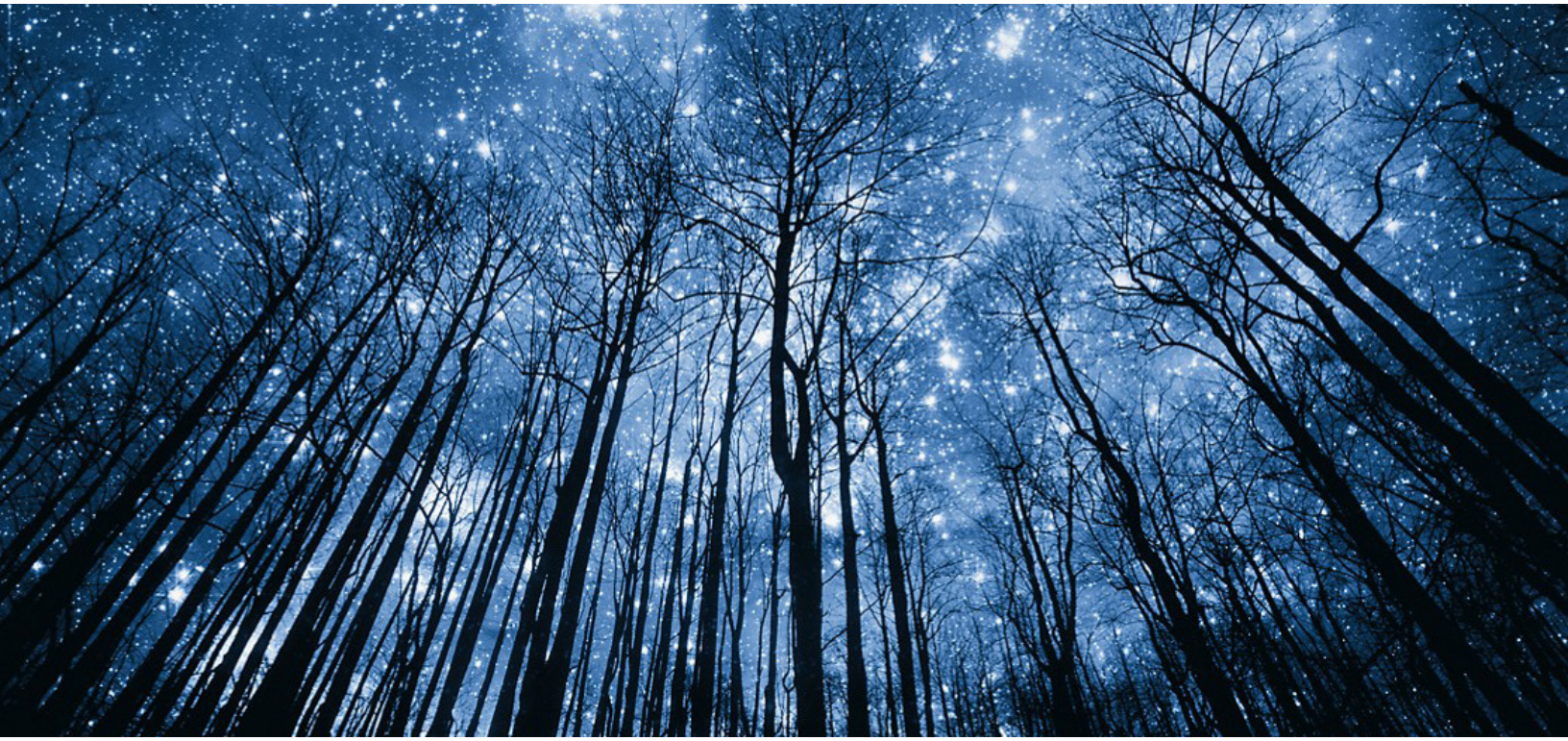
DELL Technologies

HPC: THE FUTURE OF COMPUTING IS NOW



Karishma R

Supervisor, Inside Sales Management
Dell Technologies
Karishmar.r@dell.com

Knowledge Sharing Article

DELL Technologies Proven Professional

The Dell Technologies Proven Professional Certification program validates a wide range of skills and competencies across multiple technologies and products.

