DELL Technologies

Brochure

AI, HPDA and HPC Hybrid Cloud

Get flexible capacity for advanced computing projects

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Contents

Advanced computing resources for everyone

High Performance Computing (HPC) has long delivered breakthrough power for modeling and simulation, analytics, visualization and prediction. Recently, the ability to build powerful yet affordable HPC systems has made advanced computing more accessible than ever. No longer the exclusive domain of specialists with access to expensive, complicated and proprietary equipment, new teams are seeking to power data-intensive, performance-hungry workloads such as artificial intelligence (AI) and high-performance data analytics (HPDA) for new and innovative use cases. This is driving the convergence of HPC, AI and analytics on smaller, less complex systems. And as organizations increasingly adopt hybrid cloud operating environments, their opportunities to leverage HPC, AI and analytics are expanding as well.

Hybrid cloud provides plentiful options

The as-a-service model makes consuming HPC easier than ever. Some as-a-service terms related to hybrid cloud HPC include:

- **IaaS:** Pay-as-you-go access to HPC resources in the cloud.
- **PaaS/HPC as a service (HPCaaS):** A preconfigured HPC system you can access via cloud to build, test and deliver applications.
- **SaaS:** Third-party applications hosted in the cloud, available on a subscription basis.
- **Multi-cloud:** Run/use/access multiple clouds in multiple places — on-premises, private and public — for multiple workloads.

The ability to pay-per-use for HPC resources in the cloud makes its strategic advantages affordable for almost any organization, including enterprise lines of business. And while some organizations may not be comfortable with every type of cloud computing, sharing HPC compute and storage resources over a network is hardly news to veteran IT shops. Large organizations have long shared HPC resources in various models — including infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS) — and continue to pioneer new ways to spread the HPC wealth while defraying the costs of running these advanced computing systems. As more and different types of users rush to leverage advanced computing resources, the hybrid cloud model continues to be ideally suited for HPC, AI and HPDA.

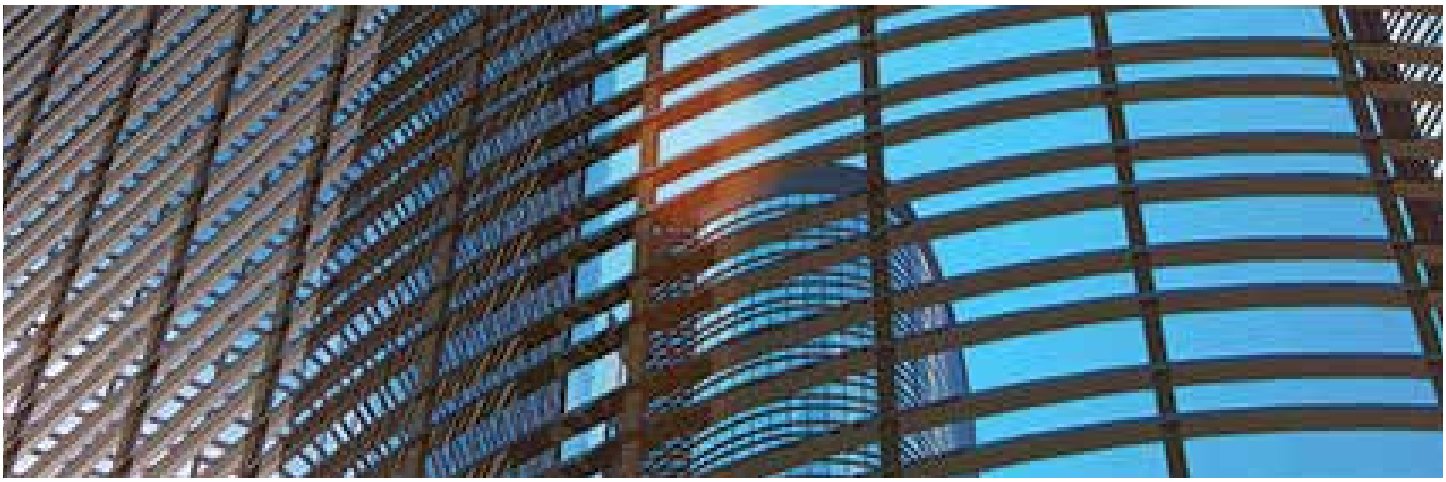
So whether you're looking to expand your existing advanced computing capabilities, or are just getting started with your first project, the world of hybrid cloud has plentiful options for getting the resources you need at a price point and commitment level that makes sense for your project. Dell Technologies is leading the way with a comprehensive range of flexible options for high performance computing on-premises and/or in multiple clouds.

The Dell Technologies approach to hybrid cloud HPC, AI and HPDA

Dell Technologies is helping expand the boundaries of this exciting new frontier with scalable, flexible hybrid cloud resources that can help you solve complex problems faster than ever. While AI might seem like the latest IT trend, Dell Technologies has been working with advanced analytics technologies for a long time. For more than a decade, Dell has been a leader in the HPC space, with proven products, solutions and expertise. Dell Technologies HPC and AI experts are active innovators and collaborators in the worldwide technical community dedicated to advancing HPC and AI.

Dell Technologies recognizes that no two organizations have the same needs and requirements. Our customized approach to hybrid cloud HPC, AI and HPDA puts you in the driver's seat, giving you options to craft a solution and/or consumption model that fits your needs and budget.

Enterprises worldwide are already using Dell Technologies hybrid cloud offerings to harness breakthrough computational power while employing standards-based technologies that have been tested and validated for industry-specific workloads and applications. All of which helps today's most visionary engineers, researchers and business executives do what they do best: make the discoveries that fundamentally change the world.



Increase agility

Reduce complexity

Grow affordably

The Dell Technologies advantage

Increase agility

With multiple choices for purchase, consumption, deployment and managed services allowing you to pick and choose the right set of capabilities for your needs. Options include using elastic or even occasional HPC resources so you can adapt quickly to changes in demand.

