SOLUTION BRIEF

Intel® Builders
NFVI Forwarding Platform

Intel® Select Solutions for NFVI Forwarding Platform

Year-over-year growth in demands on network capacity continue to outpace the OpEx and CapEx capacities of communication service providers. While virtualization of the network addresses this growing business problem, the associated disaggregated model brings with it a new set of technical and operational challenges. The Intel® Select Solutions for NFVI Forwarding Platform are verified systems of compute, network, storage, and middleware elements that can significantly accelerate the introduction of next-generation virtualized solutions into the network, reducing both time to production and TCO.

Introduction

Communication service providers (CommSPs) continuously transform and introduce new technology into their networks. Today the challenge is to accelerate the introduction of standards-based high-capacity servers capable of meeting the unprecedented level of data growth in operational networks due to the introduction of 5G, which brings an order of magnitude increase in capacity of network traffic without a corresponding increase of an order of magnitude in cost.

The primary traffic load in 5G is in the user-plane functions (the data, as opposed to the control or signaling associated with establishing traffic flow). Network implementations based on NFVI can increase speed and agility, improving time to market for added capacity growth, as well as potentially for new services within the CommSP's operational network. CommSPs are expected to continue the transformation from purpose-built solutions of the past, beyond virtualized appliances, to a model of fully virtualized and cloud native networks. To accomplish this transformation, the journey to a more fully disaggregated deployment model must be realized.

NFVI standards include the consideration that solutions at the application layer may include both virtual machine (VM) or containerized application functions; the disaggregation of the lower elements of compute, network, and storage remain critical. CommSP workloads will demand that the underlying systems can scale network capacity rapidly and yield resources when capacity requirements abate during the normal course of a day and throughout the lifetime of the installed systems. The capabilities of a well-orchestrated NFVI built on systems that can sustain significant data throughput are critical to keeping pace with a data CAGR of 58%.[1]

The community effort necessary for the success of the NFVI transformation includes ISVs, OEMs, and OSVs, in addition to the CommSPs themselves. Intel has built an ecosystem of partners from each of these segments within the Intel® Network Builders program, and working closely with industry leaders, Intel has co-created the Intel® Select Solutions for NFVI. Within this segment, the Intel® Select Solutions for NFVI Forwarding Platform delivers a verified hardware and software stack capable of sustained optimized data- and control-plane processing within the operational networks of the CommSP. These workloads span the 4G and 5G wireless functions found in vEPC and vUPF, as well as in the wireline network gateway functions vBRAS/vBNG and vCMTS within the DSL and MSO networks.

In certain configurations, the Intel Select Solutions for NFVI Forwarding Platform shows a theoretical throughput of up to 400 Gbps per system. The disaggregated model of separating the network, compute, and storage from the upper-layer application function has led in some cases to less than desired processing capability, mainly due to architectural shortcomings at various layers of the NFVI implementation. Examples of the causes for these shortcomings include resources being misaligned on the server, a lack of access to interfaces, or incompatible versions of drivers or accelerators.

Working together, Intel and other leaders in the NFVI transformation have recognized this challenge and designed the Intel Select Solutions for NFVI Forwarding Platform to address many of these concerns. The reference architecture builds from a foundation of a balanced server design, where each NUMA node has identical capacity resources. The solution is then further specified with a well-known vertical stack of all the critical software elements, including the BIOS configuration, host operating system, and network and acceleration drivers. All components are verified together to provide a system with known performance and optimized capabilities to meet the demands of the CommSP's operational network workloads.

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/original design manufacturers (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 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.

Common High-Throughput Node Architecture Across Sites

The Intel Select Solutions for NFVI Forwarding Platform are designed to maximize network I/O capacity and packet-processing throughput per node with a scalable architecture for deployment across various types of network sites.

The specification includes nodes with various theoretical throughputs to support sites with different requirements, from multiple Terabits per second at the network core to lower throughputs as the network branches out to progressively smaller sites.

The multi-node architecture of the Intel Select Solutions for NFVI Forwarding Platform supports the Control and User Plane Separation (CUPS) strategy. Specifically, that separation allows user-plane functions to be scaled out across multiple systems. The resulting topology allows for a many-to-one relationship between the node types that enables more efficient use of hardware resources, for lower TCO. Examples of typical user-plane services that might be deployed at different levels of a theoretical CommSP Network Infrastructure are shown in Table 1.

Table 1. Typical VNF workloads deployed at specific network locations.

