White Paper

Manufacturing
Intel Select Solutions for HPC on Google Cloud platform

Manufacturing and CAE with Intel Select Solutions for HPC on Google Cloud

Table of Contents

Introduction

High performance computing (HPC) solutions require an abundance of compute resources, including high CPU threads and core counts, for solving algorithms and running simulations in manufacturing and computer-aided engineering (CAE) workflows. Because walled-off, on-premises workstations can present timing and scalability challenges, many organizations running CAE workflows are considering cloud HPC solutions. Intel® Select Solutions for HPC on Google Cloud platform offer the optimal performance to boost CAE workflow speed and efficiency. In addition, manufacturing firms and others using CAE will appreciate the scalable, elastic, and on-demand nature of an Intel and Google Cloud HPC solution that allows for fast deployment, a high degree of application interoperability, and resource democratization so users can collaborate easily.

With Intel Select Solutions for HPC on Google Cloud, engineers and others can save significant time by quickly spinning up or down resources and VM instances to meet the needs of HPC jobs. Compared to a static, on-premises environment, a Google Cloud HPC environment could shrink HPC job runtime from three months to just 16 hours.[1] Running multi-scale and multi-physics simulations on demand with an Intel and Google Cloud HPC solution can help to reduce a product's time to market, improve overall product lifecycle management, reduce operating costs, and give manufacturing companies a significant competitive edge.

Compared to the on-demand nature of the cloud, scaling resources of an on-premises HPC solution can be difficult and time consuming. The biggest challenges are the capital expenditure (CapEx) of the purchase, which likely requires its own approval process, and the hardware procurement process. Approval for new hardware can take months or longer, and in manufacturing, timing is pivotal. Intel Select Solutions for HPC on Google Cloud offer pre-tuned VM images that you can easily and quickly spin up as needed, with VMs ready for CAE production workflows within a day. Working without the ability to quickly scale an on-premises HPC solution might delay problem solving and other CAE workflow phases, which in turn can strain a product's time to market and dull an organization's competitive edge.

But bringing products to market quickly isn't enough—they must also be high quality to meet safety requirements and ensure brand continuity. Manufacturers must balance high-speed development cycles with near-real-time quality control. This is another area where the speed and flexibility of Intel Select Solutions for HPC on Google Cloud can help. More CPU resources from 2nd Generation Intel® Xeon® Scalable processors allow engineers to run simulations faster. By running more simulations and solving problems more quickly, engineers have more opportunities to improve product quality by adjusting designs at earlier stages of development, even on a short timeline.

Running CAE workflows on Intel and Google Cloud HPC VM instances offers these benefits and more for organizations of all sizes, providing access to the latest

technology while diminishing the burdens of acquiring, managing, licensing, and monitoring hardware and reducing related staffing costs.

Industry overview and use cases

Two key areas of HPC where an Intel and Google Cloud solution can benefit your organization are solving problems through simulation and subsequent design optimization during product modeling. Intel Select Solutions on Google Cloud HPC platform can boost performance for your crash simulations, computational fluid dynamics, and structural mechanics workflows.

Crash simulation

Engineers learn a lot about their products from crashes, both real and simulated. Intel Select Solutions on Google Cloud HPC platform allow engineers to use numerous 2nd Generation Intel Xeon Scalable processor cores to run more crash simulations and make them more complex, applying millions of elements in each crash simulation. The use of fast computing power from Intel Xeon Scalable processors helps improve time to market while also helping engineers conduct a deeper product analysis. For example, it would be time-consuming and costly for engineers to cover a car with sensors. But running that simulation virtually on an Intel Select Solution for HPC on Google Cloud, with millions of elements, offers indefinite data points on demand, in less time, and at a fraction of the physical crash's cost. Then, by scaling up compute resources from 2nd Gen Intel Xeon Scalable processors, engineers can adjust designs and virtually test new versions of automobiles mere hours later. Running numerous simulations reduces the number of physical crashes necessary, too, which allows manufacturers to save money on building physical prototypes.

Computational fluid dynamics

Aerodynamics and hydrodynamics engineers use compute-intensive computational fluid dynamics (CFD) applications, such as ANSYS Fluent, Siemens STAR-CCM+, or Altair AcuSolve, to solve problems based on fluid-fluid, fluid-solid, and fluid-gas interactions. After they've transformed physical laws into partial differential equations, meshed the environment, and set the relevant boundary conditions, an Intel Select Solution running CFD applications on Google Cloud can solve the physical problem at hand quickly, whether it's how rain drops interact on the wings of a passenger airplane or determining the peak mass flow rate of petroleum through specific portions of a pipeline.

Structural mechanics

Running a non-linear structural finite element analysis (FEA) with an Intel Select Solution for HPC on Google Cloud can reduce an engineer's solve time, including times for non-linear contact problems. Structural engineers can use an Intel Select Solution for HPC on Google Cloud to measure the effects of torsion, vibrational energy, or buckling stress on a bridge design using particular building materials. Overall, an Intel and Google Cloud HPC solution can deliver FEA productivity increases, more efficient product development, and next-level innovation, as well as reduce licensing and CapEx.