Reduce complexity

Focus on using HPC, not deploying and managing it, by leveraging Dell Technologies and partner deployment assistance and managed services or public cloud alternatives. Extend the data center without building new capacity by moving some HPC workloads into public and private clouds. Dell Technologies can help you protect intellectual property and maintain compliance with an on- or off-premises IT resources.

Grow affordably

Enforce policy-driven governance of HPC resources to avoid “sticker shock” from lines of business tapping public cloud HPC on an ad hoc basis. Increase cost efficiency by partnering with hosting providers that have lower energy and facilities costs. Enjoy flexible payment models that may allow you to shift some capital expenses (CapEx) to operational expenses (OpEx).

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Are you experiencing any of these challenges

Challenge	Solution: HPC, AI and HPDA hybrid cloud
1 Seasonal requirements overtax compute resources • Poor customer experience due to slow response times • Loss of business to competitors • System downtime stresses IT personnel	**Respond flexibly to changes in demand** • Scale capacity up or down rapidly • Cut application-related OpEx • Burst to public cloud for additional capacity when needed
2 Lengthy time to provision HPC resources • Slow application time to market reduces competitiveness • Perceived IT inefficiencies • High IT or public cloud costs	**Access HPC resources on demand** • Automate key deployment tasks • Enable self-service resource allocation by end users • Cut application provisioning times
3 Poor utilization of IT resources • Suboptimal price/performance of compute • Inflexible infrastructure requires over-provisioning to maintain consistency • Feature limitations prohibit dynamic re-allocation	**Optimize resource utilization** • Minimize upfront investments • Provide management and monitoring tools that automatically reassign server provisioning for optimal performance and utilization
4 CapEx budget reductions or freezes • On-premises HPC can be high maintenance and require large upfront CapEx • Inability to procure new servers and storage to meet HPC demand • Lack of funds to investigate HPC applications that could drive competitive advantage	**Transition IT costs from CapEx to OpEx** • Get the benefits of powerful, fast computing with no upfront expenses • Provide public cloud scale that releases data center capacity and/or facilitates disaster recovery • Shift resources from “keeping lights on” to strategic • Drive your green agenda for the data center

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Flexibility and choice of cloud options

Dell Technologies provides flexibility for your hybrid cloud HPC, AI and HPDA deployments. Choose where to deploy your clouds and how you'd like to pay for them, then add deployment and management options to craft a solution that's just right for you.

Mix and match the options below to create a hybrid cloud HPC environment that best suits your needs

	Purchase options	Deployment options	Management options
Private on- or off-premises cloud	Buy or lease hybrid cloud solutions using Dell Technologies Financial Services.	Use internal resources or Dell Deployment services for on-premises. Use Dell or hosting provider deployment services for off-premises.	Use internal resources or outsource with Dell or partner managed services.
Dell Technologies APEX	Pay-per-use for resources as a service with APEX Cloud Services, or create your own on-demand environment with infrastructure and services you customize to order with APEX Custom Solutions.	No deployment required.	Managed by Dell Technologies.
Public cloud	Pay-per-use for HPC resources (IaaS or PaaS).	No deployment required.	Managed by the cloud provider.
Hosted and managed public or private cloud	Consume hosted and managed HPC services in a PaaS/HPCaaS model.	No deployment required f or PaaS/HPCaaS.	Managed by the cloud provider.
Public/private cloud partnerships	Pay-per-use for supercomputing resources offered by academic institutions.	Typically no deployment required.	Managed by the organization or institution.

30%+
of new materials and drugs will be discovered using AI-enhanced analytics techniques by 2025.[1]

70%
of organizations will have operationalized AI architectures by 2025.[1]

70%
of organizations will refine their data approach to provide more context for analytics and make AI less data-hungry.[1]

[1] Gartner, Inc., The 4 Trends That Prevail on the Gartner Hype Cycle for AI, 2021, September, 2021.

AI, HPDA, HPC hybrid cloud offerings

Dell Technologies can help you choose the right combination of hybrid cloud infrastructure and services to meet your AI, HPDA and HPC needs. Choose from the offerings in this section or have a Dell Technologies expert craft a custom solution for you.

APEX

APEX delivers IT infrastructure solutions for a range of data and workload requirements, enabling you to accelerate innovation, adapt to evolving requirements and stay in control of IT operations. Options include: Infrastructure Services, Cloud Services and Custom Solutions.

APEX Storage Services

Get the technology you need in a fraction of the time and scale resources on demand with resources owned and maintained by Dell Technologies. Data Storage Services are scalable and elastic storage resources built on our industry-leading technologies. Our Storage as-a-Service gives you complete oversight of your storage resources, while freeing you from the hassles of day-to-day data storage management.

APEX Cloud Services

Subscribe to cloud infrastructure for hybrid and private cloud environments. Enable secure and consistent operations and accelerate time to value, wherever resources are deployed.

APEX Custom Solutions

Create your own on-demand environment with infrastructure and services you customize to order. Deploy a pay-per-use consumption model or an enterprise-scale managed utility. Flex on Demand allows you to pay only for the technology you need – while providing access to ready buffer capacity – with payments that adjust up or down to match usage.

Data Center Utility aligns costs directly to usage, allowing you to maximize your scaling flexibility while only paying for what you use. It's a highly customizable way to move part, or all, of your data center operations into a pay-per-use model. It provides Dell's market-leading product portfolio coupled with professional services and support to fully manage your data center and its operations in a simple, single-invoice monthly payment based on your actual usage.

Build or Scale Your Cloud

Dell Technologies has an extensive portfolio of software, servers, networking, storage, solutions, Validated Designs, Ready Nodes, hyper-converged and converged systems, services and financing to help you achieve your goals. Collaborate with experts in one of the worldwide Customer Solution Centers, start a proof of concept and/or take a test drive.

Dell Technologies Services for Microsoft Azure Stack

Dell Technologies Services professionals can help you develop and customize service catalogs, enabling identity and access management systems, and extending monitoring and metering systems to Azure Stack.

Dell provides support throughout the lifecycle of the platform with each component backed by automated proactive, predictive tools and a dedicated technical account manager with ProSupport Plus.

