FlexPod®

Technical Brief

FlexPod Datacenter for Epic EHR Infrastructure

Mark Hayford, NetApp

James Maudlin, Cisco

Scott Lenz, NetApp

Monty Zarrouk, NetApp

March 2015 | TR-4389

Abstract

To deliver high availability and performance for Epic EHR application software while increasing infrastructure efficiency and agility, healthcare providers increasingly implement FlexPod®, a next-generation data center platform. The combined strengths of this prevalidated converged infrastructure from Cisco, NetApp, and VMware enable healthcare organizations to improve patient care using a fast, agile, highly scalable, and cost-effective solution.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 A New Approach for Infrastructure for Epic EHR

Healthcare provider organizations remain under pressure to maximize the benefits of their substantial investments in industry-leading Epic electronic health records (EHRs). As a mission-critical application, Epic has very stringent server and storage infrastructure requirements to ensure:

- High availability
- High performance
- Robust data protection, backup, recovery, and business continuance

As Epic users evolve their organizations to become Accountable Care Organizations and adjust to tightened, bundled reimbursement models, the challenge becomes delivering the required Epic infrastructure in a more efficient and agile IT delivery model.

Over the past decade, Epic infrastructure has customarily consisted of proprietary RISC processor–based servers running proprietary versions of the UNIX® operating system and traditional SAN storage arrays. These server and storage platforms offer little in the way of virtualization and could become cost-prohibitive as to capital and operating costs, given increasing IT budget constraints.

With Epic now supporting a production target platform consisting of a Cisco® Unified Computing System™ (UCS®) with Intel® Xeon® processors, virtualized with VMware® ESXi, running Red Hat Enterprise Linux® (RHEL), coupled with Epic's High Comfort Level ranking for NetApp FAS and All-Flash FAS storage, a new era of Epic data center optimization has begun.

1.1 Value of Prevalidated Converged Infrastructure

Epic is very prescriptive as to its customers' hardware requirements because of an overarching requirement for delivering predictable low-latency system performance and high availability. FlexPod, a prevalidated, rigorously tested converged infrastructure from the strategic partnership of industry leaders Cisco, NetApp, and VMware, is engineered and designed specifically for delivering predictable low-latency system performance and high availability. This results in Epic high comfort levels and ultimately the best response time for users of the Epic EHR system.

The FlexPod solution from Cisco, NetApp, and VMware meets Epic system requirements with a modular, prevalidated, converged, virtualized, efficient, scalable, and cost-effective platform. It provides:

- **Modular architecture:** FlexPod addresses the varied needs of the Epic modular architecture with purpose-configured FlexPod platforms for each specific workload. All are connected through a clustered server and storage management fabric and a cohesive management toolset.
- **Accelerated application deployment:** The prevalidated architecture reduces implementation integration time and risk to expedite Epic project plans. Whether the solution is used for an initial rollout of Epic, a hardware refresh, or expansion, more resources can be shifted to the business value of the project.
- **Industry-leading technology at each level of the converged stack**. Cisco, NetApp, VMware, and Red Hat are all ranked as #1 or #2 by industry analysts in their respective categories of servers, networking, storage, and open systems Linux.
- **Investment protection with standardized, flexible IT:** The FlexPod Reference Architecture anticipates new product versions and updates, with rigorous ongoing Interoperability Matrix Testing to accommodate future technologies as they become available.
- **Proven deployment across a broad range of environments:** Pretested and jointly validated with popular hypervisors, operating systems, applications, and infrastructure software, FlexPod has been installed in some of Epic's largest customer organizations.

Table 1) FlexPod Benefits.

Benefit	Description
Industry-Standard Components	Combines industry-standard x86-architecture blade and rack servers, networking, storage, and enterprise-class management into a single system running VMware ESXi™ and Red Hat Enterprise Linux (RHEL).
Centralized Operations	Centralized management tools consolidate data in the data center, eliminating the need for data copies, reducing risk and decreasing management overhead, and increasing productivity with the following tools: • Cisco UCS Manager provides centralized management capabilities, creates a unified management domain, and serves as the central nervous system of Cisco UCS. • VMware vCenter™ Server provides a centralized platform for managing Epic environments so that healthcare organizations can automate and deliver a virtual infrastructure with confidence. • The NetApp® clustered Data ONTAP® operating system with OnCommand® Insight software integrates storage management into the Epic service-delivery chain. This feature provides healthcare organizations with better control, automation, and analysis of the storage infrastructure.
Programmable Configuration	The configuration is entirely programmable using unified, model-based management to simplify and accelerate deployment of enterprise-class applications and services running in bare-metal, virtualized, and cloud-computing environments.
Unified Infrastructure	A unified I/O infrastructure uses a high-bandwidth, low-latency unified fabric to support networking, storage I/O, and management traffic. The Cisco Fabric Extender Technology (FEX Technology) directly connects the fabric to servers and virtual machines for increased performance, security, and manageability.

1.2 FlexPod Cooperative Support

NetApp and Cisco share a long history of support collaboration for FlexPod, a data center solution that is unified, pretested, and validated. It is a full solution created from best-in-class components coupled with simplified management and validated design guides that create repeatable, scalable deployments for customers and partners. With the launch of the FlexPod platform in 2010, NetApp and Cisco established Cooperative Support, a strong, scalable, and flexible support model to address the unique support requirements of the FlexPod converged infrastructure. The Cooperative Support model takes advantage of the combined experience, resources, and technical support expertise of NetApp and Cisco to provide a streamlined process for identifying and resolving a customer's FlexPod support issue, regardless of where the problem resides. The FlexPod Cooperative Support model helps make sure that your FlexPod system operates efficiently and benefits from the most up-to-date technology, while providing an experienced team to help resolve integration issues.

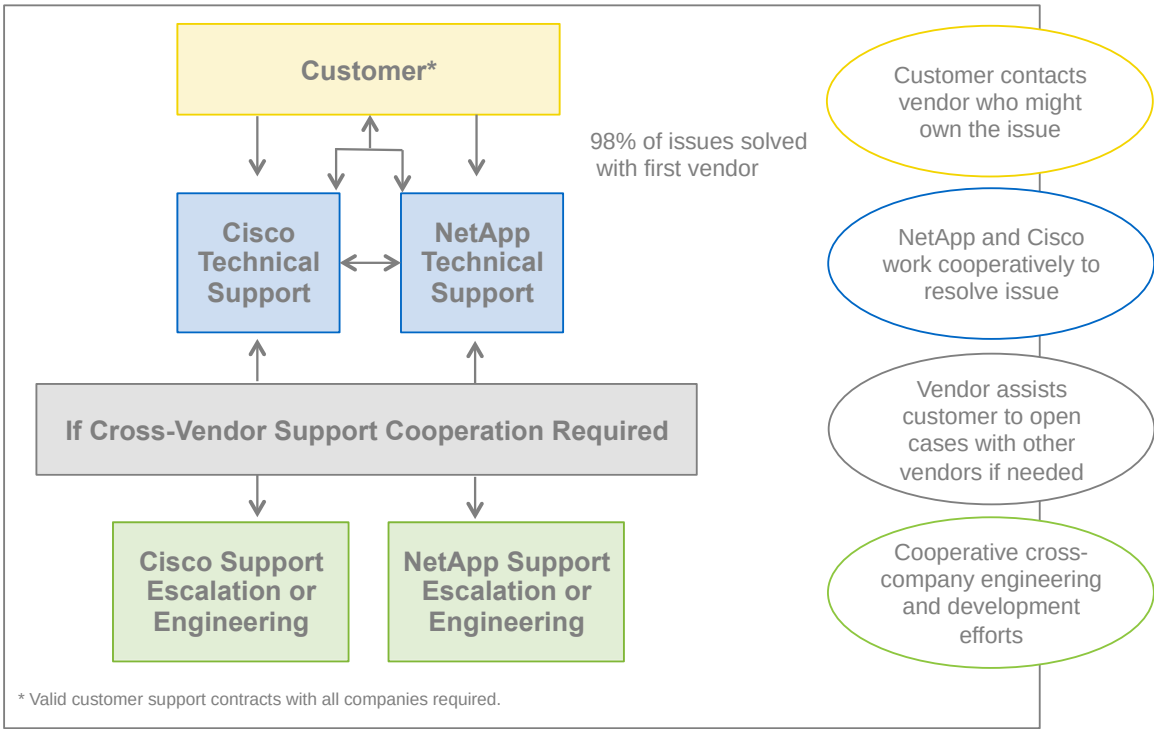
FlexPod Cooperative Support is especially valuable to healthcare organizations running business-critical applications such as Epic on the FlexPod converged infrastructure. FlexPod Cooperative Support is a