From Associate, entry-level courses to Expert-level, experience-based exams, all professionals in or looking to begin a career in IT benefit from industry-leading training and certification paths from one of the world's most trusted technology partners.

Proven Professional certifications include:

- Cloud
- Converged/Hyperconverged Infrastructure
- Data Protection
- Data Science
- Networking
- Security
- Servers
- Storage
- Enterprise Architect

Courses are offered to meet different learning styles and schedules, including self-paced On Demand, remote-based Virtual Instructor-Led and in-person Classrooms.

Whether you are an experienced IT professional or just getting started, Dell Technologies Proven Professional certifications are designed to clearly signal proficiency to colleagues and employers.

Learn more at www.dell.com/certification

Table of Contents

Disclaimer: The views, processes or methodologies published in this article are those of the author. They do not necessarily reflect Dell Technologies' views, processes or methodologies.

Introduction

This article discusses High Performance Computing (HPC):

- what it is
- how it works
- its high-level architecture
- where & in which industry it can be used
- benefits and challenges
- HPC in the cloud compared with traditional HPC
- HPC use cases
- Dell Technologies innovation in HPC and its ready solutions

HPC strongly emerged during the last three decades of the 20th century while manufacturers, systems, and buildings diminished. This rapid change is likely to continue.

Data are where revolutionary scientific discoveries are made, forward-looking innovations are encouraged, and quality of life becomes better for billions of people around the world. HPC is the bedrock for scientific, social industrial, and development.

HPC refers to the collection method of computing power that processes and performs complex data calculations faster than traditional computers and servers at a very high speed. Ideally, a laptop or tablet with 5GHz processing power could do 5 billion calculations every second. Though that It is very high when compared to what a human brain can accomplish, it pales in comparison to HPC which makes prospecting and finding answers to some of the biggest problems in science, engineering, and business in the world possible.

The building blocks of HPC are compute, network and storage. One of the most popular applications of HPC is a supercomputer. It contains thousands of compute nodes that are combined and networked together to form a cluster. Algorithms and software programs are simultaneously applied to the computes in the aggregation. For results, the aggregated compute is connected to a data storage network. These modules work together to complete various tasks like processing data and performing calculations at higher speeds. These function together to complete one or more tasks in parallel. The advantage of parallel processing is that it makes it efficient, quick and reliable for running complex operations.
To achieve the highest efficiency, each module must be aligned with the other, otherwise, the use of the entire HPC infrastructure will be compromised.

Though HPC previously was considered the underdog by theoretical researchers and computer-software developers, it has become more crucial as a research tool in many surprising areas. Technology such as Big Data Analysis, artificial intelligence (AI), Internet of Things (IoT), and 3D imaging change, the size and quantity of data organizations had to work with add to this dynamic growth.

HPC is gaining momentum in fluid dynamics, aerospace, research labs, financial technology, genomics, weather, archeology, social media, and even the media-entertainment industry HPC is now being used in industry to refine products, lower manufacturing costs, and reduce the time it takes to develop and create new products.

Wide application of HPC will continue to evolve as more people begin to understand the possibility and prospect of HPC in their respective fields.

Recognizing this development, Dell Technologies created groundbreaking solutions for HPC that enable companies to fast track their research, innovation, analytics, engineering a AI initiatives with a diversified portfolio for HPC workloads.

With all the data being generated currently that requires faster processing power, HPC is positioned to become essential rather than a choice!

What is High Performance Computing?

Today, researchers and many industries are performing jobs and projects using high end applications. HPC processes data and performs complex calculations at a very high speed; much faster than traditional computers and servers. It leverages distributed compute resources to solve difficulties with large datasets spanning Terabyte to petabyte to zettabyte of data and obtain results in minutes to hours instead of days or weeks in some cases.

