PROWESS

Accelerate and Secure Big Data, Database, and VDI Workloads in Healthcare

Benchmark testing conducted by Prowess Consulting demonstrates how healthcare organizations can significantly boost performance and security by upgrading to systems built on 3rd Gen AMD EPYC™ processors.

Technical Research Report

Executive Summary

Healthcare organizations have unique infrastructure needs due to their diverse workloads and regulatory requirements. For example, organizations typically run database and analytics workloads to support electronic health records (EHRs) and other data. They also need to support unique emerging artificial intelligence (AI) workloads that require specialized performance. In addition, it's common for healthcare organizations to rely heavily on virtual desktop infrastructure (VDI) to better manage user access. And across all these scenarios, security is paramount for healthcare organizations trying to protect confidential medical and billing records in the face of constant and growing cyberattacks. Unfortunately, older-generation servers might not be able to provide the levels of performance and security that modern healthcare organizations require for these specialized workloads.

To determine if healthcare organizations would significantly benefit from a server refresh, Prowess Consulting performed extensive testing and research. Specifically, we examined the benefits of upgrading to Dell™ PowerEdge™ R7515 servers, powered by 32-core AMD EPYC™ 7543 processors, from older-generation Dell PowerEdge R730 servers, powered by a 16-core Intel® Xeon® processor E5-2683. We relied on the HammerDB TPROC-H benchmark to test database performance and Spark-Bench with the k-means workload to test big data/artificial intelligence (AI) workloads.

Our testing showed marked improvements to benchmark performance for database and big data workloads. In addition, our analysis uncovered additional qualitative benefits provided by the newer Dell™ platform that can help organizations achieve required levels of performance with stronger levels of protection from emerging cyberthreats.

The Dell™ PowerEdge™ R7515 server, compared to the Dell PowerEdge R730 server, can provide:

- Up to **64%** faster query times[1]
- Up to **73%** faster AI processing[1]
- Industry-leading performance for virtualization[2]
- Strong built-in encryption for memory and virtualization[1]
- One efficient 32-core CPU, versus two 16-core CPUs[3]

Industry Landscape

Healthcare organizations have unique infrastructure needs due to the diverse workloads and massive datasets they contend with. Modern hospitals and clinics typically need to ingest and process large and growing amounts of data from a wide range of sources. The most obvious example of this is related to EHRs, which contain massive amounts of data. This data is read in frequent, small chunks throughout the day as medical practitioners and staff access patient health, billing, and insurance information.

Beyond EHRs, other sources of big data can also burden healthcare infrastructure. For example, many healthcare organizations collect and analyze massive amounts of data from patients with wearable or home-based devices. In addition, data on symptoms, medication use, visits, and other metrics can be extracted and analyzed to help reduce the risk of hospitalization for patients with chronic issues or to track treatment and recovery rates for diseases like cancer.

Internally, healthcare organizations can use data to improve their security postures by analyzing behaviors that might indicate a cyberattack. And they can increase productivity and efficiency by analyzing data to help manage healthcare staffing schedules.

Healthcare organizations also make use of massive datasets to feed AI algorithms used in diagnostics. These workloads can help improve accuracy, reduce time to results, and—through automation—complement over-burdened clinicians.

In addition to data processing and analytics, healthcare organizations frequently rely on VDI as a way to more easily manage and secure individual users' desktops. VDI also helps these organizations better meet regulatory requirements by offering tighter control over application and data access and usage. To handle some or all of these critical workloads, healthcare organizations need efficient, performant infrastructure that offers sufficient processing power plus high bandwidth for memory and storage. Hospitals and clinics also need infrastructure with strong built-in security to help protect patients, staff, and sensitive billing data. Unfortunately, many organizations still rely on older-generation server platforms that might struggle to match the performance, manageability, and security offered by many newer servers.

Putting Newer-Generation Dell™ PowerEdge™ Servers to the Test

To determine how much difference a server upgrade would make to healthcare organizations, Prowess compared an older-generation Dell PowerEdge R730 server powered by the Intel Xeon processor E5-2683 (with two processors) to a newer-generation Dell PowerEdge R7515 server powered by a single AMD EPYC 7543 processor. Details of both configurations are shown in Table 1.

