# IBM

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# **IBM FlashSystem storage**

A prescription for Epic requirements

# Unique storage challenge

In most use cases involving flash storage deployments, the business environment changes, driving a need for higher-performance storage. However, the case of Epic Systems Corporation software is the opposite—the storage requirements haven't changed recently, but the options for addressing them have.

Epic, a privately-held company founded in 1979 and based in Verona, Wisconsin, makes applications for medical groups, hospitals and other healthcare organizations. Epic software typically exhibits highfrequency, random storage accesses with stringent latency requirements. IBM has been working with Epic to develop host-side and storage-side solutions to meet these requirements. Extensive testing has demonstrated that the combination of IBM® POWER8<sup>TM</sup> servers and IBM FlashSystem<sup>TM</sup> storage more than meets the performance levels Epic recommends for the backend storage supporting its software implementations—at a cost point multiple times lower than other storage alternatives.

## Award-winning Epic software

Epic's integrated electronic medical record (EMR) software covers all aspects of healthcare operations, including clinical, billing and revenue, in addition to patient record access. Epic software implementations employ two main database technologies. The online transactional processing (OLTP) database runs Caché from InterSystems Corporation as the main OLTP database engine. In addition, Epic applications use analytical databases that run on Microsoft SQL Server or Oracle database software. The analytical database component has the highest bandwidth but the Caché OLTP database performance is by far the most critical to end-user satisfaction and, consequently, is where most of the attention on storage performance has been focused. As shown in Figure 1, Epic uses one of two types of implementation architectures, depending on the demands of the customer environment. The single symmetric multiprocessing (SMP) database server architecture provides the greatest ease of administration. Beyond the scalability limit of the SMP architecture, a tiered database architecture using Caché Enterprise Cache Protocol (ECP) technology is required. This tiered architecture retains a central database server with a single data storage repository, but unlike the SMP architecture, most processing needs are offloaded to application servers. The application servers contain no permanent data. This architecture offers increased scaling over the SMP architecture.

#### World-class IBM FlashSystem storage

The extreme performance, ultra-low latency, macro efficiency and enterprise-grade reliability offered by IBM FlashSystem storage arrays provide practical, cost-effective solutions to address the data challenges associated with healthcare application environments such as Epic's. Flash technology has



Figure 1: Epic reference implementation architecture.

Healthcare

transformed storage, enabling healthcare enterprises to extract extraordinary value and derive greater efficiencies from their high-velocity, high-volume data sets. Additionally, the IBM FlashSystem V840 storage server provides a wide range of enterprise-grade management and feature-rich storage services deeply integrated with the underlying hardware architecture to eliminate unacceptable latency penalties. Altogether, IBM FlashSystem storage provides multiple options for healthcare providers seeking to meet high-velocity data requirements, increase system efficiency, reduce IT costs and improve patient outcomes.

Most important to addressing the ever-escalating healthcare OLTP workloads, the IBM FlashSystem architecture is designed with IBM MicroLatency<sup>™</sup> to speed response times, delivering reads and writes in the hundred-microsecond range. Storage latency affects the performance and efficiency of mission critical healthcare applications. When hundreds of patients or their healthcare providers are simultaneously accessing and updating EMR information throughout a hospital campus or across the globe, database response times are the throttle that determines how quickly the data arrives in surgery or customer support. Few industries outside of the financial sector may be as storage-latency sensitive as the healthcare system. No storage array delivers lower latency at a lower cost and with higher reliability and efficiency than IBM FlashSystem.



Figure 2: IBM FlashSystem 840 storage array.

In addition to focusing on ultra-low latency, the engineers of IBM FlashSystem storage products also optimized Input/ Output Operations Per Second (IOPS) and bandwidth. The resulting extreme performance ensures that as healthcare workloads increase, files grow in size and there is a greater demand for response speed, IBM FlashSystem storage products continue to scale performance without latency degradation. Also, IBM FlashSystem products deliver macro efficiency, with compact physical capacity, up to 95 percent reduction in energy consumption and much higher CPU utilization rates resulting from orders of magnitude lower storage response times. Other key elements are enterprise reliability and serviceability. The all-flash arrays employ two redundant array of independent disks (RAID) dimensionsthe patented IBM Variable Stripe RAID™ at the flash module level, as well as system-wide RAID-resulting in more data protection levels than are available from competing systems. This level of protection, coupled with the no-single-point-offailure design of the IBM FlashSystem products, is critical in healthcare environments where data loss is unacceptable. Moreover, for healthcare customers with data that requires an extra layer of protection in order to adhere to internal or regulatory requirements, IBM FlashSystem products support Advanced Encryption Standard (AES) 256 hardware-based data-at-rest encryption with no impact on performance.