One of the most popular applications of HPC is a supercomputer. It contains thousands of compute nodes that are combined and networked together to form a cluster. This is called parallel processing. It's like having thousands of PCs networked together, combining compute power to complete tasks faster. It consists of multiuser system capability, optimized software and specialized hardware, many processors, low latency/high bandwidth network connections, large memories, efficient I/O flow and in some cases, custom made components as well.

How does High Performance Computing work?

There is no single way that HPC works. Conventionally, there is a widely accepted system used by businesses to enable maximum performance without the cost of using a supercomputer. This involves using small computer groups in clusters and then acting as nodes. Each unit in the cluster has an operating system and multiple processors dedicated to specific computational tasks, storage, and networking capabilities for the units to communicate to each other. In this case, these connected clusters make up the HPC system. In addition to parallel processing, HPC systems could have many effective graphics processing units (GPUs) for graphics exhaustive tasks. These powerful systems aid businesses in resolving problems that would otherwise be impossible.

High level architecture of HPC

To build a HPC architecture – Compute, Storage & Network – all the compute servers are networked together into a cluster, called the HPC cluster.

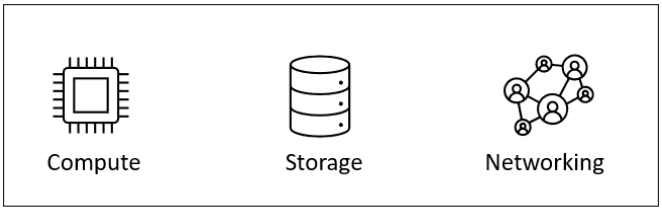


Figure 1: Basic building block of HPC solutions

Simultaneously, multiple algorithms and software packages are run on the servers in parallel. There is a cluster manager or scheduler that runs jobs on distributed resources such as FPGAs, CPUs, GPUs, and disk drives all connected through a network. While managed by policy-based scheduling or a job scheduler, the combined compute power and commodity resources can handle a dynamic workload. This cluster is interconnected by a network and connected to storage to capture the output. All results are visualized using Artificial Intelligence (AI) or other analytics. Then all the performance can be monitored and changes to the cluster can be made as required.

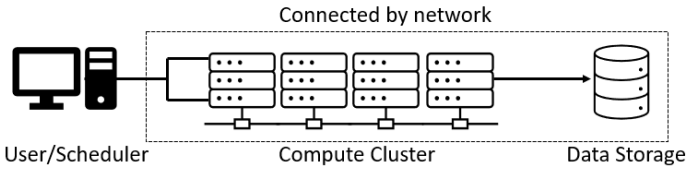


Figure 2: A HPC cluster connected to a scheduler

All the data must be fed and ingested to and from the compute by the storage component as soon as the data is processed. Similarly, the networking module must be able to provide high speed transport of data between the compute and storage module. To attain maximum efficiency, each component must be aligned with the other and seamlessly operate, otherwise the functionality of the entire HPC infrastructure will be compromised.

Benefits of HPC

HPC provides lots of benefits for different industries. It is forecasted that by 2025, the on-premises HPC market will grow to $38 billion and the cloud-based HPC will be worth almost $9 billion, uplifting the collective on-premises and cloud-based worth to about $47 billion.

1) **High Speed:** With modern CPUs, graphics processing units (GPUs), and low-latency networking components connected to all-flash storage modules, HPC can perform enormous calculations in minutes instead of weeks or even months.
2) **Cost:** HPC systems' fast processing capability enables businesses to deliver quicker outcomes and save money. Although there would be a preliminary investment in the system, the benefit in processing can quickly make up for the setup expenditures. HPC systems can identify the frail spots of a business' computing structure and aid them to run their apps more efficiently. Faster responses mean less time and money. Moreover, with cloud-based HPC, even small organizations and startups can manage to pay for HPC workloads by paying only for what they use and scaling up and down as necessary.
3) **Decreased physical testing:** HPC can be used to generate simulations, eliminating the need for physical testing. For instance, it is much easier and less expensive to test automotive accidents by generating a simulation rather than to perform a crash test.
4) **Innovation:** HPC drives innovation across nearly every industry. It's the force behind groundbreaking scientific discoveries that improve the quality of life for people around the world.
5) **High Availability:** HPC compute servers can be installed either on cloud or on-premises. Depending upon the business necessities and skill, it delivers on-demand access to data for improved workflow.
6) **Streamlining organizational procedures:** HPC systems can adapt to many organizational processes, enabling users to get a lot done in less time. The capability to examine data quicker

