



Intel® Select Solutions for Simulation and Modeling

Intel Select Solutions allow you to quickly deploy an optimized HPC cluster for simulation and modeling.



Manufacturing and research companies face enormous challenges as they struggle to innovate in an increasingly competitive environment. They're under constant pressure to design higher quality products, reduce production and development time, and bring down costs. At the same time, product and manufacturing complexity keeps increasing with the rise of sophisticated electronics, new composite materials, Internet of Things (IoT)-enabled devices, machine learning, and additive manufacturing. How can small and medium-sized businesses (SMBs) thrive in this environment?

Simulation and modeling are key to success for best-in-class organizations. According to industry analyst Aberdeen Group, "Any company that designs and delivers products must elevate the selection of a simulation platform into an enterprise decision."¹ Engineering software leader, ANSYS, says only one in six engineers use simulation today but by 2030, every engineer will do so.² And Vikram Vedantham, senior business manager at Autodesk, believes that "the use of simulation technologies will become increasingly engrained into the DNA of mainstream engineering."³

With the increased pressure to quickly incorporate simulation and modeling into their work, SMBs can benefit from an out-of-the-box solution. That's because many organizations do not have the skills or expertise to design and build the scalable, high-performance computing (HPC) clusters needed for simulation and modeling workloads. In addition, designing an HPC cluster involves more than choosing the right processor, core count, and memory; storage, remote-visualization, job scheduling, and workload-management software all need to be considered. Even enterprise businesses considering the benefits of HPC clusters must weigh the time and effort it takes to ramp up capabilities.

All of these challenges can become barriers to adopting HPC clusters for simulation and modeling, even though the eventual return on investment (ROI) can be significant.

Intel® Select Solutions for Simulation and Modeling are pre-validated and tested hardware/software stacks that provide a fast path for purchasing and deploying HPC clusters. They reduce the time and cost of acquiring an HPC cluster and provide optimized systems for simulation and modeling applications, making it easier for enterprises and SMBs to adopt simulation into their business models.

Intel Select Solutions for Simulation and Modeling

Intel Select Solutions for Simulation and Modeling are verified solutions that combine Intel® Xeon® Scalable processors and other Intel® technologies into a proven architecture based on the Intel® HPC platform specification. The solutions simplify the challenge of building an HPC cluster and are designed to provide optimized performance for simulation and modeling workloads.

In addition, Intel Select Solutions for Simulation and Modeling are validated to ensure:

- The solution includes key components and technologies to deliver performance and scalability
- The solution is compliant with industry standards and best practices for Intel-based clusters as defined in the Intel HPC platform specification
- The solution meets or exceeds defined performance levels in targeted characteristics important to HPC applications

Hardware and Software Selections

Intel Select Solutions for Simulation and Modeling comprise several key hardware and software components.

Compute

Intel Select Solutions for Simulation and Modeling use the Intel Xeon Gold 6126 processor, or a higher model number Intel Xeon Scalable processor, in the “Base” configuration, and they use the Intel Xeon Gold 6148 processor, or a higher model number Intel Xeon Scalable processor, in the “Plus” configuration. The Base configuration offers all the benefits of Intel Select Solutions, whereas the Plus configuration enables dialing up the power and impact of the system. Intel Xeon Gold 6148 processors offer 20 cores to deliver

What Are Intel® Select Solutions?

Intel Select Solutions are verified hardware and software stacks that are optimized for specific software workloads across compute, storage, and network. The solutions are developed from deep Intel experience with industry solution providers, in addition to extensive collaboration with the world’s leading data center and service providers.

To qualify as an Intel Select Solution, solution providers must:

1. Follow the software and hardware stack requirements outlined by Intel
2. Replicate or exceed Intel’s reference benchmark-performance threshold
3. Publish a detailed implementation guide to facilitate customer deployment

Solution providers can develop their own optimizations to add further value to their solutions.

exceptional performance for compute and data-intensive workloads. Optionally, Intel Xeon Platinum processors—with up to 28 cores—can be used to meet the most challenging compute needs.⁴

Intel Xeon Scalable processors feature significant enhancements that benefit HPC applications, including improvements in input/output (I/O), memory, fabric integration, and Intel® Advanced Vector Extensions 512 (Intel® AVX-512).⁵

Fabric

Intel® Omni-Path Architecture (Intel® OPA) provides 100 gigabits per second (Gbps) bandwidth and a low-latency, next-generation fabric for HPC clusters. The 48-port switch chip delivers a 33 percent increase in density over the traditional 36-port switch Application-Specific Integrated Circuit (ASIC) historically used for InfiniBand* networking, which reduces the number of required switches. Intel OPA can also reduce cabling-related costs, power consumption, space requirements, and ongoing system-maintenance requirements.