partnership between NetApp, Cisco, and our technology partners Microsoft, VMware, Citrix, and Red Hat. It is designed to simplify and streamline support for the FlexPod converged infrastructure.

We combine our experience, resources, and technical expertise to deliver full FlexPod support to our joint customers. We extend our world-class technical support by partnering with other application and management vendors through the Technical Support Alliance Network (TSANet), the industry leader in effective multivendor support management.

Your IT staff chooses which vendor to call based on your initial assessment of the problem's origin. Multivendor engineers work to resolve your issue fast, using shared communications, expertise gained through ongoing lab testing and joint training, and a formal escalation process. The result is rapid, coordinated resolution of your technical issue. FlexPod Cooperative Support helps keep your business-critical data center infrastructure up and running at peak performance. Figure 1 shows the FlexPod Cooperative Support model customer engagement process.

Figure 1) FlexPod Cooperative Support model customer engagement process.



Learn how the NetApp Customer Fitness® preventive care methodology works with FlexPod Cooperative Support to help you sustain maximum uptime.

1.3 Proven FlexPod Architecture

FlexPod is a proven data center solution, offering a flexible, shared infrastructure that easily scales to support growing workload demands without impacting performance. By leveraging the FlexPod architecture, this solution delivers the full benefits of FlexPod, including:

- **Scalability to easily accommodate clinical data growth.** Dynamically scale virtual machines, server, and storage capacity on demand, without traditional limits.
- **Enhanced efficiency.** Slash both administration time and TCO by up to 50% with a converged virtualized infrastructure that is easier to manage and stores data more efficiently while driving more performance from Epic software.

- **Reduced risk**. Minimize business disruption with a prevalidated platform built on a defined architecture that eliminates deployment guesswork and accommodates ongoing workload optimization.

In addition to these benefits, each component of the FlexPod Datacenter with Epic solution delivers specific benefits for Epic EHR workflows.

1.4 Cisco Unified Computing System (UCS)

A self-integrating, self-aware system, Cisco UCS consists of a single management domain interconnected with a unified I/O infrastructure. The system is designed as a single virtual blade chassis that incorporates and scales across multiple blade chassis, rack servers, and racks. The system implements a radically simplified architecture that eliminates the multiple redundant devices that populate traditional blade server chassis and result in layers of complexity: Ethernet switches, Fibre Channel switches, and chassis management modules. Cisco UCS consists of a redundant pair of Cisco 6200 Series Fabric Interconnects that provide a single point of management, and a single point of control, for all I/O traffic.

Cisco UCS uses service profiles to help ensure that virtual servers in the UCS infrastructure are configured correctly. Service profiles include critical server information about the server identity such as: LAN and SAN addressing, I/O configurations, firmware versions, boot order, network VLAN, physical port, and quality-of-service (QoS) policies. Service profiles can be dynamically created and associated with any physical server in the system within minutes rather than hours or days. The association of service profiles with physical servers is performed as a simple, single operation and enables migration of identities between servers in the environment without requiring any physical configuration changes. It facilitates rapid bare-metal provisioning of replacements for failed servers.

Using service profiles helps to ensure that servers are configured consistently throughout the enterprise. When using multiple Cisco UCS management domains, UCS Central can use global service profiles to synchronize configuration and policy information across domains. And if maintenance needs to be performed in one domain, the virtual infrastructure can be migrated to another domain. This helps to ensure that even when a single domain is offline, applications continue to run with high availability.

Cisco UCS has been extensively tested with Epic over a multiyear period to demonstrate that it meets the server configuration requirements. Cisco UCS is a supported server platform, as listed in customers' "Epic Hardware Configuration Guide."

1.5 Cisco Nexus

Cisco Nexus® 7000 Series switches offer one of the most comprehensive data center network feature sets in a single platform. They deliver high performance and density for both data center and campus core. They also offer a full feature set for data center aggregation, end-of-row, and data center interconnect deployments in a highly resilient modular platform.

UCS integrates computing resources with Cisco Nexus switches and a unified I/O fabric that identifies and handles different types of network traffic, including storage I/O, streamed desktop traffic, management, and access to clincial and business applications. All Cisco UCS servers are stateless. Service profiles automate the build process for each server and simplify failure recovery.

- **Infrastructure scalability.** Virtualization, efficient power and cooling, cloud scale with automation, high density, and performance all support efficient data center growth.
- **Operational continuity.** The design integrates hardware, NX-OS software features, and management to support zero-downtime environments.
- **Transport flexibility.** Incrementally adopt new networking technologies with a cost-effective solution.

1.6 NetApp FAS8000 Storage

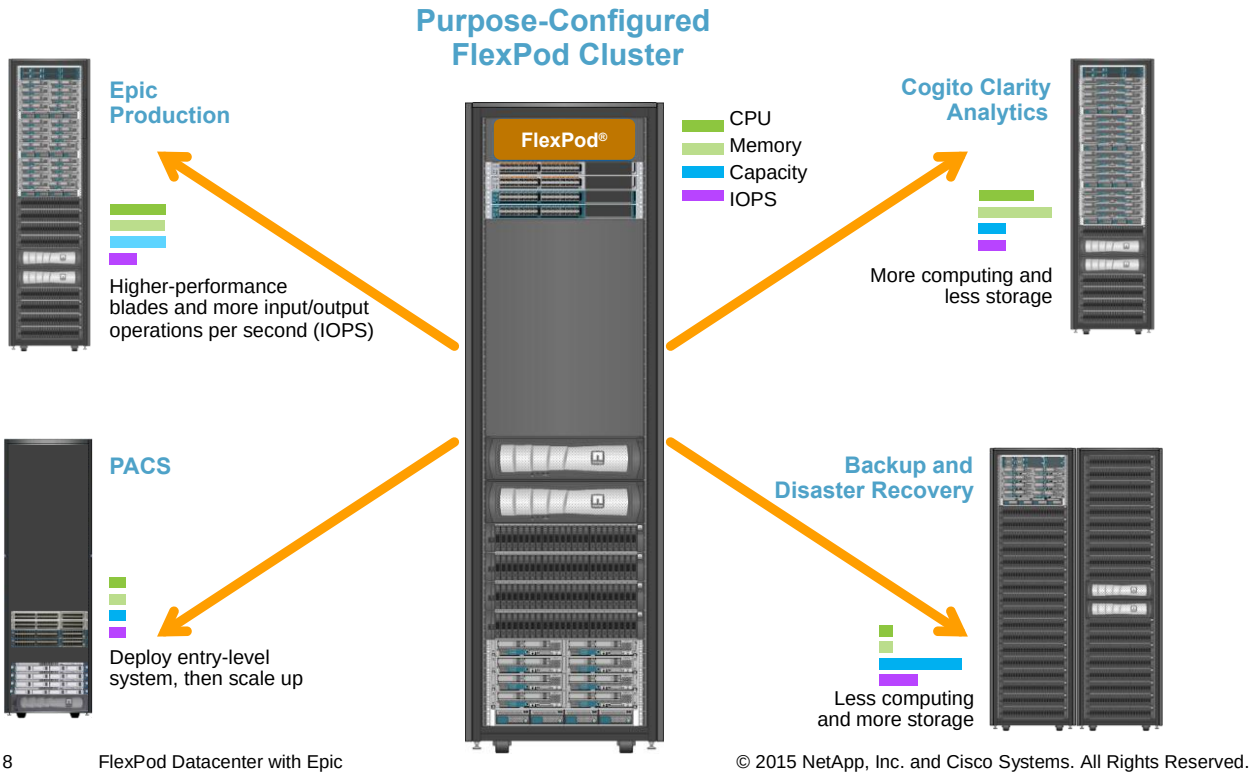
NetApp fabric-attached storage (FAS) 8000 storage systems reduce overall storage costs while delivering the low-latency read and write response times and IOPS required for Epic workloads. FAS8000 storage systems support both all-flash and hybrid storage configurations to create an optimal storage platform to meet Epic requirements. NetApp flash-accelerated FAS8000 systems received the Epic High Comfort Level rating, providing Epic customers with the performance and responsiveness key to Epic operations.