Level 1: Core Network Site	**vEPC** (virtual Evolved Packet Core)
	vGiLAN (virtual Gateway Interface Local Area Network) **5G UPF** (User Plane Function)
	vIMS (virtual IP Multimedia System)
Level 2: Regional Points of Presence	**vEPC** (virtual Evolved Packet Core)
	vGiLAN (virtual Gateway Interface Local Area Network)
	vIMS (virtual IP Multimedia System)
	vCGNAT (virtual Carrier-Grade Network Address Translation)
	vCRAN (virtual Cloud Radio Area Network)
	vCDN (virtual Content Distribution Network)
Level 3: Remote Central Offices	**vBNG** (virtual Broadband Network Gateway) **CMTS** (Cable Modem Termination System)
	dEPC (distributed Evolved Packet Core) / **S/P GW** (Secure/Packet Gateway)
	vDPI (virtual Deep Packet Inspection) / **vCPE** (virtual Customer Premise Equipment)
	MEC (Multi-Access Edge Compute)
	CMTS (Cable Modem Termination System)
Level 4: Access Central Offices	**vRAN** (virtual Radio Access Network)
	vOLT (virtual Optical Line Terminator) / **DSL** (Digital Subscriber Line)
	MEC (Multi-Access Edge Compute)
	CMTS (Cable Modem Termination System)
Level 5: Customer Premises	**vFW** (virtual Firewall)
	vSecGW (virtual Security Gateway)
	uCPE (Universal Customer Premise Equipment)

The solution has been tuned and pre-tested to ensure high throughput across different types of VNFs, using the reference architecture's hardened stack in a controlled environment. In production, this assurance helps accelerate time to market and mitigates implementation risk.

Intel® Select Solutions for NFVI Forwarding Platform: Hardware Configurations

The Intel Select Solutions for NFVI Forwarding Platform defines a hyperconverged infrastructure in a 1U or 2U rack-mounted configuration, with solution components and configurations selected to ensure maximum I/O throughput. The hardware topology incorporates 2nd generation Intel® Xeon® Scalable processors, Intel® Ethernet Server Adapters for DPDK-accelerated networking, and Intel® Solid State Drives (Intel® SSDs).

This platform addresses general use cases for NFVI, focusing resources on I/O to provide the widest data path possible into each NUMA node. Optional components can be added to meet the requirements of specific use cases. Intel® Optane™ DC persistent memory can be added to the configurations to provide massive memory resources that enlarge the pool of warm data that can be held in close proximity to the processor. User-plane nodes are available in two primary configurations, with configurability to fine-tune the stack for specific solution needs:

- **Plus node:** This configuration is tailored for the highest performance and highest density for maximum I/O packet processing.
- **Base node:** This configuration is a value/performance-optimized offering suited to deployments further from the network core.

In addition, the reference architecture specifies system configuration parameters for the Intel Select Solutions for NFVI Forwarding Platform controller node. Configuration guidelines for all three types of nodes are given in Table 2. All components are required unless otherwise noted.

The Intel Select Solutions for NFVI Forwarding Platform reference architecture is designed for high throughput across the CommSP Network Infrastructure. Intel® technologies used in the configuration specifications are described below.

2nd Generation Intel® Xeon® Gold Processors

All node configurations feature 2nd generation Intel® Xeon® Gold processors, with at least 16 physical execution cores for the controller node and a minimum of 20 physical cores for the user-plane nodes. Solutions can use a range of processor SKUs to tailor performance to the specific needs of the implementation, deployed with two-socket systems that combine rigorous requirements for high performance and efficiency, coupled with low TCO.

To boost processor-to-processor data flow, Intel® Ultra Path Interconnect (Intel® UPI) provides transfer speeds between sockets of up to 10.4 GT/s,[2] while delivering high energy efficiency. The platforms also feature enhanced performance and bandwidth across six memory channels.

Intel® Advanced Vector Extensions 512 (Intel® AVX-512) doubles the amount of data handled per instruction compared to predecessor Intel® AVX2 technology.[3] Intel® Speed Select Technology enables the platform to adjust operating frequency and voltage in response to workloads, optimizing the balance between performance and energy efficiency. In addition, Intel Xeon Gold processors also feature important platform technologies that are required or recommended for Intel Select Solutions for NFVI Forwarding Platform:

- **Intel® Virtualization Technology (Intel® VT)** provides hardware abstraction so multiple workloads can share resources; workloads are isolated in hardware. Use of Intel VT in the solutions is required.
- **Intel® Boot Guard** provides hardware-based integrity protection for the system boot blocks against compromise. Use of Intel Boot Guard in the solution is required.
- **Intel® Trusted Execution Technology (Intel® TXT)** tests the integrity of the software environment at system start-up by comparing it to a known good copy. Use of Intel TXT in the solutions is optional.

2nd Generation Intel® Xeon® Scalable processors:

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

Intel® Ethernet Network Adapter XXV710

Standards-based networking performance across NFVI workloads is provided by the Intel® Ethernet Network Adapter XXV710 through a combination of sophisticated packet processing, intelligent offloads and accelerators, and high-quality open-source drivers. 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:

- **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.
- **Dynamic Device Personalization (DDP)** is a programmable packet-processing pipeline provided by the Intel® Ethernet 700 Series that supports on-demand reconfiguration of network controllers at runtime, enabling workload-specific optimizations to increase throughput and decrease latency.