Intel® HPC Platform Specification

The Intel HPC platform specification defines common industry practices and requirements for building Intel-based clusters. This architectural foundation provides a consistent and stable platform enabling development and deployment of a wide variety of high-performance, compute- and data-intensive workloads. Included in the foundation are the Intel software performance libraries and runtime environments that allow applications to experience optimized value from the underlying Intel processors and technologies. The Intel HPC platform specification enables organizations to achieve high performance with flexibility, scalability, balance, and portability.

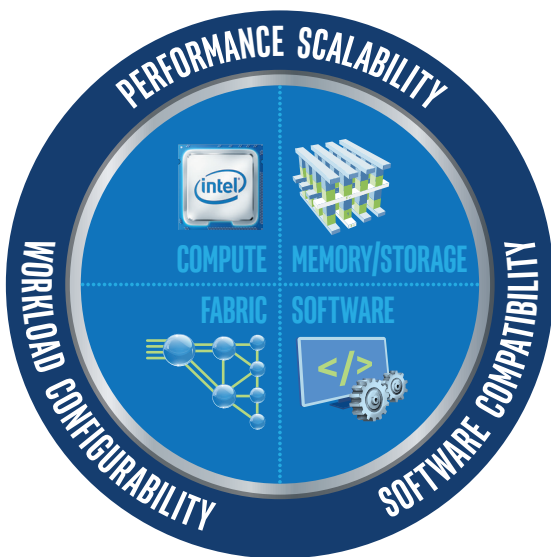


Figure 1. The Intel® HPC platform specification is the foundation for standardized integration of compute, memory/storage, fabric, and software

Verified Performance through Benchmark Testing

All Intel Select Solutions are verified to meet a specified minimum level of workload-optimized performance capabilities. Intel Select Solutions for Simulation and Modeling define performance watermarks that demonstrate optimized capabilities for HPC applications. These verified solutions meet or exceed design and testing standards across five well-known industry benchmarks that cover important system aspects and indicate potential scale-up and scale-out performance for simulation and modeling application workloads.

Three benchmarks measure the performance of key characteristics of the system: compute power, memory bandwidth, and interconnect fabric performance. DGEMM is a double-precision general matrix multiplication workload that measures the computing capabilities of the processor and memory. STREAM* measures the sustainable memory bandwidth and corresponding computation rate for simple vector kernels. IMB PingPong* measures the speed and latency of passing a single message from peer to peer across the interconnect fabric.

In addition, two popular benchmarks are used as representatives of applications. The High Performance LINPACK* (HPL*) benchmark solves a dense linear system in double-precision arithmetic calculations on distributed memory. The High Performance Conjugate Gradient* (HPCG*) benchmark models data-access patterns of real-world applications, such as sparse matrix calculations, testing memory subsystems, and internal interconnects. It also provides the ability to look at individual node performance and the collective performance of an entire system.

Base and Plus Configurations

Intel Select Solutions for Simulation and Modeling include two configurations. The Base configuration specifies the minimum required performance capability for Intel Select Solutions for Simulation and Modeling. The Plus configuration provides one example of how system builders, system integrators, and solution and service providers can further optimize to achieve higher performance and capabilities, as shown in Table 1. For example, the Plus configuration can provide 54 percent higher gigaFLOPS per second (GFLOP/s) as measured by the HPL benchmark.⁶ Use the HPL benchmark results when comparing the Base configuration to the Plus configuration.

Table 1. Compute-node configuration details for Base and Plus configurations of Intel® Select Solutions for Simulation and Modeling

INGREDIENT	INTEL® SELECT SOLUTIONS FOR SIMULATION AND MODELING CLUSTER BASE CONFIGURATION DETAILS	INTEL SELECT SOLUTIONS FOR SIMULATION AND MODELING CLUSTER PLUS CONFIGURATION DETAILS
WORKLOAD DOMAIN (MINIMUM 4-NODE CONFIGURATION)		
PLATFORM	Dual-socket server platform	Dual-socket server platform
PROCESSOR	2 × Intel® Xeon® Gold 6126 processors at 2.60 GHz, 12 cores/24 threads, or a higher model number Intel Xeon Scalable processor	2 × Intel Xeon Gold 6148 processors at 2.40 GHz, 20 cores/40 threads, or a higher model number Intel Xeon Scalable processor
MEMORY	96 GB (12 × 8 GB 2,666-MHz 288-pin DDR4 RDIMM) 2 GB memory per processor core and all memory channels populated	96 GB (12 × 8 GB 2,666-MHz 288-pin DDR4 RDIMM) 2 GB memory per processor core and all memory channels populated
LOCAL STORAGE	1 × Intel® Solid-State Drive (SSD) Data Center (DC) S3520 Series or better, or Intel SSD DC P3520 Series or better**	1 × Intel SSD DC S3520 Series or better, or Intel SSD DC P3520 Series or better**
MESSAGING FABRIC	1 × Intel® Omni-Path Architecture (Intel® OPA), single-port Peripheral Component Interconnect Express* (PCIe*) 3.0 x16 adapter, 100 gigabits per second (Gbps)	1 × Intel OPA, single-port PCIe 3.0 x16 adapter, 100 Gbps
MANAGEMENT DOMAIN		
MANAGEMENT NETWORK	Integrated 1 gigabit Ethernet (GbE)**	Integrated 1 GbE**
SOFTWARE	Linux* operating system Intel® Cluster Checker 2019 OpenHPC*** Intel® Omni-Path Fabric Software Intel® Parallel Studio XE 2018 Cluster Edition**	Linux operating system Intel Cluster Checker 2019 OpenHPC** Intel Omni-Path Fabric Software Intel Parallel Studio XE 2018 Cluster Edition**
FIRMWARE AND SOFTWARE OPTIMIZATIONS	Intel® Hyper-Threading Technology (Intel® HT Technology) enabled Intel® Turbo Boost Technology enabled XPT* prefetch enabled	Intel HT Technology enabled Intel Turbo Boost Technology enabled XPT prefetch enabled