lets the financial team detect gaps and deliver outcomes. HPC can also be used to identify opportunities to fix the issues, improving the speed of processes.

HPC Challenges

Organizations with on-premises HPC infrastructure are subject to an exorbitant amount of regulated operations and face several challenges, including:

1) Investing substantial principal for computing components, which must be constantly upgraded
2) Users might suffer with queue time or latency, of days to months prior to running their HPC workload, particularly when demand increases
3) Delaying upgrades to extra powerful and competent computing components due to elongated purchasing series, which decelerates the pace of study, innovation, and growth of businesses
4) Paying for constant administrative and other operational expenses

Comparing HPC in the cloud with traditional HPC

Most industries and organizations run some or all their IT operations in the public cloud. Recent studies show that over 90% of organizations are moving to the public cloud as an essential part of their IT set-up and how they provide technology and services to their customers.

However, for businesses that require running HPC applications, the choice between continuing to run workloads on premises or moving them to the cloud can present numerous questions and challenges that must be considered before making the leap from running HPC on prem to running in the public cloud.

HPC in the cloud uses the commercial cloud prototype as a foundation for the hardware used for HPC code. Virtualization model used in cloud computing presents extra overhead versus the traditional on prem model.

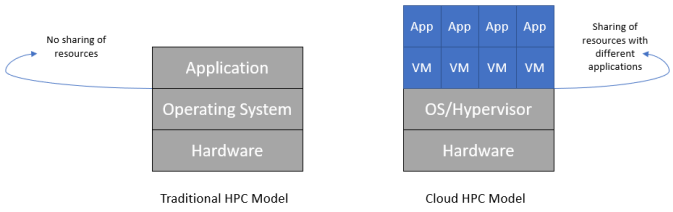


Figure 3: Traditional HPC and Cloud based HPC model

Adoption of cloud for HPC is leading to the transition of workloads from an on-premises method to one that is dissociated from explicit set-up or location.

Moreover, the nominal service level guarantees offered by the cloud prototype may be inadequate for an HPC application's requirements. Another performance concern for HPC in the cloud is the existence of additional jobs running in the cloud that may affect resource-hungry HPC applications.

Cloud might be a brilliant solution for customers who need only sporadic or bordering amounts of HPC ability. An instance of this is small to medium-sized businesses that can use HPC for simulations. Cloud also offers the advantage of access to up-to-date hardware and paying only for resources when they are being used.

These advantages and disadvantages of HPC in the cloud against traditional HPC demonstrates that while HPC in the cloud will widen access to HPC capabilities though some past consumers of supercomputers, i.e. large companies, government, and the armed forces are doubtful to shift to a cloud computing platform due to performance necessities and security of the applications and information.

High Performance Computing Use Cases

Either deployed on premises, or in the cloud, HPC solutions are utilized for various purposes across many industries. Below are a few examples:

