Improved Security and Speed in GE Healthcare's Centricity™ Clinical Archive

by Malcolm Catella, Sr., Staff Enterprise Architect, GE Healthcare;
Lokendra Uppuluri, Enterprise Analytics Solutions Solution Architect, Intel Corporation;
Rick Cnossen, Enterprise Analytics Solutions Solution Lead, Intel Corporation;
Wendy Bohner, Health & Life Sciences Solutions Architect, Intel Corporation

Enhance enterprise image management and IT operations by implementing GE Healthcare Centricity™ Clinical Archive on optimized, validated hyper-converged infrastructure based on technologies from Dell EMC™, Intel, and VMware

Executive Summary

GE Healthcare Centricity™ Clinical Archive is the world's leading Vendor-Neutral Archive (VNA) solution[1] that provides 360-degree imaging and multi-media patient content with seamless access through the EMR-integrated, zero-footprint diagnostic viewer to empower directed care and coordination across the enterprise. Based on industry interoperability standards like IHE, DICOM web, and XDS, GE Healthcare has a proven record of multi-vendor clinical system integrations and large-scale deployments that connect clinicians across hospitals, health systems, and regions in order to help drive improved patient outcomes.

Powered by Edison, Centricity Clinical Archive Analytics is the brain that powers the Centricity Clinical Archive solution. It derives intelligence from stored data that provides insight into enterprise-wide IT investments, resources, and clinical processes in order to help improve care delivery, reduce IT costs, and ensure appropriate reimbursement. With a strong understanding of how clinical imaging data is being used throughout the healthcare network, process improvement governance can be applied to help drive improved care to the right patient at the right time across the care continuum.

GE Healthcare, Dell EMC™, and Intel have collaborated to implement a robust Enterprise Imaging Platform (EIP) that adds value for organizations deploying Centricity Clinical Archive. Based on hyper-converged infrastructure (HCI), the EIP is designed to deliver responsive user experiences while scaling to handle rising data volumes and increasingly complex analytic requirements. The hardware platform has been architected, integrated, tested, and optimized by a joint team from Intel and Dell EMC, and Centricity Clinical Archive has been validated to run optimally on it.

With this collaboration, GE Healthcare and Intel sought to test the next-generation, highly optimized available hardware and software capabilities relevant to a VNA, specific for customers who are looking for the potential to create an environment that can process highly complicated analytics computations.

This white paper summarizes the EIP and describes benchmark testing that validates the key benefits that the EIP provides for organizations deploying Centricity Clinical Archive and are looking to go beyond standard large-scale configurations and into highly complicated computations.

Solution Benefits

- Consolidate patient data silos and enable data sharing across the care continuum
- Excellent performance for a responsive user experience
- Effective system scaling to accommodate growth
- Efficient encryption to strengthen data security
- Flexibility to accommodate emerging analytics workloads

GE Healthcare Centricity™ Clinical Archive: Seamless Connectivity to Help Improve Care

Centricity Clinical Archive is an open-architecture VNA solution that unifies and intelligently manages patient data, images, and enterprise content. Built on industry standards, Centricity Clinical Archive enables seamless connectivity among disparate systems across multiple archive systems, specialties, and facilities.

Unlike VNAs that only consolidate departmental DICOM files, Centricity Clinical Archive provides full support for a wide range of interoperability standards. These include HL7 as well as Integrating the Healthcare Enterprise's Cross-Enterprise Document Sharing (IHE-XDS) format and the Enterprise Master/Patient Index (EMPI). Centricity Clinical Archive further overcomes the limitations and inconsistencies of multi-vendor picture archiving and communications systems (PACS) by providing advanced tag morphing and image lifecycle management capabilities that optimize image sharing and workflows across diverse systems and technologies.

This broad support helps health systems securely share and interact with virtually any enterprise or community archive. It also helps clinicians streamline enterprise-level and community-wide collaboration to improve clinical decision making and treatment planning and deliver efficient, coordinated care.

Figure 1 summarizes Centricity Clinical Archive and shows capabilities, standards, and interfaces.

Enterprise Imaging Platform: High Performance and Efficiency for Centricity Clinical Archive

The EIP leverages HCI, combining compute, storage, networking, and virtualization software resources to deliver a scalable modern enterprise platform. As a preconfigured and validated solution, the EIP takes the guesswork out of infrastructure choice and deployment, helping health systems speed time-to-value, simplify IT operations, save data center space, and reduce total cost of ownership (TCO).

