

## Intel® Select Solutions for NFVI with Red Hat OpenStack\* Platform

**Communications service providers are virtualizing their service platforms to gain flexibility, agility, and scale. Virtualization can be challenging and add complexity and unpredictability to network services. Intel® Select Solutions for NFVI are consistent building blocks that ease interoperability, improve stability, and speed deployment, thereby addressing the challenges faced when choosing the right infrastructure to implement NFV-based services.**

### Introduction

With the Intel Select Solutions for NFVI, Intel's ecosystem partners can deliver workload-optimized server solutions to communication service provider (CoSP) customers. Network functions virtualization infrastructure (NFVI) is the foundation of virtualized network services and has a significant impact on overall system and service performance. With a thoroughly tested hardware and software reference design, Intel Select Solutions for NFVI can help CoSPs lessen the time, effort, and expense involved with evaluating hardware and software integrations for NFV-based services and help speed deployment.

The Intel Select Solutions for NFVI are based on a clustered multi-node configuration. This reference design is defined in collaboration with CoSP and ecosystem partners to expose the value of an I/O balanced architecture based on a data-centric foundation of 3rd Generation Intel® Xeon® Scalable processors, Intel® Ethernet 800 Series Network Adapters, Intel® QuickAssist Technology (Intel® QAT), Intel® Optane™ persistent memory, and Intel® Solid State Drives (Intel® SSD).

The Intel Select Solutions for NFVI are developed from Intel's deep experience with industry partners including independent software vendors (ISVs), operating system vendors (OSVs), and original equipment and original design manufacturers (OEMs/ODMs). These partners, or CoSPs, can utilize the Intel Select Solutions for NFVI as a testing platform for determining VNF performance that is repeatable in a broad deployment and scale the configuration from testing and trial to live deployment. Because the Intel Select Solutions for NFVI platform is defined in detail, it's easier to understand and fix performance issues arising from OEM/ODM or CoSP changes to the reference design.

Intel Select Solutions for NFVI contain a cloud node for network function delivery and a controller node for clustered node deployments. They include a Base or Plus configuration for the cloud node, and a configuration for the controller node. Together, these configurations—cloud (Base or Plus) and controller nodes—help realize an efficient balance of function to meet many deployment needs (see Figure 1).



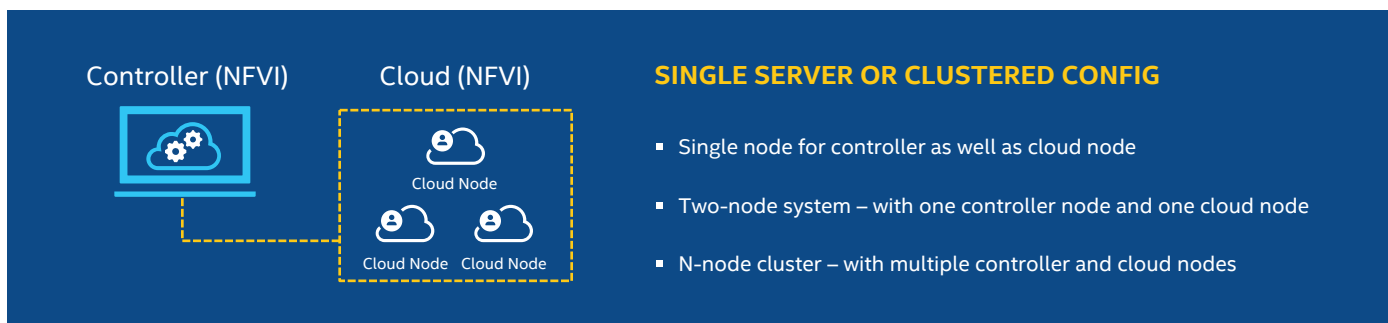


Figure 1. Intel® Select Solutions for NFVI clustered multi-node architecture.

To fully implement the NFVI clustered multi-node solution, servers based on the Intel Select Solutions for NFVI reference designs should include ingredients to implement a software-defined infrastructure that resides within each cloud node instance with the controller node used for hosting the control functions in the OpenStack environment.