1) **Research Labs:** HPC helps in developing faster solutions for complex scientific analysis. Scientists discover sources of renewable energy, comprehend the expansion of our universe, create new materials and prediction and track storms with the help of HPC.
2) **Media and entertainment:** Streaming live events, rendering special effects and editing features are made possible by the use of HPC.
3) **Oil & gas:** HPC is used to precisely pinpoint elusive oil and gas reserves. Identification of where to drill for new wells and accelerating production from current wells is done with the help of HPC.
4) **Financial vertical:** Monitoring real time stocks and automating trading is easier with HPC. It assists customers with processing trades and transactions faster and determining risk and opportunities
5) **Artificial Intelligence & Machine Learning:** HPC helps with fraud detection of credit cards, improvisation in screening methodologies for cancer, offering self-assisted tech support and teach self-driving vehicles
6) **Design new products and Simulate scenarios:** HPC is also used to reduce production costs, the time taken to develop new product and improve existing products. New products can be designed, test scenarios can be simulated, and verifying if enough stock is present, so that production lines aren't held up.
7) **Healthcare:** HPC can accelerate drug design, forensics, bioinformatics, and genomics. Diseases such as cancer and diabetics are diagnosed faster and more accurate due to HPC.
8) **Big Data:** As our ability to collect information increases, HPC systems can be highly beneficial to analyze the massive amount of data.

Dell Technologies HPC-ready solutions

The mainstreaming of HPC is driving market for in small- to large-scale HPC solutions and Dell Technologies is poised to help.

Dell Technologies recognizes that designing an optimized solution begins with the use case and target workload. Thus, time is taken to understand the customer's business goals and environment. Then a solution level method is taken for the customer's HPC initiative that results in an optimum solution of clients, compute, networking, data storage, and software, coupled with the services and support that is required to flourish.

Dell EMC Ready Solutions for HPC are tested scalable systems that are tuned for explicit verticals such as digital manufacturing, research, and life sciences.

Dell EMC Ready Solutions for HPC data storage makes it easier to reveal the worth of the data with scalable systems for Lustre, NFS, PixStor, and BeeGFS storage.

Figure 4: Dell EMC Ready solutions for HPC

Dell Technologies offers a wide-ranging service portfolio for HPC starting from design and implementation to support and system management for on-premises and on demand cloud. Dell Technologies collaborates with customers along every step of the way, connecting people, developments, and expertise to fast-track innovation and create ideal business outcomes for companies to succeed in their HPC journey.

Conclusion

As High Performing Computing systems develop with time, so is its demand in the industry. Businesses and organizations across various verticals are moving to HPC, driving evolution that is anticipated to endure for several years to come.

Soon, we will likely see big data and HPC converging, with the same huge cluster of computers that is used to analyze big data and run simulations and various HPC workloads. As those two trends congregate, the outcome will be additional computing power and capacity for each, leading to even more revolutionary research and invention

With graphic-intensive applications requiring faster processing, HPC is ready to become a requirement rather than an option.

References

https://analyticsindiamag.com/why-high-performance-computing-could-become-the-next-frontier-for-enterprise-ai/
https://www.quora.com/What-are-current-research-topics-in-HPC-with-respect-to-parallel-computing-and-GPU-computing
https://www.quora.com/High-Performance-Computing-What-are-the-areas-in-HPC-that-are-currently-being-researched-the-most
https://www.quora.com/Who-are-the-major-players-in-Cloud-High-Performance-computing-HPC
https://inside.dell.com/docs/DOC-423100
https://warwick.ac.uk/fac/cross_fac/hpc-sc/importance/
https://www.acecloudhosting.com/blog/high-performance-computing/
https://www.oracle.com/in/cloud/hpc/what-is-high-performance-computing/
https://www.geeksforgeeks.org/high-performance-computing/
https://www.sciencedirect.com/topics/computer-science/high-performance-computing
https://www.delltechnologies.com/asset/en-us/products/ready-solutions/industry-market/dell-ready-for-hpc-forrester-total-economic-impact.pdf
https://www.networkworld.com/article/
high-performance-computing-white-paper.pdf
https://inside.dell.com/docs/DOC-363221
https://techlibrary.hpe.com/us/en/enterprise/servers/high-performance-computing/hpc-services-and-support/index.aspx
https://buy.hpe.com/in/en/use-cases/high-performance-computing/c/h001023
https://insidehpc.com/2022/01/hyperion-research-exceptional-global-hpc-growth-in-2021/