Dell Technologies OpenStack firsts[2]

- First to co-engineer an OpenStack cloud solution
- First SPEC Cloud IaaS benchmark
- First to deliver instance high availability, host live migration with containers
- First to integrate high availability Ceph® object storage and software-defined storage architecture
- First OpenStack configuration supporting concurrent multiple storage back-ends via Cinder

Dell EMC Integrated System for Microsoft Azure Stack Hub

Consume HCI as-a-Service

Dell EMC Integrated System for Microsoft Azure Stack Hub is an on-premises hybrid cloud platform for delivering IaaS and PaaS with a consistent Azure cloud experience on-premises or in the field.

Organizations can now adopt Azure as an HCI as-a-Service experience with Azure Stack HCI. Through native and deep Azure integration, customers can leverage Azurere sources both on-premises and in the public cloud, enjoying regular and consistent feature and security updates. With a single Azure portal, create and orchestrate HCI clusters at scale, easily.

Dell Technologies provides a metered payment solution for Dell EMC infrastructure that allows customers to scale up and down within the available buffer capacity and easily manage unpredictable growth, workload bursts, and temporary changes in IT infrastructure requirements. Along with the Azure subscription that allows customers to adopt which services they need and manage costs, Dell EMC Integrated System for Microsoft Azure Stack HCI provides a truly public cloud experience across the entire stack.

Dell Technologies Validated Design for Red Hat OpenStack Platform

Rapid, automated deployment of an OpenStack private cloud for HPC

The Red Hat® OpenStack® Platform virtualizes HPC resources, organizes them into clouds, and manages them so users can access what they need, when they need it. But deploying OpenStack can be challenging due to the interdependency of OpenStack's multiple projects and the rapid evolution in OpenStack components. Building a production-grade OpenStack environment typically requires significant staff resources with extensive OpenStack expertise to understand and integrate the many interdependent projects — something many enterprises don't have.

Dell Technologies and Red Hat have solved this dilemma by co-engineering the Validated Design for Red Hat OpenStack Platform. It combines a core validated design with selected extensions to create an adaptive infrastructure that integrates the best innovations from the OpenStack community with proven Dell Technologies and Red Hat platforms. This complete, open, secure, reliable and supported design is built with validated, integrated components and features rapid, automated provisioning to simplify and speed deployment, so you can take advantage of cloud benefits sooner. Seamless integration among Dell EMC hardware, Red Hat OpenStack and Bright Computing® management software means you can manage the entire environment from a single pane of glass.

[2] Source: delltechnologies.com.

Dell Technologies partner cloud for HPC, AI and HPDA

Strong industry partnerships enable you to enjoy a seamless hybrid cloud experience by extending into Microsoft® Azure®, Amazon Web Services® (AWS), Google® Cloud Platform™ and 200+ other cloud partners on a subscription, lease or pay-per-use basis.

Azure Cloud HPC receives HPCwire Editors' Choice Award[3]

Best HPC Cloud Platform

Azure Cloud Services from Dell Technologies

Deployment, managed services and support for public cloud HPC

Azure Cloud Services from Dell Technologies enable hybrid cloud environments by extending data center capabilities with scalable IT services delivered from the Azure cloud and charged on a pay-as-you-go basis. Dell Technologies makes it easy and efficient to adopt Azure Cloud Services on your terms and within your timeframe with an accelerated provisioning process and single point of contact for support. Leverage Dell Technologies and Microsoft expertise to extend and enhance your cloud data center operations with trusted agile cloud services.

Azure offers several ways to design and implement, extending on-premises systems by enabling dynamic bursting to the cloud to complement on-premises capabilities. Azure gives you the power and capacity to run your workloads with maximum performance, scalability and cost efficiency. Example supported workloads include:

- **AI** — Get powerful remote workstations, run clusters with near-infinite scale and gain better insights with advanced analytics, ML and AI workloads on Azure.
- **Computer-aided engineering (CAE)** — Provide an HPCaaS platform for engineers and designers to rapidly iterate on product design to reduce time to market and improve product quality with scalable and highly secure, on-demand infrastructure.
- **Bioinformatics** — Accelerate insights in genomics, precision medicine and clinical trials with near-infinite high-performance bioinformatics infrastructure.
- **Seismic processing and reservoir simulation** — Optimize upstream oil and gas industry exploration, appraisal, completion and production.
- **Computational fluid dynamics (CFD)** — Enable researchers to execute CFD simulations on Azure.
- **3D video rendering on Azure** — Enable designers, artists and architects the ability to run native HPC rendering workloads in Azure using the Azure Batch Service.

[3] HPCwire, HPCwire Reveals Winners of the 2020 Readers' and Editors' Choice Awards During SC20's Virtual Conference. November 2020.

Dell Technologies provides a streamlined on-boarding and setup process for Azure Cloud Services that gets you operational in a matter of hours. The Dell EMC Azure Control Portal provides a single point of monitoring and integrated billing with Azure Cloud Services, along with a single source of truth for consumption and usage so you can easily monitor and manage your Azure Cloud Services. Dell Technologies Services include:

- "White glove" rapid on-boarding and subscription setup.
- Single point of monitoring for usage and billing across your Microsoft Azure subscriptions.
- 24x7x365 support for billing/usage, technical issues and account setup and access.
- Basic and enhanced support plans with a variety of service level agreements (SLAs) and engagement points.

> "The extreme performance... has enabled Cambridge University to provide a world-class cloud-native supercomputer for driving research that will benefit all of humankind."[4]
>
> *— Paul Calleja, Director of Research Computing, Cambridge University*

VMware Cloud on AWS

Innovate faster, lower your risk and rapidly transition to the cloud

VMware Cloud on AWS provides access to elastic and scalable resources to run HPC, AI and HPDA applications and workloads beyond the limitations of on-premises HPC systems. Simplify your hybrid IT operations by using the same VMware Cloud Foundation technologies including vSphere, vSAN™, NSX®, and vCenter Server® across both on-premises data center environments and the AWS Cloud.