The scale-out architecture of NetApp FAS storage and the NetApp clustered Data ONTAP operating system can flexibly adapt to a variety of I/O workloads. To deliver the necessary throughput and low latency required for clinical applications while providing a modular scale-out architecture, all-flash configurations are typically used within clustered Data ONTAP architectures. All-Flash FAS nodes can be combined in the same scale-out cluster with hybrid (HDD plus flash) storage nodes suitable for storing large datasets with high throughput. Customers can also clone, replicate, and back up the Epic environment (from expensive SSD storage) to more economical HDD storage on other nodes, meeting or exceeding Epic guidelines for SAN-based cloning and backup of production disk pools.

NetApp FAS storage offers features that are extremely useful in Epic environments, simplifying management, increasing availability, and reducing the total amount of storage needed:

- **Storage efficiency:** Reduce total capacity requirements with deduplication, compression, and thin provisioning.
- **Space-efficient cloning:** The NetApp FlexClone® capability allows you to almost instantly create clones to support additional desktops. These clones consume additional storage only as changes are made.
- **Integrated data protection:** Full data protection and disaster recovery features help customers protect critical data assets and provide disaster recovery.
- **Nondisruptive operations:** Upgrading and maintenance can be performed without taking data offline.
- **Quality of service (QoS):** Storage QoS allows you to limit the storage resources that a particular workload can consume.

Figure 2) Optimized for any workload.



1.7 VMware vSphere ESXi

The VMware vSphere® hypervisor is a hypervisor that virtualizes servers that consolidate applications on less hardware.

- **Built-in management tool**. Create and provision virtual machines easily and within minutes.
- **Storage usage efficiency**. Overallocate storage resources beyond the actual capacity of the physical storage.
- **Advanced memory management**. Overcommit memory resources and perform page sharing and compression to optimize performance of memory resources.
- **Hardened drivers for high reliability**. Ensure optimal performance for vSphere hypervisor through partnerships with independent hardware vendors.

1.8 Red Hat Enterprise Linux (RHEL)

Red Hat Enterprise Linux 6 on VMware ESXi 5.5 on Xeon processors is a supported InterSystems Operational Caché Database Platform. RHEL 6 is designed to be the world's leading enterprise-focused open source operating system platform. It includes a comprehensive set of features that span from midlevel servers to the largest enterprise data center environment.

- Please follow the “Cisco Validated Design Red Hat Enterprise Linux Built on FlexPod Deployment Guide.” This document guides you through the specific steps to deploy Red Hat Enterprise Linux 6 and the high-availability add-on in the base FlexPod architecture.

1.9 Overall Solution Benefits

FlexPod Datacenter with Epic delivers a number of benefits specific to the healthcare industry. These include:

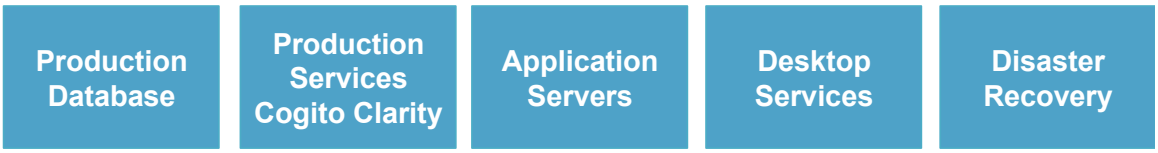
- **Simplified operations and lower costs.** Eliminate the expense and complexity of legacy proprietary RISC/UNIX platforms, replacing them with a much more efficient and scalable shared resource capable of supporting clinicians wherever they happen to be. This solution delivers higher resource utilization for greater return on investment.
- **Ability to deploy infrastructure more quickly.** Whether it’s in an existing data center or a remote location, the integrated and tested design of FlexPod Datacenter with Epic enables customers to have the new infrastructure up and running in less time with less effort.

2 Purpose-Built for Specific Epic Workloads

Though Epic does not resell server, network, or storage hardware, hypervisors, or operating systems, the company has very specific requirements for each component of the infrastructure stack. This is why Epic, Cisco, and NetApp worked together to test and enable FlexPod Datacenter to be successfully configured, deployed, and supported to meet customers’ Epic production environment requirements. This testing, technical documentation, and growing number of successful mutual customers have resulted in Epic expressing an increasingly high level of comfort in FlexPod Datacenter’s ability to meet Epic customers’ needs (see the “Epic Storage Products and Technology Status” document and the “Epic Hardware Configuration Guide” for a current listing of comfort levels).

The end-to-end Epic Reference Architecture is not monolithic, but modular. A high-level view outlines five distinct modules, each with unique workload characteristics.

Figure 3) Epic workloads.



These interconnected but distinct modules have often resulted in Epic customers having to purchase and manage specialty silos of storage and servers. These might include a vendor's platform for traditional tier 1 SAN, a different platform for NAS file services, platforms specific to protocol requirements of Fibre Channel, FCoE, iSCSI, NFS, SMB/CIFS, separate platforms for flash storage, and appliances and tools to attempt to manage these silos as virtual storage pools.

With FlexPod connected through NetApp clustered Data ONTAP, you are able to implement purpose-built nodes optimized for each targeted workload while achieving the economies of scale and streamlined operational management of a consistent compute/network/storage data center.

Clustered Data ONTAP Provides an Enterprise Data Fabric Enabled by NetApp

By running an Epic environment on this architectural foundation, healthcare organizations can expect to see staff productivity improve and capital and operating expense decrease. Additional benefits of running Epic software on FlexPod Datacenter include:

- **Scale-out architecture.** Scale SAN and NAS from terabytes to tens of petabytes without reconfiguring running applications.
- **Nondisruptive operations.** Perform storage maintenance, hardware lifecycle operations, and software upgrades without interrupting the business.
- **Secure multi-tenancy:** This benefit supports the increased needs of virtualized server and storage-shared infrastructure, enabling secure multi-tenancy of facility-specific information, particularly if hosting multiple instances of databases and software.
- **Pooled resource optimization:** This benefit can help reduce physical server and storage controller counts, load balance workload demands, and boost utilization while improving performance.
- **Quality of service (QoS).** Reduce costs with one of the most comprehensive storage efficiency offerings in the industry.
- **Agility:** FlexPod's industry-leading workflow automation, orchestration, and management tools allow IT to be far more responsive to business requests, ranging from the provisioning of additional test and training environments to analytics database replications for Population Health Management initiatives.
- **Productivity:** This solution can be deployed and scaled quickly for optimal clinician end user experiences.