With a future-facing design and the latest technologies from Intel and Dell EMC, the EIP delivers outstanding performance for Centricity Clinical Archive. Health systems can take full advantage of Centricity Clinical Archive's rich feature set while also gaining the flexibility to manage data growth and accommodate innovations such as powerful new artificial intelligence (AI) algorithms. Organizations also gain capabilities to help make patient information more accessible and secure with available cloud-connected disaster recovery and virtual server deployment options, along with standardized configurations that help improve reliability.

EIP REMOVES THE GUESSWORK

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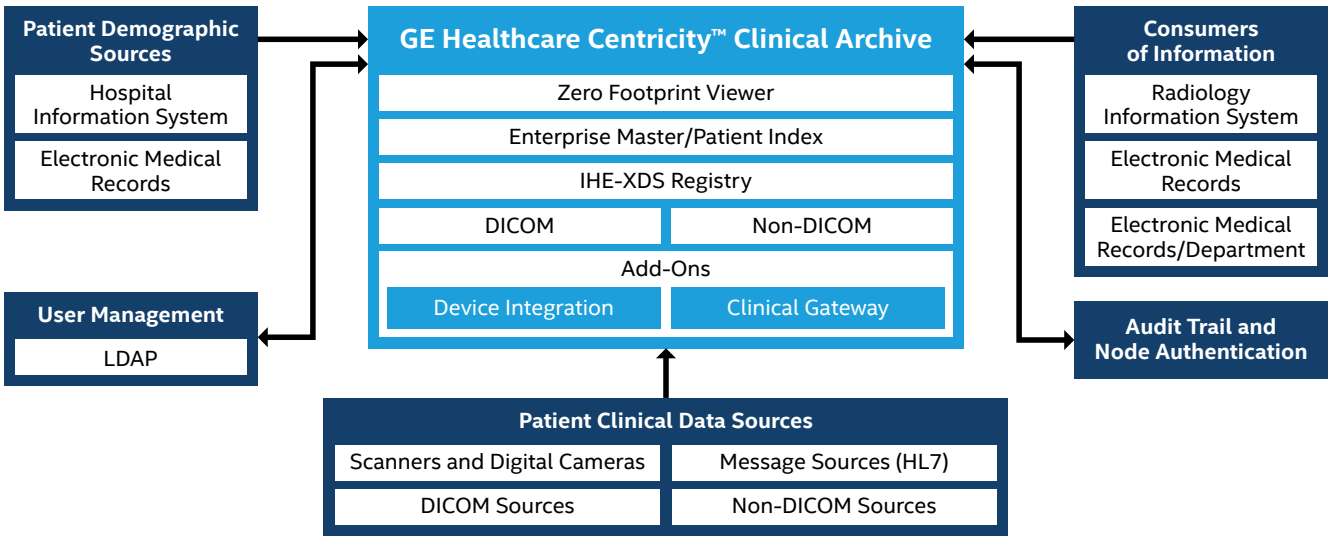


Figure 1. GE Healthcare Centricity™ Clinical Archive supports secure information sharing across diverse information systems.

Figure 2 shows the EIP's hardware and software components, with Centricity Clinical Archive installed at the top of the solution stack.

Tables 1-3 list the hardware and software that comprise the EIP.

Validating Platform Performance

To validate the EIP/Centricity Clinical Archive system and provide potential users with a realistic idea of its performance, a team of solution architects and benchmarking experts from Intel developed a benchmarking suite that simulates a real-world, large-hospital environment. The benchmarking team ran a range of tests on the EIP described in Tables 1-3. Tests were performed in July 2018 at the Intel test lab in Hillsboro, Oregon.

The simulation model incorporated data from the research firm Frost & Sullivan[2] showing traits such as average and peak study sizes, procedure volume and mix, file sizes by modality, and imaging volumes for hospitals with 500 or more beds. The model also reflected the load on the server from scanners, viewers, and other hospital information systems.