Table 1. System configurations used for performance testing

	Dell™ PowerEdge™ R730	Dell™ PowerEdge™ R7515
Hardware		
Processor	2 x Intel® Xeon® processor E5-2683	1 x AMD EPYC™ 7543 processor
Number of CPUs	2	1
Cores	16	32
Cores/Threads Total	32/64	32/64
Frequency (Base/SCT/MCT)	2,100 MHz	2,800 MHz
Storage Controller 01	No operating system (OS) boot-optimized server storage (BOSS)	Dell™ Boot Optimized Server Storage (BOSS)-S1
Disk	Not applicable (N/A)	223.57 GB
Number of Disks	N/A	2
Storage Controller 02	N/A	Dell™ PowerEdge RAID Controller (PERC) H730P
Disk	1,787.88 GB	1,787.88 GB
Number of Disks	4	4

	Dell™ PowerEdge™ R730	Dell™ PowerEdge™ R7515
Installed Memory	128 GB	128 GB
Memory DIMM	Error Correction Code (ECC) DDR4	Error Correction Code (ECC) DDR4
Memory Speed	2,133 MHz	3,200 MHz
Number of Memory DIMMs	8	8
BIOS Version	2.13.0	2.7.3
OS Performance Profile	Performance	Performance
Software		
OS	Red Hat® Enterprise Linux® 8.6	
OS Version	8.6	
OS Kernel	4.18.0-372.13.1.el8_6.x86_64	
Database	Microsoft® SQL Server® 2019 - 15.0.4236.7	
Benchmarking Tools		
Database Performance	HammerDB TPROC-H benchmark	
Big Data (Machine Learning [ML]) Performance	Spark-Bench k-means workload	

Our analysis included both benchmark testing and analysis covering the following areas:

- Database and analytics performance
- AI performance
- VDI considerations
- Security capabilities

Database Performance

To measure database performance, we relied on HammerDB TPROC-H. This benchmarking tool was selected because it offers an accurate representation of the read-heavy (as opposed to transactional) nature of most healthcare database workloads, where doctors and clinicians need to frequently access varying amounts of both simple and complex data.

We ran the HammerDB TPROC-H benchmark against a Microsoft® SQL Server® database. For each server, we ran tests for 1, 5, and 10 virtual users against both 100 GB and 300 GB databases. Results are the geometric mean of query times. In addition, we performed three runs for each query and then used the median value for our comparisons.

As Figures 1 and 2 illustrate, the AMD® processor–powered Dell PowerEdge R7515 server out-performed the Intel® processor–powered Dell PowerEdge R730 server by up to 1.64x in tests against a 100 GB database and up to 1.60x against a 300 GB database.

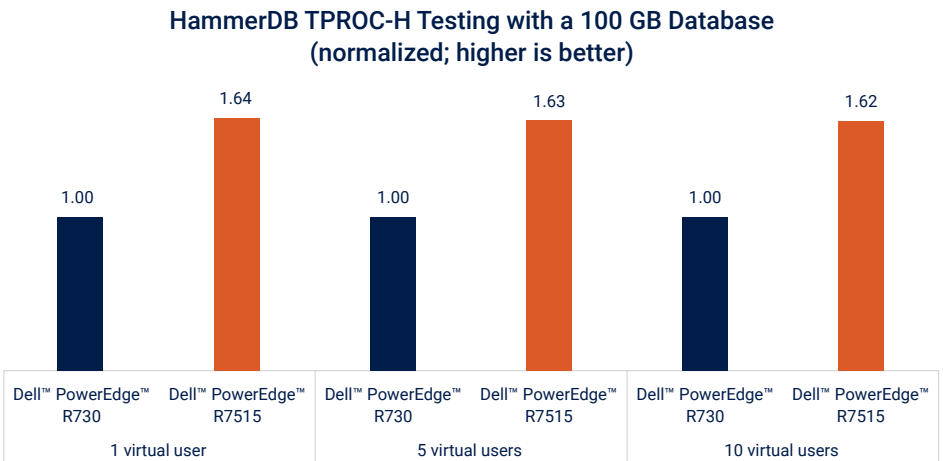

Figure 1. The Dell™ PowerEdge™ R7515 server showed significant performance gains over the Dell PowerEdge R730 server in HammerDB TPROC-H testing against a 100 GB database

