Dell EMC High Performance Computing Solutions Portfolio

Accelerate discovery and innovation

Table of Contents

Go ahead. Dream big. .................................................. 2
   Dell Technologies has what you need... .......................... 2
   HPC use cases .................................................. 3

Dell Technologies has a simple strategy: Transform the future with HPC/AI ........ 5
   Democratizing HPC: Speed time to results with confidence and savings .... 5
   Optimizing HPC: Maximize performance, efficiency and flexibility ...... 6
   Advancing HPC: Leverage expertise to fast-track projects and success ... 6
   Customer success stories .......................................... 7

Technical specifications ............................................. 8
   Ready Solutions for AI and Data Analytics .......................... 8
   Ready Solutions for HPC Research .................................. 9
   Ready Solutions for HPC Life Sciences .............................. 10
   Ready Solutions for HPC Digital Manufacturing ....................... 12
   Ready Solutions for Virtualized HPC ................................ 15
   Ready Solutions for GPU as a Service ................................ 16
   Ready Solutions for HPC Storage .................................. 16

Services and financing .................................................. 21

Why choose Dell Technologies for HPC? .................................. 22
   Customer Solution Centers .......................................... 22
   AI Experience Zones ............................................... 22
   HPC & AI Innovation Lab ........................................... 22
   HPC & AI Centers of Excellence ................................... 22
   Proven results ...................................................... 23

Take the next step, today ............................................. 23
Go ahead. Dream big.

Discovery and innovation have always started with great minds dreaming big. With the help of increasingly powerful and sophisticated technology, you’re now empowered to dream even bigger.

High performance computing (HPC) has been a powerful tool for researchers and scientists for decades. But recent rapid advancements in processing power and connectivity, combined with massive new sources of real-time information, are fueling the next industrial revolution, and the next quantum leap in human progress.

That’s because, as it becomes more accessible, HPC is enabling adoption of artificial intelligence (AI) and advanced data analytics in multiple industries across a variety of use cases. This convergence of HPC, AI and data analytics creates more opportunities to break new ground, make important discoveries and solve some of the most important challenges of our time.

Dell Technologies is helping expand the boundaries of this exciting new frontier with scalable, flexible solutions designed to help you solve complex problems faster than ever. In fact, we’re one of the only companies in the world with a portfolio for HPC, AI and data analytics that spans workstations, servers, networking, storage, rack systems and services. In addition, Dell Technologies HPC experts are active innovators and collaborators in the worldwide technical community dedicated to advancing HPC. Our goal is to enable more organizations like yours to leverage HPC to do what you do best — change the world.

Dell Technologies has what you need.

Expertise and guidance
Technology is evolving quickly, so your team may not have the resources to design, deploy and manage solution stacks optimized for HPC. While HPC might seem like the latest IT trend, Dell Technologies has been a leader in the advanced computing space for over a decade, with proven products, solutions and expertise. Dell Technologies has a team of HPC, AI and data analytics experts dedicated to staying on the cutting edge, testing new technologies and tuning solutions to your applications to help you keep pace with this constantly evolving landscape.

Dell EMC Ready Solutions for HPC
The advantage in today’s marketplace goes to the data-driven enterprise. For many organizations, HPC is — or is becoming — an important source of competitive advantage. An optimized HPC solution delivers the compute, throughput and capacity needed to manage the rapid data growth and increased workload demands presented by advanced data analytics and other enterprise workloads. Dell EMC Ready Solutions for HPC speed time to results with the confidence of engineering-tested systems while saving valuable time and resources.

Solutions customized for your environment
Dell Technologies uniquely provides an extensive portfolio of technologies to deliver the advanced computing solutions that underpin successful HPC, AI and data analytics implementations. With years of experience and an ecosystem of curated technology and service partners, Dell Technologies provides innovative solutions, workstations, servers, networking, storage and services that reduce complexity and enable you to capitalize on a universe of data.
HPC Workloads

How does your organization plan to leverage HPC? Dell Technologies has the proven expertise in assisting with building, deploying and supporting workload-optimized HPC solutions. The following are just a few examples.

Research

HPC helps researchers move quickly from raw data to actionable insights. There are a wide range of use cases for research HPC. Some of the more common ones include:

- **Genomics** — Get the compute power necessary to solve the mystery of the human genome.
- **Instrumentation** — Speed medical breakthroughs enabled by instruments such as cryo-electron microscopy (cryo-EM).
- **Molecular dynamics / quantum physics** — Simulate the behavior of atoms and molecules.
- **Astronomy** — Analyze data from large telescopes such as the Large Synoptic Survey Telescope (LSST), the Cherenkov Telescope Array (CTA) and the Square Kilometre Array (SKA).
- **Climate and weather modeling** — Model vast amounts of data to improve the accuracy of predictions around the formation, intensity and movement of weather systems.
- **Geosciences** — Identify patterns in geological data to predict and model vast systems with very high accuracy.

Life sciences

The computing power of HPC is the key to using medical data to save lives and protect health — better, faster and with lower costs. Use cases for life sciences organizations include:

- **Healthcare research** — Speed and improve research outcomes including genomics, proteomics, bioinformatics, cryo-EM and neuroscience.
- **Pharmaceutical** — Transform the process of drug development by speeding processes such as drug discovery, computational chemistry and molecular dynamics, precision medicine and clinical trials.
- **Healthcare providers** — Identify disease sooner and treat it more effectively and efficiently using HPC in such areas as oncology, alerts and diagnostics, medical imaging, hospital workflows, clinical decision support and personalized medicine.
- **Governments** — Protect population health with advanced epidemiology and protect government resources with enhanced fraud-detection capabilities.

Digital manufacturing

Manufacturers use HPC to power the specialized software that helps create innovative products and grow share and revenue while cutting costs and improving quality. Typical workloads include:

- **Structural analysis** — Increase computational efficiency, so users can complete more analyses in less time with fewer errors.
- **Computational fluid dynamics (CFD)** — Use simulations to predict fluid behavior faster and more accurately to help keep to tight development schedules.
- **Noise, vibration and harshness (NVH)** — Identify and reduce NVH prior to prototyping to save time and costs. AI-enhanced NVH can also be embedded in products, leveraging Internet of Things (IoT) to help warn of impending failures.
- **Virtual desktop infrastructure (VDI)** — Supercharge engineering productivity with powerful HPC systems that can be used to support remote visualization for multiple users on a single, virtualized server running a variety of computer-aided engineering (CAE) applications.

“We’re changing how we connect devices, how we connect biological systems, and really how we connect people.”