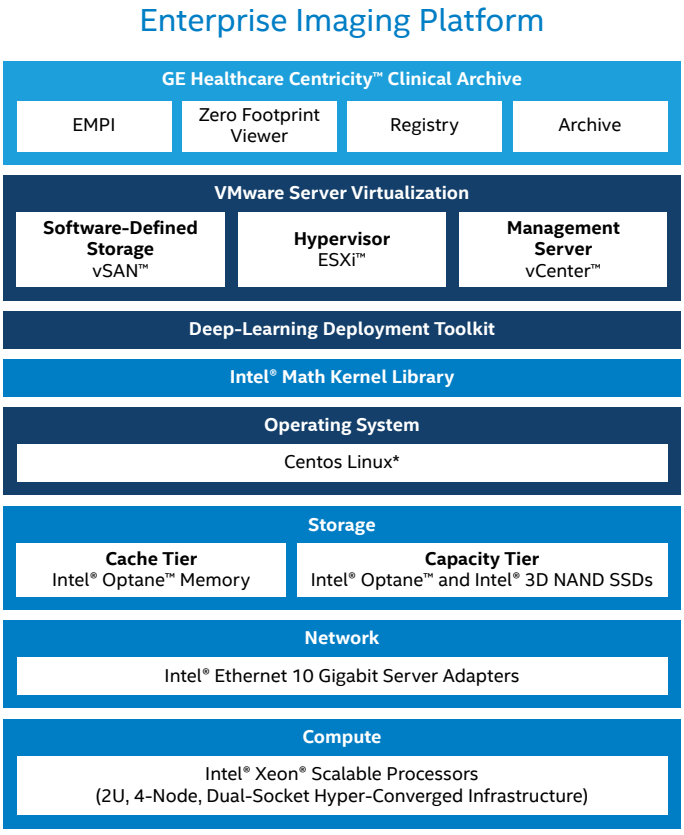


Figure 2. Enterprise Imaging Platform (EIP) solution stack with GE Healthcare Centricity™ Clinical Archive installed.

Table 1. Enterprise Imaging Platform (EIP) Hardware Components

Component	Quantity	Summary
Chassis	1	Dell EMC™ PowerEdge™ C6400 enclosure, 2.5" NVMe, Dell EMC PowerEdge C6420 vSAN™ Ready Node
Processor	8	Intel® Xeon® Gold 5120 processor 2.2 GHz, 14C/28T, 10.4 GT/s 2UPI, 19 M Cache, Turbo, HT (105 W) DDR4-2400
Memory	48	32 GB RDIMM, 2667 MT/s, dual-rank
Network Adapter	4	Intel® X710 dual-port 10 GB direct attach, SFP+, converged network adapter, low profile
Network Adapter	4	Intel X710 dual-port 10 GB, SFP+, OCP mezzanine card
Storage Controller	4	Dell PERC H330 RAID controller card
Boot Drive	4	64 GB micro SDHC/SDXC card
Flash Cache Drive	8	375 GB Intel® Optane™ SSD DC P4800X Series U.2 NVMe
Flash Capacity Drive	16	2 TB Intel® SSD DC P4510 Series U.2 NVMe

Table 2. Physical Resources Summary

Category	Requirement
Compute	112 cores
Memory	1536 GB
Cache Storage	3.20 TB
Capacity Storage	30.72 TB
Network	10 Gbps

Table 3. Software Components

Software	Version
VMware® vSphere™ ESXi™	6.7
VMware® vSAN™	6.7
VMware® vCenter™	6.7
Intel® Math Kernel Library	2018 update 3
OpenVINO™ Deep Learning Deployment Toolkit	2018 R2 release
Python*	3.6

Test Descriptions

Tests included real-world simulations focused on traits affecting user responsiveness, as well stress tests and peak-performance tests to determine how well the platform performed under each workload. The team used Locust.io, a scalable, open-source load-testing framework, to simulate the real-world load of Centricity Clinical Archive running on the EIP.

The **real-world scenario, large-hospital** test used the team's simulation model. Locust simulated uploads (which typically come from scanners and others hospital systems) as well as downloads (which are used for viewing by radiologists and transmission to other hospital systems). Uploads consisted of studies selected randomly from a pool of curated, open-source medical imaging data. The pool contained full studies of DICOM images for computed tomography (CT), digital radiography, magnetic resonance, mammography, nuclear medicine, ultrasound, and x-ray angiography. Downloads consisted of all requests needed to pull a randomly selected full study load (FSL) from previously uploaded studies. Downloads included search requests, study metadata requests, thumbnail downloads, JPEG downloads, and .RAW data files for a requested study.

