EMC SOLUTIONS FOR OPTIMIZED EPIC EMR ENVIRONMENTS
Redefining your environment for application services, consolidation, and agility

ABSTRACT
Healthcare organizations face mounting challenges to "do more with less" and reduce costs while implementing new EMR technologies such as the Epic Care EMR. To address these challenges, the EMC XtremIO® all-flash storage solution provides healthcare delivery organizations with a consistently high-performance, highly efficient infrastructure to achieve more value from their Epic environment with fewer resources. This white paper presents test results with XtremIO in an Epic environment that show how XtremIO data services shrink the complete Epic data footprint by more than 70 percent. Also covered are test results that demonstrate how XtremIO performance exceeds Epic service level requirements by a wide margin. Ultimately, this paper validates XtremIO as a solution that can help healthcare providers accelerate their strategic objectives of improving patient care and decreasing costs.

February 2015
# TABLE OF CONTENTS

## EXECUTIVE SUMMARY

- EXECUTIVE SUMMARY.................................................................................................................4

## INTRODUCTION

- INTRODUCTION .......................................................................................................................... 5
  - EVOLVING EPIC AND INDUSTRY REQUIREMENTS.................................................................5

## REDEFINING APPLICATION SERVICES, CONSOLIDATION, AND AGILITY FOR EPIC

- REDEFINING APPLICATION SERVICES, CONSOLIDATION, AND AGILITY FOR EPIC........5
  - XtremIO Meets Epic Challenges Head On ..............................................................................5
  - In-line, Scale-Up and Scale-Out Architecture........................................................................5
  - a rich set of always-on data services....................................................................................6

## A CONVERGED INFRASTRUCTURE FOR EPIC

- A CONVERGED INFRASTRUCTURE FOR EPIC .................................................................7

## ARCHITECTURE FOR CACHÉ AND COGITO CLARITY

- ARCHITECTURE FOR CACHÉ AND COGITO CLARITY ..................................................8

## VALUE ACROSS THE EPIC LANDSCAPE

- VALUE ACROSS THE EPIC LANDSCAPE .................................................................................9
  - PROTECTING EPIC PATIENT DATA......................................................................................9
  - XtremIO delivers HIGH Performance and Efficiency for Caché ........................................10
  - XtremIO Exceeds Epic SLAs .................................................................................................11
  - RICH SET OF DATA SERVICES...........................................................................................12

## HIGH THROUGHPUT FOR COGITO CLARITY

- HIGH THROUGHPUT FOR COGITO CLARITY ........................................................................13
  - HANDLING LARGE BLOCK READS FOR SQL SERVER Workloads .......................................14

## VIRTUAL DESKTOPS DEMANDING TOP PERFORMANCE

- VIRTUAL DESKTOPS DEMANDING TOP PERFORMANCE ..................................................14
  - GROWING Virtual desktop environments..........................................................................15

## SERVICES SERVERS: STRONG USE CASE FOR DEDUPLICATION

- SERVICES SERVERS: STRONG USE CASE FOR DEDUPLICATION ....................................17

## CLINICAL ARCHIVING FOR LEGACY SYSTEMS

- CLINICAL ARCHIVING FOR LEGACY SYSTEMS ...............................................................17

## PROFESSIONAL SERVICES ACCELERATE TIME-TO-VALUE

- PROFESSIONAL SERVICES ACCELERATE TIME-TO-VALUE ........................................17

## CONCLUSION

- CONCLUSION ..............................................................................................................................18
EXECUTIVE SUMMARY

Healthcare organizations face enormous challenges to reduce costs while continuing to invest in critical EMR technologies. These challenges are expected to intensify as the government rolls out new requirements for meaningful use, including additional security and data protection regulations.

The Epic EMR with its Caché and Cogito databases present unique workloads that are increasingly difficult for traditional disk-based storage to handle without over-provisioning. Epic environments also contain numerous copies of the databases to support a wide range of ancillary processes. This requires an even greater investment in traditional storage capacity.

The XtremIO all-flash storage solution addresses these challenges by delivering outstanding performance and efficiency for Epic environments. It offers high throughput and consistently low latency that easily handle Epic's demanding workloads.

In addition, XtremIO provides an array of data services, such as instant snapshots, always-on, inline deduplication, and compression to minimize the proliferation of data across the Epic infrastructure. XtremIO also delivers inline data services such as thin provisioning, flash data protection, and encryption. What this means for an Epic IT environment is a dramatically reduced storage footprint with less complexity and easier to manage, and reduced capital and operational expense.

