but spend more quality time caring for their patients rather than waiting to log in or for applications to load, data to be returned, and processes to be completed. In turn, this will increase clinician satisfaction when using clinical systems and ultimately improve the patient experience because clinicians are able to focus more on the patient than on waiting for the "technology" to respond.

ALL-FLASH USE CASES

A breakthrough technology, all-flash storage provides faster access to mission-critical health information found in imaging and EHR systems. All-flash storage also improves the performance of big data and analytics systems and backup and disaster recovery systems. For most healthcare IT organizations, the decision is not whether to use all-flash storage but for which critical workloads to use it first. Healthcare organizations are using all-flash storage for the use cases discussed in the sections that follow to improve clinician workflow and patient care.

Imaging 3D

Medical imaging is changing rapidly and taking on an evermore important role in diagnosis and care delivery across the globe. Advances in CT and MRI technologies are resulting in more images in each study, thus greatly increasing the size of image files and corresponding storage requirements. For example, a typical image file size for a CT scan is 5MB, with 30–1,000+ images contained in 2–6 series, and for an MRI, the typical file size is 5–6MB, with 100–1,000+ images contained in 4–19 series. Standard output for CT scans and MRIs is 2D. However, 3D images can be created by combining

multiple images to create a 3D model, which can be manipulated by the physician. Enhanced 3D visualization is a valuable tool for diagnosis and preparing for surgery but requires high-performing storage and compute environments to be practical for clinical users.

Historically, healthcare organizations have taken a tiered approach to storage because of the size and volume of medical images. Images for hospitalized and recently discharged patients are kept in tier 1 storage since it is highly likely that their images will need to be reviewed by the extended care team within the first 90 days from image creation. These images and corresponding reports need to be available to physicians in seconds. Anywhere, anytime access to these images and reports from any secure browser-enabled device will also drive decision making about where and how to store medical imaging data. Tier 2 and 3 storage consisting of redundant arrays of inexpensive disks (RAID), magneto-optical device (MOD), and tape are used for older images; images are available, but performance levels drop, with retrieval times taking upward to a minute or more. This tiered approach allows healthcare organizations to cost effectively allocate conventional storage while meeting their archival and retrieval requirements but requires specialized archiving software and constant attention from PACS administrators. However, greater deployment of all-flash arrays obviates the need to tier medical image storage. Instead, all medical images could be stored in tier 1, providing the same response time to clinicians caring for a hospitalized patient with an acute episode or treating a patient with multiple chronic conditions and wanting to review medical images over a span of several years to access the patient's prognosis. Administering image storage on scale-out platforms without tiering removes complexity and cost.

EHRs and Virtual Desktop Interfaces

Clinicians have long railed against EHRs with complaints ranging from user interface design and the number of clicks to document patient care to overall performance of the application and having to repeatedly log in to the EHR as clinicians move from one location to the next to see patients. Healthcare organizations have used virtualized desktops (VDI), along with virtualized servers and applications, in an attempt to overcome mobility and security issues while making EHRs more clinician friendly. With VDI in place, EHR sessions follow clinicians as they move from room to room accessing their patients' records from different devices including desktops, computers on wheels, or mobile devices. However, "time to chart," that is the time for the VDI instance to bring up patient information, remains a major issue for clinicians. All-flash storage with its faster access to data addresses the I/O blender effect, which is brought about by virtualization and occurs when multiple virtual machines all send their I/O streams to a hypervisor for processing (e.g., locking and unlocking files), thus degrading performance. Healthcare organizations have seen "time to chart" times fall from nearly a minute to seconds. The obvious benefits are faster access to patient information and greater clinician efficiency and productivity. Clinicians are also less frustrated because they don't have to wait so long for data to be retrieved and images or documents to be rendered. The performance needs of EHRs continue to grow as users and functionalities are added, and I/O requirements for EHR are expected to double every three years for the foreseeable future, making all flash a basic requirement for most common EHR platforms with or without virtualization.