Stress tests assessed maximum throughput for uploading studies to the clinical archive and downloading studies for viewing. In the **maximum upload stress test**, Locust repeatedly uploaded a golden CT DICOM study of random patients, which had been added to the system before the test. The test gradually increased the number of Locust users uploading the study to reach a maximum images/second throughput value.

For the **maximum download stress test**, Locust repeatedly downloaded a golden CT DICOM study that was uploaded during an earlier upload test. The test gradually increased the number of Locust users downloading the study to determine the maximum number of images/second throughput value.

The team also ran tests with and without encryption enabled to assess the performance impact. This activity reflects the importance of data security. Full encryption enabled means TLS for all end points, SQL server database, and full disk encryption is enabled.

Benchmarking Environment

To characterize system performance for the various test scenarios, the team gathered profiling metrics such as CPU usage (the percentage of CPU resources being used actively across all cores), network usage (the percentage of network bandwidth being used), disk usage (the percentage being used for both read and write operations), and memory usage (the amounts used and cached) to characterize system performance for the various test scenarios. The team used open-source software from Zabbix* for monitoring networks, operating systems, applications, and other IT resources —to observe performance and gather relevant data.

Figure 3 provides an overview of the benchmarking environment, and Table 4 lists software elements used in the environment.

Table 4. Software Components of Benchmarking Environment

Component	Purpose
HL7 Package	Handle HL7 message format for registering patients in the GE Centricity™ Clinical Gateway
pynetdicom	Handle DICOM image format
pydicom	Handle DICOM image format
Locust.io	Simulate load on the system
Zabbix*	Monitor and collect metrics

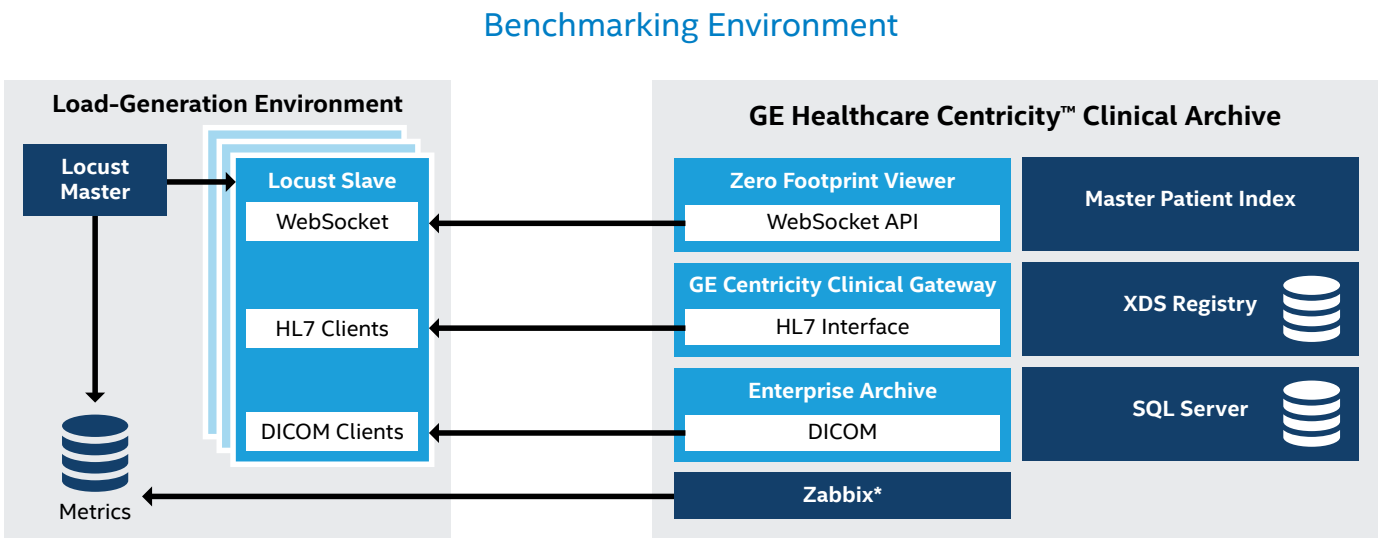


Figure 3. Technical overview of the benchmarking environment. The benchmark team used Locust.io to simulate the real-world load of the GE Healthcare Centricity™ Clinical Archive system running on the Enterprise Imaging Platform (EIP) and the Zabbix* monitoring tool to gather profiling metrics.