This white paper presents technical evidence to validate how XtremIO provides breakthrough performance in Epic environments. EMC conducted laboratory tests of three key Epic workloads: Caché, Cogito Clarity, and VDI. For each workload, Epic-specified requirements, test environment descriptions, and test results are described. A sizing example based on an actual customer implementation is also included.

XtremIO advanced data services such as deduplication, data compression, thin provisioning and on-demand writeable snapshots deliver transformative potential for Epic IT environments. Such services demonstrate the ability to shrink the Epic data footprint by more than 70 percent when compared to traditional storage infrastructure.

With XtremIO, healthcare providers will be able to achieve higher performance with fewer resources in Epic environments, all without sacrificing security or data protection. Quite simply, XtremIO holds the key to increasing the value of Epic for patient care while lowering costs, as well as achieving and maintaining regulatory compliance.
INTRODUCTION

The Epic electronic medical record (EMR) solution is a powerful, integrated system that enables clinicians to diagnose, treat, and manage patient care with great precision and efficiency. The Epic solution also allows healthcare delivery organizations to meet incentives established by the Health Information Technology for Economic and Clinical Health (HITECH) Act for adopting meaningful use. As an EMR, Epic is one of the most important and significant investments a healthcare organization can make today.

E Volving Epic and Industry Requirements

Epic is already a broad-reaching solution that places considerable demands on a healthcare provider’s underlying IT infrastructure. As the industry evolves, those demands only are going to intensify.

Epic comprises several interdependent workloads: Caché database, Cogito analytics and reporting, virtual desktop infrastructure (VDI), and numerous virtual servers for ancillary services. Each workload has specialized characteristics and stringent service level requirements set by Epic. Traditional infrastructures often struggle to meet these demands and can become resource-intensive and costly to maintain.

Epic environments are rife with duplicate data due to the need to maintain multiple database copies used for analytics, reporting, test and development, and other processes. To accommodate this extra data, healthcare IT must continually add storage, further increasing costs. Creating these copies is also problematic. Cloning the Caché database onto traditional spinning disk can take hours. This forces administrators to clone during off-peak hours to avoid compromising production performance.

To handle growth more quickly and efficiently, healthcare organizations are moving toward the software-defined data center. This transition will enable them to expand their environments easily by moving select workloads in and out of a hybrid cloud as performance and capacity requirements surge and diminish.

Over time, there will be increased demand for data sources that provide valuable insights from data within and external to Cogito analytics. These data lakes, which will consolidate multiple disparate data sources of both structured and unstructured data, will become the standard for clinical research and help enhance patient care and operational efficiency.

In addition, increasing volumes of patient information, medical data, and business intelligence will require data- and patient-centric security to protect healthcare providers from cyber threats and ensure their compliance with HIPAA, HITECH, and the Affordable Care Act.

Redefining Application Services, Consolidation, and Agility for Epic

XTREMIO MEETS EPIC CHALLENGES HEAD ON

XtremIO is equipped to meet current and future challenges facing Epic environments. XtremIO is an all-flash, scale-out storage array that is fully supported on Linux and VMware ESX operating environments, as well as UNIX environments, including AIX and HP-UX.

The XtremIO architecture is designed to provide the Epic IT environment with greater performance, scalability, efficiency, and data protection.

The EMC solution delivers consistently high performance for Epic workloads, far exceeding Epic service level requirements and providing a superior user experience. Data throughput, latency, and capacity utilization remain predictable and consistent, even as system demands increase.

IN-LINE, SCALE-UP AND SCALE-OUT ARCHITECTURE

In a recent EMC-sponsored survey, hospital IT executives reported they expect data from their EMR environments to grow by an average of 48 percent in 2015.

To manage this explosive growth, Epic users would benefit from the XtremIO unique architecture and scale-out design that delivers investment protection with linear scalability to more than one million IOPS. XtremIO uses X-Bricks, which are building blocks that can be easily clustered when additional performance and capacity are required. Unlike traditional scale-up flash arrays, X-Bricks allow XtremIO to use all resources evenly across the cluster and provide long-term investment protection.

In this architecture, capacity continues to grow while consistent performance and throughput are maintained as nodes are added to the system (Figure 1). Additional workloads are easily supported as new nodes are added. Such additional workloads may use XtremIO data services and consistent performance to scale out and meet increasing IOPS, capacity and bandwidth requirements.
A RICH SET OF ALWAYS-ON DATA SERVICES

XtremIO offers a rich set of always-on data services. For example, inline compression and deduplication shrink data volumes dramatically to reduce storage capacity for Epic. (Figure 2) Unlike other solutions, XtremIO with not write duplicate data to disk regardless of intensity of demand. This eliminates the need for post-processing to achieve data reduction. In addition, XtremIO does not perform any system-level garbage collection. Instead, XtremIO uses advanced SSD functionality to continuously handle “garbage collection” and completely avoid system performance penalties.