Overview of a manufacturing CAE HPC environment

On-premises environments

Organizations typically use one of two approaches for on-premises HPC solutions. One approach is to build the solution using OEM hardware and software. The organization then must integrate, update, and manage the solution and CAE software on their own, requiring IT operating expenses (OpEx) and staff time and effort.

The other option is to buy a turnkey appliance, delivering an on-premises, managed software-as-a-service (SaaS) solution. Organizations choosing this second approach will likely have a single point of contact and less to figure out than organizations building their own HPC solution.

Cloud environments

Organizations choosing a cloud environment, such as an Intel Select Solution for HPC on Google Cloud, face a similar choice as organizations using on-premises solutions, but may deal with less complexity. One approach is to build an HPC environment using a toolkit from a cloud service provider and then manage the solution while retaining and managing the CAE software.

Intel Select Solutions for HPC on Google Cloud share qualities and advantages with on-premises turnkey solutions. Organizations choosing Intel and Google Cloud HPC platform get a completely functional HPC solution typically in less than a day, allowing engineers and IT staff to focus on applications, development, and other critical tasks. In addition, a turnkey cloud solution reduces the need to manage and monitor on-premises hardware, which could potentially save funds from an IT budget.

Hybrid environments

By blending on-premises and cloud HPC environments, organizations get a hybrid HPC solution that offers the benefits of both. Organizations often choose hybrid solutions because they have heterogeneous workload requirements, want to utilize on-premises hardware, or want to keep pace with technology life cycles.

Value of HPC in the cloud for CAE use cases

Considering the CAE workflows you run and the advantages of the cloud, how exactly can your manufacturing company benefit from choosing Intel Select Solutions for HPC on Google Cloud?

First, when you choose Google Cloud C2 VM instances, you can leverage the compact placement policy. It gives organizations the ability to keep VM instances close together within the logical infrastructure, which helps reduce the network distance for data to travel, lowering latency between nodes. This means the time to complete simulations, for example, gets reduced. In addition, you can choose the spread placement policy for C2 VM instances, which allows VM instances to be placed on distinct hardware for higher reliability. The aim of the spread placement policy is to reduce the impact of possible hardware failures. This policy is also available for N1 and N2 VM instances, but the compact placement policy is available only for C2 VM instances.

Another advantage of HPC with an Intel and Google Cloud solution is a shortened time to value. You can choose to spin up a pre-tuned VM instance image, which means you quickly create HPC-ready VM instances out of the box, configure VM instances to unblock tightly coupled HPC workloads, and get consistent performance and improved usability.

Choosing an Intel Select Solution on the Google Cloud HPC platform takes a lot of the guesswork out of configuring an HPC environment. Intel Select Solutions must meet several compute and networking performance metrics, so you won't need to fine tune settings to get the consistent performance you need. Intel Select Solutions also are designed to be OS compatible and function across many software application environments, working with an extensive partner ecosystem to enable numerous HPC applications on VM instances.

Selecting a Google Cloud HPC environment enabled by Intel

Whether you're considering augmenting your on-premises HPC infrastructure with additional capacity or placing your workloads entirely in the cloud, Intel Select Solutions for HPC on Google Cloud provide the latest technologies and can accelerate your time to insight with easily scalable resources. Google Cloud Compute Engine VM instances are quick to boot, have persistent disk storage and guaranteed high availability, come in specialized configurations to get the most from your specific workloads, and include 2nd Gen Intel Xeon Scalable processors for increased computing power. While N1, N2, and E2 VM instance families are available for general-purpose computing, Google Cloud offers specialized HPC VM instance configurations in the C2 VM instance family. Intel Select Solutions for HPC on Google Cloud deliver easy message passing interface (MPI) scalability and flexibility on best-of-class hardware, with software developed with a vast ecosystem of technology partners.

Google Cloud VM instance images are CentOS 7 based and spin up with custom tunings to optimize HPC workloads, including disabled hyper-threading, increased TCP memory settings, and Intel MPI collective tunings that give you faster time to insight. For the most latency-sensitive workloads, Google Cloud offers isolation in placement as well as colocation for nodes in the same cluster.

Workload management and scheduling

Google Cloud makes it simple to manage your entire HPC cluster through a single pane of glass. With Cloud Scheduler, admins can set batch jobs to orchestrate work consistently, without the need for constant hands-on orchestration. Cloud Scheduler integrates many leading HPC management tools including Slurm Workload Manager, Nimbix, Rescale, Altair, and more.

For overall HPC cluster monitoring, Google Cloud uses Operations Suite, which allows admins to monitor, troubleshoot, and improve application performance in the cloud by giving visibility into the performance, uptime, and overall health of applications.