— April Agee Carroll, Vice President of R&D, AeroFarms

Dell Technologies case study, A harvest full of insights, accessed February 2021.
Oil and gas
Energy companies rely heavily on advanced computational techniques to gain a clearer picture of the earth, enabling targeted drilling, reduced acquisition costs and lower environmental impact. Typical workloads include:

- **Data processing** — Remove noise from raw data coming in from well logs, seismic, gravity and magnetic surveys to produce more accurate images and earth models.
- **Reservoir modeling and simulation** — Convert data into 3D models of the subsurface using complex algorithms highly tuned for the most sophisticated computer hardware.
- **Seismic processing and interpretation** — Make more informed drilling decisions by converting hundreds of terabytes of raw data into useful subsurface models.
- **Computational chemistry** — Reduce and manage subsurface uncertainty by enabling hyper-predictive models for identifying chemical compounds.
- **Product optimization** — Avoid wasted resources by better predicting where and how to drill to maximize value.

Financial services
Both established financial services groups and financial technology (fintech) upstarts are seeking to capitalize on new technologies to improve returns and attract and retain more customers in a competitive global marketplace. Use cases include:

- **Algorithmic and high-frequency trading (HFT)** — Get instant, actionable insights to optimize trades.
- **Risk analysis including Monte Carlo simulations** — Monitor and evaluate thousands of risk factors.
- **Pricing** — Set optimal pricing for a variety of financial products, calibrating in real time.
- **Fraud protection** — Use algorithms to detect suspicious behavior and anomalies in real time.

Media and entertainment
Multiple aspects of this industry have taken a huge leap forward with the power of HPC. Common workloads include:

- **Visual effects (VFX) and computer-generated imagery (CGI)** — Create more realistic effects, faster by speeding image modeling, animation and editing.
- **Immersive entertainment** — Enhance virtual reality (VR) and augmented reality (AR) and gaming with the power for a new generation of immersive experiences.
- **Content management and delivery** — Save time and costs using HPC power to transcode massive amounts of streaming media in real time, and push it out to millions of consumers on the devices of their choice.

Government
Use cases for federal, state and local government include:

- **Monitoring and safety** — Transform public safety by identifying incidents and alerting the authorities.
- **Cybersecurity** — Protect networks, computers, software and data from unauthorized access.
- **Emergency management** — Prioritize emergency calls and recommend responses based on multiple factors such as caller sentiment analysis, location, proximity to other callers and outcomes from similar calls.
- **Military and defense** — Advance military power and preparedness.
- **Weather modeling** — Protect people and property with more accurate weather and climate predictions.
- **Public health** — Predict and respond more quickly to public health crises.

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“In the future, we believe data will guide every medical decision. That’s why technology will be key for every healthcare company.”

— Kiyotaka Fujii, President of Global Healthcare at Konica Minolta

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3 Dell Technologies case study, Realizing X-ray that moves using technology that transforms, accessed February 2021.
Dell Technologies has a simple strategy: Transform the future with HPC/AI

Dell Technologies is committed to democratizing, optimizing and advancing high performance computing (HPC) and artificial intelligence (AI) to help our customers shape the future. The key pillars of our HPC and AI strategy are focused on making this transformative technology approachable and available to a much larger audience than ever before.

Dell Technologies starts by offering a broad portfolio of innovative technologies, optimizing key parts for HPC and AI, and wrapping it all with deep expertise, industry partnerships and the services that lead to successful HPC and AI implementations.

> Challenge: “We want to get started with or expand HPC, but we don’t have the in-house resources.”

HPC has the potential to add value for your organization on the path to AI. That’s why organizations across a wide spectrum of sizes and industries are starting to explore HPC — expanding HPC’s impact well beyond typical research, life sciences and manufacturing applications. But, the complexity of designing, deploying and managing an HPC system can be daunting, especially for small and medium enterprises.

Democratizing HPC: Speed time to results with confidence and savings

Dell Technologies is working to democratize access to HPC, enabling small and medium enterprises to accelerate adoption with our Ready Solutions for HPC. These domain-specific configurations are designed, validated and tuned by HPC engineers and workload/application experts. The result is industry-standard IT modular building blocks that offer simplified design, configuration and ordering in hours instead of weeks, with a single point of contact available for services. Ready Solutions for HPC have been shown to provide 15% faster value recognition, 18-20% faster deployment, and three-months faster processing of models.

> Challenge: “We need to show value from our HPC investments.”

Researchers and lines of business alike need to show how IT is driving value. Total cost of ownership (TCO) is an important element of the return on investment (ROI) equation. Keeping TCO low starts with cost-optimized solutions for lower capital expense (CapEx). Management simplicity can help keep operational expenses (OpEx) lower over the life of the solution. And systems that are ready for hybrid cloud help future-proof investments. In addition, a single point of contact for procurement and support can streamline ordering and help avoid costly downtime.

“Using Dell EMC PowerEdge servers, we are able to increase our platform capacity in a matter of weeks versus a matter of months.”

— Jun Chen, Senior Vice President of Technology Services, Epsilon


1 Dell Technologies case study, “Using AI to see what eye doctors can’t,” November 2019.

5 Dell Technologies case study, Epsilon, accessed February 2021.
Optimizing HPC: Maximize performance, efficiency and flexibility

Our robust portfolio of products and services is optimized for HPC, providing performance and efficiency from a company invested in your future. Dell Technologies is proud to power 16 of the TOP500® supercomputers and provide solutions for a range of HPC needs. Our price-performance-optimized portfolio includes workstations, servers, networking and storage. Management and orchestration capabilities maximize utilization, including hybrid cloud, with innovations that make it possible for one person to update 300 servers in just 30 minutes. Plus, you can opt for a wide selection of services: consulting, education, deployment, managed services, support, and financing, with 30,000 full-time service experts available to assist you worldwide.

> Challenge: “Deploying HPC resources takes too long and doesn’t always provide the results we expected.”

Properly deploying and tuning an HPC cluster can be a specialized, error-prone task that requires a significant investment of time and resources. In more traditional HPC settings, researchers often have to deploy their own clusters, which may not be their core competency. For organizations that are relatively new to HPC, hiring specialists can be a challenge because shortages make them both hard to find and expensive to add to the payroll. In both cases, the process for selecting, procuring and deploying HPC clusters can take weeks or months. If the system isn’t configured properly for the target workloads, performance may not be as expected. And HPC is a rapidly evolving discipline, so it can be hard to keep up with the latest advancements.

