Cloud Adoption Strategy for High Performance Computing

Cloud infrastructure enables organizations to better leverage high performance computing for improved business outcomes.

HPC Opportunity

High performance computing (HPC) has been critical to helping government agencies and commercial businesses solve their most challenging and complex problems.

Organizations with HPC infrastructures have been investing in new technologies and tools to stay competitive while addressing one of the key drivers for use of cloud computing: access to surge capacity.[1]

As demand for HPC grows, new technologies such as advanced analytics, artificial intelligence (AI), large language model (LLM), and machine learning (ML) are needed to expand the capability of computing environments.

However, on-premises HPC systems—even those with the most current technologies—are having difficulty supporting current organizational needs and effectively allocating scarce HPC resources efficiently. The skills required to manage and maintain these systems have increased significantly due to the thousands of computing elements, large storage capacities, and high-speed, low latency networks required to support varied and complex computations. In addition, keeping the HPC ecosystem up to date is costly, as computing capacity needs to scale with variable workloads, cybersecurity requirements continue to expand, and procurement and implementation cycles can be lengthy.

As a result, organizations that need HPC capabilities and providers of HPC technologies are exploring new avenues to overcome these challenges using cloud computing. Spending in public clouds for HPC (Exhibit 1) grew an average of 25% from 2013 to 2020. In 2024, the market for cloud HPC is valued at USD $48.15 billion. It is projected to grow at a combined annual growth rate of 7% to USD $82.73 billion by 2031.[2]

As HPC demand rises, cloud service providers (CSPs) are investing in infrastructures, platforms, and the applications required to support a broader set of complex HPC workloads and customers.

[1] Drivers and Barriers to Using High Performance Computing in the Cloud, Cloud Lightning.

[2] Global Cloud High-Performance Computing Market Size By Component (Solutions, Services), By Deployment (Cloud, On-premises), By Geographic Scope And Forecast: Verified Market Research.

Organizations are adopting cloud technologies because they are seeking a competitive technology advantage.

Figure 1.0 | Global Spending in Public Clouds for HPC Applications Expected to Reach $82.73 Billion by 2031
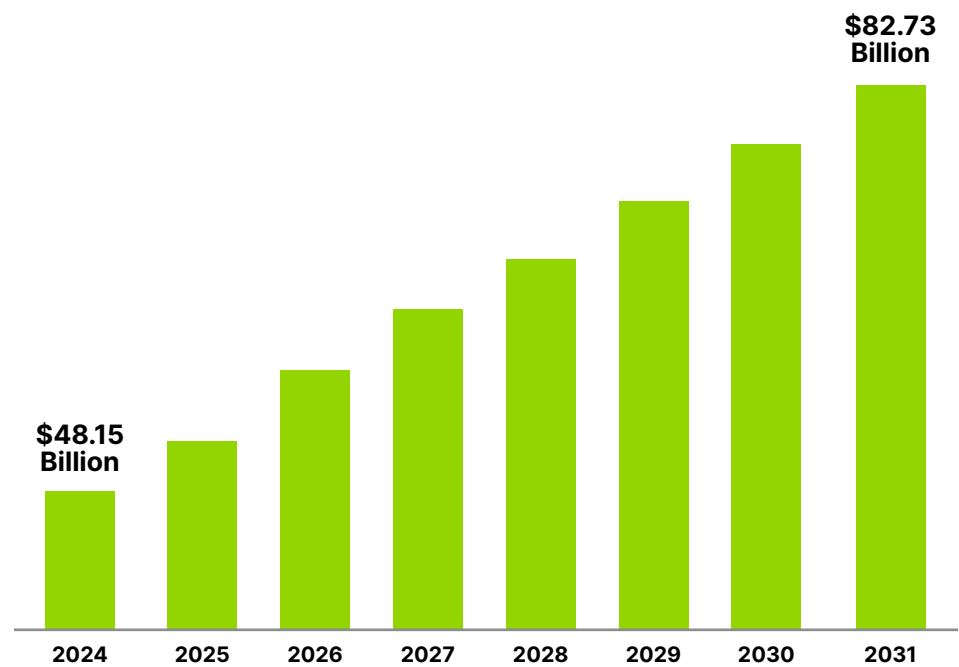
Catalysts Driving HPC in the Cloud

Organizations are adopting cloud technologies because they are seeking a competitive technology advantage. They realize that their HPC capabilities will benefit from cloud infrastructure, which will enable them to serve users more effectively, better execute strategic priorities, scale operational capacity, and innovate faster. Guidehousehas identified multiple organizational drivers for the emergence of HPC commercial cloud solutions:

- Accelerating time-to-market and time-to-decision-making
- Enabling rapid elasticity and dynamic scalability of HPC resources to allow fast, cost-effective right-sizing as needs change
- Providing access to new technology such as AI, ML, and advanced analytics
- Managing compliance with industry and government regulations
- Enhancing an organization's resilience and mitigate data security and other cyber risks
- Increasing access to HPC resources and build scalable capacity for solutions like AI and ML that demand increased compute power
- Testing viability of use cases, workloads, computational models, or other applications
- Supporting critical new initiatives such as digital engineering and transformation
- Creating an integrated, seamless, and more advanced collaboration environment

Embarking on a journey to adopt cloud technology for HPC requires a plan that fits the needs of the organization.