Although an in-depth examination of the Epic suite is beyond the scope of this paper, there are several key components common to Epic implementations, including the InterSystems Caché Database, Cogito Clarity Analytics RDBMS, and Epic Hyperspace Desktop Services.

2.1 Caché Production Database

Caché, manufactured by InterSystems, is the database system upon which Epic is built. All patient data within Epic is stored in a Caché database.

In an InterSystems Caché database, the data server is the access point for persistently stored data. The application server services database queries and makes data requests to the data server. For most Epic software environments, the use of the symmetric multiprocessor architecture in a single database server suffices to service the Epic applications' database requests. In large deployments, using InterSystems' Enterprise Caché Protocol can support a distributed database model.

By using failover-enabled clustered hardware, a standby data server can access the same disks (that is, storage) as the primary data server and take over the processing responsibilities in the event of a hardware failure.

InterSystems also provides technologies to satisfy shadow, disaster recovery, and high-availability (HA) requirements. InterSystems' shadow technology can be used to asynchronously replicate a Caché database from a primary data server to one or more secondary data servers.

2.2 Cogito Clarity

Cogito Clarity is Epic's integrated analytics and reporting suite. Starting as a copy of the production Caché database, Cogito Clarity delivers information that can help improve patient care, analyze clinical performance, manage revenue, and measure compliance. As an OLAP environment, Cogito Clarity utilizes either Microsoft® SQL Server® or Oracle® RDBMS. Since this environment is distinct from the Caché Production Database environment, it is important to architect a FlexPod platform that supports the Cogito Clarity requirements following Cisco and NetApp published validated design guides for SQL Server and Oracle environments.

- **SnapManager for Oracle.** NetApp SnapManager® for Oracle software creates complete database clones in seconds, either on primary storage or straight to development and test environments. Use clones to engage in parallel QA, development, testing, and other processes, deploying applications faster than ever before.
- **SnapManager for SQL Server**. SnapManager software reduces SQL Server data-recovery times to minutes. It simplifies data protection for SQL Server applications by providing federated database backups of multiple SQL Server instances and databases.

2.3 Epic Hyperspace Desktop Services

Hyperspace is the presentation component of the Epic suite. It reads and writes data from the Caché database and presents it to the user. Most hospital and clinic staff members interact with Epic through the use of the Hyperspace application.

Although Hyperspace can be installed directly on client workstations, many healthcare organizations use application virtualization through Citrix XenApp or, increasingly, a virtual desktop infrastructure (VDI), to deliver applications to users.

Over the last few years, virtualizing XenApp server farms using ESXi has become supported. Refer to the validated designs for FlexPod for ESXi noted in the "Additional Information" section of this document for configuration and implementation guidelines.

For customers interested in deploying full VDI Citrix XenDesktop or VMware Horizon View™ systems, careful attention must be paid to ensure an optimal clinical workflow experience. A foundational step for obtaining precise configurations is to clearly understand and document the scope of the project, including detailed mapping of user profiles. Many user profiles include access to applications beyond Epic. Variables in profiles include:

- Authentication, especially Imprivata or similar tap-n-go SSOs, for nomadic clinician users
- PACS Image Viewer
- Dictation software and devices, such as Dragon NaturallySpeaking
- Document management, such as Hyland OnBase or Perceptive Software integration
- Departmental applications such as health information management coding from 3M Health Care or OptumHealth
- Pre-Epic legacy EMR or revenue cycle apps that the customer may still be working with
- Video conferencing capabilities that could require use of video acceleration cards in the servers

Your certified FlexPod reseller, with specific certifications in VMware Horizon View or Citrix XenDesktop, will work with your Cisco and NetApp Epic Consulting System Engineers and Professional Services provider to scope and architect the solution for your specific VDI requirements.

Note: Please refer to Additional Information to download reference documents.

2.4 Disaster Recovery and Shadow Copies

Evolving to Active-Active Dual Data Centers

In Epic software environments, a single patient-centric database is deployed. Epic's hardware requirements refer to the physical server hosting the primary Caché data server as the production database server. This server requires dedicated, high-performance storage for files belonging to the primary database instance. For HA, Epic supports the use of a failover database server that has access to the same files.

A reporting shadow database server is typically deployed to provide read-only access to production data. It hosts a Caché data server configured as a backup shadow of the production Caché data server. This database server has the same storage capacity requirements as the production database server. This storage is sized differently from a performance perspective because reporting workload characteristics are different.

A shadow database server can also be deployed to support Epic's Read-Only (SRO) functionality, in which access is provided to a copy of production in read-only mode. This type of database server can be switched to read-write mode for business continuity reasons.

To meet business continuity and disaster recovery (DR) objectives, a DR shadow database server is commonly deployed at a site geographically separate from the production and/or reporting shadow database servers. A DR shadow database server also hosts a Caché data server configured as a backup shadow of the production Caché data server. It can be configured to act as a shadow read-write instance if the production site is unavailable for an extended time. Like the reporting shadow database server, the storage for its database files has the same capacity requirements as the production database server. In contrast, this storage is sized the same as production from a performance perspective, for business continuity reasons.

For healthcare organizations that need continuous uptime for Epic and have multiple data centers, FlexPod can be used to build an active-active design for Epic deployment. In an active-active scenario, FlexPod hardware is installed into a second data center and is used to provide continuous availability and quick failover or disaster recovery solutions for Epic. The "Epic Hardware Configuration Guide" provided to customers should be shared with Cisco and NetApp to facilitate the design of an active-active architecture that meets Epic's guidelines.

2.5 Licensing Caché

NetApp and Cisco have experience in migrating legacy Epic installations to FlexPod following Epic's best practices for platform migration. They can work through any details if a platform migration is required.

One consideration for new customers moving to Epic, or existing customers who are evaluating a hardware and software refresh, is the licensing of the Caché database. InterSystems Caché can be purchased with either a platform-specific license (limited to a single hardware OS architecture) or a platform-independent license. A platform-independent license allows the Caché database to be migrated from one architecture to another, but it costs more than a platform-specific license.

Note: Customers with platform-specific licensing may need to budget for additional licensing costs to switch platforms.

3 Comprehensive System Management Tools

3.1 Cisco UCS Manager

Cisco UCS Manager provides centralized management capabilities, creates a unified management domain, and serves as the central nervous system of Cisco UCS. It manages the system from end to end as a single cohesive system using an intuitive GUI, with both command-line interface (CLI) and XML API options. It speeds configuration and reconfiguration of resources so that tasks that used to require days or hours now can be accomplished in minutes.

- It manages each UCS domain, including service profiles, to help deploy servers effectively and efficiently.
- Each management domain consists of a set of Cisco UCS server chassis, Cisco UCS Fabric Interconnects, and Cisco UCS server blades, managed by UCS Manager.
- Hardware and firmware upgrades, routine hypervisor and infrastructure maintenance, and troubleshooting can all require taking one of the management domains out of production.

3.2 VMware vCenter Server

VMware vCenter Server provides a centralized platform for managing Epic environments so healthcare organizations can automate and deliver a virtual infrastructure with confidence.