MINIMUM PERFORMANCE STANDARDS

Verified to meet or exceed the following minimum performance capabilities:⁶

HIGH PERFORMANCE LINPACK* (HPL*) (ACROSS ALL FOUR NODES)	More than 5,200 gigaFLOPS per second (GFLOP/s)	More than 7,700 GFLOP/s
HIGH PERFORMANCE CONJUGATE GRADIENT (HPCG*) (ACROSS ALL FOUR NODES)	More than 118 GFLOP/s	More than 127 GFLOP/s
HPCG (ON EACH NODE)	More than 30.1 GFLOP/s	More than 32 GFLOP/s
DGEMM (ON EACH NODE)	More than 1,300 GFLOP/s	More than 2,480 GFLOP/s
STREAM* (ON EACH NODE)	More than 150,000 MB per second (MB/s)	More than 164,000 MB/s
IMB PINGPONG* (ON EACH PAIR OF NODES)	More than 11,300 MB/s (bandwidth) Less than 1.80 microseconds (latency)	More than 11,300 MB/s (bandwidth) Less than 1.80 microseconds (latency)

BUSINESS VALUE OF CHOOSING A PLUS CONFIGURATION OVER A BASE CONFIGURATION

Up to 54 percent higher GFLOP/s than the base configuration, as measured by the HPL benchmark.⁶

**Recommended, not required

Technology Selections for Intel Select Solutions for Simulation and Modeling

Intel HPC platform specification-compliant solutions include many Intel technologies and software components that optimize performance and enhance supportability. These include:

- **Intel AVX-512:** Boosts performance for the most demanding computational workloads, with up to double the number of floating point operations per second (FLOPS) per clock cycle, compared to previous-generation Intel processors.⁵
- **Intel Cluster Checker:** Inspects more than 100 characteristics related to cluster health. Intel Cluster Checker examines the system at both the node and cluster level, making sure all components work together to deliver optimal performance. It assesses firmware, kernel, storage, and network settings and conducts high-level tests of node and network performance using the Intel® MPI Library benchmarks, STREAM, the HPL benchmark, the HPCG benchmark, and other benchmarks. Intel Cluster Checker can be extended with custom tests, and its functionality can be embedded into other software.
- **Intel® Cluster Runtimes:** Supplies key software runtime elements that are required on each cluster to ensure optimal performance paths for applications. Intel runtime performance libraries, including Intel® Math Kernel Library (Intel® MKL) and Intel MPI Library, deliver excellent performance optimized for clusters based on Intel architecture.
- **Converged parallel programming for Intel Xeon Scalable processors and Intel® Xeon Phi™ processors:** Enables the creation of a highly integrated portfolio of powerful technologies, software tools, and libraries. Intel Xeon Scalable processors offer an unparalleled flexible framework, based on a common programming model, that supports code-modernization initiatives across artificial-intelligence (AI) frameworks.

Intel® Xeon® Scalable Processors

Intel Xeon Scalable processors:

- Offer high scalability for enterprise data centers
- Deliver performance gains for virtualized infrastructure compared to previous-generation processors
- Achieve exceptional resource utilization and agility
- Enable improved data and workload integrity and regulatory compliance for data center solutions

The family includes Intel Xeon Bronze processors, Intel Xeon Silver processors, Intel Xeon Gold processors, and Intel Xeon Platinum processors.



- **OpenHPC*:** Provides a community-driven, open source software stack that includes a number of common ingredients required to deploy and manage Linux* HPC clusters. The package includes provisioning tools, resource management, I/O clients, development tools, and a variety of scientific libraries.