In addition, XtremIO incorporates advanced security data-at-rest encryption. This capability allows healthcare organizations to comply with evolving HITECH requirements without investing in additional technology. XtremIO also features agile, writeable snapshots for generating copies of the Caché database while maintaining high performance of production workloads. XtremIO creates snapshots, avoiding metadata bloat and the need for extra storage space. This empowers healthcare organizations to create and use copies of Epic data as needed without consuming additional storage capacity or IT resources for management.
While delivering these powerful capabilities, XtremIO also helps healthcare organizations reduce total cost of ownership. The system requires fewer drives to do the same work as traditional spinning disk, decreasing physical storage footprint. XtremIO is simple to configure and manage, without the need for tuning or extensive planning. As a result, IT spends less time and money maintaining operations and achieves significant operational savings.

A CONVERGED INFRASTRUCTURE FOR EPIC

To optimize an Epic environment EMC recommends a converged infrastructure. Epic users rely on VCE Vblock systems from EMC for the fastest deployment of infrastructure and applications, the highest application performance and availability, and the lowest TCO. The Vblock 540 System is the industry’s first all-flash-based converged infrastructure, incorporating the next-generation Cisco Unified Computing System and ACI-ready network, and industry-leading VMware virtualization. With Vblock systems Epic users can we simplify integration into existing and emerging management frameworks, providing complete system context of configuration and health to introduce a new era of converged operations for IT infrastructure. Through focused integration with leading applications a Vblock converged infrastructure simplifies application deployment and operations to deliver data protection, virtualization, and simplified management of pools of storage resources across the healthcare enterprise.

EMC’s architecture for Epic is depicted below in Figure 3.

Vblock systems are engineered by VCE working in concert with Cisco, and VMware, are manufactured and delivered as an integrated product, and are supported as one product by VCE.

Although EMC recommends Vblock Systems because they enable fast deployment of Epic infrastructure and applications, and enhance application performance at a low total cost of ownership, Epic users always have the option of building and supporting their Epic infrastructure with components of their choice.
ARCHITECTURE FOR CACHÉ AND COGITO CLARITY

EMC has developed an XtremIO architecture that meets all of Epic’s specifications and best practices for performance, high availability, and recoverability. Because data in the Epic Caché database is irreplaceable and cannot be regenerated, utmost data availability must be assured.

To protect against catastrophic data loss, a secondary data recovery methodology must be in place. To support the greatest level of data resiliency, Epic strongly recommends storage of the Caché database on separate media from the associated journal files to ensure data protection and recoverability. The reference architecture shown above includes two XtremIO arrays in the primary data center. One array is dedicated to the production Caché database, report shadow, support, clones, and virtual machines (VMs) for services servers. The second array is a multipurpose cluster for the journal files, Cogito Clarity reporting database, Cogito Data Warehouse, and various test environments. The XtremIO arrays could be part of a Vblock 540 configuration or stand-alone as depicted in figure 4.

For business continuity, this architecture includes an EMC storage array in a secondary data center. To simplify managing the environment, healthcare providers can use the EMC VPLEX® storage virtualization solution depicted in the architecture above to present multiple XtremIO arrays as a single array while achieving the separation Epic recommends.

Healthcare IT teams may choose to use EMC ViPR® software-defined storage management solution to centrally automate provisioning and delivery of XtremIO resources. To help increase operating efficiency and streamline management, EMC also provides ViPR as a single management interface for all of the arrays in the Epic infrastructure. ViPR aggregates physical storage into virtual arrays and provides administrative control to manage XtremIO and Isilon storage, compute and networking resources, as well as Epic databases. ViPR also provides direct integration to VMware for complete management and monitoring of the VDI and virtual machine environments.
VALUE ACROSS THE EPIC LANDSCAPE

PROTECTING EPIC PATIENT DATA

For local protection and high availability, Epic requires mirroring of the Caché database using built-in Epic replication technologies. EMC augments Caché mirroring with EMC VPLEX virtual storage to achieve near active-active operations across campus data center sites for numerous functions. VPLEX enables two separate campus-based data centers to act as one, providing simultaneous access to storage from either site. If connectivity to Epic is lost at one data center, it automatically continues to run from the other data center without disrupting clinical services.