Advancing HPC: Leverage expertise to fast-track projects and success

Dell Technologies has the expertise, innovation and strategic partnerships to help you advance the state of the art for HPC, from the workgroup to the TOP500. Our field team of dedicated HPC experts are active members in the HPC community, helping us stay at the head of the curve for HPC innovation. We invite customers to collaborate with our worldwide Customer Solution Centers, our Dell Technologies HPC & AI Innovation Lab — dedicated to cutting-edge research and development (R&D) — and/or with one of our many global Dell Technologies HPC & AI Centers of Excellence.

Our experts will work with you to design, test and tune solutions, with a deep understanding of optimal system design to help enhance performance for your specific workloads. And we keep an eye on the future, investing USD $20 billion in R&D in the last five years and obtaining more than 30,678 patents.

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8 Dell Technologies case study, “Automating IT Saves Time and Brings Big Results,” January 2019.
9 Dell Technologies, Key Facts, September 2019.
“Our partnership with Dell Technologies has been a cornerstone to a lot of work that we’ve done, and has enabled TGen to stay ahead of the pack, and be a leader in precision medicine.”

— James Lowey, Chief Information Officer, TGen

Customer success stories
Translational Genomics Research Institute (TGen®)

<table>
<thead>
<tr>
<th>7–8 hours</th>
<th>12 trillion</th>
<th>1 million</th>
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<tbody>
<tr>
<td>instead of two weeks to process a genome</td>
<td>operations per second</td>
<td>CPU hours per month</td>
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Read the case study: [Groundbreaking research with life-changing results](#).

Cross-customer economic impacts

<table>
<thead>
<tr>
<th>111%</th>
<th>11-month</th>
<th>4X</th>
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</thead>
<tbody>
<tr>
<td>return on investment (ROI)</td>
<td>payback</td>
<td>increase in compute power</td>
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</table>

Read the report: [The Total Economic Impact™ Of Dell EMC Ready Solutions For HPC](#).

AeroFarms®

<table>
<thead>
<tr>
<th>Millions</th>
<th>390X more</th>
<th>95% less</th>
</tr>
</thead>
<tbody>
<tr>
<td>of data points collected, 24/7</td>
<td>productivity than a commercial farm</td>
<td>water used for the same crop yield</td>
</tr>
</tbody>
</table>

Read the case study: [A Harvest Full of Insights](#).

- **Epsilon®** sends billions of emails daily, with campaign adjustments in real time.
- **Mastercard®** applies 1.9 million rules to 165 million transactions per hour in a matter of milliseconds.
- **Konica Minolta®** integrates Internet of Things (IoT), AI and ML to process up to 300 medical images in a single scan and animate them in minutes.
- **ZIFF.ai** got up and running in one hour instead of weeks and months of configuration, decision making and troubleshooting.
- **OTTO Motors®** uses AI to process gigabytes of data per hour.
- **Cambridge University** delivers HPC and data analytics services to over 1,000 staff across the university.

Read more [customer stories](#).

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7 Dell Technologies case study, [Setting the pace of progress](#), accessed February 2021.
Solution overview

Technical specifications

HPC Ready Solutions for AI and Data Analytics

A unified system for high-performance simulation, AI and high-performance data analytics

HPC, AI and data analytics are converging. Combining AI and data analytics methods with traditional HPC workflows can speed scientific discovery and innovation. Historically, the variance in HPC, AI and data analytics workload needs has led customers to believe they need three separate environments; however, this is no longer the case. HPC Ready Solutions for AI and Data Analytics enables you to quickly and easily run HPC, AI and analytics workloads on the same systems.

- **Lower TCO** — Purchase and operate a single environment instead of three separate ones.
- **Streamline and simplify** — Build a single unified architecture that supports multiple AI, HPC and data analytics workloads.
- **Increase opportunity** — Use AI to augment traditional HPC workloads and vice versa while enabling new HPC, AI and data analytics workloads.

### Configuration options

<table>
<thead>
<tr>
<th>Management node</th>
<th>Compute nodes</th>
<th>Acceleration nodes</th>
<th>Accelerators</th>
<th>Networking</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>PowerEdge R750 Servers</td>
<td>PowerEdge R750xa, R7525, C6520, C6525 Servers</td>
<td>- PowerEdge XE8545 or C4140 and/or R750xa or R7525</td>
<td>- NVIDIA A100 or T4</td>
<td>Choice of: PowerSwitch 25/100Gb Ethernet or NVIDIA® Mellanox® HDR100 InfiniBand®</td>
<td>- PowerScale Ready Solutions for HPC NFS or BeeGFS® Storage</td>
</tr>
</tbody>
</table>

“You want clinical results back as fast as possible, so physicians can make decisions in a more timely manner. You don’t want to wait two to three weeks to do this. You want to do it in a much faster time period.”

— James Lowey, Chief Information Officer, TGen

*Dell Technologies case study, *Groundbreaking research with life-changing results*, November 2020.*
Ready Solutions for HPC Research
Match the unique needs of research workloads, more quickly and cost-effectively.
Many research organizations are in a race to address complex research challenges, such as handling massive amounts of simulation and machine-generated data from sensor systems and scientific instruments; dealing with complex algorithms for modeling, rendering and analysis; and managing the time-criticality of research projects. This makes HPC an important source of competitive advantage.
Dell EMC Ready Solutions for HPC Research enable quick development of HPC solutions that match the needs of complex research applications. They deliver the performance and throughput, large shared memories, and ultrafast interconnect fabrics required to keep up with demanding research workloads.

- **Optimize investments** — Tailored for specific workloads to speed deployment, reduce software and hardware issues and optimize performance.
- **Customize a solution** — A flexible building-block approach helps you efficiently design, implement and scale HPC solutions.
- **Test and tune** — Dell Technologies HPC & AI Innovation Lab engineers work closely with customers and partners to optimize and test these solutions.

### 16 of the TOP500 supercomputers
are powered by Dell EMC infrastructure.

<table>
<thead>
<tr>
<th>Configuration options</th>
<th>Dell EMC PowerEdge servers</th>
<th>Networking</th>
<th>Dell EMC storage</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute nodes</td>
<td>Choose of:</td>
<td>NVIDIA Mellanox</td>
<td>• Ready Solutions for HPC NFS, BeeGFS, or PixStor™ Storage</td>
<td>Choice of:</td>
</tr>
<tr>
<td>Accelerators</td>
<td>AMD® EPYC™: R6515, R6525, R7515, R7525, C6525, XE8545 or Intel® Xeon® Scalable: R650, R750, R750xa, C6520</td>
<td>Quantum QM8700 series HDR and PowerSwitch S, N and Z series Ethernet</td>
<td>• PowerScale scale-out NAS</td>
<td>Bright Cluster Manager® or OpenHPC™ Red Hat® Enterprise Linux®</td>
</tr>
</tbody>
</table>
Ready Solutions for HPC Life Sciences
Make breakthroughs faster.

