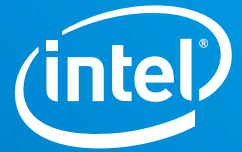


SOLUTION BRIEF

Intel® Select Solutions
High Performance Computing
2nd Generation Intel® Xeon® Scalable Processors
February 2020



Intel Select Solutions for Simulation & Modeling

Enhance competitiveness and productivity with an optimized, quick-to-deploy high-performance computing (HPC) cluster for simulation and modeling.



High-performance computing (HPC) simulation and modeling can be the key element of success for manufacturing and research companies facing an increasingly competitive environment. Numerous HPC applications provide capabilities to explore design parameters, reduce prototype costs, and produce optimized products in shorter amounts of time. In addition, many of these applications are capable of distributing computation across multiple machines that are configured to act as one large unit: an HPC cluster. An HPC cluster can provide a scalable resource that enables faster results, finer grained models, and ultimately, higher productivity, compared to using a single system for simulation workloads.

But for many organizations, the skills or expertise to deploy and maintain scalable HPC clusters for simulation and modeling workloads present a barrier to adoption. Building 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. In addition, integrating the hardware and software to meet the requirements for simulation and modeling applications is highly complex. In the end, businesses can spend weeks or more researching and assembling the components needed for their solutions.

Intel Select Solutions for Simulation & Modeling offer an easier path and quick-to-deploy infrastructure that significantly reduces this complexity for the purchaser. Using a standards-based approach defined in the Intel HPC Platform Specification, these solutions provide verified interoperability with common applications used in simulation and modeling. Intel Select Solutions for Simulation & Modeling must also meet or exceed characteristics and performance thresholds that are needed for scaling performance across the cluster. Branded designs have demonstrated these capabilities and are ready to deploy for use.

Intel Select Solutions for HPC

Intel Select Solutions for Simulation & Modeling serve as a common foundation for a family of solutions designed for productivity, compatibility, and workload-optimized performance across a broad range of HPC applications.

Intel Select Solutions for HPC offer easy and quick-to-deploy infrastructure that mitigates the complexity of advanced computing and helps accelerate the time to actionable insights for users in manufacturing and science. The portfolio of solutions defines workload-optimized hardware and software configurations that provide capabilities for simulation and modeling, simulation and visualization, genomics analytics, and HPC and artificial intelligence (AI). Each of these solutions shares a common base architecture and complies with the Intel HPC Platform Specification. The solutions offer the advantage of validated compatibility with a wide range of HPC workloads, including those listed in the [Intel HPC Application Catalog](#) (updated frequently).

Intel Select Solutions for Simulation & Modeling

Intel Select Solutions for Simulation & Modeling are pre-validated and tested solutions that combine 1st Generation or 2nd Generation Intel Xeon Scalable processors and other Intel technologies into a proven architecture based on the Intel HPC Platform Specification. The solutions can help reduce the time and cost of building an HPC cluster and are designed to provide optimized performance for simulation and modeling workloads.

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

- The solutions include key hardware and software components important for HPC
- The solutions are compliant with industry standards and best practices for Intel-based clusters as defined in the Intel HPC Platform Specification
- The solutions meet or exceed defined performance levels in targeted characteristics important to HPC applications

Hardware and Software Selections

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

Compute

Intel Select Solutions for Simulation & 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 dials up the performance and impact of the system. Intel Xeon Gold 6148 processors offer 20 cores to deliver 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.¹ Solutions incorporating the 2nd Generation Intel Xeon Scalable processors deliver the same or better performance as similarly configured solutions based on previous-generation Intel Xeon Scalable processors.

2nd Generation Intel Xeon Scalable processors feature significant enhancements that can benefit HPC applications, including improvements in input/output (I/O), memory, and Intel Advanced Vector Extensions 512 (Intel AVX-512).²

For HPC users adopting AI, Intel Deep Learning Boost (Intel DL Boost) uses the Vector Neural Network Instructions (VNNI) set to accelerate performance of AI deep learning (inference) workloads, such as speech recognition, image recognition, object classification, machine translation, and others. VNNI accomplishes in a single instruction what formerly required three, resulting in up to an 11x performance increase in low-precision inferencing with systems based on 2nd Generation Intel Xeon Scalable processors, compared to systems based on previous-generation processors.³

WHAT ARE INTEL SELECT SOLUTIONS?

Intel Select Solutions are pre-defined, workload-optimized solutions designed to minimize the challenges of infrastructure evaluation and deployment. Solutions are validated by OEMs/ODMs, certified by ISVs, and verified by Intel. Intel develops these solutions in extensive collaboration with hardware, software, and operating system vendor partners and with the world's leading data center and service providers. Every Intel Select Solution is a tailored combination of Intel data center compute, memory, storage, and network technologies that delivers predictable, trusted, and compelling performance.