Benchmark Results

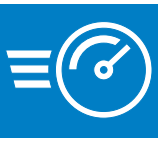
Figures 4-7 show test results for Centricity Clinical Archive running on the EIP in real-world scenarios and under stress with full encryption enabled.

Maintaining Clinician Productivity: Average Image Access Times in Real-World Scenarios

Figure 4 reports the average image access times for the real-world, large-hospital scenario with an upload-to-download ratio of 1:1. The team tested five types of files:

1. First image load JPEG format (FIL JPEG)
2. Full study load JPEG Format (FSL JPEG)
3. First image load DICOM format (FIL)
4. Full study load DICOM format (FSL)
5. First image upload (FIU)

The tests showed that Centricity Clinical Archive delivers outstanding performance on EIP, loading a full study in less than two seconds. This steady performance ensures a responsive experience, enabling clinicians to load and view large imaging studies with little or no lag.



GE Centricity™ Clinical Archive loaded a full study in less than two seconds, enabling clinicians to load and view large imaging studies with little or no lag.

Scaling to Handle More Users: Upload Stress Tests

The benchmark tests confirmed that the EIP smoothly scales to handle increasing numbers of simulated Centricity Clinical Archive users under peak load and stress scenarios without significant degradation. The upload stress test results in Figure 5 show that the average upload time per image less than doubled even as the number of users rose tenfold. Performance remained well within optimal limits, ensuring that the system can scale to accommodate large numbers of users without significant performance degradation.

Strengthening Security: Upload Stress Test with and without Encryption

Encrypting patient data at rest and in flight is an effective way to strengthen data protection, but traditional software-based data encryption often brings a significant performance penalty. To avoid this, enterprises often choose to avoid encrypting data.

Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI) applies hardware-aided capabilities that accelerate encryption tools such as BitLocker* and help maintain high performance. Performance impact becomes evident when EFS encryption is used, which does not support AES-NI, instead of BitLocker, which does support it.

Figure 6 shows the average upload time with encryption enabled and disabled during the upload stress test. With Intel AES-NI running, the performance impact when encryption is enabled is less than 2 percent, allowing institutions to reinforce data security by running encryption for all operations.

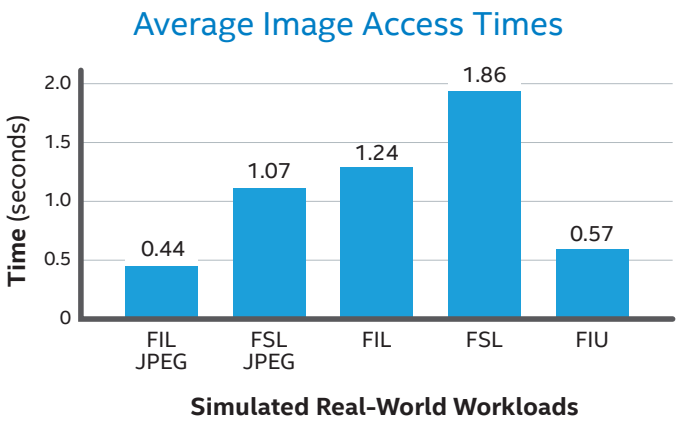


Figure 4. In the simulated real-world hospital of 500 or more beds, the Enterprise Imaging Platform (EIP) loaded a full study in 1.86 seconds, to deliver a responsive experience for busy clinicians.

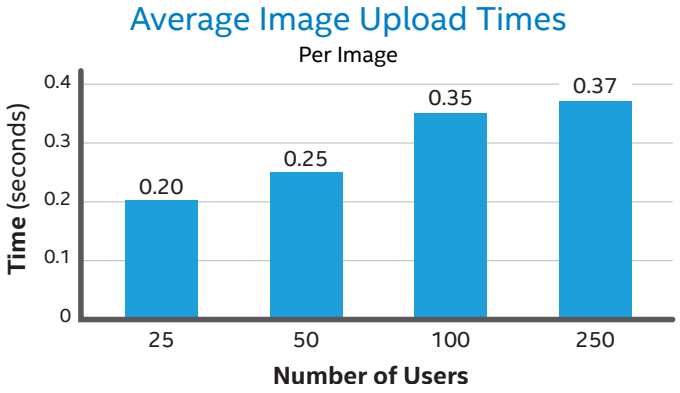


Figure 5. The upload stress test showed the average upload times per image increased less than twofold as the number of users rose tenfold.