Amazing work is being done today in healthcare and the life sciences. For some projects, every hour closer to discovery and results can mean the difference between life and death. But organizations face many factors that may hinder discovery and cause inefficiencies. Dell EMC Ready Solutions for HPC Life Sciences can accelerate time to insight for a range of applications, including drug design, cancer research, agriculture, forensics, genomics and bioinformatics.

- **Faster time to production** — Enables efficient planning, design and implementation.
- **Better performance** — Recommended configurations facilitate achieving performance and reliability goals.
- **Easier scalability** — Building-block design makes it easy to manage and extend storage and networking on-premises so the solution can grow over time.

### Configuration options

<table>
<thead>
<tr>
<th>Dell EMC</th>
<th>PowerEdge servers</th>
<th>Networking</th>
<th>Storage</th>
<th>Software</th>
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</thead>
<tbody>
<tr>
<td>Compute nodes</td>
<td>Accelerators</td>
<td>PowerSwitch S, N and Z series Ethernet and NVIDIA Mellanox Quantum QM8700 series HDR</td>
<td>• Ready Solutions for HPC NFS, BeeGFS, or PixStor Storage • PowerScale scale-out NAS</td>
<td>Choice of: Bright Cluster Manager or OpenHPC Red Hat Enterprise Linux</td>
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<tr>
<td>Intel® Xeon® Scalable: R650, R750, R750xa, R950, C6520</td>
<td>NVIDIA® A100, A40</td>
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<td>AMD® EPYC™: R6525, C6525, XE8545</td>
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Genomics with BioBuilds
Sequence and assemble more genomes, faster.

Advanced computing technologies have rapidly transformed genomics, giving researchers the power to work with vast amounts of data. However, as the science advances, the amount of data increases as well. This necessitates continuing innovation to fuel the breakthroughs that help build our understanding of the human genome. The building blocks for Genomics with BioBuilds are optimized, tested and tuned for a variety of key genomics use cases, such as next-generation sequencing (NGS) and de novo assembly.

### Configuration options

<table>
<thead>
<tr>
<th>Dell EMC</th>
<th>Infrastructure nodes</th>
<th>Compute nodes</th>
<th>Networking</th>
<th>Software</th>
<th>Operating system</th>
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<tbody>
<tr>
<td>PowerEdge servers</td>
<td>Storage</td>
<td>Networking</td>
<td>Software</td>
<td>Operating system</td>
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<tr>
<td>Master nodes: R440</td>
<td>DNA sequencing: C6400 enclosure with 4x C6420 De novo assembly: R740xd</td>
<td>• Ready Solutions for HPC BeeGFS • PowerScale scale-out NAS</td>
<td>• Dell EMC PowerSwitch S3048-ON • NVIDIA Mellanox InfiniBand QM8790 (HDR) or SB7890 (EDR)</td>
<td>• Bright Cluster Manager (recommended) • BioBuilds™ (tested and recommended)</td>
<td>Red Hat Enterprise Linux or CentOS®</td>
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<tr>
<td>Login nodes: R640</td>
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Solution overview

Genomics with NVIDIA Clara Parabricks
Accelerate secondary analysis for NGS.

Keeping up with the pace of genetics research requires the ability to handle large — and growing — data sets. The secondary analysis phase of NGS can take minutes or days depending on the available software, computing and storage resources. When you’re talking about the difference between life and death, a few days can be too long to wait. Having the secondary analysis resources to keep pace with the rate of raw NGS data generation is critical for preventing analysis backlogs. For NGS secondary analysis, this solution is capable of processing ~70 50X genomes per day.

<table>
<thead>
<tr>
<th><strong>Configuration options</strong></th>
<th>Dell EMC</th>
<th>Software</th>
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<tbody>
<tr>
<td><strong>PowerEdge servers</strong></td>
<td><strong>Server GPU compute node</strong></td>
<td><strong>Storage</strong></td>
</tr>
</tbody>
</table>
| R640 | DSS 8440 with 16x NVIDIA T4 GPUs | Isilon F800 All-Flash NAS | • 2x Z9100-ON  
• N2248X-ON (management) | NVIDIA Clara™ Parabricks |

Radiology Kubeflow implementation with One Convergence DKube
Quickly build deep-learning platforms for detecting disease in X-rays with GPU clusters on-premises.

Radiology is a particularly good fit for deep learning (DL), since it combines visual data with complicated, hard-to-define outcomes. Dell Technologies and One Convergence® have joined forces to provide integrated, scalable and cost-effective DL systems that combine the leadership family of Dell EMC PowerEdge servers with the One Convergence DKube™ cloud-native machine learning operations (MLOps) solution. By joining forces, Dell Technologies and One Convergence simplify on-premises deployment of GPU clusters for detecting disease in X-rays. The extensive Dell EMC PowerEdge server portfolio can be paired with DKube to build a DL solution that meets your specific requirements.

<table>
<thead>
<tr>
<th><strong>Configuration options</strong></th>
<th>Dell EMC servers</th>
<th>Max server GPUs</th>
<th>Target workloads</th>
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<tbody>
<tr>
<td><strong>PowerEdge T640</strong></td>
<td>4x NVIDIA V100</td>
<td>VDI, ML/DL training and inferencing, database/analytics</td>
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</tbody>
</table>
| **PowerEdge R740 / R7425** | 3x NVIDIA V100  
6x NVIDIA T4 | VDI, ML/DL training and inferencing, database/analytics |
| **PowerEdge 940XA** | 4x NVIDIA V100 | ML/DL training, database/analytics |
| **DSS 8440** | 10x NVIDIA V100 | ML/DL training and inferencing |
| **PowerEdge C4140** | 4x NVIDIA V100 | ML/DL training, HPC |
Ready Solutions for HPC Digital Manufacturing
Tap into the power of HPC and AI to speed design workloads.

The manufacturing sector already leads the way in applying advanced computing to power the engineering and design that help create innovative products and grow revenue while cutting costs. The mainstreaming of analytics and AI powered by HPC will revolutionize engineering to help manufacturers speed time to market with more innovative and higher quality products. And Dell Technologies is helping push the boundaries of performance with scalable, flexible solutions designed to help bring products to market faster.