## What Are Intel® Select Solutions?

Intel Select Solutions are predefined, 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's reference-design specifications
2. Replicate or exceed established reference-benchmark test results
3. Publish solution content 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® Select Solutions for NFVI Configurations

There are three configurations in the Intel Select Solutions for NFVI reference designs. There are two cloud node designs and one controller node design. Details on each of the Intel Select Solutions for NFVI cloud and controller nodes are listed below.

- **Intel Select Solution for NFVI Base configuration cloud node:** This configuration is based on 3rd Generation Intel® Xeon® Gold 5318N processors and is a value/performance optimized configuration. It specifies network, storage, and add-in platform acceleration products from Intel for carrier-class use cases, which require longer life and higher reliability than many standard server use cases. The Base configuration also specifies Intel® QAT encryption/decryption and compression acceleration technology, which is required for verification, but optional for deployment.<sup>1</sup>
- **Intel Select Solution for NFVI Plus configuration cloud node:** This configuration is based on high-performance 3rd Generation Intel® Xeon® Gold 6338N processors. This CPU is coupled with Intel® QAT for acceleration, and both components are integrated on the motherboard to deliver very high NFVI performance. It is designed to maximize virtual machine density, supporting many simultaneous applications.
- **Intel Select Solution for NFVI controller node:** This configuration is designed to function as an OpenStack cloud controller to control various cloud nodes and features with a combination of optimized efficiency and additional networking functionality. Based on the 3rd Generation Intel® Xeon® Gold 5318N processor, the controller node can also optionally feature local application storage and hardware acceleration components.

The cloud node configurations of Intel Select Solutions for NFVI feature high-performance CPUs, balanced I/O, and on-board acceleration with Intel® QAT, combined with optimizations through DPDK, for exceptional throughput and low-latency performance. The configurations are designed to optimize performance for virtualized packet-based network traffic workloads and crypto/compression acceleration.

## Hardware Selections

**3rd Generation Intel Xeon Scalable processors** are the foundation for all hardware configurations used in the solutions. These CPUs are available in configurations optimized for diverse network environments, in a wide range of frequency, feature, and power levels. The following platform characteristics and technologies are particularly valuable to the Intel Select Solutions for NFVI:

- **New balanced, scalable architecture** increases per-core performance, memory, and I/O bandwidth to accelerate diverse workloads from the edge to the data center.
- **Increased core count and cache**, available in a flexible range of SKUs with from 8 to 40 powerful cores and L1 cache up to 48 KB (50 percent larger than the previous generation), helping drive up the number of subscribers that can be handled per node.
- **New extensions to Intel® AVX-512 instructions** accelerate bit-processing kernels that move and reorder blocks of data within the wireless signal processing pipeline.
- **Intel® Software Guard Extensions (Intel® SGX)** provides protected execution enclaves that isolate and help protect application code and data while in use and enable new ways to collaborate using shared data without compromising privacy.

**Intel® Optane™ Persistent Memory 200 series** is designed to improve overall system performance and to lower latencies by using non-volatile media to supplement DRAM and increase the warm memory located close to the processor—reducing time-consuming disk accesses. Intel® Optane™ persistent memory modules are available in per-module capacities of 128 GB, 256 GB, and 512 GB.

**Intel® Solid State Drive Data Center Family (Intel® SSD DC Family)** includes the NVMe-based Intel® SSD Data Center P5500 and P5300 Series, which are designed for cloud infrastructures and offer outstanding quality, reliability, advanced manageability, and serviceability to minimize service disruptions. The Intel® 3D NAND Technology-based SSDs provide high-capacity storage. The Intel® Optane™ DC SSD P5800X Series supports fast caching and fast storage at low latency and high endurance compared to traditional NAND and hard disk drives. When used for caching, Intel Optane DC SSDs help to increase scale by accommodating more capacity than alternative DRAM-based memory technologies typically used for that purpose.

**Intel® QAT** is a hardware acceleration technology that provides lookaside cryptographic and compression/decompression co-processing services for the host. Intel® QAT is built into certain Intel Xeon Scalable processor platform chipsets and can be added to any server by means of standard PCI add-in card options.

**Intel® QAT Engine for OpenSSL** includes software-based acceleration of cryptographic operations, implemented using instructions that take advantage of Intel® Crypto Acceleration. Some of these instructions utilize Intel Advanced Vector Extensions 512 (Intel® AVX-512). For more information on building software acceleration features in the Intel® QAT Engine for OpenSSL, refer to [this article](#) for additional information.