Compute

For HPC workloads, the compute-optimized C2 VM instance family offers 60 vCPUs featuring 2nd Gen Intel Xeon Scalable processors (up to 3.8 GHz Turbo). Compute Engine C2 VM instances offer up to 40 percent higher performance per core compared to general-purpose VM instances, with acceleration for HPC and AI applications built directly into each Intel Xeon Scalable processor with Intel® Advanced Vector Extensions 512 (Intel® AVX-512). Intel AVX-512 handles the most demanding compute tasks to accelerate 3D modeling/analysis, scientific simulations, deep learning, and more. Intel Deep Learning Boost (Intel DL Boost) further speeds performance for many deep learning workloads using INT8 instructions.

Google Cloud C2 VM instances are Non-Uniform Memory Architecture (NUMA) aware, which means they balance cores and threads to ensure high performance for virtualized HPC workloads. vNUMA optimizes memory access to prevent memory bandwidth bottlenecks.

Storage

Google Cloud offers various storage services to offload the burden of deploying and managing storage and provide the fast access that HPC workloads require to complete on time. Compute Engine's C2 VM instances enabled by Intel Xeon Scalable processors offer up to 9TB local NVMe SSD storage for scratch and fast access, physically attached to the server node via PCIe.

Google Cloud Storage is simple to use, with consistent latency and speed to ensure predictable performance for your demanding workloads. It offers exabyte-scale, feature-rich object storage that scales throughput automatically as well as persistent disks (either HDD or SSD) with high-performance, replicated block storage. With four nines (99.99%) of availability in geo-redundant locations, Google Cloud guarantees uptime so big HPC jobs don't fall behind due to unexpected outages.

Networking

Google Cloud VM instances run on a high-performance private network that ensures high throughput and low latency across clusters and data centers. With Google Cloud Interconnect, you can connect your on-premises network to the Google Cloud network to optimize networking performance in hybrid cloud use cases. A key feature of Intel Select Solutions for HPC on Google Cloud is the aforementioned compact placement policy. The policy allows you to keep your HPC VMs on the same rack to further reduce network latency.

Google Cloud supports RDMA protocols, which go a step further to reduce network latency and ensure accelerated time to insight.

Building your cloud or hybrid environment

Design considerations

Whether you're using Intel Select Solutions for HPC on Google Cloud for a cloud or hybrid environment, the cloud infrastructure offers many options for customization and scalability that can grow with your project. When designing your solution for CAE workflows, you should:

- Use dynamic architecture – part of the benefit of cloud is its on-demand flexibility and scalability
- Size your solution so you pay for only what you need – paying for unused resources can eat up your IT budget
- Prioritize your data – where it comes from, how much the solution will ingest, etc.
- Use code to automate VM instance creation and replication systems – this helps reduce cost and avoid the expenses of manual effort
- Promote collaboration – engineers may not understand the challenges facing IT architects and vice versa
- Use cloud-native designs – such as those available from Intel Select Solutions
- Check your workloads with real-world situations – better to see any areas for adjustment as soon as possible
- Use time and cost filters when thinking about performance – Intel Select Solutions for HPC on Google Cloud can help you save both

Best practices

Let this document give you the overview you need to get started setting up your Intel Select Solution for HPC on Google Cloud, but check out the additional resources linked in this document for more information. For example, by properly tuning the underlying systems and network infrastructure, you can achieve optimal MPI performance to smooth intra-system communication. You can find more information on that process here. In addition, as we alluded to in the Design Considerations subsection, it is considered best practice to benchmark HPC applications for efficiency and cost effectiveness. Other important best practices include using a pre-configured HPC VM instance image, such as those from Intel Select Solutions for HPC on Google Cloud; applying configurations using Bash or Ansible; using compact placement policy; and disabling hyper-threading, among others.

Customer deployment example

Global climate change has made it harder for communities around the world to fight famine and food insecurity. One company, Descartes Labs, works to predict crop health and yield by analyzing an archive of more than 1 petabyte of scientifically calibrated satellite imagery. As you might guess, such analysis requires tremendous computing power. By using Google Compute Engine of Google Cloud Platform and Intel Xeon Scalable processors, Descartes Labs can scale compute, networking, and storage to process the image archive in just over 15 hours. By enabling back-testing, the company claims it now can predict corn yields more quickly and accurately than government organizations.[2]

Additional resources

In addition to the information and examples provided in this paper, Intel and Google offer much more to help you configure your Intel Select Solution for HPC on Google Cloud for your CAE workflows.

For more information on Intel Select Solutions, visit Intel® Select Solutions for High Performance Computing (HPC).

For more information on the Google Cloud HPC platform, visit High Performance Computing (HPC) Solutions | Google Cloud.

1. Google Cloud Tech, "What is High Performance Computing?," accessed November 20, 2021, https://youtu.be/nIBu1EFYmBU.
2. Google Cloud, "Descartes Labs: Advancing global food security," accessed December 15, 2021, https://cloud.google.com/customers/descartes-labs.