VPLEX also provides the flexibility to relocate workloads from one site to another and minimize planned downtime for maintenance or upgrades. Adding EMC RecoverPoint® to the VPLEX environment for non-Caché environments provides continuous data protection by enabling providers to restore data to a specific point in time. (Figure 5) This powerful combination of VPLEX and RecoverPoint provides healthcare organizations with a highly efficient means to recover instantly data for compliance purposes and strong protection against data loss.

Figure 5. Continuous Protection of Epic Environments with VPLEX and RecoverPoint

In addition, EMC provides a complete enterprise backup solution with The EMC Data Protection Suite and Data Domain® deduplication storage systems. (Figure 6) Enabling daily full backups and single-step recovery, Data Domain provides healthcare organizations with a single solution for backing up all of their Epic data, as well as data residing in other environments. Data Domain deduplicates data during the backup process and can reduce backup volumes 10-30 times, as well as save space and lower costs. Data Domain Replicator software provides safe offsite storage that eliminates the need for tape. Data Domain is ideal for large and growing Epic environments because it easily scales by simply adding appliances.
The Epic application uses a wide variety of data sets. In addition to the production database, which is based on Caché, Epic also uses SQL or Oracle data warehouse and reporting instances, Web Binary Large Object (BLOB) file space and various Citrix and VMware data sets that require a combination of full and incremental backups.

Epic’s diverse data types and backup requirements require a comprehensive backup and recovery solution designed to meet the most stringent SLAs. EMC’s Data Protection Suite software and EMC Data Domain provide a complete enterprise solution with a rich feature set and flexibility to address each unique use case. The combination of multi-streaming and Data Domain Boost distributed processing delivers the robust performance needed for both backup and recovery of the Epic environment.

**XtremIO DELIVERS HIGH PERFORMANCE AND EFFICIENCY FOR CACHÉ**

One of the primary use cases for XtremIO is the Caché database—the central source for patient data that feeds all other processes and workloads in the Epic environment. The database runs on physical UNIX or is virtualized with Linux using VMware vSphere.

As a post-relational, transactional database, Caché presents several challenges, which are outlined in Table 1. First, the database has nearly 100 percent random reads, creating highly unpredictable I/O on the storage array. In addition, Caché has a write burst that is flushed out to disk every 80 seconds. To ensure an acceptable user experience, Epic requires this write burst to complete in less than 30 seconds. Epic also specifies an average write latency of less than one millisecond while sustaining a read latency of less than 15 milliseconds.

<table>
<thead>
<tr>
<th>Read/Writes</th>
<th>Must assume 100% random reads/writes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Read Latency</td>
<td>Less than 15 milliseconds</td>
</tr>
<tr>
<td>Average Write Latency</td>
<td>Less than one millisecond</td>
</tr>
<tr>
<td>Write Bursts</td>
<td>Flushed every 80 second; must be completed in 30 seconds to ensure positive user experience</td>
</tr>
<tr>
<td>Destaging</td>
<td>All Flash Array must handle write flushes without destaging</td>
</tr>
</tbody>
</table>

**Table 1 Epic Performance Requirements for Caché database**

To meet end-user performance requirements with traditional spinning disks, healthcare IT often needs to over-provision the Epic storage environment using traditional spinning media arrays. As the Caché database grows and mechanical disks are added to keep up with growing demand, healthcare organizations often encounter performance and latency problems. This leads to an inconsistent PHI availability and user experience, as well as increasing capital and operating expenses.
**XtremIO EXCEEDS EPIC SLAs**

The all-flash XtremIO array is ideal for handling highly randomized workloads such as Caché. For validation, EMC created a test environment comprised of two XtremIO X-Bricks. EMC also configured the environment with four host bus adapters (HBAs) and two front-end ports on the XtremIO array to support the Caché database I/O. EMC PowerPath software provided automated data path management and load balancing for the test environment. Finally, EMC used Epic's GenIO utility to accurately simulate production I/O of Caché workloads.

Running Caché workloads on XtremIO delivered consistently high performance and low latency levels that far exceeded Epic's established SLAs. And with its thin provisioning capability, XtremIO achieved these results without over-provisioning.

In handling Caché's random reads, XtremIO thoroughly eliminated any latency issues. While the maximum read latency Epic will tolerate is 15 milliseconds, XtremIO did not exceed 1.3 milliseconds during the tests. Figures 7 and 8 show EMC lab results testing Epic GenIO running on XtremIO 3.0 for read and write latency ranging from zero to more than 70,000 IOPS.

XtremIO consistently maintained extremely low latency even as the tests scaled from zero to more than 70,000 IOPS. This provides healthcare organizations with an enormous amount of headroom for growth. In addition, XtremIO is able to deliver these performance results with active snapshots running. This means that Epic users can create clones during the busiest production hours without compromising performance. They also can refresh their snapshots more frequently at any time of day or night.