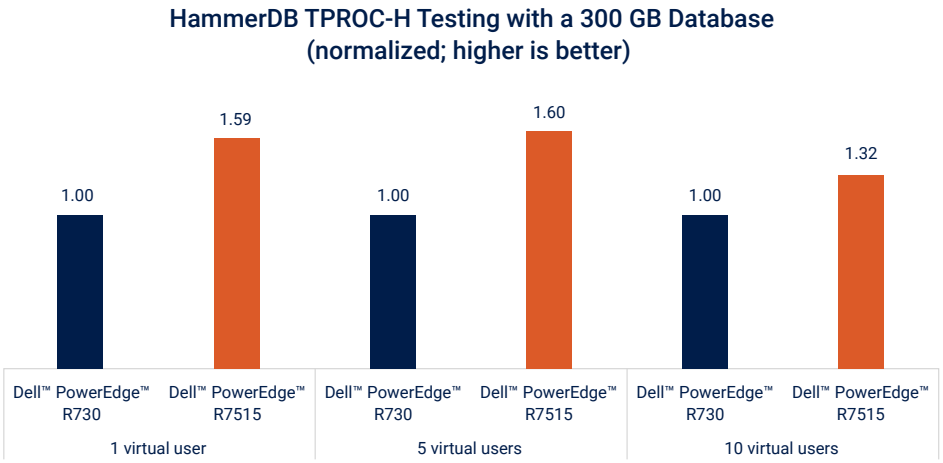

Figure 2. The Dell™ PowerEdge™ R7515 server also demonstrated significant performance gains over the Dell PowerEdge R730 server in HammerDB TPROC-H testing against a 300 GB database

These results show that the Dell PowerEdge R7515 server can provide exceptional database performance in healthcare settings where frequent, read-focused transactions are performed throughout the day.

Big Data/Analytics Performance

For analytics performance testing, we ran Spark-Bench tests using a workload based on the k-means algorithm. This benchmark records cumulative time to load, train, and test AI datasets that are representative of the AI workloads used by healthcare organizations looking for patterns in diseases and treatments. We ran two sets of tests with this benchmark—one with 100,000 rows and one with 50,000,000 rows—to represent the larger end of workloads typically found in healthcare research projects today.

As Figure 3 shows, the Dell PowerEdge R7515 server performed up to 1.64x faster than the Dell PowerEdge R730 server in the 100,000-row test, and up to 1.73x faster than the Dell PowerEdge R730 server in the 50,000,000-row test.

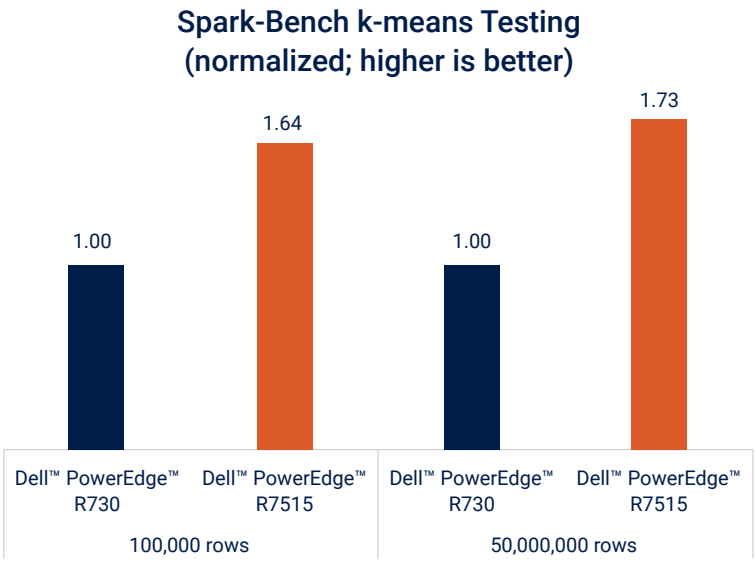

Figure 3. The Dell™ PowerEdge™ R7515 server ran simulated AI workloads significantly faster than the Dell PowerEdge R730 server

Based on these benchmark results, the Dell PowerEdge R7515 server would be a good option for organizations looking to analyze large datasets for patterns in complex healthcare data.