- **Faster performance** — Rigorously tuned for specific applications and workloads, with a focus on efficiency, performance and reliability.
- **Easier scaling** — A flexible building-block approach helps you efficiently design, implement and scale HPC and AI solutions.
- **Reduced risk** — One source for solution design, delivery and support.

### Configuration options

<table>
<thead>
<tr>
<th>Dell EMC PowerEdge servers</th>
<th>Networking</th>
<th>Dell EMC storage</th>
<th>Software</th>
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<tbody>
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<td>Compute nodes</td>
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<td>Choice of:</td>
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<tr>
<td>AMD EPYC: R6525, R7525, C6525</td>
<td>PowerSwitch S, N and Z series Ethernet and NVIDIA Mellanox Quantum QM8700 series HDR</td>
<td>- Ready Solutions for HPC NFS, BeeGFS, or PixStor Storage - PowerScale scale-out NAS</td>
<td>Bright Cluster Manager or OpenHPC Red Hat Enterprise Linux</td>
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<tr>
<td>Intel Xeon Scalable: R650, R750, C6520</td>
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### Altair HyperWorks

Speed computer-aided engineering (CAE) workloads.

HPC-powered analytics and AI are revolutionizing CAE, helping manufacturers speed time to market with higher-quality products. An architecture created specifically for Altair® HyperWorks® software enhances performance for CAE workloads ranging from model-based systems design and early geometry ideation to detailed multiphysics simulation and optimization.

<table>
<thead>
<tr>
<th>Dell EMC PowerEdge servers</th>
<th>Compute building blocks</th>
<th>Basic building blocks</th>
<th>Operational storage</th>
<th>Networking</th>
<th>Software</th>
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<tbody>
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<td>Infrastructure servers</td>
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<tr>
<td>R640</td>
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<td>R840</td>
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<tr>
<td>R740</td>
<td>R740xd</td>
<td>R740xd</td>
<td>R740xd</td>
<td>Dell EMC PowerSwitch S3048-ON</td>
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<td></td>
<td>NVIDIA Mellanox SB7890 36-port EDR InfiniBand (recommended)</td>
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</table>
**Solution overview**

**ANSYS**

Speed CFD simulations and finite element analysis workloads.

Many manufacturers use ANSYS® software for CFD simulations and finite element analysis (FEA) workloads. That’s why Dell Technologies offers a validated design for ANSYS software, including ANSYS CFX®, Fluent® and Mechanical™. This solution was designed and configured specifically for ANSYS digital manufacturing workloads, to enhance performance for CFD and FEA applications that are critical for virtual product development.

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<th>Configuration options</th>
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<tbody>
<tr>
<td>Dell EMC PowerEdge servers</td>
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<tr>
<td>Infrastructure servers</td>
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<tr>
<td>R640</td>
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</table>

**SIMULIA Abaqus**

Speed FEA workloads.

Leveraging robust simulation software powered by HPC vastly reduces physical testing requirements for manufacturers, helping reduce product costs and enhance quality while speeding time to market. Because best-in-class manufacturers are taking advantage of Dassault Systèmes® SIMULIA® Abaqus® software to consolidate processes and tools and reduce costs and inefficiencies, Dell Technologies offers an engineering-validated architecture for the Abaqus Unified FEA software suite. The combination offers powerful solutions for both routine and sophisticated engineering problems, covering a vast spectrum of industrial applications.

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<td>Dell EMC PowerEdge servers</td>
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<tr>
<td>Infrastructure servers</td>
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<td>R640</td>
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</table>
LSTC LS-DYNA
Speed FEA and simulation workloads.
Manufacturers in the automotive, aerospace, construction and other industries use LS-DYNA® from Livermore Software Technology Corporation (LSTC) to perform complex FEA workloads. LS-DYNA is a multi-purpose explicit and implicit finite element and multiphysics application used to analyze the nonlinear response of structures. Any LS-DYNA features can be combined for a given simulation to model a wide range of physical events. Its potential applications are numerous and can be tailored to many fields.

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<tbody>
<tr>
<td>Dell EMC PowerEdge servers</td>
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<tr>
<td>Infrastructure servers</td>
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</tbody>
</table>
| R640 | R640 or C6420 | R840 | R740xd | • Dell EMC PowerSwitch S3048-ON  
| | | | | • NVIDIA Mellanox SB7890 36-port EDR InfiniBand (recommended)  
| | | | | • LS-DYNA  
| | | | | • Bright Cluster Manager |

Siemens Simcenter STAR-CCM+
Speed product design and simulation workloads.
Siemens® Simcenter™ STAR-CCM+® is CFD and multiphysics software for the simulation of products and designs operating under real-world conditions. It’s capable of capturing the physics that will influence product performance, enabling engineers to predict performance changes in response to multiple parametric design changes. It provides engineers with automated design exploration and optimization, allowing them to efficiently explore the entire design space instead of focusing on single-point design scenarios. With decades of experience, Dell Technologies is helping digital manufacturers transform performance for Simcenter STAR-CCM+ workloads.

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<tbody>
<tr>
<td>Dell EMC PowerEdge servers</td>
</tr>
<tr>
<td>Infrastructure servers</td>
</tr>
</tbody>
</table>
| R640 | R640 or C6420 | R840 | R740xd | • Dell EMC PowerSwitch S3048-ON  
| | | | | • NVIDIA Mellanox SB7890 36-port EDR InfiniBand (recommended)  
| | | | | • STAR-CCM+  
| | | | | • Bright Cluster Manager |
Virtualized HPC
Get the flexibility and agility, simplicity and efficiency of virtualization for HPC.
Virtualization is a time-tested technology that creates measurable IT value. And while virtualization has been widely embraced in enterprise data centers for traditional workloads, HPC workloads, such as AI, have typically been run on bare-metal, unvirtualized systems that require specialized skills to deploy and manage. However, with the introduction of the latest version of VMware® vSphere®, more organizations can experience the benefits of virtualized HPC.

To take advantage of virtualized HPC, Dell Technologies brings these technologies together to deliver an elastic, centrally managed, self-service and secure virtual HPC environment that’s ready for the enterprise.

- **Flexibility and agility** — Rapid provisioning of infrastructure on-demand enables speedy iteration and scale-out and less time spent on setup and retooling.
- **Simplicity** — Run AI and HPC on a familiar virtualization platform with a broad ecosystem of technology partners.
- **Efficiency** — Minimize setup and configuration time with centralized management. Simplify operations such as ongoing provisioning and maintenance. Avoid planned downtime through live migration.