Similarly, XtremIO performance also exceeded Epic's write SLAs for Caché. (Figure 8) EMC ran tests in the range of 3,000 to 40,000 IOPS per second with latency measured in microseconds.
To meet Epic’s established SLA, write latency cannot exceed one millisecond. EMC’s tests showed that XtremIO delivered consistent write latency as IOPS scaled, never exceeding 200 microseconds or 0.2 milliseconds. This opens opportunities for healthcare organizations to explore extended clusters or other infrastructure designs for enhanced data mobility and disaster protection. Healthcare providers can reduce risk, downtime, and cost of their Epic infrastructures without concerns about exceeding the write latency SLA.

**RICH SET OF DATA SERVICES**

Not only does XtremIO provide exceptional performance, but it also offers value with always-on data services, such as deduplication and compression. While Epic specifies a minimum of six full copies of the Caché database in the EMR environment, EMC has found that most healthcare organizations use at least 12 full-sized copies. EMC has developed a set of rigorous sizing rules based on sizing methodologies, lab testing, and field validation of nearly 200 Epic customers. The sizing comparisons in Tables 2, 3, and 4 is based on these inputs.

By employing inline deduplication and compression, XtremIO dramatically reduces the total amount of storage capacity and associated cost required for all of these copies. For example, EMC compared sizing for a 9.3 terabyte Caché database between traditional spinning disk and XtremIO. Traditional disk technology required 179 terabytes to support the original database, including all of the copies and required Epic storage pools. (Table 2)

### Disk Sizing

<table>
<thead>
<tr>
<th>Epic Pool Number</th>
<th>Epic Storage Function</th>
<th>Epic Capacity Required</th>
<th>Disk Model</th>
<th>Array</th>
<th>Min. Drive Count</th>
<th>Capacity (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pool 1</td>
<td>Production database</td>
<td>9,600</td>
<td>300GB 15K</td>
<td>Production</td>
<td>164</td>
<td>22,099</td>
</tr>
<tr>
<td>Pool 2</td>
<td>Reporting data, production journal</td>
<td>13,600</td>
<td>300GB 15K</td>
<td>Production</td>
<td>112</td>
<td>15,030</td>
</tr>
<tr>
<td>Pool 5</td>
<td>Clarity and production release &amp; testing environments</td>
<td>59,300</td>
<td>600GB 15K</td>
<td>Production</td>
<td>164</td>
<td>66,026</td>
</tr>
<tr>
<td>Pool 6</td>
<td>VMs, BLOB, Archiving</td>
<td>33,850</td>
<td>300GB 15K</td>
<td>Production</td>
<td>188</td>
<td>37,844</td>
</tr>
<tr>
<td>Pool 8</td>
<td>Clones for nightly backups</td>
<td>23,600</td>
<td>600GB 15K</td>
<td>Production</td>
<td>68</td>
<td>27,377</td>
</tr>
</tbody>
</table>

Production Array Totals - Prod on FC 696 178,741

Table 2: Epic Traditional Disk Sizing Table

In contrast, XtremIO deduplication supports that same 9.3 terabyte database and all of its copies with just 46 terabytes of all-flash capacity for the same configuration as defined by Epic from an Epic Preliminary Hardware Configuration Guide. (Tables 2 and 3)

That translates to a 73 percent reduction in storage footprint. The degree of consolidation of storage capacity requirements between traditional storage and XtremIO all-flash arrays varies by implementation and each end-user’s unique environment. Tables 3 and 4 are based on a recent XtremIO deployment for Epic.

### Production Database Cluster

<table>
<thead>
<tr>
<th>Epic Pool Number</th>
<th>Epic Storage Function</th>
<th>Epic Capacity Required (GB)</th>
<th>Consumed Capacity (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pool 1</td>
<td>Production Database</td>
<td>11,500</td>
<td>7,667</td>
</tr>
<tr>
<td>Pool 2</td>
<td>Reporting Data</td>
<td>11,700</td>
<td>1,560</td>
</tr>
<tr>
<td>Pool 5a, 8</td>
<td>Clones, support and backup</td>
<td>33,200</td>
<td>4,427</td>
</tr>
<tr>
<td>Pool 6a</td>
<td>Multipurpose VMs/Service Servers</td>
<td>6,380</td>
<td>2,552</td>
</tr>
</tbody>
</table>

Total Capacity Demand 62,780

Total Capacity Consumed 16,205

Table 3. Epic XtremIO Cluster Sizing with inline deduplication and compression
As additional testimony to the value of XtremIO, a customer using XtremIO for Epic discovered that two additional snapshots of the production Caché database required virtually no additional space when created. The healthcare provider had allocated 16 terabytes of space for the seven-terabyte production Caché database for growth. With thin provisioning and the addition of these two snap copies, a total of only 3.4 terabytes of storage capacity was required—a space savings of 80 percent. The customer also expects the overall efficiency rate of 19:1 to increase as more snapshots are generated. These powerful results come from XtremIO application services, such as thin provisioning, in-line deduplication and compression.