You can keep the same VMware provisioning, storage and lifecycle policies you use today. This means you can easily move applications between their on-premises environments and AWS without having to purchase any new hardware, rewrite applications or modify your operations. Near limitless scalability combined with access to a broad portfolio of cloud-based services like analytics, AI and ML help you redefine traditional HPC workflows to innovate faster. Benefits include:

- **Increase innovation** — Access 165+ AWS services including compute, database, analytics, Internet of Things (IoT), AI/ML, security and more. Latency-sensitive applications hosted in the VMware Cloud can directly access databases on Aurora, Dynamo or Redshift for petabyte-scale analysis, as well as direct and secure access to low-cost S3 buckets, objects and API functions.
- **Simplify operations** — Keep the same VMware provisioning, storage and lifecycle policies you use today. Easily move applications between on-premises and AWS environments without rewriting applications or modifying operations. You can use VMware's management and policy tools across on-premises and VMware Cloud on AWS so you have a unified and operationally consistent experience.
- **Reduce costs** — Optimize costs with no need for hardware, and no need to modify applications to shift to a hybrid cloud model. Along with unified management, these capabilities let you leverage existing investments to save money.
- **Enhanced availability** — Accelerate migration of VMware vSphere-based workloads to the AWS Cloud. VMware-based workloads can be provisioned in a single-tenant, isolated Amazon virtual private cloud (VPC), allowing you to take immediate advantage of the scalability, availability, security and global reach of the AWS Cloud.

[4] NVIDIA, NVIDIA Accelerates World's First TOP500 Academic Cloud-Native Supercomputer to Advance Research at Cambridge University, April 2021.

Google Cloud

Move at the speed of inspiration

Google Cloud accelerates your most complex HPC workloads with competitive pricing to help you stay within budget. Dell is a validated hardware provider for Google Cloud's Anthos. If you're using Dell EMC hyperconverged infrastructure (HCI) on-premises you can leverage it to seamlessly migrate to or from the cloud, while continuing to use Dell hardware, services and support. The Dell and Google Cloud partnership delivers a variety of benefits that help transform how you consume HPC resources:

- **Pay-per-use HPC** — Google Cloud offers on-demand access to custom machine configurations that are billed on a per-second basis with committed use discounts and sustained use discounts available.
- **Access HPC hardware and software on demand** — Accelerate insights with the power of Google Cloud, leveraging Dell EMC compute, networking and storage infrastructure. Build your own supercomputer in the cloud using the latest Dell EMC PowerEdge servers, Intel® processors, NVIDIA® GPUs, and Google Cloud Tensor Processing Unit (TPUs) with high-throughput, low-latency object and file storage.
- **Provide custom, scalable resources** — With Google Cloud each team can have access to their own HPC system, relieving compute resource limitations, reducing wait times for large-batch workloads and helping teams solve problems faster.
- **Manage containerized workloads** — Batch on Anthos Google Kubernetes® Engine (Anthos GKE), a cloud-native solution for running batch workloads at scale. Batch frees applications from the limitations of fixed-sized clusters by dynamically allocating resources to meet application needs.

Hosted public and private cloud for HPC, AI and HPDA

Dell Technologies partners with leading global cloud HPC providers to provide managed services, hosting, colocation services and on-demand resources for HPC.

DXC Technology

Outsourced managed services and hosting for private cloud and public cloud IaaS and PaaS

DXC Technology® enables a hybrid cloud model that delivers value to your business by enabling your digital transformation, giving it the best from the public cloud and on-premises infrastructure services, and transcending the corporate boundary — all while keeping you firmly in control.

Benefits

- Spans private and public clouds, allowing the selection of the right location for workloads.
- Provides a relevant set of IaaS and PaaS services under a hybrid cloud delivery model, to combat the challenges of shadow IT.
- Provides unified and granular visibility into resource consumption to help address governance, risk and compliance, and cost optimization.
- Offers as-a-service models that can be scaled to fit business needs on demand.
- Harmonizes service characteristics across public and private cloud to provide a consistent experience.
- Delivers the benefits of a managed service with the level of control your business needs.

Why Iceland is the perfect spot for off-premises HPC

Iceland is ideally located between Europe and North America and offers competitive data connections to major hubs on both sides of the Atlantic. Perhaps more importantly, Iceland offers low-cost, 100% renewable energy — and data center power requirements are much lower due to the year-round, free cooling of Iceland's arctic climate. This all adds up to savings of more than 70% when compared to data centers in New York, London and Frankfurt.[6]

Verne Global

Industrial scale HPCaaS, colocation and hosting

Verne Global® delivers advanced data center solutions at industrial scale, allowing you to run HPC applications in an optimized environment, all provided via one of the world's most reliable and lowest cost power grids — located in Iceland. With HPC capabilities focused on AI, engineering, financial services, IT services and research applications, Verne Global enables many types of organizations to massively expand their HPC capabilities.

- **HPC-as-a-Service** — Craft your own infrastructure and push the boundaries of innovation on an industry-leading, bare metal platform built on Dell EMC PowerEdge servers, storage and networking, and housed in Verne Global's HPC-optimized, cost-effective Iceland data center. Verne Global and Dell Technologies build and support sustainable, turnkey high intensity compute infrastructures that you simply can't get from typical cloud service providers.
- **HPC Colocation** — The powerADVANCE solution provides the highest specification hosting on the same campus. powerDIRECT is engineered for industrial scale, ultra-high-density deployments.
- **DGX-Ready system hosting** — Verne Global was one of the first data centers to be certified by NVIDIA as part of their DGX-Ready Data Center Program. That means Verne Global is certified to host high performance for the most challenging AI workloads.

HPC on demand with R Systems

Hosted and managed off-premises private cloud and public PaaS, IaaS and cloud bursting

If you want to host HPC with a cloud provider, you need architectural options that are not available from standard public or multitenant cloud services. HPC on demand with R Systems service provides a secure private cloud environment, hosted and managed by Dell Technologies and R Systems, an HPC Solutions Partner. R Systems® provides white-glove HPC services with custom HPC architectures in your choice of locations, including their company-owned data centers at the University of Illinois Research Park in Champlain, IL. R Systems offers Dell EMC HPC systems with Dell EMC servers, networking and storage, as well as custom engagements/configurations based on specific business needs.[5]

HPC on demand with R Systems service offers greater flexibility than public cloud by enhancing your ability to operate production workloads that might otherwise be limited to custom, on-site operations in a hosted private cloud.