To refer to a solution as an Intel Select Solution, a vendor must:

1. Meet the software and hardware stack requirements outlined by the solution reference-design specifications
2. Replicate or exceed established reference-benchmark test results
3. Publish a solution brief and a detailed implementation guide to facilitate customer deployment

Solution providers can also develop their own optimizations in order to give end customers a simpler, more consistent deployment experience.

INTEL XEON SCALABLE PROCESSORS

2nd Generation Intel Xeon Scalable processors:

- Offer high scalability that is cost-efficient and flexible, from the multi-cloud to the intelligent edge
- Establish a seamless performance foundation to help accelerate data's transformative impact
 - Support breakthrough Intel® Optane™ persistent memory technology
 - Accelerate artificial-intelligence (AI) performance and help deliver AI readiness across the data center
 - Provide hardware-enhanced platform protection and threat monitoring

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

**SOLUTION
POWERED BY:**



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 that deliver compatibility with a wide range of applications. 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.

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 & 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.

INTEL SELECT SOLUTIONS FOR HIGH PERFORMANCE COMPUTING (HPC)

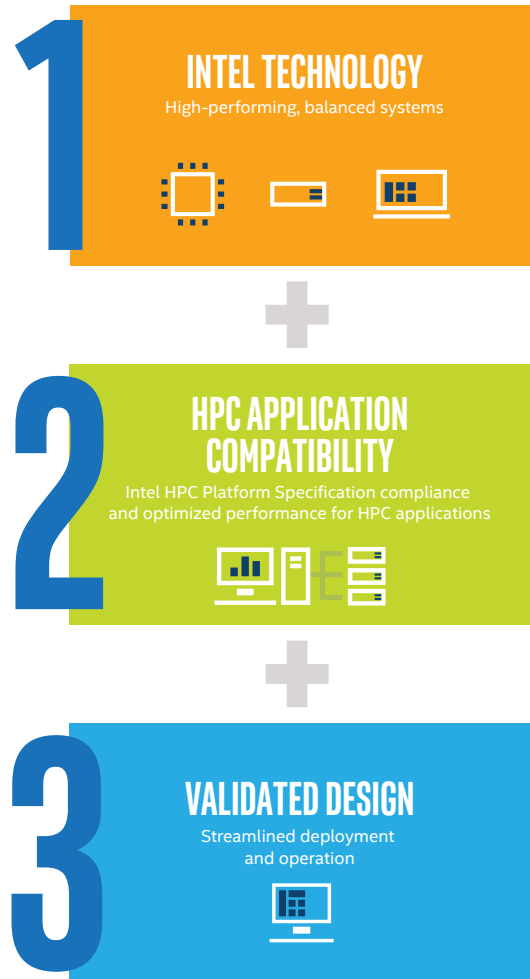


Figure 1. Intel Select Solutions for HPC combine Intel hardware and software technologies into an optimized, validated design that simplifies your path to an HPC deployment

Base and Plus Configurations

Intel Select Solutions for Simulation & Modeling include two configurations. The Base configuration specifies the minimum required performance capability for Intel Select Solutions for Simulation & 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.⁴ Use the HPL benchmark results when comparing the Base configuration to the Plus configuration.

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

INGREDIENT	INTEL SELECT SOLUTIONS FOR SIMULATION & MODELING BASE CONFIGURATION DETAILS	INTEL SELECT SOLUTIONS FOR SIMULATION & MODELING PLUS CONFIGURATION DETAILS
WORKLOAD DOMAIN (MINIMUM 4-NODE CONFIGURATION)		
PLATFORM	Dual-socket server platform	Dual-socket server platform
PROCESSOR	2 × Intel Xeon Gold 6126 processor (2.60 GHz, 12 cores, 24 threads), Intel Xeon Gold 6226 processor (2.70 GHz, 12 cores, 24 threads), Intel Xeon Gold 6226R processor (2.90 GHz, 16 cores, 32 threads), or a higher model number Intel Xeon Scalable processor	2 × Intel Xeon Gold 6148 processor (2.40 GHz, 20 cores, 40 threads), Intel Xeon Gold 6252 processor (2.10 GHz, 24 cores, 48 threads), Intel Xeon Gold 6248R processor (3.00 GHz, 24 cores, 48 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 or better, or Intel SSD DC P3520 or better*	1 × Intel SSD DC S3520 or better, or Intel SSD DC P3520 or better*
MESSAGING FABRIC	1 × Intel Omni-Path Architecture (Intel OPA), single-port 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 Cluster Management Software Stack* Intel Omni-Path Fabric Software Intel Parallel Studio XE 2018 Cluster Edition*	Linux operating system Intel Cluster Checker 2019 Cluster Management Software Stack* 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: ⁴		
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 INSTEAD OF A BASE CONFIGURATION⁴	Up to 54 percent higher GFLOP/s than the Base configuration, as measured by the HPL benchmark.	