### HIGH THROUGHPUT FOR COGITO CLARITY

Another prime use case for XtremIO is Cogito Clarity, Epic’s integrated analytics and reporting environment. Cogito Clarity is a relational database, typically using Microsoft SQL Server. Historically, Cogito Clarity runs on physical servers, but more recently healthcare providers moving toward virtualized environments for this database environment.

The database supports the Cogito Clarity reporting engine, which generates thousands of Epic Care reports from general ledger to patient census and drug administration. It also feeds the Cogito Data Warehouse, which combines Epic data with data from other systems in the enterprise.

The Cogito Clarity environment has two key workloads that are different from Caché and present their own challenges to the underlying infrastructure. The first workload is Extract, Transform, and Load (ETL), which collects data from a copy of the Caché database, transforms it to match a SQL Server format, and writes data to the Cogito database. Data writes in the ETL process typically run at 25 to 500 megabytes per second or greater depending on the size of the environment and server capabilities. Consequently, throughput becomes one of the biggest challenges in traditional spinning disk storage systems due to physical limitations of a mechanical device.

The second key workload is reporting. Typically, the heaviest impact on the Cogito Clarity database is batch reporting, which often runs three to four hours, or even longer, performed nightly. During this process, database reads can push toward 800 megabytes or even one gigabyte per second. This level of read intensity can quickly overwhelm traditional disk-based storage systems.

EMC tested these SQL workloads on XtremIO to determine how well the all-flash array could handle the read/write demands. The test environment utilized an XtremIO 2X-Bricks cluster. EMC PowerPath software again provided automated data path management and load balancing to further optimize the test environment.
HANDLING LARGE BLOCK READS FOR SQL SERVER WORKLOADS

With six X-Bricks, XtremIO ingests data at a rate of up to 4.8 gigabytes per second. This rate is five to six times what is typically required and easily handles the largest Cogito Clarity workloads. The tests also showed that XtremIO excels in handling the large block sequential reads that Cogito Clarity demands.

In general, XtremIO has proven that it is very effective for heavy SQL Server workloads. EMC conducted a series of tests running nine SQL Server workloads concurrently on XtremIO. Even when workloads drove more than 4,200 transactions per second and 200,000 IOPS, XtremIO maintained high performance with consistent latency of less than one millisecond. (Figure 9)

VIRTUAL DESKTOPS DEMANDING TOP PERFORMANCE

Virtual desktop infrastructure (VDI) is becoming a critical environment for Epic as more clinicians and administrators seek greater mobility. The biggest challenge for most VDI environments is controlling the cost per desktop while delivering high performance and scalability.

Epic supports two VDI approaches: VMware Horizon View or Citrix XenDesktop. Horizon View allows organizations to deliver virtual desktops running the Epic Hyperspace application directly to the local user device as a single solution. XenDesktop provides remote delivery of Hyperspace but also needs to run on a VMware ESXi host to support the scale necessary required by many Epic environments.

XtremIO provides the I/O performance and scalability required to deliver a smooth and consistent end-user desktop experience for both Horizon View and XenDesktop environments. The I/O requirements for XenDesktop are higher than Horizon View and range from 20 to 40 IOPS per desktop, a level of performance that is difficult to achieve with traditional spinning disk. With its scale-out architecture and deduplication capability, XtremIO can sustain high performance and low latency for up to 3,500 Horizon View desktops or as many as 2,500 XenDesktop servers per X-Brick. The appropriate number of supported desktops for any deployment will vary depending on the configuration.
GROWING VIRTUAL DESKTOP ENVIRONMENTS

EMC tested XtremIO with Horizon View workloads in a laboratory setting on a VCE Vblock infrastructure configured with two XtremIO X-Bricks. (Table 5)