**Intel® Ethernet 800 Series Network Adapters** provide standards-based networking performance across NFVI workloads through a combination of sophisticated packet processing, intelligent offloads and accelerators, and high-quality open-source drivers for data-plane processing. In addition to optimizing throughput, the adapters are designed to enable broad interoperability and agility. Key features and capabilities associated with the adapters include the following:

- **Application Device Queues (ADQ)**, a capability unique to the Intel Ethernet 800 Series Network Adapters, provides dedicated queues to key workloads, enabling application-specific data steering, signaling, and rate limiting using an optimized application thread-to-device data path. ADQ increases predictability, reduces latency and jitter, and improves throughput.
- **Dynamic Device Personalization (DDP)** is a programmable packet-processing pipeline provided by the Intel Ethernet 800 Series Network Adapters that supports on-demand reconfiguration of network controllers at runtime, enabling workload-specific optimizations to increase throughput and decrease latency. DDP is enhanced in the Intel Ethernet 800 Series Network Adapters with greater programmability than predecessors, as well as workload-specific protocols for added flexibility.
- **Data Plane Development Kit (DPDK)** is an open-source set of libraries and drivers that accelerates packet-processing in the data path. It also facilitates building packet forwarders designed to operate on general-purpose, standards-based servers.

The adapters deliver excellent small-packet performance that is well suited to NFVI, together with advanced I/O virtualization that helps drive up throughput on virtualized servers. In addition, they offer network virtualization optimizations including VXLAN, GENEVE, NVGRE, MPLS, and VXLAN-GPE with Network Service Headers (NSH).

## Verified Performance Through Benchmark Testing

The Intel Select Solutions for NFVI v3, based on 3rd Generation Intel Xeon Scalable processors, increases performance over its predecessor across key KPI targets, as shown in Figure 2.

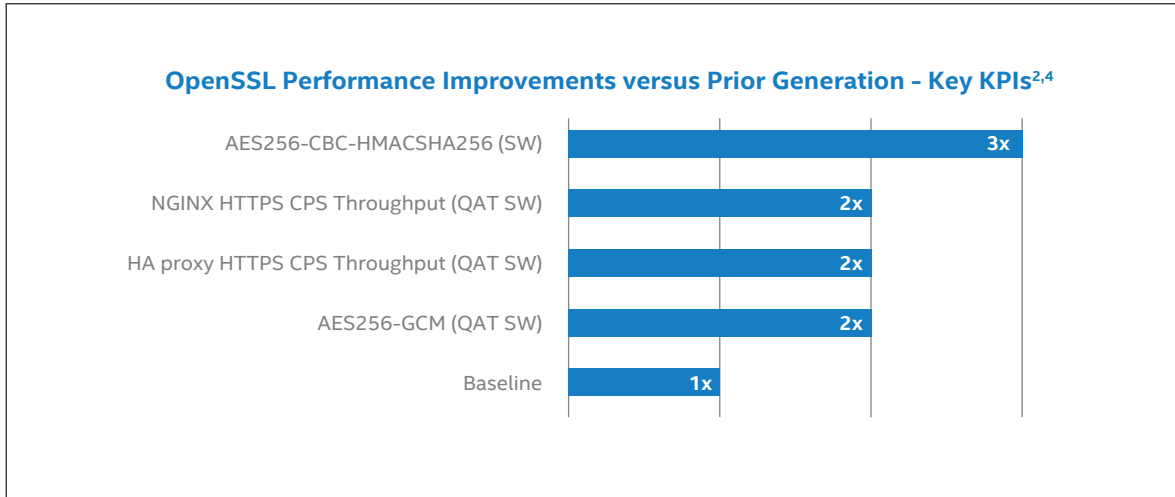


Figure 2. Value proposition of Intel® Select Solutions for NFVI compared to prior generation.<sup>2,4</sup>

Intel and its solution definition partners have set minimum performance benchmarks for the Intel Select Solutions for NFVI to ensure that the design and software configuration deliver expected performance, as provided in Table 1. Performance testing is specified for the following areas:

- **The performance baseline benchmark** shows that applications running on Intel Select Solutions for NFVI will offer performance targets for latency, memory bandwidth, and jitter. These metrics will demonstrate that the BIOS, advanced technology configuration, and software stack are configured according to the reference design.
- **Data Plane Development Kit (DPDK)** improves packet-processing efficiency and is a core platform technology component of the Intel Select Solutions for NFVI for all configurations. Compliant platforms must implement DPDK software and meet benchmark performance metrics.
- **Intel® QAT** is essential for high performance encryption/ decryption acceleration for the SSL layer 7 application in public key exchange as well as bulk encryption and decryption applications. This benchmark is designed to demonstrate how Intel® QAT can efficiently address the growing needs for compression and critical encryption operations that are a growing portion of network traffic.
- **Intel® QAT Engine for OpenSSL** includes acceleration of cryptographic operations based on software instructions. The optimized software libraries for Intel® QAT take advantage of Intel Crypto Acceleration. Some of these new crypto acceleration routines use Intel Advanced Vector Extensions 512 (Intel® AVX-512). Please refer to the [solution brief](#) for more information.

Table 1. Select benchmark testing specifications for Intel® Select Solutions for NFVI.

Key KPI Targets	Base Configuration <sup>3</sup>	Plus Configuration <sup>4</sup>	Value Proposition (Plus over Base Configuration)
Intel® QAT Compression <sup>1</sup> - Compress and Verify Throughput Base on 8 KB Packets	34 Gb/s	54 Gb/s	1.5x
Intel® QAT AES256-CBC-HMAC-SHA512 Encryption Throughput - 4KB Packet Size	50 Gb/s	100 Gb/s	2x
OpenSSL Performance (RSA4K Utilizing Software All Cores)	9K Ops/s	13K Ops/s	1.4x
OpenSSL Performance in Gbps (Utilizing Intel® QAT Hardware - 8 Cores) (AES256-CBC-HMAC-SHA256 Operation Based on 16KB Packets)	50 Gb/s	100 Gb/s	2x
Packet Processing (Network IO Density per Server)	100-200 Gb/s	200-400 Gb/s	2x

## Board and System Design Configurations

The Intel Select Solutions for NFVI reference designs are anchored on a balanced I/O for network and storage media. All workloads benefit from deterministic latency and performance for their resources, including NFVI workloads when they are deployed within the same non-uniform memory access (NUMA) node. Table 2 identifies the high-level hardware elements for the controller node and each of the cloud nodes.

**Table 2.** Example hardware configurations for Intel® Select Solutions for NFVI.

Ingredient	Controller Node Requirement	Cloud Node Base Requirement	Cloud Node Plus Requirement
<b>Processor</b>	Intel® Xeon® Gold 5318N processor 20c 2.0GHz 135W (SST-PP Config 2)	Intel® Xeon® Gold 5318N processor 24c 2.1GHz 150W	Intel® Xeon® Gold 6338N processor 32c 2.2GHz 185W
<b>Memory</b>	Required – 256 GB		Required – 512 GB
<b>Intel® Optane™ Persistent Memory</b>	Not Required <sup>5</sup>		Recommended <sup>5</sup>
<b>Network Interface Card</b>	2x Intel® Ethernet Network Adapter E810-XXVDA2 or 2x Intel® Ethernet Network Adapter E810-CQDA2	2x Intel® Ethernet Network Adapter E810-CQDA2	2x Intel® Ethernet Network Adapter E810-CQDA2 or 2x Intel® Ethernet Network Adapter E810-2CQDA2
<b>LAN-on-Motherboard</b>	Required		
<b>Intel® QAT<sup>1</sup></b>	Recommended <sup>1</sup>	Required <sup>1</sup>	
<b>Storage for Boot</b>	Required – 2x Intel® SSD D3-S4510 (480 GB)		
<b>Application Storage</b>	Required – 2x Intel® SSD D7-P5510 Series (3.84 TB)	Required – 4x Intel® SSD D7-P5510 Series (3.84 TB)	

## Software and Firmware Stack

Minimum supported versions of firmware, operating systems, drivers, hypervisors, BIOS, and other software components for Intel Select Solutions for NFVI as specified in the reference design must be integrated in the solution stack for proper operation, stability, and optimal performance.