Guidehouse teams are experienced in helping our clients adopt and build HPC cloud capacity in the following areas, where it is having an outsized impact.

Healthcare applications such as:
- Accelerating research in drug discovery and disease treatment
- Using data to drive patient-centric care, effective decision making, and efficient resource allocation
- Analyzing biomedical imaging data or conducting genomic analysis to expedite the diagnosis of conditions and identify potential therapies sooner

Complex scientific models with energy, climate, and other scientific applications:
- Simulating or forecasting energy reservoirs and reserves
- Weather/climate modeling and visualizations
- Computational seismic modeling
- Emergency management planning

Public sector cybersecurity applications:
- Threat detection/response and Secure Access Server Edge adoption

As organizations migrate applications and run workloads in HPC cloud environments, they often find that the transition can be complex and expensive. Cloud initiatives must be assessed and planned with a focus on aligning HPC capabilities with technical requirements and meeting expectations for return on investment (ROI). In addition, cloud migration or integration typically requires redesigning existing business models and processes.

A Journey in Adopting HPC Cloud

Embarking on a journey to adopt cloud technology for HPC requires a plan that fits the needs of the organization. More specifically, the cloud must be incorporated in an organization's HPC strategy so that it is supported within its operating model, aligns with existing and future infrastructure, and the workforce can be trained in the skills needed to ensure optimum results. Working with clients, Guidehouse has leveraged these five components—strategy, operating model, infrastructure, workforce, and cost—to define a new go-to-market model for the client and formulate a cogent HPC cloud adoption plan that significantly improved benefits for the user community.

High Performance Computing Strategy

A high-performance computing strategy determines the future HPC capability needs to meet performance standards and business expectations. The process creating the strategy helps to answer whether HPC cloud is the right solution for the organization and defines the target state for HPC capabilities. Business and IT stakeholders collaboratively establish the strategic foundational services and capabilities that customers require and that will enable innovation and support growth.

Furthermore, the HPC strategy ensures that the vision of HPC cloud aligns to the organization's business goals and objectives, and that the expected value created by HPC is clearly articulated and understood by all stakeholders.

A properly aligned operating model will increase the benefits realized from HPC investments.

Operating Model

To effectively support efficient adoption of HPC cloud, organizations need to align and potentially redesign key aspects of their operating model to meet HPC cloud requirements.

A properly aligned operating model will increase the benefits realized from HPC investments, enable efficient resource allocation, expand capacity, and aid in defining effective process and management support.

For organizations that decide to migrate all or a portion of their on-premises HPC resources to the cloud, it is important to anticipate capacity changes and effectively balance computing supply and demand. In addition, building standardized workflows and common access platforms to allow users to run workloads between HPC cloud and on-premises infrastructure can optimize resource utilization. Implementing "capacity on demand" capabilities and workflow management for scale-up and scale-out helps meet business needs and improves service levels, as well. If the organization previously allocated HPC resources on a per-user basis, adjusting the allocation approach is recommended to maximize efficiency and usage of the hybrid ecosystem.

In addition, it is important to provide cloud technical support to ease the transition and uptake of users to speed adoption of the new capabilities, while making sure that streamlined processes for resource management and results analysis are implemented to fully realize the value of this investment.

At the same time, it is equally important to establish robust data management and governance processes to maintain the security and integrity of data.

Since processes are the enablers of the HPC strategy, organizations must recognize that redesigning business processes is often required to allow HPC cloud services to meet internal and external customer demand. HPC cloud services require core business processes to assess the performance, consumption, and growth of cloud services by user groups and organizations in order to leverage the analytical tools offered by CSPs. Additional analytics can be performed on HPC-cloud-based computations, so managers have a clear perspective on how users are employing the capabilities and for what purposes. In addition, managers should establish a cadence for reporting key performance indicators for cloud usage to provide transparency and support proactive cost modeling and ROI calculations.

Lastly, some organizations may need to collaborate with industry and research institutions as a critical component of adopting leading practices in managing HPC.

Infrastructure

As the infrastructure serves as the physical and virtual foundation to support the target-state HPC environment, it is critical to deploy a robust set of capabilities to effectively manage infrastructure, applications, and workloads. This has the added benefit of creating capability and capacity to add software, algorithms, and models as the need for them arises.

Implemented and managed correctly, cloud technology will yield competitive advantages and financial benefits over the long term.

For example, IT automation capabilities can automatically scale to meet capacity needs, manage applications and workloads in a hybrid environment, and optimize consumption attributed to the HPC cloud through rule-based management and predictive analytics. A well-designed supporting infrastructure creates a platform for resources to access innovative technologies, such as AI, ML, and advanced analytics, and apply them to new programs that position the organization for success in the market.