### Configuration options

<table>
<thead>
<tr>
<th>Dell EMC</th>
<th>Storage</th>
<th>Networking</th>
<th>Software</th>
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<tbody>
<tr>
<td><strong>PowerEdge servers</strong></td>
<td><strong>Accelerator nodes</strong></td>
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</tr>
<tr>
<td>Compute nodes</td>
<td>Accelerator nodes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Choice of: R640, R840, C6420, R6525, R7525, C6520 | Choice of: C4140, R740, R7525 | • Ready Solutions for HPC NFS | • VMware vSphere  
• VMware NSX®,  
vRealize®, Horizon® (optional)  
• NVIDIA CUDA® |
| | | • Ready Solutions for HPC Lustre | |
| | | • PowerScale Isilon F800 All-Flash NAS | |
| | | Choice of: Dell EMC PowerSwitch 25 or 100GbE or NVIDIA Mellanox HDR100 InfiniBand | |
Solution overview

GPU as a Service
The power, portability and simplicity required to make HPC and AI a reality
As HPC and AI become increasingly prevalent, forward-thinking organizations are looking for ways to streamline and simplify IT. This will enhance your ability to run traditional and advanced computing workloads side-by-side in a hybrid cloud model that provides simplicity, flexibility and cost optimization.

To help you take advantage of hybrid cloud for HPC and AI, Dell Technologies has created engineering-validated designs that incorporate servers, networking and storage along with VMware Cloud Foundation™ and new advanced features included in VMware vSphere. Together they provide the power, portability and management simplicity required to make HPC and AI possible.

- **Power** — Enables virtualizing accelerators on-premises or in the cloud and gives developers self-service access to acceleration.
- **Portability** — Provides a consistent Kubernetes® containerized environment for porting applications across clouds.
- **Simplicity** — Enables IT teams to run AI and other applications together in familiar VMware environments running on proven Dell EMC PowerEdge servers, networking and storage.

### Configuration options

<table>
<thead>
<tr>
<th>Dell EMC</th>
<th>Storage</th>
<th>PowerSwitch networking</th>
<th>Software</th>
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</thead>
<tbody>
<tr>
<td>PowerEdge servers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choice of: R740xd or C4140 with NVIDIA V100 or T4 accelerators</td>
<td>PowerScale Isilon F800 All-Flash NAS</td>
<td>Choice of: 10, 25 or 100GbE</td>
<td>• VMware Cloud Foundation with vSphere • VMware NSX • VMware Tanzu™ Kubernetes Grid (TKG) • NVIDIA vCompute Server • Automation with HashiCorp Terraform vSphere Provider</td>
</tr>
</tbody>
</table>

### Ready Solutions for HPC Storage
Unlock the value of your data with storage optimized for HPC.
The data-driven age is dramatically reshaping industries and reinventing the future. As vast amounts of data pour in from increasingly diverse sources, leveraging that data is both critical and transformational. Dell EMC Ready Solutions for HPC Storage are delivered with hardware, software and support from Dell Technologies. HPC & AI Innovation Lab engineers develop and tune each solution based on performance characterizations and best practices to simplify installation and provide faster time to results.

- **Simplicity** — Simplify monitoring and management with no specialized training or expertise required.
- **Reliability** — Take the guesswork out of configuration, reducing interoperability issues and improving quality with storage that’s highly available, with no single point of failure.
- **Efficiency** — Lower the cost of planning and deploying HPC storage with tested and tuned solutions and manage your data center hardware from anywhere, at any time with the power of Dell EMC OpenManage.
Solution overview

NFS Storage
Enhance availability of storage services with Red Hat Enterprise Linux NFS.

Storage solutions based on the NFS protocol are widely used for HPC clusters because NFS is simple and time-tested and is a standard package in virtually every Linux distribution. Dell EMC Ready Solutions for HPC NFS Storage are preconfigured, tested and validated solutions that allow deployment of large-capacity storage solutions more easily and with less risk, while preserving resources and budget for higher-value activities. They also provide the power to quickly and easily scale storage capacity as computing needs grow.

- **Low cost** — Compute, storage, networking and software are integrated to provide excellent performance and scalability for the money.
- **Performant** — A robust storage file system with good performance as primary storage for small to medium systems or for larger clusters with lower I/O needs.
- **Scalable** — Meets future needs more easily with the ability to scale easily up to 64 nodes and 480TB raw capacity in a supported single namespace.

### Configuration options

<table>
<thead>
<tr>
<th>Dell EMC</th>
<th>Networking</th>
<th>Software</th>
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<tbody>
<tr>
<td>PowerEdge servers</td>
<td>PowerVault storage</td>
<td>Choice of: Dell EMC PowerSwitch 10GbE or NVIDIA Mellanox ConnectX®-5 InfiniBand EDR</td>
</tr>
</tbody>
</table>
| 2x R740 | ME4084 | • Red Hat Enterprise Linux
• Red Hat Cluster Suite
• Red Hat Scalable File System |

Lustre Storage
High-performance, massively scalable and cost-effective HPC storage

Generating and consuming data at speed can make storage the major bottleneck for HPC clusters. Many organizations with large HPC systems with high I/O needs choose Lustre®, an open-source, massively parallel file system. However, designing and deploying storage systems can be complicated and time-consuming. The Dell EMC Ready Solution for HPC Lustre Storage provides the power and scalability of Lustre with simplified installation, configuration and management to bring the benefits of a Lustre file system to a broad range of organizations. Lustre storage is available in scalable building blocks for 4, 8, 10 and 12TB hard disk drives (HDDs).

- **High performance** — Run larger and more complex applications faster with a high-performance, high-availability storage solution.
- **Massively scalable** — Easy to scale in capacity, performance or both, providing a convenient path for future growth.
- **Cost-effective** — Get more performance for the HPC budget and protect IT investments with simplified solutions for scaling out HPC.