Operating systems are the foundation of the software stack, and this solution integrates Red Hat Enterprise Linux\* for its host operating system. The Intel Select Solutions for NFVI must also be certified with Red Hat OpenStack Platform as the deployed open NFVI platform for next-generation networking services and applications.

To meet the optimized deterministic performance requirements for an Intel Select Solutions for NFVI platform, the BIOS settings must be set to maximize performance using Intel® Turbo Boost Technology (turbo mode).

Contact your Intel representative for access to a detailed design specification for each configuration including the software solution stack. These specifications and associated test plans are posted to the Intel Resource and Design Center. Intel continually validates and integrates new versions of this firmware and software to ensure that software updates will perform correctly when integrated into a deployed system.

## Conclusion

Intel has developed the Intel Select Solutions for NFVI reference designs based on feedback and in cooperation with industry leaders that are playing a key role in the CoSP virtualization transformation. The Intel Select Solutions for NFVI integrate balanced networking and optimized compute and storage options, and they provide acceleration for demanding encryption and compression workloads. In addition, the solution is based on well-known BIOS configurations, current instances of the middleware from host OS providers, and driver combinations that are regularly integrated and performance-tested to ensure optimal performance.

Intel Select Solutions for NFVI provide Intel's OEM/ODM partners with a reference design that meets or exceeds the production traffic needs of CoSPs in a cloud network world. In addition, Intel Select Solutions for NFVI provide ISV partners with a reference design up through the virtualization layer that can be used as a baseline for structural validation when establishing performance metrics. And finally, for the CoSP, the Intel Select Solutions for NFVI provide a vertical platform that can serve as the foundation for a network cloud design—removing many person-years of research and analysis. Intel and its leading partners in the ecosystem have invested significant time up front to enable CoSPs to be more confident in the performance of their virtualized solutions and to drive a much more rapid deployment schedule.

### Learn More

Intel® Select Solutions web page: [intel.com/selectsolutions](https://intel.com/selectsolutions)

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

Intel Select Solutions are supported by the Intel Network Builders Program: [networkbuilders.intel.com](https://networkbuilders.intel.com)

Red Hat: [redhat.com/telco](https://redhat.com/telco)

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<sup>1</sup> Intel® QuickAssist Technology is required for Intel® Select Solutions technical verification. For the Base configuration, it is not required to ship with the server for workloads that do not require crypto or compression acceleration.

<sup>2</sup> Prior Generation: Test by Intel as of 4/15/2021. One node, 2x Intel® Xeon® Gold 6252N processor (24 cores, 2.3 GHz, 205w TDP); Intel® Hyper-Threading Technology enabled; Intel® Turbo Boost Technology enabled; total memory 384 GB (12 slots/32 GB/2933 MHz), BIOS: SE5C620.86B.02.01.0013.121520200651 (ucode:0x5003003); Red Hat 8.2, kernel 4.18.0-193.28.1.el8.x86\_64; gcc compiler 8.3.1 20191121 (Red Hat 8.3.1-5).

<sup>3</sup> Base Configuration tested by Intel as of 6/1/2021. One node, 2x Intel® Xeon® Gold 5318N Processor, 24 cores, 2.1GHz, 150W TDP, HT On Turbo On, Total Memory 256 GB (16 slots/16GB/ 2666 MHz), BIOS: SE5C6200.86B.0020.P24.210402081120210402 (ucode: 0xd000280), Red Hat 8.2 Kernel Linux 4.18.0-193.28.1.el8.x86\_64, gcc compiler 8.3.1 20191121 (Red Hat 8.3.1-5).

<sup>4</sup> Plus Configuration tested by Intel as of 6/1/2021. One node, 2x Intel® Xeon® Gold 6338N Processor, 32 cores, 2.2GHz, 185W TDP, HT On Turbo On Total Memory 512 GB (16 slots/ 32GB/ 2666 MHz), BIOS: SE5C6200.86B.0020.P09.2012290309 (ucode: 0xd000280), Red Hat 8.2 Kernel Linux 4.18.0-193.28.1.el8.x86\_64, gcc compiler 8.3.1 20191121 (Red Hat 8.3.1-5).

<sup>5</sup> Intel® Optane™ persistent memory recommendation will be subject to workload requirements and system cost benefits.

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