Workforce

Workforce alignment with the operating model and processes is essential for a business to deliver maximum value to customers and users. As the operating model to support HPC cloud services evolves and processes are redesigned, the organization will need to be augmented with key resources and up-skilled. Successful cloud adoption requires executive support and starts with the formulation of a core cloud team to help the organization and its users navigate HPC cloud service complexities. In addition, most organizations will need to hire or appoint a senior cloud leader to oversee cloud computing, along with cloud architects and subject matter experts, to provide guidance to users and enable a smooth transition from the current computing environment. It is important that the senior cloud leader has considerable latitude within the organization (and sometimes externally) to drive cloud adoption and to champion any necessary business process or operational changes. In addition, the cloud leader should be part of a combined IT and operational governance structure that allows the cloud team to be embedded in the decision-making process and enable the organization to integrate new cloud capabilities to expand usage. Also, providing targeted training in cloud technologies is important to up-skill the workforce and build core capabilities to realize the value of the cloud investment.

Cost

There is much debate about cost factors when it comes to cloud usage. Organizations should not be deterred in making cloud decisions because of these discussions. However, they should understand the costs, as well as the associated benefits. While experts agree costs can be significant, they also agree that costs will diminish over time by improving an organization's ability to right-size computational resources when needed. Having completed several studies on cloud cost factors, we recommend that organizations think strategically about augmenting with cloud technologies or migrating internal HPC computational capabilities to cloud environments. Cost analysis requires a multi-year perspective with defined scenario forecasts, as cloud adoption takes time and will evolve along with the organization's needs. Implemented and managed correctly, cloud technology will yield competitive advantages and financial benefits over the long term. If organizations only assess cloud technology in terms of one-time costs, they may be less able to invest and compete over the longer term.

The ability to dynamically scale up and down—to right-size computing power as an organization's need for it increases or decreases—is one of the key strategic cost benefits an organization can realize over the medium to long term.

Additionally, we can help organizations understand how using the cloud can give them access to HPC resources that would otherwise be cost-prohibitive if they were implemented as on-premises solutions.

The core steps of detailing required investments, outlining an integration plan and schedule, and defining operational benefits will enable ROI and payback-period calculations to support decision making and tracking of value realized over time.

Success Factors When Adopting HPC Cloud

As organizations progress in their HPC cloud journey and mature their technical capabilities, they can expect to realize multiple measurable benefits. Depending on the strategy and business needs, the benefits could include reduction in capital or operating expenditures, increased scalability of infrastructure and computing resources, improved ease of use, and accelerated ability to develop prototypes and bring solutions to market. In addition, a well-integrated hybrid cloud environment with portability of workloads can increase process efficiency and operational productivity.

Several success factors for HPC cloud adoption influence an organization's ability to achieve these benefits. It is critical that business continuity be uninterrupted as organizations adopt cloud services.

As applications and workloads are migrated to the cloud, ongoing operations must continue seamlessly to support users. It is also important to have leadership buy-in and stakeholder engagement to maximize cloud awareness and obtain commitments for adoption not only from leadership, but also from impacted teams across the business and supporting functions. A detailed analysis of the costs and benefits will enable better decision making and timing of investments as available technologies continue to evolve. Furthermore, organizations need to take a disciplined approach to cloud technology selection and implementation to achieve these potential benefits.

Guidehouse has the experience and expertise in high performance computing, cloud strategy and architecture, technology acquisition strategies, and systems integration to help organizations overcome challenges, formulate detailed cloud-adoption plans, and work closely with vendors to successfully implement HPC in the cloud. We work with clients at every level, and at each step in the process, to identify solutions that are aligned with organizational goals, leverage current technologies, enable the organization to operate at a high level of performance, maximize value, and successfully navigate the transition.

How Guidehouse Can Help

Guidehouse has been working with the High Performance Computing Modernization Program (HPCMP) since 2016. This is the Office of the Secretary of Defense-directed entity that manages, among other things, the Department of Defense's supercomputing assets.

Through this program, we have helped the DOD remove workloads from on-premises resources using commercial cloud technology. This work has allowed critical workloads to be given priority within the DOD's supercomputing resource centers, all while working strictly within both the unclassified and secret levels the department requires.

Source:
A Practical Solution to the Department of Defense's Digital Engineering Challenge

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About Guidehouse

Guidehouse is a global consultancy providing advisory, digital, and managed services to commercial and public sector organizations. Purpose-built and driven by proven success, the award-winning firm serves the defense and security, energy, sustainability, and infrastructure, financial services, and healthcare industries. With agility, capabilities, and scale rarely seen across legacy consulting models, Guidehouse delivers customized, technology-forward, future-focused solutions that position clients for innovation, resilience, and growth. Its more than 17,000 employees help leaders solve complex, interrelated industry challenges, navigate regulatory pressures, mitigate risks, and achieve transformational change.

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