# Epic storage requirements

The Epic application can generate considerable data traffic to and from its backend databases, especially when the demands of various types of analytics processing are added to the mix. To ensure successful deployments, Epic has documented baseline host- and storage-system performance requirements and provides these to its customers in a hardware configuration guide that is part of Epic's system deployment services. Epic proactively researches and tests various thirdparty hardware and software products and architectures with which their software will normally be implemented. The results of this testing and ongoing research are used to periodically update their hardware configuration guide. The production OLTP database server has stringent storage response requirements for both reads and writes in order to ensure acceptable response times for interactive user workflows. Table 1 shows the random read service time requirements to maintain good application level performance on the production Caché database server. These response time targets are measured at the application level.

Average for very large ECP configurations	≤8 ms
Average for typical ECP configuration	≤12 ms
Average for SMP configuration	≤15 ms
99.0%	≤60 ms
99.9%	≤200 ms
99.99%	≤600 ms

Table 1: Random read response time targets provided by Epic

The Caché database on which the Epic application runs has a write cycle of 80 seconds. The flush of writes from the database must be completed well before the next write cycle begins, even under the heaviest of workloads. The expected flush size is provided by Epic in their customer hardware configuration guide. Table 2 shows general write service time requirements.

Average random write service time for typical SMP configuration	≤1.0 ms
Average random write service time for typical ECP configuration	≤0.6 ms

Table 2: Random write response time targets provided by Epic

The data access profile for Epic OLTP environments is essentially 100 percent random. This requires fast storage access with little opportunity to take advantage of I/O read-aheads or the optimal use of storage cache. Epic monitors onsite performance metrics and alerts customers if performance thresholds are reached. In order to meet and, most important, maintain these recommended baseline levels of storage performance when using disk-based systems, Epic software customers often deploy expensive high-performance configurations that improve performance but also drive up cost and complexity.

### Prescription for performance

Epic and IBM maintain a close technical relationship through continual exchange of information by way of regular meetings, road maps and the like that fosters a thorough understanding of each others' products and what does and doesn't work. Epic regularly uses IBM Benchmark Centers or onsite IBM hardware to collect performance data. This close relationship is valuable for customers, because it has resulted in a deep collaboration in resolving customer issues. Though Epic is "vendor agnostic" and does not certify or support vendor hardware, they add new IBM technologies based on their customer recommendations, when appropriate.

With the introduction of the IBM FlashSystem 840 storage product and, more recently, the IBM FlashSystem V840 storage product, flash solutions are becoming less expensive than traditional high-performance disk storage solutions, while providing orders of magnitude better performance at



Figure 3: IBM FlashSystem V840 storage array.

operationally less cost. IBM FlashSystem V840 combines the high-performance, ultra-low latency, very efficient and extremely reliable IBM FlashSystem 840 platform with a rich set of advanced storage features, such as real-time compression, dynamic tiering, thin provisioning, copy services and high-availability configurations.

#### **Test results**

Epic software testing with IBM FlashSystem storage was conducted using a tool (GenerateIO) provided by Epic which closely models the I/O load profile of the Caché database. The configuration consisted of one IBM FlashSystem V840 storage unit (16 core controller, 40 TB flash, code level v7.3) array and one IBM Power Systems<sup>™</sup> S824 (24 POWER8 cores, 512 GB, 8x8 Gb FC ports, IBM AIX® 7.1 TL3 SP3) server. The Power Systems family provides flexible computing resources designed for the most mission-critical applications, with higher utilization, performance and scalability than previously available. Engineered to bring insights to the point of impact, these first-generation systems are the ideal platform for analytic applications that require exceptional computing power, memory bandwidth, I/O and smart acceleration. These new systems extend a heritage of resiliency, availability and security for big data and analytics, and scale to meet the most demanding data-processing requirements.

Table 3 provides IBM FlashSystem V840 storage array results from the testing compared to Epic system requirements.

The test was conducted using the standard Caché database 80-second write burst data stream profile common to Epic software function, with a 45-second write burst limit. With these limited workloads, the IBM FlashSystemV840 array sustained an impressive 0.39 ms read latency and 45-second write cycle at 85,000 IOPS, nearly three times more than required by a typical large-customer Epic deployment. The results above were achieved with the controller cache node disabled for maximum performance. With the controller cache enabled, the IBM FlashSystem V840 array still achieved spectacular results of 75,000 IOPS and 0.41 ms average latency.