Behind the Numbers

Several factors led to the performance gains measured in the Dell PowerEdge R7515 server, with the processor being a significant contributor. Compared to the two Intel processors (the Intel Xeon processor E5-2683) found in the Dell PowerEdge R730 server, the newer Dell server is powered by a single AMD EPYC 7543 processor that provides more efficient performance from a higher core count and higher frequency CPU. The newer Dell PowerEdge R7515 server also offers a faster memory bus and faster PCIe® interconnect (PCIe Gen4, versus PCIe Gen3).[3]

Additional Performance Benefits of Dell PowerEdge R7515 Servers in Healthcare

The performance benefits alone of Dell PowerEdge R7515 servers offer a compelling narrative for organizations considering an upgrade. But several other factors need to be considered beyond raw performance. To go beyond benchmark testing, we performed research to determine what additional technologies the newer Dell PowerEdge R7515 servers offered that could benefit performance for typical healthcare workloads.

Accelerating AI Performance in Healthcare

AI inferencing performance is driven by how much calculating the processor register can do. The register is the location within a processor that holds the instructions, storage addresses, and individual numeric data necessary for computation.

One way to speed up AI inferencing, then, is to increase the amount of numeric data that a processor can calculate in a clock cycle (in other words, the bandwidth of the processor). Increasing the quantity of floating-point numbers on which processors can calculate automatically speeds up inferencing because AI models are generally based on decimal numbers. The generation-on-generation doubling of the intake floating point in 3rd Gen AMD EPYC processors is an example of this.

One advantage to this approach is that it is completely transparent to existing AI models. Therefore, a healthcare organization can speed up inferencing for its diagnostics imaging AI models by using Dell PowerEdge R7515 servers powered by AMD EPYC 7543 processors, which are built to accommodate more floating-point numbers in their registers.

Another way to accelerate inferencing is to quantize AI models to use 8-bit integers (INT8) instead of floating-point numbers. Moving to INT8 inferencing aids with both memory management and processing time. For memory management, a single 32-bit floating-point number takes up the same memory footprint as four 8-bit integer numbers. To accelerate processing time, the increased bandwidth in 3rd Gen AMD EPYC processors can perform the same operation on multiple 8-bit integers in a single processor clock cycle.

As mentioned earlier, the Dell PowerEdge R7515 server supports PCIe 4.0. Compared to the PCIe 3.0 interconnect found in the Dell PowerEdge R730 server, PCIe 4.0 can provide a performance boost for add-on inference accelerators, which require high bandwidth for the connection between the accelerator and the server processor. Specifically, PCIe 4.0 provides 16 gigatransfers per second (GT/s), compared to 8 GT/s in PCIe 3.0, which can translate to faster data transfers for inference accelerators.

Virtual Desktop Infrastructure (VDI) Considerations

Due to regulatory requirements and the need for privacy and security, healthcare organizations often deploy and manage their employees' operating systems and software via VDI sessions. Although VDI benchmark testing was beyond the scope of this study, we performed additional research to determine what benefits, if any, modern Dell PowerEdge servers powered by 3rd Gen AMD EPYC processors could offer for VDI users.

VDI workloads would benefit from many of the same technology advancements in the Dell PowerEdge R7515 server that help accelerate big data workloads. These include:

- High core counts
- High-frequency CPUs
- High memory bandwidth
- PCIe 4.0 to support modern NVM Express® (NVMe®) solid-state drives (SSDs) and graphics processing units (GPUs)

Recent studies seem to validate the benefits of these upgraded technologies. In one example, testing demonstrated a gain of 20 percent more VDI users and 11 percent lower cost per VDI user for a Dell PowerEdge R7515 server powered by a 3rd Gen AMD EPYC processor, compared to the same server with a 2nd Gen AMD EPYC processor.[4]

VMware testing also demonstrates exceptional virtualization performance for the PowerEdge R7515 server. In VMmark® 3.x tests of 2-socket servers, the PowerEdge R7515 took the top three scores for the category.[2]

In addition, AMD published a technical data sheet touting that its AMD EPYC 7763 processor enables up to 2.1x more VDI sessions on Login VSI™, compared to an Intel Xeon Gold 6258R processor.[5] Although both of these processors are newer than the ones we used for benchmark testing, the relative performance provides a good indication of VDI capabilities for the two processor platforms. Relative performance of 3rd Gen AMD EPYC processors is likely to be even higher compared to earlier-generation Intel Xeon processors, like the one in this study.