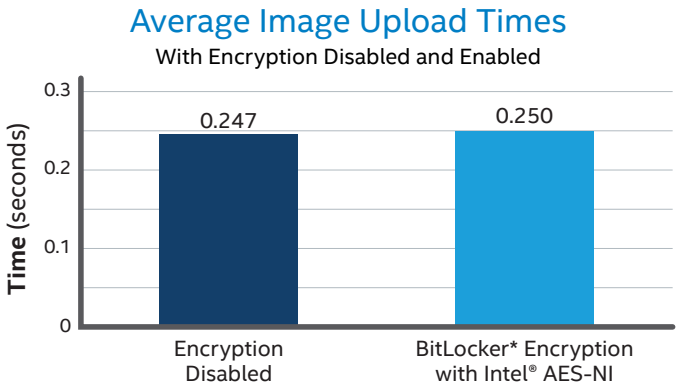


Figure 6. With Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI) in place, the upload stress test showed only a minimal performance impact from encryption.

Providing Headroom for New Use Cases: Maximum CPU Usage

Many Centricity Clinical Archive users are beginning to deploy increasingly sophisticated analytics and AI capabilities to gain valuable new insights from their growing stores of healthcare data. EIP has been architected with the system resources needed to handle these and other additional workloads. Figure 7 shows maximum CPU usage of key Centricity Clinical Archive components during upload and download stress tests. With maximum CPU usage under stress of 40 percent or less, the system has ample overhead room to run additional compute-intensive workloads.

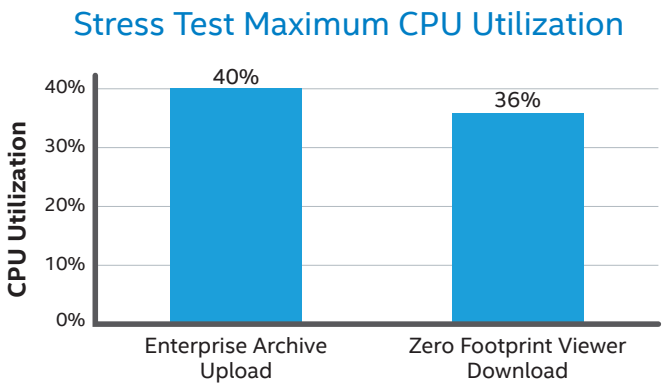


Figure 7. Maximum CPU usage remains well within accepted limits even under stress, offering flexibility to support additional workloads.

Imagination at work

Summary

The industry's #1 VNA[1], Centricity Clinical Archive offers a comprehensive, longitudinal view of patient data from a wide variety of healthcare information systems. By delivering clinical insight at the point of care, Centricity Clinical Archive can help improve decision making, reduce unnecessary tests, and optimize TCO. By facilitating collaboration across the healthcare enterprise and beyond, Centricity Clinical Archive helps organizations meet the mandate for efficient, coordinated care.

The EIP developed by GE Healthcare, Dell EMC, and Intel is architected for optimal performance and easy deployment for organizations implementing Centricity Clinical Archive. The teamwork among GE Healthcare, Dell EMC, and Intel simplifies infrastructure choice and deployment while providing healthcare organizations with a powerful foundation to improve clinical care, workflows, and costs, as well as achieve important clinical and operational objectives.

Find the solution that is right for your organization. Contact your Intel or GE Healthcare representative or visit intel.com/healthcare and gehealthcare.com.

Learn More

You may also find the following resources useful:

- GE Centricity Clinical Archive
- Enterprise Imaging Platform from Dell EMC and Intel
- Dell EMC Hyper-converged Infrastructure
- Intel Xeon Gold Processors
- VMware vCenter Server
- VMware vSAN
- VMware vSphere ESXi

References

1 IHS, Medical Enterprise Data Storage Market, 2017. gehealthcare.com/en/products/healthcare-it/enterprise-imaging/centricity-clinical-archive.

2 Frost & Sullivan, *Estimates of Hospital Load*, December 2017.

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