Intel Select Solutions for Professional Visualization

Simulation and modeling are two important processes in engineering and scientific workflows. In their efforts to better understand and analyze the complex results from these workflows, researchers need photorealistic visualizations. Engineers and scientists rely on visualizations for greater and faster insights and for demonstrating complex ideas to business managers, directors, and executives. With Intel Select Solutions for Simulation and Modeling and [Intel Select Solutions for Professional Visualization](#), organizations get a complete solution for advancing product innovation and scientific discoveries.

Simplify Deployments of HPC Clusters for Simulation and Modeling

Intel Select Solutions for Simulation and Modeling combine Intel Xeon Scalable processors, Intel OPA, and other Intel technologies. The Intel HPC platform specification is the foundation that combines these hardware and software components to deliver optimized performance for Message Passing Interface (MPI)-based simulation and modeling applications in a single comprehensive, verified solution.

Visit intel.com/selectsolutions for more information on Intel Select Solutions.

Learn More

Intel Select Solutions: intel.com/selectsolutions

Intel Xeon Scalable processors: intel.com/xeonscalable

Intel OPA: intel.com/omnipath

Intel Cluster Checker: <https://software.intel.com/intel-cluster-checker>

Intel® Parallel Studio XE: <https://software.intel.com/parallel-studio-xe>

Intel HPC platform specification: intel.com/content/www/us/en/high-performance-computing/hpc-platform-specification.html

Intel Select Solutions are supported by Intel® Builders: <http://builders.intel.com>. Follow us on Twitter: [#IntelBuilders](#)



¹ Aberdeen Group. "Achieving Product Development Success Through a Consolidated Simulation Platform." January 2015. <https://investors.ansys.com/~media/Files/A/Ansys-IR-V2/industry-product-insights/aberdeen-achieving-product-development.pdf>

² ANSYS. "Product Design Challenges Drive Simulation Evolution." 2016. [ansys.com/about-ansys/dimensions-magazine/summer-2016/product-design-challenges-drive-simulation-evolution](https://www.ansys.com/about-ansys/dimensions-magazine/summer-2016/product-design-challenges-drive-simulation-evolution).

³ Shawn Wasserman. "Engineering Simulation Software in 2018 and Beyond." Engineering.com. January 2018. [engineering.com/DesignSoftware/DesignSoftwareArticles/ArticleID/16124/Engineering-Simulation-Software-in-2018-and-Beyond.aspx](https://www.ansys.com/DesignSoftware/DesignSoftwareArticles/ArticleID/16124/Engineering-Simulation-Software-in-2018-and-Beyond.aspx).

⁴ Intel. "Performance Benchmarks and Configuration Details for Intel® Xeon® Scalable Processors." intel.com/content/www/us/en/benchmarks/xeon-scalable-benchmark.html.

⁵ Intel® Advanced Vector Extensions (Intel® AVX) provides higher throughput to certain processor operations. Due to varying processor power characteristics, utilizing Intel AVX instructions may cause a) some parts to operate at less than the rated frequency and b) some parts with Intel® Turbo Boost Technology 2.0 to not achieve any or maximum turbo frequencies. Performance varies depending on hardware, software, and system configuration and you can learn more at intel.com/go/turbo.

⁶ Intel internal testing as of May 29, 2018. Base configuration: four nodes, 2 × Intel® Xeon® Gold 6126 processors (2.60 GHz, 12 cores, 24 threads), 1 × Intel® Server Board S2600WFT, total memory: 96 GB 2,666 MHz DDR4 DIMM; 1 × one-port, low-profile Intel® Omni-Path Host Fabric Interface Adapter 100 Series (100HFA016LS), x16, Peripheral Component Interconnect Express* (PCIe*); 1 × Intel® Solid State Drive (SSD) DC S4500 Series; 24-port Intel® Omni-Path Edge Switch 100 Series, 16-port 1 gigabit per second (Gbps) Ethernet switch. Plus configuration: four nodes, 2 × Intel Xeon Gold 6148 processors (2.40 GHz, 20 cores, 40 threads), 1 × Intel Server Board S2600WFT, 96 GB 2,666 MHz DDR4 DIMM; 1 × one-port, low-profile Intel Omni-Path Host Fabric Interface Adapter 100 Series (100HFA016LS), x16, PCIe; 1 × Intel SSD DC S4500 Series; 24-port Intel Omni-Path Edge Switch 100 Series, 16-port 1 Gbps Ethernet switch.

Performance results are based on testing as of May 29, 2018, and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit intel.com/benchmarks.

Cost reduction scenarios described are intended as examples of how a given Intel- based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.

Intel technologies' features and benefits depend on system configuration and may require enabled hardware, software, or service activation. Performance varies depending on system configuration. No computer system can be absolutely secure. Check with your system manufacturer or retailer or learn more at intel.com.

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