- **Simple deployment**. Quickly and easily deploy vCenter Server using host profiles or a Linux-based virtual appliance.
- **Centralized control and visibility**. Administer the entire vSphere infrastructure from a single location.
- **Proactive optimization**. Allocate and optimize resources for maximum efficiency.
- **Management.** Use powerful tools to simplify management and extend control.

3.3 OnCommand Insight and Clustered Data ONTAP

NetApp OnCommand Insight integrates storage management into the Epic service-delivery chain. This provides healthcare organizations with better control, automation, and analysis of the storage infrastructure. IT can optimize the current infrastructure for maximum benefit while simplifying the process of determining what and when to buy. It also takes the risk out of complex technology migrations. Because it requires no agents, installation is straightforward and nondisruptive. Installed storage and SAN devices are continually discovered, and detailed information is collected for full visibility of your entire storage environment. You can quickly identify misused, misaligned, underused, or orphaned assets and reclaim them to fuel future expansion.

- **Optimize existing resources**. Identify misused, underused, or orphaned assets using established best practices to avoid problems and meet service levels.
- **Make better decisions**. Real-time data helps resolve capacity problems more quickly to accurately plan future purchases, avoid overspending, and defer capital expenditures.
- **Accelerate IT initiatives**. Better understand virtual environments to manage risks, minimize downtime, and speed cloud deployment.

4 Solution Sizing and Getting Started

One of the great advantages of the FlexPod architecture over other integrated infrastructure solutions is that all solution elements can be flexibly sized to meet specific requirements. IT can easily tailor the configuration to meet specific compute, storage, and network bandwidth needs to satisfy Epic requirements.

Because FlexPod Datacenter is well established, many resources exist to facilitate and streamline deployment. The guidance provided in this section applies directly to the FlexPod Datacenter with Epic solution.

4.1 Use of the "Epic Hardware Configuration Guide"

The "Epic Hardware Configuration Guide" prepared by Epic for each customer provides the inputs into the System Performance Modeling tools and Reference Architecture templates that Cisco, NetApp, and reseller partner system engineers use to architect and size the appropriate FlexPod configurations. An Epic Infrastructure Design Workshop is also available.

We recommend that you review the "Epic Hardware Configuration Guide" and sort through options, such as plans for disaster recovery sites and use of virtual desktop infrastructure (VDI).

4.2 Epic GenerateIO Tool

GenerateIO, or the Epic IO Simulator, is the storage-performance testing tool developed and used by Epic. It simulates the workload generated by an InterSystems Caché database used in an Epic production environment, including the write-cycle patterns. It is available as a command line application on various host operating systems on which Caché is deployed.

A performance test run involves executing the GenerateIO application on the production Epic database host with a set of I/O parameters. These parameters simulate the I/O patterns for the customer Epic environment, including the write cycles.

GenerateIO is primarily used to determine how different storage configurations handle the workload generated in an Epic production environment. It is used by Epic server system support representatives to verify storage performance prior to the customer deployment going live.

NetApp conducts regular formal testing using GenerateIO. These tests are performed by the NetApp Datacenter Solutions Group workload engineering labs, with results validated by Epic. These results also validate the use of the NetApp System Performance Modeler (SPM) tool to accurately size and deliver very predictable performance in real-world customer environments. This information is correlated with data from Epic on NetApp and Epic on FlexPod customers in the field.

Note: For more information, request a copy of the following documents from your Cisco or NetApp sales team or partner:

- NetApp Technical Report: TR-3930-1014: "NetApp Sizing Guidelines for Epic" is used along with Epic Reference Configuration Templates in SPM for validated configurations based on inputs from the "Epic Hardware Configuration Guide."
- Storage should be integrated with the host system according to TR-3955: "NetApp Deployment Guide for Epic" and TR-3928: "NetApp Best Practices for Epic."

Recommendations for SnapMirror for Epic SAN Cloning

In some cases, Epic requires and recommends SAN-based cloning for several disk pools. NetApp SnapMirror® software complies with Epic requirements and recommendations and is deployed at many sites today. Epic is comfortable with SnapMirror technology as a SAN-based cloning technology. The use of NetApp SnapMirror technology generally incurs a small additional workload for the storage system. The NetApp SPM tool takes into account the use of SnapMirror when sizing is performed for a production system.

Note: For more information, request a copy of the following documents from your Cisco or NetApp sales team or partner:

- NetApp Technical Report: TR-3446: "SnapMirror Async Overview and Best Practices Guide"

4.3 Cisco and NetApp Reference Architecture for Epic

The following diagrams provide an abstracted architectural reference to begin sizing and validation based on the customer-provided Epic “Hardware Configuration Guide.”

Figure 4) Example of a small Epic configuration.

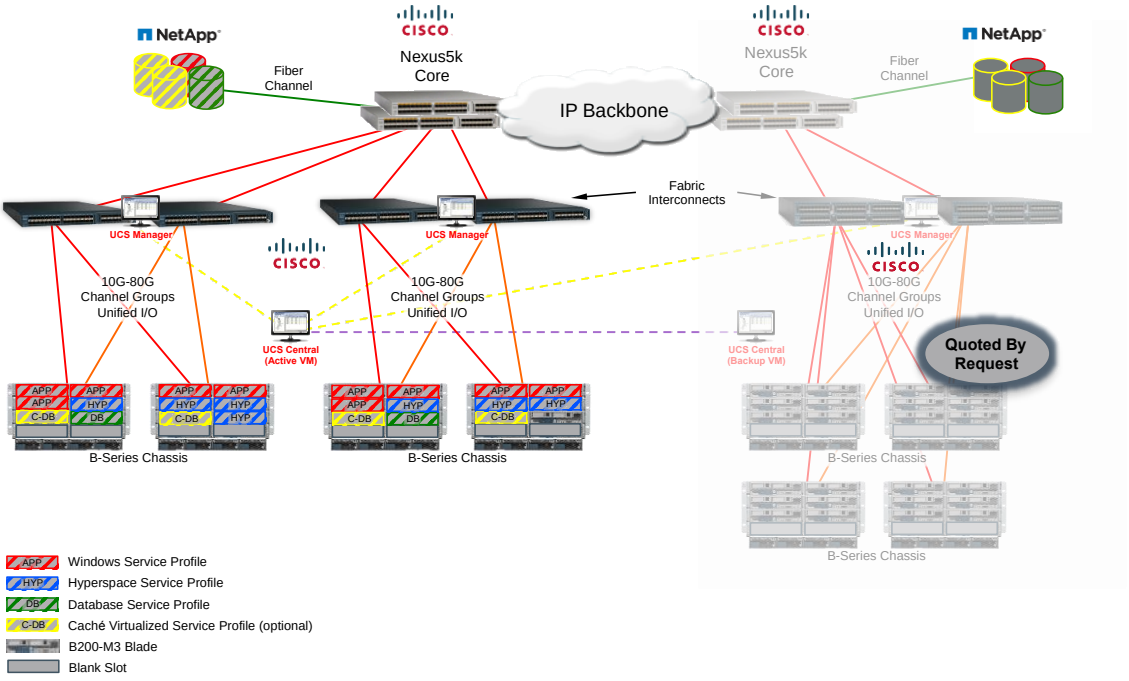


Figure 5) Example of a large Epic configuration.