Security Considerations in Healthcare

There is no shortage of cyberattacks on healthcare systems. According to a study by the CyberPeace Institute, in the period between June 2020 and September 2021, more than 10 million healthcare records were stolen. These records included Social Security numbers, patient medical records, financial data, HIV test results, and the private details of medical donors.[6]

Healthcare organizations can strengthen their security defenses by employing software-based tools to help with threat protection, response, and recovery. But to fully embrace cybersecurity best practices established by the National Institute of Standards and Technology (NIST) Cybersecurity Framework, healthcare organizations need to take a more proactive approach. Modern security features, such as confidential computing, go beyond software-based techniques by extending protections into the hardware layer and even into the supply chains of hardware suppliers.

According to a white paper published by Dell Technologies, the company integrates security into the development cycle and includes several features as part of its PowerEdge Cyber Resilient Platform.[7] But Prowess also performed additional research on the newer Dell PowerEdge R7515 server, as well as the AMD EPYC 7543 processor that powers it, to identify what hardware-based security technologies the server offers that can help healthcare organizations facing an onslaught of daily cyberthreats.

Memory Encryption

System memory can represent a vulnerability for data. While data might be encrypted at rest, in storage, and in motion across the network, it typically needs to be decrypted into memory for use by applications. This can put sensitive healthcare information at risk, particularly from attacks focused on accessing system memory from physical devices that are lost or stolen.

The AMD EPYC 7543 processor helps address this vulnerability by using AMD® Secure Memory Encryption (AMD® SME) to transparently encrypt system memory for operating systems.

Encrypted Virtualization

In 2021, researchers at Symantec published evidence that ransomware attackers had started using virtual machines (VMs) to help prevent discovery of their malware after encryption had begun.[8] Because VMs play an increasingly important role in healthcare organizations for efficiency and cost reasons, protecting or isolating VMs is critical to safeguarding healthcare data.

AMD® Secure Encrypted Virtualization (AMD® SEV), provided by the AMD EPYC 7543 processor, helps limit threats to VMs by isolating guest operating systems and hypervisors from one another. It does this by encrypting the respective pages in system memory so that VMs and hosts cannot directly access each other's data in memory. AMD® Secure Encrypted Virtualization-Encrypted State (AMD® SEV-ES) goes further and encrypts all CPU register contents when a VM stops running. This technique helps prevent leakage of information in CPU registers to components such as the hypervisor. AMD SEV-ES can even detect malicious modifications to a CPU register's state.

Silicon Root of Trust and Secure Boot

Firmware is an attractive attack vector because it provides a way to compromise servers while they are booting, before software-based malware defenses even have a chance to start running. To head off these attacks, the Integrated Dell™ Remote Access Controller (iDRAC), found in the Dell PowerEdge R7515 server, provides a read-only encryption key that validates that the BIOS or Unified Extensible Firmware Interface (UEFI) drivers are legitimate. This type of cryptographic verification helps meets NIST recommendations for BIOS protection for servers and BIOS-integrity measurement; it also undergirds software-based security features such as Secure Boot in Windows Server®.

Additionally, AMD® Secure Boot helps continue the chain of trust from the system BIOS to the OS bootloader.

Firmware can be further protected by additional hardware-based technologies. For example, BIOS live scanning in iDRAC can verify the integrity and authenticity of the BIOS image when a server is powered on, which can help protect systems from attacks that manipulate the BIOS as a way to alter firmware. In addition, dynamic system lockdown, such as that provided by iDRAC, can even help prevent system access using administrator privileges from altering firmware while the lockdown is in place. Locking down firmware in this manner also helps prevent unintentional migration of compromised firmware and configuration settings from one server to another, which can lead to additional vulnerabilities on the other servers.

Secure Supply Chains

Another vector of attack is one that often goes unnoticed by healthcare IT admins: manufacturing supply chains. During manufacturing and shipping, hardware and firmware components can be altered in ways customers can't detect. The only way to defend against these attacks is for server vendors to work to ensure that there is no tampering with products or insertion of counterfeit components before shipping products to customers. To do this, original equipment manufacturer (OEM) controls must span supplier selection, sourcing, production processes, and governance through auditing and testing. Material inspections during production can help identify components that are mismarked, that deviate from normal performance parameters, or that contain an incorrect electronic identifier. Healthcare organizations can better protect themselves by seeking out vendors, such as Dell Technologies, that provide Secured Component Verification (SCV) on top of a secured supply chain.