Internet of Things

The use of IoT-enabled sensors in healthcare is expanding in terms of types of sensors, target conditions, age groups, and settings, reaching the lowest resource settings including the home. Top use cases include remote health monitoring for chronic conditions, fitness and activity trackers, and real-time location services to track asset location (e.g., wheelchairs, infusion pumps, and medical equipment). According to a recent IDC survey, 39% of providers and 52% of payers reported that IoT

projects were in pilot or production stages either in a single department or enterprisewide. The widespread adoption of IoT across the continuum of care — from home to hospital or ambulatory clinic and back again — has led to increased volumes of structured and unstructured data. Consequently, the use of big data and analytics and cognitive computing to analyze and glean deeper insights from all this data will continue to drive demand for all-flash storage. The utility of such IoT systems highly depends on the quality of embedded analytic and decision-support systems to generate meaningful alerts and/or derive value from the data. Computer-based intelligence will also play an important role in turning data collected via IoT-enabled sensors into actionable information and insights for both consumers and clinicians.

Big Data and Analytics

All-flash storage improves performance when analyzing large data sets, enabling clinicians to combine data from multiple data sources in new ways to support AI-enabled predictive analytics and other sophisticated analytics techniques. All-flash arrays do not use caches and can handle considerably larger data sets because they provide uniform access latencies to all storage capacity within an appliance. This allows tasks, which in the past had to be separated to run on different platforms for performance reasons (metadata databases and sequential tasks in a multistage workflow), to be collapsed and run on a single platform, minimizing data movement operations and providing much better performance. Flash's speed provides the responsiveness that today's line-of-business executives and clinicians demand, thus improving the overall user experience and bringing real-time insights to the point of decision making.

Backup and Disaster Recovery

As flash capacity grows and price per gigabyte continues to drop, flash storage for widespread backup and disaster recovery will begin to make economic sense, especially when space, power, and cooling costs are factored in to the cost equation. Until then, healthcare IT organizations will roll out flash backup storage for specific use cases where flash is well suited (e.g., providing continuous backups of highly transactional data or heavily used EHR databases). Flash backups can also reduce the data backup window when used simultaneously to back up multiple lower demand workloads, which is an important consideration when high availability of systems is essential. Another use case is continuous data protection in which backups occur every five minutes or so with multiple systems being backed up to a single backup server. Point-in-time snapshots help healthcare IT organizations lower recovery point objectives (RPOs) and enable zero recovery time objectives (RTOs) with instant recovery. It is not uncommon for this arrangement to cause a backup performance bottleneck because of the volume of data the backup server needs to process during the backup window. A high-speed flash storage tier alleviates this bottleneck because data is written as fast as the network connection allows within the backup window.

ESSENTIAL GUIDANCE

Adoption of flash storage in healthcare IT is on the upswing, especially as price per unit drops and the ever-increasing demand for more data storage continues to grow. IDC predicts that flash storage — both hybrid flash arrays and all-flash arrays — will dominate enterprise storage spend through at least 2020. Healthcare organizations considering all-flash storage as part of their IT infrastructure strategy should consider the following recommendations:

- **Assess the current state of storage performance.** The first step is to understand where the bottlenecks and resource constraints are by assessing the current state of storage

performance. This assessment will help identify the appropriate storage technology for your environment and prioritize where the addition of flash storage would be beneficial.