Gain bursting ability

Public cloud resources can help you:

- Service intermittent processing spikes that surpass local capacity
- Use multiple operating systems and applications

Tap into professional hosting and management

Industry- and domain-specific hosting helps users who:

- Want their data, their collaborators' data and reference data in one location for processing
- Want access to high-performance networks and file systems

[5] Dell bare-metal service is available only in North America.

[6] Verne Global Industry use case, Verne Global superpowers the quantitative finance revolution, accessed November, 2021.

Services

- Customizable burst or short-term HPC capacity served as an operating expense in 24-hour increments
- Large-scale core count clusters with the option of NVIDIA InfiniBand® interconnectivity
- High-memory configurations available for memory-intensive workloads
- User support for knowledge levels from novice to experienced
- Customizable security for public or private cloud
- Easy to set up access
- Support for Linux and Windows Server®
- In-depth experience with a wide variety of independent software vendors (ISVs), such as ANSYS®, CD-adapco®, Milliman® and SIMULIA®

Benefits

- Workload-optimized system configurations
- Enables easy migration with a standards-based architecture
- Lowers technical barriers to HPC via burst models
- Empowers researchers and increases collaboration
- Allows you to pay only for the resources you use through on-demand cloud computing
- Reduces CapEx and total cost of ownership (TCO)
- Leverages the agility and efficiencies of cloud
- Provides superior user support from highly experienced R Systems technicians.

Virtustream HPCaaS in action

Watch how Dell Technologies and Virtustream HPCaaS accelerate the work of an emerging leader in driver-assistance and autonomous-driving technologies: "Zenuity Customer Reference."

Virtustream Enterprise Cloud

Enterprise public, virtual and hybrid cloud services

Not all clouds are created equal. Unlike general-purpose public clouds that focus on best-effort delivery model, Virtustream® Enterprise Cloud is built to run complex, I/O-intensive, mission-critical enterprise applications. It offers guaranteed availability and performance backed by industry-leading SLAs, rigorous end-to-end security, and government- and industry-specific compliance solutions. In addition, Virtustream Enterprise Cloud includes a full suite of professional and managed services from the infrastructure up to the application layer, all while achieving superior economics to maximize your IT investments.

For enterprises, service providers and government agencies, Virtustream meets the security, compliance, performance, efficiency and consumption-based billing requirements of complex production applications in clouds.

- **Performance assurance** — Performance-based SLAs mean mission-critical applications can access the data they need, when they need it, in a timely manner for their specific business requirements.
- **Availability and resilience** — High availability is built into every level of architecture, enabling applications to run without disruption from the infrastructure to the application layer.
- **Security** — With Virtustream Enterprise Cloud, you get a rigorous set of security features recognized by cloud industry experts as best-in-class.
- **Compliance** — Virtustream works closely with customers to ensure your enterprise-class workloads are hosted in the right environment based on your compliance needs.
- **Consumption-based economics** — You get a single, unified metric to measure your usage of cloud resources, so you only pay for the resources consumed, unlike the typical T-shirt-sized utility billing from the general-purpose public cloud providers.
- **Cloud migration services** — Virtustream assists with moving your most complex and demanding applications to the cloud quickly and efficiently.

HPC powers autonomous mining for Caterpillar

Caterpillar® leverages an HPC system from Dell Technologies to accelerate time to insights about product issues and optimization opportunities for their autonomous mining vehicles. As part of the solution, X-ISS provides remote cluster management services including remote system monitoring and management of their HPC cluster in order to enhance productivity. Read the full case study.

X-ISS

Outsourced managed services for on- or off-premises private cloud

Managing HPC is much more complicated than managing a typical enterprise data center, and qualified HPC system administrators are hard to come by. Dell Technologies HPC Managed Services with X-ISS is a remote HPC administration and monitoring service designed for enterprises that lack the internal resources or expertise to manage HPC environments, or for large organizations with clusters located at multiple facilities. The service provides daily remote monitoring of customer-owned, on-premises or off-premises HPC systems.

How HPC Managed Services with X-ISS works

- **Setup** — X-ISS® sets the cluster system up for remote management and monitoring as well as for you to be able to call in and ask for help as needed. X-ISS proactively monitors your cluster to identify and resolve issues in a timely manner.
- **Support** — You have multiple channels for support. X-ISS sets up systems to be able to respond expeditiously to both system-generated events as well as user requests.
- **Review** — Ongoing assessment is critical to improvement; X-ISS provides regular performance reports and recommendations to help you identify trends and better plan for the future.

Services

- Provides outsourced HPC management expertise for secure remote monitoring, management and support.
- Offers services just for the duration of your project/lease/grant.
- Monitors and responds proactively to alerts.
- Triages and coordinates issue resolution between hardware, operating system and application vendors.
- Supports most applications, including those from ANSYS, Dassault Systèmes®, and Autodesk®.
- Provides quarterly management reports.

Benefits

- Saves the difficulty and expense of hiring hard-to-find HPC experts.
- Provides a fixed cost budget to maintain your HPC cluster or cloud.
- Assists your staff with job submission and monitoring.
- Keeps your HPC environment running at optimum uptime and performance.
- Supports your private HPC cluster or cloud in the most cost-effective manner.
- Allows researchers, engineers and developers focus on your core business and research initiatives.
- Helps you identify trends and better plan for the future via quarterly performance reports and recommendations.

"Setting up a next-generation HPC system isn't a simple task of swapping out old servers for new ones... With a great deal of ingenuity and a big hand from Dell Technologies, we staged, stood up and fully commissioned our new HPC infrastructures plus a new and secure mobile trackside IT package in just three weeks... And we saved millions to invest in other data-driven innovation efforts."[7]

— Edward Green, principle digital architect, McLaren Racing

Public/private HPC cloud partnerships

Many public universities engage with the private sector to provide HPC cloud resources.