*Recommended, not required

Technology Selections for Intel Select Solutions for Simulation & 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.²
- **Intel DL Boost:** The performance acceleration extends to integer operations and handles dense computations characteristic of convolutional neural network (CNN) and deep neural network (DNN) workloads. It accelerates AI workloads, increasing Int16 and Int8 peak operations/second. Intel DL Boost was designed to accelerate performance of AI deep learning (inference) workloads (for example, speech recognition, image recognition, object classification, machine translation, and others).
- **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.
- **Cluster Management Software Stack:** Provides a software stack required to deploy and manage Linux HPC clusters. The stack includes provisioning tools, resource management, I/O clients, development tools, and scientific libraries, such as OpenHPC, Bright Cluster Manager, xCAT, and others.

Simplify Deployments of HPC Clusters for Simulation and Modeling

Intel Select Solutions for Simulation & Modeling combine 1st or 2nd Generation 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.

The Complete Family of Intel Select Solutions for HPC

Intel Select Solutions for Simulation & Modeling serve as a common foundation for the family of Intel Select Solutions for HPC, and they are designed for productivity, compatibility, and workload-optimized performance across a broad range of traditional HPC applications. Other solutions in the family include:

- **Intel Select Solutions for Simulation & Visualization:** Allow users to process massive datasets concurrent with simulation runs by making use of in-memory computing and open source libraries optimized for Intel Xeon Scalable processors. The solutions enable users to create photorealistic and interactive visualizations to more quickly gain insights and more effectively communicate new product designs and research breakthroughs.
- **Intel Select Solutions for Genomic Analytics:** Ease deployment and speed time to analysis of genomics pipelines for life-sciences research and healthcare insights. The solutions include workflow-definition-language scripts that allow users to replicate Genome Analysis Toolkit (GATK) best-practices pipelines or create their own pipelines.
- **Intel Select Solutions for HPC & AI Converged Clusters:** Extend the simulation and modeling solution to allow users to run a wide range of analytics and AI applications on common infrastructure. These solutions increase flexibility, improve utilization, and support the trend toward converged simulation, modeling, analytics, and AI workloads to accelerate discoveries and insights.

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

If you are looking to simplify deployment of optimized infrastructure for your business, ask your preferred integrator for an Intel Select Solution. If you are a system integrator, visit the Intel Select Solutions partner portal at <https://builders.intel.com/selectsolutionspartner> for information on how to create Intel Select Solutions for your customers.

Learn More

Intel Select Solutions for HPC: [intel.com/content/www/us/en/products/solutions/select-solutions/hpc.html](https://www.intel.com/content/www/us/en/products/solutions/select-solutions/hpc.html)

Intel HPC Platform Specification: [intel.com/content/www/us/en/high-performance-computing/hpc-platform-specification.html](https://www.intel.com/content/www/us/en/high-performance-computing/hpc-platform-specification.html)

Intel HPC Application Catalog: [intel.com/content/www/us/en/high-performance-computing/hpc-application-catalog.html](https://www.intel.com/content/www/us/en/high-performance-computing/hpc-application-catalog.html)

Intel Xeon Scalable processors: [intel.com/xeonscalable](https://www.intel.com/xeonscalable)

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



¹ Intel. "Performance Benchmarks and Configuration Details for Intel® Xeon® Scalable Processors." [intel.com/content/www/us/en/benchmarks/xeon-scalable-benchmark.html](https://www.intel.com/content/www/us/en/benchmarks/xeon-scalable-benchmark.html).

² 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](https://www.intel.com/go/turbo).

³ Intel. "Intel® AI—The Tools for the Job." August 2018. <https://itpeernetwork.intel.com/intelcisummit-artificial-intelligence/>.

⁴ 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, PCIe; 1 × Intel Solid State Drive (SSD) DC S4500; 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; 24-port Intel Omni-Path Edge Switch 100 Series, 16-port 1 Gbps Ethernet switch.

Performance results are based on testing as May 29, 2018, and may not reflect all publicly available security updates.

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](https://www.intel.com/benchmarks).

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 product or component can be absolutely secure.**

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.

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