### Configuration options

<table>
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<tr>
<th>Dell EMC</th>
<th>PowerVault storage</th>
<th>Networking</th>
<th>Software</th>
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<tbody>
<tr>
<td>PowerEdge servers</td>
<td>Object storage target (OST): 1, 2 or 4x ME4084 or ME4024, or NVIDIA Mellanox InfiniBand EDR 10/40GbE</td>
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<tr>
<td>Management server (IML): 1x R640</td>
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<tr>
<td>Metadata server (MDS): 2x R740</td>
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</table>
| Object storage server (OSS): 2x R740 | Choice of: Dell EMC PowerSwitch H-Series, or NVIDIA Mellanox InfiniBand EDR 10/40GbE | • Lustre Community edition — Whamcloud®
• CentOS |
PixStor Storage
High-performance, scalable parallel file system with data tiering and simplified management
Delivering data-driven insights requires storage that can handle massive data growth with security, reliability and performance. Accelerating data growth makes the economics of processing, accessing and storing data on some Fibre Channel and scale-out network-attached storage (NAS) unsustainable. PixStor™ is high-performance, highly scalable, enterprise-class software-defined storage that empowers you to search, manage, securely isolate and protect data, collaborate and share across distances, and run in the cloud. The Dell Technologies engineering-validated design for PixStor storage delivers high performance with limitless scale at lower cost than traditional legacy solutions.

- **Unified** — Data moves seamlessly through many storage tiers — from fast flash and disk tiers to cost-effective, high-capacity object storage, all the way to the cloud — to put data at your fingertips.
- **Scalable** — Quickly and easily scale storage capacity as computing needs grow.
- **Easy to adopt** — Tested and tuned systems speed adoption of high performance, scalable HPC storage systems with simplified installation, configuration and management features.

### Configuration options

<table>
<thead>
<tr>
<th>Dell EMC servers</th>
<th>Storage</th>
<th>Networking</th>
<th>Software</th>
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<tbody>
<tr>
<td><strong>PowerEdge R440</strong></td>
<td><strong>Storage nodes:</strong> 2x PowerEdge R740</td>
<td>• Dell EMC PowerSwitch S3048-ON (management)</td>
<td>• PixStor</td>
</tr>
<tr>
<td><strong>Gateway: R740</strong></td>
<td><strong>Object storage:</strong> 1, 2 or 4x PowerVault ME4084</td>
<td>• 2x NVIDIA Mellanox InfiniBand SB7800 EDR or QM8700 HDR</td>
<td>• CentOS</td>
</tr>
<tr>
<td></td>
<td><strong>Optional high-demand metadata nodes:</strong> 2x PowerEdge R740 with up to 4x PowerVault ME4024</td>
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</table>
BeeGFS Storage
High performance and ease of use for I/O-intensive workloads
BeeGFS® was designed specifically to manage I/O-intensive workloads in performance-critical environments. Hundreds of leading enterprises, universities and researchers worldwide choose BeeGFS for its ease of installation, massive scalability, robustness and exceptional flexibility, including converged systems where servers are used for storage and compute. Dell EMC Ready Solutions for HPC BeeGFS Storage are preconfigured, tested and validated solutions that enable deploying storage systems more easily and scaling as needed.

- **Simple** — Tested and tuned HPC storage systems with simplified installation, configuration and management features simplify infrastructure and streamline technology.
- **Scalable** — Deploy large-capacity storage systems that scale seamlessly from small clusters up to enterprise-class systems with thousands of nodes — on-premises or in the cloud.
- **Performant** — Designed specifically to manage I/O-intensive workloads in performance-critical environments.

### High-performance storage configuration options

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<tr>
<th>Dell EMC PowerEdge servers</th>
<th>Networking</th>
<th>Software</th>
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<tbody>
<tr>
<td><strong>Management</strong></td>
<td><strong>Storage</strong></td>
<td></td>
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<tr>
<td>R640</td>
<td>Metadata servers (MDS) and storage servers (SS): 6x R740xd (12 drives on one server are dedicated for metadata)</td>
<td>• 1x Dell EMC PowerSwitch S3048-ON (management)</td>
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<tr>
<td></td>
<td></td>
<td>• 2x NVIDIA Mellanox InfiniBand SB7890 EDR or QM8790 HDR</td>
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<td>• 2x NVIDIA Mellanox ConnectX-5 EDR or 2x Mellanox ConnectX-6 HDR per MDS and SS (InfiniBand HCA)</td>
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### High-capacity storage configuration options

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<tr>
<th>Dell EMC PowerEdge servers</th>
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<th>Software</th>
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<tr>
<td><strong>Management</strong></td>
<td><strong>Storage</strong></td>
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</tr>
<tr>
<td>R640</td>
<td>Metadata servers (MDS): 2x R740xd</td>
<td>• 1x Dell EMC PowerSwitch S3048-ON (management)</td>
</tr>
<tr>
<td></td>
<td>Metadata storage: 1x PowerVault ME4024</td>
<td>• 2x NVIDIA Mellanox InfiniBand SB7890 EDR</td>
</tr>
<tr>
<td></td>
<td>Storage server (SS): 2x R740xd</td>
<td>• 1x NVIDIA Mellanox ConnectX-5 EDR card per MDS and SS (InfiniBand HCA)</td>
</tr>
</tbody>
</table>
Solution overview

Data Accelerator
Solve I/O bottlenecks with one of the world’s fastest open-source NVMe storage solutions.

Workloads have become increasingly data-centric in recent years, especially as HPC and AI converge, and IT teams seek to run these data-intensive workloads on the same systems. Growing data sets, coupled with bandwidth- and latency-sensitive workloads are placing simultaneous high demands on parallel file systems. This situation significantly impacts time to results, as well as ROI for HPC systems.

Dell Technologies, Intel and the University of Cambridge collaborate to enable the next generation of data-intensive workflows with a storage solution that makes optimal use of modern server NVMe™ fabric technologies to mitigate I/O-related performance issues.

• **Open-source** — Utilizes infrastructure-as-code and cloud-native technologies built on readily available server and networking technologies.

• **Powerful** — Alleviates performance bottlenecks for data-intensive applications on central networked file systems. Provides deterministic, high-performance, schedulable I/O resources, providing breakthrough I/O performance.

• **Easy to adopt** — Integrates with any traditional HPC storage without redesign to interact with commonly-used scheduling tools.

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<tr>
<td><strong>PowerEdge servers</strong></td>
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<td>R740xd</td>
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**Dell Precision workstations**: Run high-demand, industry-specific applications for scientific calculations, remote visualization, 3D industrial designs, engineering simulations and digital content creation at peak performance to help you save time and control costs. Dell Precision workstations, together with accelerators, deliver breakthrough performance for parallel computing applications.

**Dell EMC PowerEdge servers**: Dell EMC PowerEdge servers are engineered to deliver unmatched performance and versatile configurations to meet the demands of HPC workloads. Flash storage, the latest processors, greater memory bandwidth and flexible local storage make Dell EMC PowerEdge servers a foundational choice for HPC.