- **Evaluate current network performance.** Storage area network (SAN) infrastructure if not configured correctly for all flash can result in bottlenecks. When configured correctly, investing in all flash means, for many health systems and workloads, taking storage out of the equation when troubleshooting infrastructure.
- **Understand current and future storage requirements.** The volume, velocity, and variety of healthcare data will continue to grow as healthcare providers look to add more data sources that will provide a 360-degree view of patients' health status. Flash storage with its scale-out architecture enables healthcare IT organizations to buy the storage they need today and have the flexibility to add storage as data storage needs grow.
- **Include the secondary economic benefits of all-flash storage to calculate a true TCO.** It is true that when AFAs first shipped in 2011, they were expensive and thus used for selective workloads. But prices of AFAs have dropped considerably in recent years. Secondary economic benefits that increase the return on investment and lower TCO include considerations such as reducing the number of devices needed to meet performance and capacity requirements. This reduction in devices translates into much lower energy and less datacenter floor space. Fewer application servers also result in lower software licensing fees. Softer costs include lower support costs because flash devices are more reliable and self-sufficient, resulting in lower administration costs.
- **Look for design efficiencies in flash-optimized platforms.** Important considerations include features that make the most out of flash capacity. These features include inline data reduction, thin provisioning, data protection with low overhead, and space-efficient snapshots. These features not only help boost performance and improve availability and reliability but also help lower TCO.
- **Consider flash storage when enterprise storage platforms come up for a technology refresh.** Increasingly, all-flash arrays are showing themselves to be price competitive, especially when secondary economics are taken into consideration. Healthcare IT organizations should consider enterprise-class all-flash arrays that offer a proven track record for delivering "five-nines plus" availability in the field.

ABOUT PURE STORAGE FLASHBLADE

FlashBlade is a turnkey solution packaged as an appliance, preconfigured with necessary hardware and software and including a highly scalable object store that supports both NFS and S3 access and an integrated, enterprise-class switch fabric. Appliances are much easier and faster to install, expand, and/or reconfigure than DIY approaches researchers must assemble themselves, and a single FlashBlade system that supports over 500,000 IOPS can be unpacked and installed in under an hour. Bundled data services, including a dual-parity RAID implementation for data protection and encryption, make it easy to protect and secure data. One or more FlashBlade systems can be managed through a web-based graphical user interface and are monitored through Pure1 — Pure Storage's cloud-based predictive analytics platform that continuously monitors any attached systems across the internet, managing systems to Pure Storage's high standards for system availability (a proven 99.9999% across the company's entire installed base of thousands of FlashArrays). Pure1 also aids in capacity planning and provides a wealth of statistics about system utilization, performance, and health status in easy-to-understand graphics instantly available from anywhere. Like the FlashArray//m, FlashBlade is self-managing, with no requirements for tuning, caching, or other administrative complexities required with traditional storage platforms, making storage management very simple. FlashBlade's object store is

fully distributed, supporting very consistent flash performance with varying workloads and efficient, well-balanced utilization of resources as systems are scaled. The scale-out architecture lends itself very well to delivering well-balanced performance across a wide range of scalability and automatically distributes workload across new system resources as they are added without any manual involvement. Because host connections are based on high-performance industry-standard Ethernet (see *Accelerating High-Concurrency Genomics Workloads: Driving Better Patient Outcomes in Life Sciences,* IDC #US42374917, March 2017), it is simple to scale server-side attachments into the thousands without having to bring in Fibre Channel (FC) or other storage protocol-specific expertise. Scale-out, fully distributed designs like what FlashBlade uses will dominate not only genomics and other life science workloads but also most big data and analytics environments. Legacy scale-up designs do not offer as wide a range of balanced scalability, which is important when storage capacities grow from terabytes to petabytes and beyond, and generally do not offer as simple a technology refresh model or the same elegance in availability management as FlashBlade systems.

PARTING THOUGHTS

Healthcare organizations no longer need to choose between price and performance when considering technology solutions to support growing patient data needs. Falling flash storage prices combined with secondary economic benefits such as a smaller footprint, lower energy costs, and fewer servers to license mean that flash can be used for primary storage beyond only mission-critical applications. In addition to the IT benefits — resiliency, durability, performance, and optimized virtualization — flash storage can help change how clinicians practice medicine because they will have faster access to health information and clinical insights than ever before.

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