<table>
<thead>
<tr>
<th>VM Attribute</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop Operating System</td>
<td>Microsoft Windows 7 (Ultimate), 64-bit</td>
</tr>
<tr>
<td>VMware Virtual Hardware</td>
<td>Version 8</td>
</tr>
<tr>
<td>VMware Tools Version</td>
<td>9.4.10.2068191 (Up to Date)</td>
</tr>
<tr>
<td>Virtual CPU</td>
<td>2vCPU</td>
</tr>
<tr>
<td>Virtual Memory</td>
<td>2GB (Reserved)</td>
</tr>
<tr>
<td>OS Page File</td>
<td>2048MB</td>
</tr>
<tr>
<td>vNICs</td>
<td>1</td>
</tr>
<tr>
<td>Virtual Network Adapter Type</td>
<td>VMXNET3</td>
</tr>
<tr>
<td>Virtual SCSI Controller</td>
<td>LSI Logic SAS</td>
</tr>
<tr>
<td>Virtual Disk (VMDK)</td>
<td>32GB</td>
</tr>
<tr>
<td>Virtual Floppy Drive</td>
<td>In Place</td>
</tr>
<tr>
<td>Virtual CD/DVD Drive</td>
<td>In Place</td>
</tr>
<tr>
<td>Optimizations</td>
<td>VMware Windows7 NoPersona</td>
</tr>
<tr>
<td>Installed Software</td>
<td>Microsoft Office 2010</td>
</tr>
<tr>
<td></td>
<td>Horizon View Agent v6.0</td>
</tr>
<tr>
<td></td>
<td>LoginVSI Target SW v4.1.2</td>
</tr>
<tr>
<td></td>
<td>Adobe Acrobat Reader 10, Doro PDF Printer, FreeMind, Notepad</td>
</tr>
</tbody>
</table>

Table 5. XtremIO Test Configuration for Horizon View

The tests demonstrated outstanding desktop performance on XtremIO with strong deduplication and compression results. On average, storage latency for 100 virtual desktops was consistently under one millisecond. Desktop pools were deployed and all 1,000 desktops were powered on and ready to use in just 55 minutes. (Figure 10)

Figure 10. XtremIO Delivers High Performance to 1,000 Virtual Desktops
In addition, XtremIO achieved deduplication and compression rates expressed in ratios described in Table 6. Multiple test runs produced a range of deduplication and compression metrics. This table shows these ratios with the range of test results.

<table>
<thead>
<tr>
<th>Clone Type</th>
<th>Deduplication</th>
<th>Compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>5:1 to 15:1</td>
<td>1.5:1 to 2.2:1</td>
</tr>
<tr>
<td>Linked</td>
<td>2.5:1 to 4:1</td>
<td>1.4:1 to 2.2:1</td>
</tr>
</tbody>
</table>

Table 6. Guidelines on XtremIO Inline Data reduction Ratios for VDI

XtremIO also proved to be up to five times more efficient than traditional storage in recomposing virtual desktop pools. In a 1,000 desktop recompose in the XtremIO lab, EMC recorded approximately 30,000 IOPS at 850 megabytes per second, as depicted in the screenshot below. The 30,000 IOPS are mixed across multiple I/O sizes. (Figure 11)

![Figure 11. Typical Performance Profile for 1,000 Medium (Knowledge Worker) Users](image)

In this lab test, EMC observed an average of 850MB/s with peaks in excess of one gigabyte per second. (Figure 11). The 850 megabytes per second performance level equates to more than 100,000 8kB I/Os on the array backend, but the XtremIO reporting collates all I/O requests regardless of transfer size into a single front-end IOPS figure. This test was conducted with a single data store as a performance experiment.

![Figure 12. Typical Performance (Latency) Profile for 1,000 Medium (Knowledge Worker) Users](image)
During a 1,000-seat recompose, XtremIO supported 70,000 IOPS at 1,000 megabytes per second. Desktop pool maintenance operations also had little impact on existing user populations. This would eliminate the need for healthcare IT staff to schedule these activities on nights and weekends. By delivering virtual desktops so efficiently, XtremIO helps reduce the cost per desktop significantly.

SERVICES SERVERS: STRONG USE CASE FOR DEDUPLICATION

Epic Services Servers run a variety of Epic functions, from basic print and Web services to Federal Information Processing Standard (FIPS) reporting on controlled substance distribution. A typical Epic environment may contain anywhere from 20 to 50 services servers. Each services server is a virtual machine running VMware combined with Microsoft Windows. Data is comprised primarily of the Microsoft Windows operating system and tends to be highly repetitive from one services server to another. That makes the services server environment an ideal use case for XtremIO strong deduplication capabilities.

In addition, services servers have a demanding I/O profile similar to the virtual desktop infrastructure built on XenApp and VMware. With its clean-sheet, scale-out design that maximizes benefits from flash, XtremIO sustains high throughput with greater consistency and efficiency than traditional storage infrastructures.