**Dell EMC PowerSwitch networking**: Today’s HPC workloads call for new thinking about network architecture. Based on open standards, Dell EMC PowerSwitch networking frees the data center from outdated, proprietary approaches. Our future-ready networking technology helps you improve network performance, lower networking costs and remain flexible to adopt new innovations. Take control of your network’s future and learn how the Dell Technologies strategy for open networking can dramatically transform your business.

**Dell EMC PowerScale NAS**: HPC environments require large, scalable, reliable and efficient storage. With support for multiple workloads and enterprise-grade data and file management capabilities out of the box, Dell EMC PowerScale scale-out NAS is the leading storage for HPC. You can take advantage of the high capacity of PowerScale to reduce the acquisition and ownership cost for managing and monetizing data using advanced or predictive analytics and ML.

**Dell EMC Omnia software**: Dell EMC Omnia is an open-source, Ansible®-based software stack designed to automate the deployment of mixed-workload clusters, giving IT the agility to run AI, HPC and data analytics workloads in the same environment, with a single pane of glass for cluster provisioning, deployment and management, with easy-to-use point-and-click templates for building complete environments.
“Over a number of years, I’ve had the opportunity to work with many people at [Dell Technologies] who are really passionate about what they do, and believe in the mission. I think Michael Dell puts it best when he says it’s not just about building technology for technology’s sake. It’s about building technology to solve problems, to work in the real world and to make a difference. That philosophy aligns very closely with what we are trying to do here at TGen. Having a partner who is truly invested in trying to change things for the better is absolutely critical. That’s something we value immensely.”

— James Lowey, Chief Information Officer, TGen

**Services and financing**

Dell Technologies is with you every step of the way, linking people, processes and technology to accelerate innovation and enable optimal business outcomes.

- **Data Analytics Consulting Services** Help you create a competitive advantage for your business. Our expert consultants work with companies at all stages of data analytic to help you plan, implement and optimize solutions that enable you to unlock your data capital and support advanced techniques, such as HPC.

- **Deployment Services** help you streamline complexity and bring new IT investments online as quickly as possible. Leverage our 30+ years of experience for efficient and reliable solution deployment to accelerate adoption and ROI while freeing IT staff for more strategic work.

- **Support Services** driven by AI and DL will change the way you think about support with smart, ground-breaking technology backed by experts to help you maximize productivity, uptime and convenience. Experience more than just fast problem resolution — our AI engine proactively detects and prevents issues before they impact performance.

- **Payment Solutions** from Dell Financial Services help you maximize your IT budget and get the technology you need today. Our portfolio includes traditional leasing and financing options, as well as advanced flexible consumption products.

- **APEX Custom Solutions** offer a simple approach that gives you a wide range of consumption models, payment solutions and services so you can optimize for a variety of factors while realizing more predictable outcomes.

- **Managed Services** can help reduce the cost, complexity and risk of managing IT so you can focus your resources on digital innovation and transformation while our experts help optimize your IT operations and investment.

- **Residency Services** provide the expertise needed to drive effective IT transformation and keep IT infrastructure running at its peak. Resident experts work tirelessly to address challenges and requirements, with the ability to adjust as priorities shift.
Solution overview

“With [Dell Technologies], we get world-class support, so we can avoid the finger-pointing you get with competing vendors. This is a key to our relationship.”

— Barry Carter, Chief Information Officer, RealPage

Why choose Dell Technologies for HPC

We’re committed to advancing HPC, AI and data analytics.

- Schedule an executive briefing and collaborate on ways to reach your business goals.
- Dell Technologies Customer Solution Centers are staffed with computer scientists, engineers and subject matter experts in a variety of disciplines.
- We are committed to providing you with choice. We want you to get what you need and have a great experience working with us. If we don’t have what you need, we’ll tell you who does. We believe in being open, and we publish our performance results.
- Dell Technologies is the only company in the world with a portfolio that spans from workstations to supercomputers, including servers, networking, storage, software and services.
- Because Dell Technologies offers such a wide selection of solutions, we can act as your trusted advisor without trying to sell you a one-size-fits-all approach to your problem. That range of solutions has also given us the expertise to understand a broad spectrum of challenges and how to address them.

Customer Solution Centers

Our global network of dedicated Dell Technologies Customer Solution Centers are trusted environments where world-class IT experts collaborate with you to share best practices, facilitate in-depth discussions of effective business strategies and help your business become more successful and competitive. Dell Technologies Customer Solution Centers reduce the risks associated with new technology investments and can help improve speed of implementation.

AI Experience Zones

Are you curious about AI and what it can do for your business? Run demos, try proofs of concept and pilot software in Singapore, Seoul, Sydney, Bangalore and other Customer Solution Centers. Dell Technologies experts are available to collaborate and share best practices as you can explore the latest technology, get the information and hands-on experience you need for your advanced computing workloads.

HPC & AI Innovation Lab

The Dell Technologies HPC & AI Innovation Lab in Austin, Texas, is the flagship innovation center. Housed in a 13,000-square-foot data center, it gives you access to thousands of Dell EMC servers, three powerful HPC clusters, and sophisticated storage and network systems. It’s staffed by a dedicated group of computer scientists, engineers and subject matter experts who actively partner and collaborate with customers and other members of the HPC community. The team engineers HPC and AI solutions, tests new and emerging technologies, and shares expertise including performance results and best practices.

HPC & AI Centers of Excellence

As data analytics, HPC and AI converge and the technology evolves, Dell Technologies worldwide HPC & AI Centers of Excellence provide thought leadership, test new technologies and share best practices. They maintain local industry partnerships and have direct access to Dell and other technology creators to incorporate your feedback and needs into their roadmaps. Through collaboration, Dell Technologies HPC & AI Centers of Excellence provide a network of resources based on the wide-ranging know-how and experience in the community.

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12 Dell Technologies case study, RealPage Boosts Property Management Performance and Results with Data Analytics, July 2019.
Solution overview

Proven results
Dell Technologies holds leadership positions in some of the biggest and largest-growth categories in the IT infrastructure business, and that means you can confidently source information technology needs from Dell Technologies.

- #1 in servers
- #1 in converged and hyperconverged infrastructure (HCI)
- #1 in storage
- #1 cloud IT infrastructure

See Dell Technologies Key Facts.

Take the next step, today.
Don’t wait to harness the benefits of HPC on optimized solutions designed from the ground up to accelerate and simplify HPC so you can achieve success at any scale. Contact your Dell Technologies representative to find out more today.

Contact us
To learn more, visit DellTechnologies.com/HPC or contact your local representative or authorized reseller.

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