San Diego Supercomputer Center

Affordable HPCaaS for campus and corporate users

For over 30 years, the San Diego Super Computer Center (SDSC) has led the way in deploying and supporting cutting-edge HPC systems for a wide range of users, from the campus to the national research community. SDSC launched the Triton Shared Computing Cluster (TSCC) after recognizing that UC San Diego investigators could benefit from an HPC system dedicated to their needs and with near-immediate access and reasonable wait times instead of accessing a national system entailing competitive proposals and often longer wait times.

Following an extensive study of successful research computing programs across the country, SDSC selected the "condo computing" model as the main business model for TSCC. Condo computing is a shared ownership model in which researchers use equipment purchase funds from grants or other sources to purchase and contribute servers to the system. The result is a researcher-owned computing resource of medium to large proportions. Today, other users may also take advantage of TSCC "hotel" service for short, term, temporary or HPC bursting needs.

- **Condo** — The condo plan gives participants access to computing capability through the pooling of computing resources, offering participants significantly greater computational power and higher core counts than if limited to their own hardware or individual laboratory cluster. Researchers who contribute to the TSCC cluster have priority access to the nodes that they contribute. In addition, they can run jobs on any available nodes, including hotel and other condo nodes.
- **Hotel** — Pay-as-you-go jobs run on 48 general computing nodes with 768 cores. Additional nodes may be added based on demand. Hotel nodes are configured with 64GB of memory and an NVIDIA InfiniBand interface. They're allocated per-core, allowing up to 16 jobs to run on each node simultaneously. Hotel users purchase cycles that reflect the total cost of ownership, albeit leveraging the economies of scale afforded by TSCC.

McLaren Racing gains an edge with HPC

No sport in the world is more technologically advanced than Formula 1 car racing. Racing at speeds of up to 223 miles per hour, the car's aerodynamics is the most critical factor for success.

McLaren uses HPC infrastructure from Dell Technologies to conduct complex CFD studies that help them optimize their cars and minimize turbulence. This saves them the time and expense of prototyping multiple parts for wind-tunnel testing.

Read the story: The McLaren Racing Team Accelerates F1 Performance From the Edge.

[7] Dell Technologies perspectives, The McLaren Racing Team Accelerates F1 Performance From the Edge, May 2021.

University of Florida helps transform society

"You have an app and you want to do something, and you want the results there immediately. And now our researchers are going to do high performance computing calculations, deep learning, artificial intelligence and research tasks in much the same way. They just go to their browser and — zip, zip — they get the results right there."[10]

— Dr. Erik Deumens, Director of Research Computing, University of Florida

"We've been helping the nation's most sophisticated manufacturers with some of their biggest problems for more than 25 years, and our work with the [DMDII] is an extension of that."[11]

— Merle Giles, Head of NCSA's Industry Program

University of Florida HiPerGator

HiPerGator is a powerful supercomputer and the second-fastest academic supercomputer in the country, according to the TOP500.[8] Two years after the HiPerGator supercomputer was introduced at the University of Florida, it was expanded to add capacity and capabilities with 30,000 cores in approximately 1,000 nodes from Dell Technologies. HiPerGator resources are available for academic users at the university as well as commercial enterprises. And discounted commercial rates are available for University of Florida–supported startup companies, such as those associated with the University's Innovation Hub.

National Center for Supercomputing Applications

The National Center for Supercomputing Applications (NCSA) provides powerful computers and expert support that help scientists and engineers improve our world. Established in 1986 as one of the original sites of the National Science Foundation's Supercomputer Centers Program, NCSA is supported by the state of Illinois, the University of Illinois, the National Science Foundation and grants from other federal agencies.

NCSA Industry Program

The NCSA Industry Program offers partners globally recognized domain expertise, comprehensive infrastructure services and the ability to collaborate across the University of Illinois system with renowned faculty and motivated students. NCSA partners with government groups and global companies to tackle big questions and provide meaningful results in fields ranging from AI to genome mapping to autonomous transportation — all supported by an eight-time HPCWire Award-winning team of experts and delivered on advanced computing resources.

The NCSA Industry Program has aided many of the world's largest companies in sectors including manufacturing, oil and gas, finance, retail/wholesale, bio/medical, life sciences, agriculture and technology. In fact, NCSA Industry has been advancing more than one third of the Fortune50® and nearly 60 percent of manufacturers in the Fortune100® for more than 30 years[9] by bringing industry, researchers and students together to solve grand challenges at rapid speed and scale. Caterpillar, Deere & Company, Dow Chemicals and Rolls-Royce® are all members of the NCSA Industry Program.

[8] TOP500, The List, June 2021.

[9] Top500 news, Why We Care About Industrial HPC, accessed November 2021.

[10] Dell Technologies case study, HiPerGator, May 2020.

[11] NSCA, NSCA Plays a Key Role in Digital Manufacturing Lab, accessed November 2021.

Turbocharge HPC, AI and HPDA

Today, Moore's law is reaching its practical limits, and CPU performance advances at an average of about 10 percent each year. But GPU technology is giving the industry new momentum. NVIDIA GPUs promise to deliver a 1,000x performance boost over CPUs by 2025.[12] To learn more, read the Spiceworks eBook "Turbocharge Your Applications."

The powerful iForge cluster was designed specifically for NCSA's industry partners, featuring distinct Dell Technologies HPC systems designed for differing computational needs. Using four generations of Dell EMC PowerEdge servers, iForge addresses the needs of power users so commercial clients can solve their most complex modeling and simulation challenges faster. A new GPU queue builds on this mission by offering fast new technology that's already solving bigger problems in less time. With the latest NVIDIA GPUs and NVlink interconnect, users can get more from their machine learning and engineering applications.

Areas of expertise include:

- **HPC operations** — Building, optimizing, advancing and maintaining HPC systems for thousands of active users across the globe.
- **Analytics and AI** — Data analysis, data management and ML at massive scale for HPC and cloud environments.
- **Software and applications** — Development of flexible, extensible software tools and frameworks for data analysis and management.
- **Bioinformatics and genomics** —Production workflows and optimization for genomics and computational biology analysis on HPC and cloud.
- **Modeling and simulation** — Consulting for domain-specific fluid dynamics and finite element analysis on HPC.
- **Visualization** — Exploration and application of representation techniques to maximize insight and understanding of complex data.