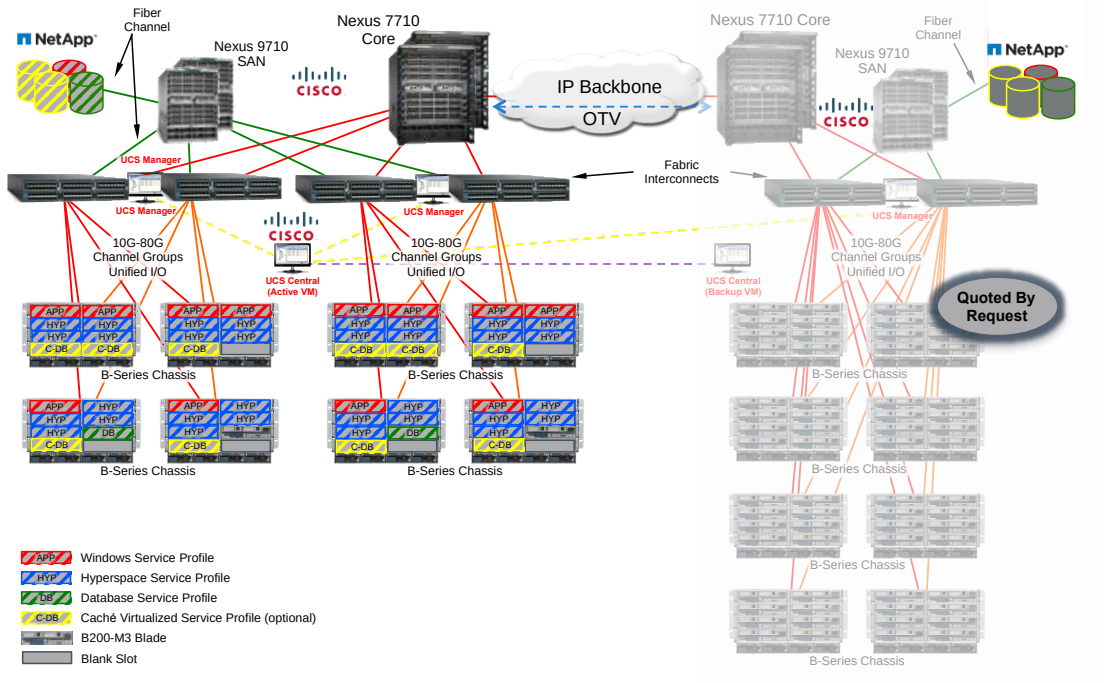


Figure 6) Example of a Hyperspace active-active Epic configuration.

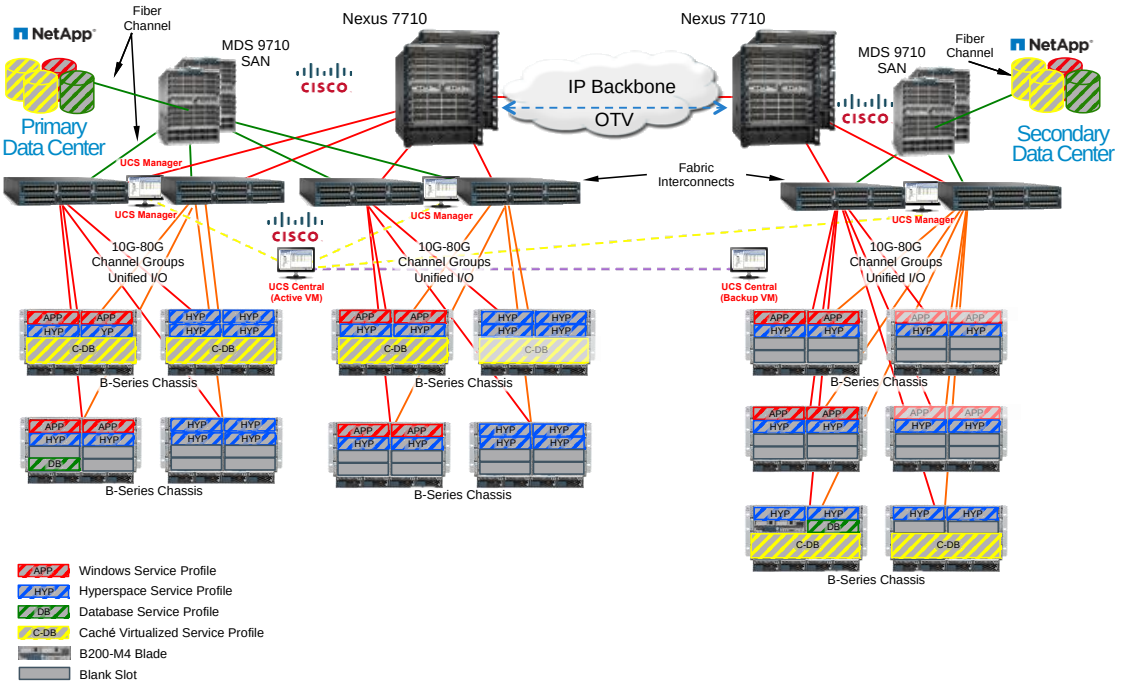


Figure 7) Epic six-node reference architecture: storage plane detail.

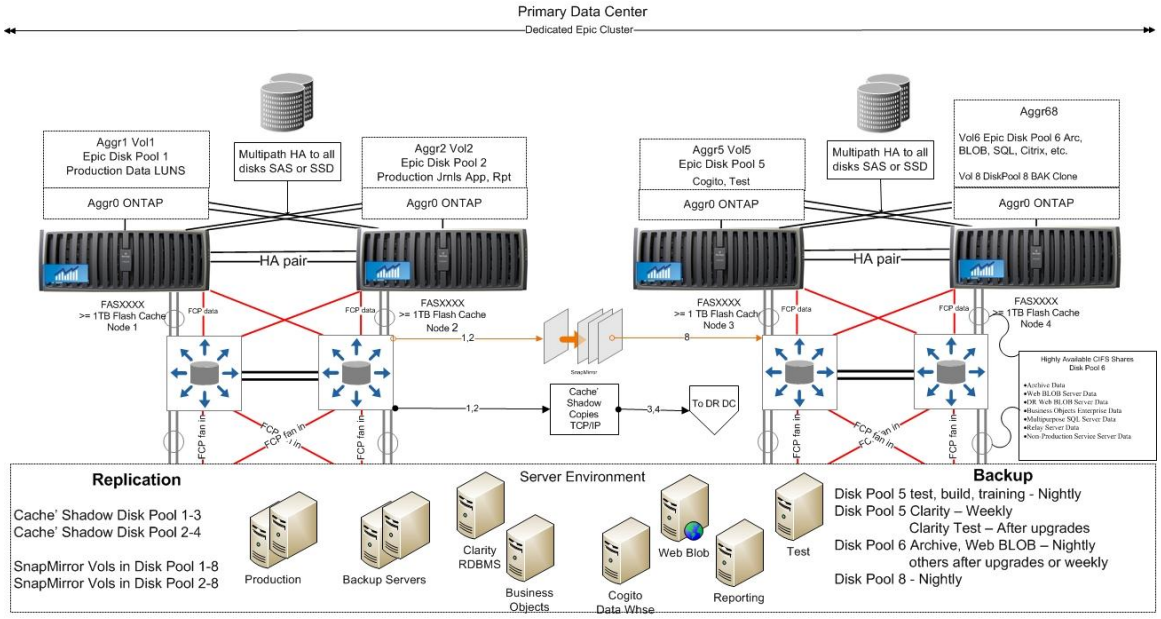


Figure 8) Epic four-node reference architecture: storage plane detail.