Epic recommends daily full backups using SAN-level pointin-time full copies. To test I/O performance during the backup window, the test team used the integrated management features of the IBM FlashSystem V840 storage array to implement incremental IBM FlashCopy® functionality. FlashCopy delivers high levels of data protection, using advanced snapshot technologies, and helps manage frequent, near-instant, non-disruptive, applicationaware backups and restores. When this configuration was tested, the results also surpassed all Epic system requirements.

Metric	Epic requirement	IBM FlashSystem V840
I/O per second write burst within 45s	36,000 IOPS very large Epic workload	85,000 IOPS
Average read	<8 ms	0.39 ms
99% of all I/O	<60 ms	1.96 ms
99.9% of all I/O	<200 ms	3.11 ms
99.99% of all I/O	<600 ms	5.59 ms

Table 3: Epic test results with IBM FlashSystem V840 and IBM POWER8

Table 4 provides a comparison of tests performed by IBM using the IBM FlashSystem V840 array and a highperformance SSD-based system equivalent to those most commonly deployed currently by Epic customers, and then additional test results comparing the IBM FlashSystem V840 array to an array using high-performance disks.

In addition to outperforming high-end disk and SSD-based storage arrays by up to 55 percent, the IBM FlashSystem V840 array also achieved very low random read latency—90 percent lower than high-end disk and 40 percent lower than SSDs.

Finally, Figure 4 provides a comparison of the IOPS profiles for each storage array for the 80-second write burst test with the 45-second write burst limit, modeling the system requirements recommended by Epic. The IBM FlashSystem V840 array achieved greater IOPS—23 percent better performance than high-end disk arrays and 55 percent better performance than high-end SSD arrays. The IBM FlashSystem V840 array more than meets the performance levels Epic recommends for the backend storage supporting its software implementations. Testing demonstrated that the IBM FlashSystem V840 and POWER8 combination provides read latency at a staggering 20 times below Epic's recommendations and 11 times faster than equivalent disk-based storage. At a 45-second write burst limit, the IBM FlashSystem V840 array doubled the IOPS recommendation. And the IBM solution finished 99.99 percent of all I/O over one-hundred times faster than the 600 ms performance target. But perhaps the most important result to note from the testing effort is that the IBM FlashSystem V840 array used to achieve the testing results was more than four times less expensive than the SSD-based system tested, proving that IBM FlashSystem storage products offer a cost-effective storage solution for Epic customers.

Storage tested	Maximum IOPS	Random read latency (ms)
IBM FlashSystem V840 (12 flash modules)	85,000	0.39
High-end disk array (1,536 disks)	69,000	4.30
High-end SSD array (128 SSDs)	57,000	0.63

Table 4: Comparison of high-performance disk and SSD storage to IBM FlashSystem V840

# IBM FlashSystem storage meets Epic challenges

Unlike most narratives involving flash, when it came to Epic software, the storage requirements didn't change; the available solutions did. IBM FlashSystem storage products now offer cost-competitive alternatives to hard disk-based systems that also include the reliability, data protection and storage management features demanded by the healthcare industry and recommended for Epic software.

More and more, IT is playing an increasingly prominent role in both supporting and helping drive positive outcomes within the healthcare system. Patient information needs to arrive at the point of service quickly, EMR information must be shared efficiently, medical images need to arrive in surgeries and doctors' offices in near real-time, reports must be accurate and secure, analytics need both depth and speed, and medical billing must get done in a flash. Each of these requirements demands high-velocity systems, and the performance of the backend data storage directly impacts the effectiveness of the solution.

With IBM FlashSystem storage, IBM set out to redefine the dynamics of data storage in high-velocity, high-volume environments such as those found in healthcare. With unprecedented investment and commitment to the technology, global solution design and implementation support and an unmatched suite of extreme performance, low latency and high-efficiency capabilities, IBM FlashSystem storage is fast becoming the new tool of choice for leading healthcare enterprises determined to thrive in an environment where speed can directly affect outcomes.



# Epic GenerateIO longest write cycle

Figure 4: Comparison of IOPS during Epic write cycle.

### For more information

To learn more about the IBM FlashSystem 840 and IBM FlashSystem V840 storage solutions, please contact your IBM representative or IBM Business Partner, or visit the following websites:

- ibm.com/systems/storage/flash/840
- ibm.com/systems/storage/flash/v840



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It is the user's responsibility to evaluate and verify the operation of any other products or programs with IBM products and programs.

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