Manufacturing X Digital

NCSA is deeply involved in the Chicago-based Manufacturing X Digital (MxD) — formerly known as the Digital Manufacturing and Design Innovation Institute (DMDII). MxD is an applied research institute whose focus is developing and commercializing digital manufacturing technologies for consumer products, heavy machinery and military equipment.

This public-private effort is made possible by $70 million from the U.S. Department of Defense and more than $250 million from industry, academic, government and community partners. Many of the industry partners have strong ties with NCSA, such as Boeing, Caterpillar, Deere & Company, Dow Chemicals, and Rolls-Royce — all of which are members of the NCSA Industry Program. These partners collaborate with NCSA and its hardware and software partners to address digital challenges, such as: finite element analysis, CFD, extreme scaling of commercial and home-grown codes, multi-physics modeling and remote visualization.

[12] NVIDIA, Turbocharge Your Applications, accessed November 2021.

Hybrid cloud security

Secureworks

Protect your HPC clouds

As enterprises move quickly to leverage multiple public and private clouds to enable digital transformation goals, security teams need to rethink their program strategy and enhance their operations. Secureworks, a Dell Technologies company, enriches existing defenses with intelligence from up to 290-billion cyber events observed each day, across 4,300 clients in more than 50+ countries.[13] By investing in supervised machine learning and analytics, as well as the brightest minds in the industry, Secureworks has successfully automated and accelerated event detection, correlation and contextualization. The Secureworks team can help you:

- **Define your strategy** — Visualize how HPC cloud adoption will affect your security program and prepare the security requirements for a successful cloud migration.
- **Monitor your clouds** — Detect anomalies in high volumes of cloud log data and separate routine events from security incidents worth investigation.
- **Manage vulnerabilities** — Incorporate cloud asset discovery and cloud vulnerability scan data into your security program.
- **Strengthen your security posture with adversarial testing** — Discover if your controls can withstand a cloud-focused hack from Secureworks.

Secureworks solutions are backed by over 20 years of security expertise, proprietary processes and technologies, and the use of cloud security best practices and industry benchmarks to provide the peace of mind knowing your cloud environment is safe.

93%
of enterprises have a multi cloud strategy.[14]

67%
of enterprises are concerned about security risk with the public cloud.[14]

Boomi AtomSphere

For any cloud service, security must be carefully scrutinized. The Boomi AtomSphere platform addresses security with four main areas that provide extensive security to keep your company and data secure:

- **Data center security** — The Boomi data center stores a set of configuration and management information for all client accounts that allows for centralized control and distribution of integrations from any location even when a specific Atom is not running.
- **Data communications security** — Data is stored behind the firewall where the Atom is deployed. It is transported directly to the application through a connector configured to user-specific security requirements.
- **Atom communication security** — Inbound firewall ports don't need to be open for the Atom to communicate with the data center. The Atom initiates the connection, using an SSL handshake to authenticate the data center before transmitting data.
- **Password encryption security** — When you register an account and activate it, we generate a private/public X.509 key for you. We store both the public certificate and the private key in our secure data center.

[13] Built In, 20 Public Cybersecurity Companies Being Traded Today, May 2021.

[14] G2 Learn Hub, 31 Hybrid Cloud Statistics That Can Affect Your Business, April 2021.

Services for HPC, AI and HPDA hybrid clouds

Consulting, deployment, management and support

From consulting, education, design and implementation to support and systems management, Dell Technologies offers a comprehensive services portfolio for HPC systems including on-premises and managed systems, as well as those in the cloud. With thousands of successful implementations, direct access to Dell Technologies engineers, our HPC & AI Innovation Lab, and our partners' latest code, Dell Technologies is perfectly positioned to enable your success.

Dell Technologies HPC Consulting capabilities

- Code migration and optimization
- Cluster optimization and tuning
- Development: Debug, compile, test
- Cluster management: Bright Computing, Omnia, Slurm® Workload Manager, and more
- Networking fabrics: InfiniBand, RoCE, Ethernet, fabric management
- x86 storage servers: selection of Linux, OpenFabrics
- File systems: NFS, Oracle® ZFS®, BeeGFS®, PixStor, OneFS, plug-ins
- HPC cluster management processes and other consulting requests

For more information on Dell Technologies Services for HPC Cloud, visit delltechnologies.com/services.

HPC add-on: Individual nodes

- Install individual server nodes
- Professionally label cabling
- Configure BIOS for HPC
- Install the OS

HPC add-On: MX

- Install fully populated MX (chassis and sleds)
- Professionally label cabling
- Configure the network

HPC add-on: Storage

- Install Dell Technologies Validated Designs for HPC Storage

Deploy: ProDeploy for HPC

HPC deployments require specialists who understand that "cutting edge" is yesterday's news. Dell Tchnologies' HPC deployment model provides comprehensive, proven system implementation at the right price. Dell deploys the world's fastest systems and understands the nuances that make them perform. Dell Technologies ProDeploy provides the following standard services:

- Rack and stack remotely or build a cluster on-site
- Install and configure cluster management software
- Configure HPC nodes and switches
- Validate the implemented design
- Provide product orientation
- Perform cluster benchmarking
- Upload all deployment and benchmark data to Dell Technologies Support tools

You can then add installation services in any combination to fit your exact system requirements.

Support: ProSupport Add-on for HPC

Dell Technologies delivers a true end-to-end support experience across the HPC environment. Our goal is to handle all support needs — one contact, one handshake, one single source of accountability — to get you back up and running quickly when issues arise. Start with either Dell Technologies ProSupport or ProSupport Plus, then select the ProSupport Add-on for HPC, which provides:

- Access to senior HPC experts
- Advanced HPC cluster assistance: performance, interoperability, configuration
- Enhanced HPC solution-level support
- Remote pre-support engagement with HPC specialists during ProDeploy implementation

Manage: Dell Technologies Managed Services

IT decision makers know they can trust Dell Technologies – the global IT leader from edge to core to cloud – to deliver expertise, processes, and advanced technology to keep their technology environment operating at peak performance. Knowing that Dell Technologies has their IT operations well in hand, customers can confidently redirect team members to accelerate transformation efforts.
Learn more: Dell Technologies Managed Services.