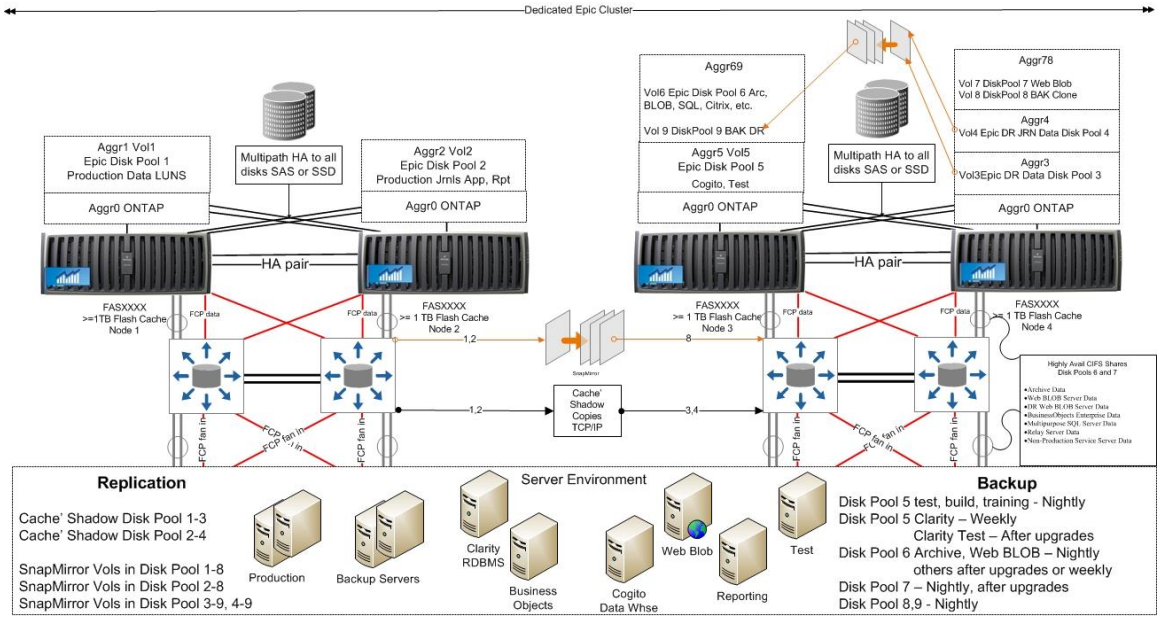
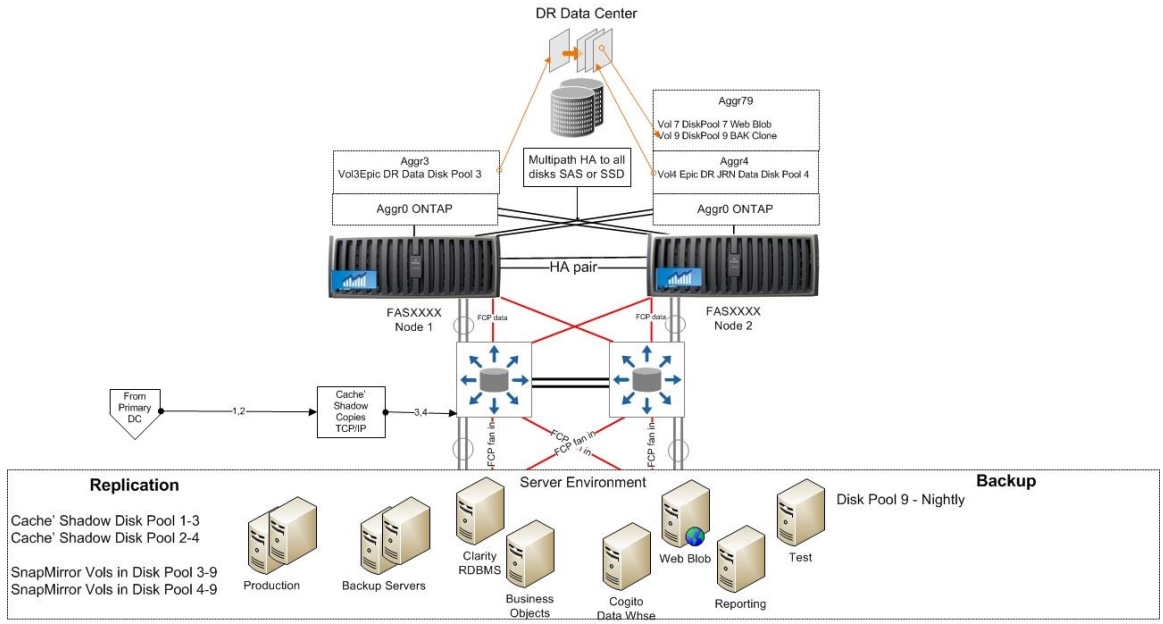


Figure 9) Epic disaster recovery reference architecture: storage plane detail.



4.4 Cisco UCS Server Sizing

Cisco and Cisco partners regularly work with Epic customers to develop data center architectures to support Epic that are tightly aligned with guidance and recommendations from Epic described in the customized “Epic Hardware Configuration Guide” that each customer receives. Cisco and Cisco partner engineers work with each customer to expertly size and architect a proven, recommended solution in conjunction with the “Epic Hardware Configuration Guide” and Cisco best practices for sizing the Cisco UCS configuration of FlexPod. These data center designs and UCS configurations afford customers the reliability, performance, and scalability needed for high availability and security of patient data.

4.5 NetApp FAS Storage Sizing

Epic provides a document titled “Storage Area Network Considerations” to all potential customers. “Storage Area Network Considerations” describes the I/O characteristics of the production database workload. Read and write requests are defined as 100% random, generating an estimated average mix of 75% reads and 25% writes by using an 8kB request size. In addition to the workload description, Epic provides each customer with the number of read input/output operations per second (IOPS) estimated for a specific environment in a customized hardware configuration guide. Epic creates a guide for each new Epic deployment as well as for major system changes, such as upgrades or the addition of new Epic modules.

Storage Layout

The first step toward satisfying Epic’s performance, high-availability, and architectural requirements is the proper design and storage layout for the Epic software environment.

Following Epic’s recommendations, storage for the Epic disk pools and, most importantly, the production database server LUNs, must be provisioned from dedicated disks that map to dedicated clustered Data ONTAP aggregates. No other workloads should be provisioned to use the same disks and aggregates other than as specified by the “Epic Hardware Configuration Guide.” This ensures that performance specifications are achieved and proper and timely support of the configuration and environment are provided.

Additional dedicated aggregates are built and mapped to Epic disk pools per the “Epic Hardware Configuration Guide.” These aggregates provide the other storage required by the production database servers and production services, which includes storage for the production journal files and any Epic application or system files. Having journal files in aggregates separate from the aggregates used for database files provides redundancy and workload separation at the data level.

Subsequent aggregates are built with more emphasis on manageability. For example, all reporting shadow database storage can be provisioned from one large aggregate for easier management. Production Services workloads do not require that you match disk pools to aggregates with dedicated disks; a large aggregate with volumes-to-disk-pools mapping can be used.

Because Epic allows the sharing of storage resources for nonproduction needs, in many cases the second storage system can also service the Clarity server and any non-Epic storage needs, such as for virtual desktop infrastructure and other enterprise functions.

FAS8000 Series Sizing and Performance Validation Using Clustered Data ONTAP

NetApp field engineers and partners use the NetApp System Performance Modeler (SPM) custom Epic templates to help determine the specifications of the storage system that will satisfy workload needs for each customer. The SPM tool uses storage models that take into account NetApp technologies and statistical field data, and it is the method that NetApp recommends to determine the type of storage controller and number of disks required for a specific workload. The output of SPM provides data for sensitivity analysis when a number of configurations are being considered. It also provides estimates for system utilization metrics, such as the disk-to-host operations ratio and CPU utilization.