Upgrading Hardware Yields Powerful Results

Healthcare organizations are increasingly relying on high-performance servers on premises to power their database, VDI, AI, and other big data uses cases. From EHRs to remote desktops to medical diagnostics—healthcare workloads all require infrastructure that can meet demanding performance requirements while also helping protect the sensitive data being processed.

Testing and research by Prowess demonstrates that upgrading from older servers to newer Dell PowerEdge R7515 servers powered by 3rd Gen AMD EPYC processors can provide organizations with a substantial boost in performance for database and big data workloads.[1]

The AMD processor–powered PowerEdge R7515 platform also brings potential cost savings in two ways. These platforms are built with efficient 32-core CPUs, compared to the two 16-core CPUs powering the PowerEdge R730. The more efficient 32-core design can reduce licensing costs for some software applications. And because this platform provides higher levels of performance, businesses can consolidate their data center footprint by deploying fewer servers to handle equivalent or even larger workloads.

And finally, the PowerEdge R7515 platform also provides the additional performance and security features needed by modern healthcare organizations so their IT admins can focus on expanding care, instead of maintaining and securing hardware.

For detailed testing methodology and configurations used in this study, see the methodology report at www.prowesscorp.com/project/dell-amd-servers-build-secure-performant-healthcare-it-infrastructure/.

Learn More

To learn more about the Dell PowerEdge R7515 server, view its specification sheet: https://i.dell.com/sites/csdocuments/Product_Docs/en/poweredge-r7515-spec-sheet.pdf

[1] Based on Prowess testing. For detailed testing methodology and configurations used in this study, see the methodology report at www.prowesscorp.com/project/dell-amd-servers-build-secure-performant-healthcare-it-infrastructure/.
[2] Based on VMware® VMmark® 3.x testing as of October 6, 2022. The Dell™ PowerEdge™ R7515 server held the three top positions for all tested two-socket servers. Source: VMware. VMmark 3.x Results. October 6, 2022. www.vmware.com/products/vmmark/results3x.0.html#?totalsockets=2-total-sockets&sort=score&matchedpair=matched-pair.
[3] Source: Dell Technologies specification sheets for Dell™ PowerEdge™ R730 (https://i.dell.com/sites/doccontent/shared-content/data-sheets/en/Documents/Dell-PowerEdge-R730-Spec-Sheet.pdf) and Dell PowerEdge R7515 (https://i.dell.com/sites/csdocuments/Product_Docs/en/poweredge-r7515-spec-sheet.pdf) servers.
[4] Principled Technologies. "Support more VDI users with a Dell EMC PowerEdge R7515 server powered by an AMD EPYC 75F3 processor." Commissioned by Dell Technologies. March 2021. www.delltechnologies.com/asset/en-us/products/servers/industry-market/support-more-vdi-users-with-a-dell-emc-poweredge-r7515.pdf.
[5] AMD. MLN-004. Login VSI™ Pro v4.1.40.1 comparison based on AMD internal testing as of 02/01/2021 measuring the maximum "knowledge worker" desktop sessions within VSI Baseline +1,000 ms response time using VMware ESXi™ 7.0u1 and VMware Horizon® 8 on a server using 2 x AMD EPYC™ 7763 processors versus a server with 2 x Intel® Xeon® Gold 6258R processors for ~112 percent more max [~2.1x the] performance. Results may vary. www.amd.com/en/claims/epyc#faq-MLN-004.
[6] CyberPeace Institute. "If healthcare doesn't strengthen its cybersecurity, it could soon be in critical condition." November 2021. www.weforum.org/agenda/2021/11/healthcare-cybersecurity.
[7] Dell Technologies. "Technical White Paper: Cyber Resilient Security in Dell EMC PowerEdge Servers." December 2020. www.delltechnologies.com/asset/en-us/products/servers/industry-market/cyber-resilient-security-with-poweredge-servers.pdf.
[8] Symantec. "Ransomware: Growing Number of Attackers Using Virtual Machines." June 2021. https://symantec-enterprise-blogs.security.com/blogs/threat-intelligence/ransomware-virtual-machines.