Continuing support: Dell Technologies Residency Services

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.
Learn more: Dell Technologies Residency Services

Multi-cloud infrastructure and operating model services

Dell Technologies Consulting Services can help you define your cloud strategy, develop a holistic roadmap and business case, build a multi-cloud operating model, implement Dell Technologies Cloud Platforms and modernize your network. By rapidly adopting your hybrid or multi-cloud environment, you can focus on driving IT and business innovation faster.

Jumpstart your transformation to multi-cloud

Proconsult Advisory for Multi-Cloud helps you understand the impact of your cloud transformation and develop a plan to move forward. Dell Technologies consultants will work with you to assess your current state and define a target state, create a customized roadmap to get there, and determine the cost savings and benefits of your plan.

Realize the benefits of hybrid cloud platforms

Cloud Infrastructure Platform Services are designed to help you implement and integrate Dell Technologies Cloud Platforms and underlying Dell EMC converged and hyperconveged infrastructure into your environment. We can help you build a foundation for flexible cloud operations with multi-cloud IaaS and PaaS platforms that support VMware, Pivotal® and Microsoft Azure environments.

Deliver traditional IT and cloud-native services faster

Cloud Operating Model Services help you create a service-based operating model that supports both current IT and new cloud-native operations. Dell experts can help you automate IT processes, organize around service delivery and integrate IT operations and cloud-native development.

Extend your Microsoft Azure cloud to on-premises

Innovate and thrive with Dell Technologies Consulting Services for Microsoft Azure Stack. Our experts help identify the right path for your business, make sure you're prepared for your cloud, and add value to your cloud so you can deliver modern, portable applications faster.

Modernize your network

Dell Technologies Networking Services help you upgrade your network with efficient, agile and innovative service delivery models. Transform your network to meet today's growing demands, accelerate new service delivery to market and overcome complexities of implementing NFV and SD-WAN.

For more information on Dell Technologies Services for HPC Cloud, visit delltechnologies.com/services.

Flexible financing options

Dell Financial Services (DFS), part of the Dell Technologies family, delivers innovative payment solutions for hardware, software and services, allowing your organization to align and scale the cost of IT solutions with technology consumption and budget availability.

- **Predictability for increased simplicity** — Simplify and predict budgeting, billing and technology lifecycle management.
- **Flexibility for enhanced agility** — Select both the technology and the terms that work best for you.
- **Choice for increased control** — Choose to pay over time or pay based on usage to manage budgets.

Dell Technologies APEX Flex On Demand

Today's dynamic business environment drives the need for immediate access to available capacity, whenever it's required. Flex On Demand allows you to pay only for the technology you need — while providing access to ready buffer capacity — with payments that adjust up or down to match usage. Flex On Demand is available on Dell EMC storage solutions as well as Dell EMC PowerEdge servers, select hyperconverged solutions and PowerOne CI solutions.[15]

Flex On Demand, together with Dell Technologies Cloud Platform, improves cloud economics via a consistent hybrid cloud that delivers public cloud agility on-premises, optimizes cloud utilization and is tailored to suit your business priorities.

- **Deploy with confidence** — We work with you to establish your projected baseline capacity requirements and the buffer capacity needed to cover peak use. All technology is preconfigured and available on day one.
- **Pay flexibly** — Each payment includes the fixed cost of your committed capacity plus the variable cost of buffer capacity, which is measured on a regular basis using automated tools.
- **Adapt on demand** — If usage consistently consumes most of the installed buffer capacity — or none at all — simply amend your committed capacity threshold up or down.

"The HPC & AI Innovation Lab gives our customers access to cutting-edge technology from Dell, Intel, AMD, NVIDIA, Bright Computing and more. Customers can bring us their workloads and we can help them tune a solution before the technology is readily available."

— Garima Kochhar, Distinguished Engineer

Guidance and best practices for hybrid cloud HPC, AI and HPDA

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 Customer Solution Centers help reduce the risks associated with new technology investments and can help improve speed and ease of implementation.

HPC & AI Innovation Lab

The HPC & AI Innovation Lab in Austin, Texas, is our 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.

Dell Technologies HPC & AI Centers of Excellence

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

[15] Payment solutions provided and serviced by Dell Financial Services L.L.C. or its affiliate or designee ("DFS") for qualified customers. Offers may not be available or may vary in certain countries. Where available offers may be changed without notice and are subject to product availability, applicable law, credit approval, documentation provided by and acceptable to DFS and may be subject to minimum transaction size. Offers not available for personal, family or household use. Dell EMC and the Dell EMC logo are trademarks of Dell Inc. Restrictions and additional requirements may apply to transactions with governmental or public entities. Flexible Consumption: At the end of the initial term customer may: 1) extend original term or 2) return the equipment to DFS.

DELL Technologies

Contact us

To learn more, visit delltechnologies.com/cloud or contact your local representative or authorized reseller.

Why Dell Technologies

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 your IT needs from one provider.

- #1 in servers[16]
- #1 in converged and hyper-converged infrastructure[17]
- #1 in storage[18]
- #1 in enterprise infrastructure — buyer and cloud deployment[19]

See Dell Technologies Key Facts.

[16] IDC, WW Quarterly x86 Server Tracker, 2Q2021, Vendor Revenue & Shipments, September 9, 2021.

[17] IDC, WW Quarterly Converged Systems Tracker, Vendor Revenue, March 2021.

[18] IDC, WW Quarterly Enterprise Storage Systems Tracker, 2Q2021, September 9, 2021.

[19] IDC, WW Quarterly Enterprise Infrastructure Tracker: Buyer and Cloud Deployment, 2Q2021, Vendor Revenue, October 1, 2021.