Note: For more information, request a copy of the following documents from your Cisco or NetApp sales team or partner:

- NetApp Technical Report: TR-3955: “NetApp Deployment Guide for Epic”
- NetApp Technical Report: TR-3930: “NetApp Sizing Guidelines for Epic” for details about how to use NetApp sizing tools to determine the correct RAID group size and number of RAID groups for Epic software environment storage needs

4.6 FlexClone Volumes for Production Services

NetApp FlexClone software enables additional cloning opportunities within the Epic environment, providing instant replication of data files, LUNs, and volumes without requiring additional storage space at the time of creation. Each cloned file, LUN, or volume is a transparent, virtual copy of data that can be used for essential enterprise operations such as QA, testing, development, platform and upgrade checks, multiple simulations against large datasets, remote facility testing and staging, and provisioning of server and desktop images. NetApp FlexClone provides substantial storage space savings that enable more dataset variations to be managed in less time and with less risk.

With NetApp FlexClone, dataset replicas of entire Data ONTAP volumes can be created, as well as replicas at the individual file or LUN level. For volume-level cloning, a FlexClone replica is a writable Snapshot® copy with all of the capabilities of a NetApp FlexVol® volume. It is a truly virtual data container that can be provisioned, sized, and resized dynamically to simplify operations and increase the responsiveness of Epic installations. For those applications in which more granularity is needed, file- and LUN-level cloning leverages NetApp block sharing technology. This results in maximum storage utilization since incremental capacity is needed only for clone-specific metadata and nonredundant data blocks.

4.7 Flash Cache for Meeting Epic Random Read Performance

NetApp Flash Cache™ intelligent caching is a hardware module that provides intelligent caching to improve random read performance while potentially lowering the number of hard drives required to support comparable performance.

Epic’s read and write latency requirements are specific, and storage systems must be adequately sized to meet the specifications. To meet the specifications, you normally expect that adequate read and write performance requires a high number of disk spindles, resulting in unused disk space. Flash Cache accelerates random reads while offloading the Epic-heavy load of random reads from the disks, freeing them up for writes. Given this type of workload, storage system cache technologies should be used to avoid a large disk, disk shelf, and cabling footprint, saving costs.

The database storage random read latency thresholds required by Epic generally dictate the use of Flash Cache. When Flash Cache is deployed, the cache warm-up time incurred when a system is first started must be considered in the sizing exercise. Epic-specific SPM templates adjust for the amount of Flash Cache caching needed to meet the specifications when sizing is performed.

Note: For more information, request a copy of the following documents from your Cisco or NetApp sales team or partner:

- NetApp Technical Report: TR-3832: “Flash Cache Best Practices Guide” for more information on cache warm-up times and how they affect system performance
- NetApp Technical Report: TR-3930: “NetApp Sizing Guidelines for Epic” for details about using NetApp sizing tools to determine the appropriate amount of Flash Cache needed

4.8 NVRAM for Meeting Epic Caché Write Bursts

The underlying database for Epic is InterSystems’ Caché. Caché writes occur in 80-second bursts from the database servers to the storage LUNs and must complete within the latency specifications set by Epic. NetApp stores writes in NVRAM and then writes large sequential stripes to aggregates containing LUNs. As soon as the Caché writes are stored in NVRAM an acknowledgement (ACK) is returned to the

servers. Because of its very fast speeds compared to the speed of directly writing to disks, NVRAM provides improved write performance. NetApp NVRAM is synergistic with Caché write bursts and improves overall response time and write performance.

4.9 All-Flash FAS Delivers Low-Latency Random Reads for Epic Workloads

All-Flash FAS (AFF) systems deliver consistent low-latency performance for random read workloads. What differentiates AFF from other all-flash arrays is support for both SAN and NAS, the rich data management and scale-out features of the NetApp Data ONTAP operating system, and the proven enterprise-level reliability and availability of NetApp FAS systems. These features result in Epic currently expressing a High Comfort Level in NetApp FAS plus flash SSDs.

AFF contrasts with other vendors' flash appliances that create additional storage silos, struggle to match up to Epic's SAN requirements, and have the status of either No or an Insufficient level of comfort from Epic for use in enterprise production environments.

In addition, the flexibility and versatility of configuring all-flash storage within a cluster that also has hybrid flash-HDD or HDD-only storage are unique to FAS. Some Epic system modules need all-flash performance for only a subset of the data, so the ability to easily use both all-flash nodes and hybrid storage together is very cost-effective for customers.

5 FlexPod Reseller Partners

FlexPod Premium Partners are an elite group of Cisco and NetApp resellers who have been recognized for the depth and breadth of their FlexPod expertise. They offer a comprehensive suite of FlexPod system integration and implementation services applicable to the entire FlexPod Datacenter lifecycle. FlexPod Premium Partners orchestrate a master implementation plan, including Epic-specific and Epic-experienced resources through Cisco and NetApp. Engaging a FlexPod Premium Partner for a data center deployment can help IT departments reduce risk, customize their FlexPod solution, and accelerate time to production availability.

For the most recent worldwide partner directory, visit www.netapp.com/flexpod

Additional Information

Solution Briefs

- FlexPod Datacenter Solution Brief
- FlexPod for Healthcare Solution Brief
- FlexPod Datacenter with Citrix XenDesktop and NVIDIA GRID Solution Brief
- Healthstore for FlexPod – BridgeHead NetApp Datasheet
- High-Availability Access to Patient Records with Epic on NetApp Agile Storage Infrastructure
- Customer Fitness for FlexPod Customers Quick Reference Card
- Epic on UCS Solution Brief

Customer Success Stories

- Group Health Cooperative of South Central Wisconsin Success Story
- DuPage Medical Group Success Story
- Best Practices: High-Level Infrastructure Achievements Drive EHR Success at Mercy Health Systems

Customer Videos

- Group Health Cooperative of South Central Wisconsin Video
- Mercy Customer Video
- FlexPod Cooperative Support Video

Partner Information

- Additional information for channel partners: http://www.cisconetapp.com

NetApp Technical Reports (please request a copy of the following documents from your Cisco or NetApp sales team or partner)

- TR-3446: “SnapMirror Async Overview and Best Practices Guide”
- TR-3832: “Flash Cache Best Practice Guide”
- TR-3928: “NetApp Best Practices for Epic”
- TR-3930: “NetApp Sizing Guidelines for Epic”
- TR-3955: “NetApp Deployment Guidelines for Epic”
- TR-3987: “Snap Creator Framework Plug-In for InterSystems Caché”
- TR-4050: “System Performance Modeler”

Cisco Technical Reports

- Cisco UCS Management
- Enable Local and Global Infrastructure Scale with Cisco UCS Central Software
- Cisco UCS Overview
- Cisco UCS Invicta Series Solid State Systems
- Cisco UCS Central
- Using OTV to Extend Layer 2 Between Two Data Centers
- Cisco MDS 9710 Multilayer Director
- Cisco Nexus 7700 Series Switches
- Red Hat Enterprise Linux Built on FlexPod Deployment Guide
- VMware View 4.5 on FlexPod VMware Design Guide

FlexPod and Cisco Validated Design Technical Reports

For additional information, visit http://www.netapp.com/flexpod.

- FlexPod Datacenter with VMware vSphere 5.1 U1 and Cisco ACI Design Guide
- FlexPod Datacenter with Citrix XenDesktop 7.1 and VMware vSphere 5.1