In testing, EMC has determined that XtremIO will support I/O requirements of 2,500 virtual services servers on a single X-Brick. EMC also has documented that XtremIO provides deduplication rates of approximately 65 percent, substantially reducing the amount of storage space required for VM environments.

CLINICAL ARCHIVING FOR LEGACY SYSTEMS

Today’s Epic EMR solutions and the older legacy systems that share the same IT environment are generating increasing amounts of all types of patient-related information, such as clinical and administrative documents, voice recordings, and medical images, and more. Managing this data growth is a challenge for IT.

In addition, as organizations transition to Epic, the older clinical systems will become obsolete and often need to be maintained in read-only mode to continue providing clinicians access to their data. This makes it more difficult for healthcare providers to decommission these legacy systems and realize the cost savings, reduced complexity and decreased risk that would typically follow after removing them from the environment.

EMC takes a holistic approach to supporting an enterprise Epic environment, knowing that any “weak link” in the free flow of patient information to authorized caregivers can degrade the quality of care delivery. The EMC Documentum Clinical Archiving Solution is built specifically for Epic EMR environments and addresses the information management and cost challenges of managing and maintaining legacy systems. This Web-based application launched from Epic Hyperspace enables users to find and view archived records, both structured and unstructured data, including clinical documents and medical images. Clinical Archiving also gives Epic users on-demand access to all archived patient records, documents and images—eliminating the need to navigate multiple systems and user interfaces. Clinicians gain immediate access to Hyperspace for a complete view of patient history, diagnosis and treatment.

Based on XML standards, Clinical Archiving provides healthcare providers with scalable and seamless interaction with their Epic EMR solution and other IT environments by using native Epic APIs and industry standards. Documentum Clinical Archiving runs on the Documentum Content Server, which is supported by a variety of EMC storage platforms.

PROFESSIONAL SERVICES ACCELERATE TIME-TO-VALUE

EMC Professional Services staffs a team of Epic and IT experts who have delivered 200 successful IT environments for Epic to healthcare providers. The EMC Services Delivery team ensures that deployment of EMC infrastructure solutions abide by the most up-to-date best practices and Epic-specific configuration rules.

Benefitting from extensive EMC eLab testing and collaboration between EMC and Epic engineering, EMC Professional Services have the skills, knowledge and resources to plan and execute successful Epic deployments. Compared to Epic’s other infrastructure vendors, the EMC Professional Services Industry Verticals Team provides an unparalleled level of service for all Epic deployments. This team helps to support the solution sizing and creation of policies, procedures and tools used in delivery and deployment.

As part of its service offerings, EMC provides Epic-specific configuration, deployment and go-live activities for customers running Epic in XtremIO environments. In addition, EMC Professional Services have established SKUs and bundles to streamline infrastructure deployments supporting the Epic application.
CONCLUSION

XtremIO delivers game changing advantages to Epic EMR environments. It directly addresses the most pressing challenges healthcare providers face: lowering costs and delivering new application services without performance impact, all while improving patient care and enabling compliance.

Where traditional storage systems with mechanical disk drives may struggle to handle Epic’s unique workloads, XtremIO excels. In fact, XtremIO far exceeds Epic’s SLAs, delivering consistently high performance even under the most demanding conditions. That means clinicians can count on a reliable, highly-responsive EMR to support fast, efficient patient care.

Outstanding XtremIO performance, scalability, and efficiency also help healthcare organizations drive greater use of analytics to better manage population health, optimize clinical quality, and mitigate risk. The all-flash array also provides ample headroom to take on an increasingly mobile healthcare workforce.

Beyond raw performance and efficiency, XtremIO offers a wealth of data services that further enhance Epic. XtremIO dramatically reduces the storage capacity required for Epic through always-on inline deduplication and compression. This is a prime advantage by reducing capital expenses. The built-in data at-rest encryption capabilities of XtremIO enable healthcare organizations to comply with new HITECH security regulations without additional investment.

In addition, instant snapshots created with XtremIO eliminate the manual, time-consuming process of creating database copies. Instead, healthcare organizations can create snapshots any time of day or night without impacting production EMR services or using valuable storage space.

EMC ViPR integrated in VMware Operations simplifies management of the entire Epic infrastructure with a single, centralized interface that spans storage, compute, virtual machines, and networking resources. This not only reduces operating costs, it also frees healthcare IT resources for strategic projects that address emerging HIPAA requirements and the HITECH Act. Ultimately, this saves even more money by avoiding costly penalties for non-compliance.

From the data center to the bedside, from deployment and delivery to legacy application decommissioning and archiving, XtremIO and the entire EMC Federation portfolio deliver performance, efficiency, scalability, and availability to help healthcare organizations achieve the most value from their Epic investments.