The adapters deliver excellent small-packet performance that is well suited to the requirements of 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).

Intel® Optane™ DC Persistent Memory

A redefined memory tier based on Intel® Optane™ DC persistent memory (recommended) improves overall system performance and reduces latency by putting more data close by the processor on non-volatile memory, reducing the need for disk accesses. It combines the byte-addressability of DRAM with the persistence of storage, with idle read latency that's an order of magnitude faster than SSDs or other storage types. In a form factor that's socket-compatible with DDR4, Intel Optane DC persistent memory is available in capacities from 128 GB to 512 GB.

Software and Firmware Stack

The Intel Select Solutions for NFVI Forwarding Platform includes a comprehensive, workload optimized software and firmware stack, as shown in Table 3. While the solution initially focuses on Red Hat Enterprise Linux* and Red Hat OpenStack*, it can accommodate other OSs and VIMs as well.

Table 2. Intel® Select Solutions for NFVI Forwarding Platform hardware configurations (required unless otherwise noted).

Ingredient	Plus Configuration	Base Configuration	Controller Node Configuration
Processors	2x Intel® Xeon® Gold 6252 processor @ 2.1 GHz or Intel Xeon Gold 6252N processor @ 2.3 GHz, 24C/48T or higher	2x Intel® Xeon® Gold 6230 processor @ 2.1 GHz or Intel Xeon Gold 6230N processor @ 2.3 GHz, 20C/40T or higher	2x Intel® Xeon® Gold 5218 processor @ 2.3 GHz or Intel Xeon Gold 5218N processor @ 2.3 GHz, 16C/32T or higher
Memory	384 GB DDR4-2666 or 192 GB DDR4-2666 plus Intel® Optane™ DC persistent memory		192 GB DDR4-2666 or 192 GB DDR4-2666 plus Intel Optane DC persistent memory
Intel® Optane™ DC Persistent Memory	1-1.5 TB Intel Optane DC persistent memory (recommended)	512 GB Intel Optane DC persistent memory (recommended)	
Discrete Network Adapters	4x Intel® Ethernet Network Adapter XXV710 SPF 28+ quad-port @ 25 Gbps	2x Intel® Ethernet Network Adapter XXV710 SPF 28+ quad-port @ 25 Gbps or 4x Intel® Ethernet Network Adapter XXV710 SPF 28+ dual-port @ 25 Gbps	2x Intel® Ethernet Network Adapter XXV710 SPF 28+ dual-port @ 25 Gbps
Local Storage	2x Intel® SSD D3-S4510 Series or higher @ 480 GB or larger		
LAN on Motherboard	10 Gbps or 25 Gbps port for Pre-boot Execution Environment (PXE) and Operation, Administration and Management (OAM)		
	1/10 Gbps port for management		

Table 3. Intel® Select Solutions for NFVI Forwarding Platform software configurations (minimum).

	Ingredient	Software Version Details	
Firmware	BIOS MCU	SE5C620.86B.0X.02.0040.060420190144 Release Date June 04, 2019 0x5000026	
	FV25 NIC FW	v6.02 or later	
	Intel® Optane™ DC persistent memory FW, DIMM FW	NVMDIMMDriver: v01.00.00.3371 NVMDIMMHii: v01.00.00.3371	
Host	OS	Red Hat Enterprise Linux*	RHEL7.6-kernel- 3.10.0-957.21.3.el7.x86_64
	Hypervisor	KVM/QEMU	2.12.0
	Libvirt	Libvirt	4.5.0
	Docker	docker	Version 18.09.7, build 2d0083d
	APPs	DPDK	18.11, 19.02
	APPs	CollectD	5.8.0
	Drivers	I40e NVMe	2.3.2-k 1.0
Guest	APPs	DPDK	18.11, 19.02
	OS	Ubuntu*	18.04LTS
		Red Hat Enterprise Linux	7.6
		CentOS*	7.6
	Drivers	I40evf	3.2.2-k

Conclusion

The Intel Select Solutions for NFVI Forwarding Platform are based on a workload-optimized reference architecture that is purpose-built for high throughput and to provide a single coherent infrastructure for NFV that will enable the 5G rollout over the next several years, by means of network transformation at the access, next-gen central office (NGCO) and core. With pre-validated, pre-optimized solution stacks from a choice of OEMs, the solution can dramatically accelerate deployment and time to new services, while reducing implementation risk for CommSPs.

Learn More

Intel® Select Solutions: **intel.com/selectsolutions**

2nd-generation Intel® Xeon® Scalable processors: **intel.com/xeonscalable**

Intel Select Solutions are supported by the Intel® Builders program: **builders.intel.com**

[1] "IDC Forecasts Network Functions Virtualization Infrastructure (NFVI) Revenues to Reach $5.6 Billion in 2022." https://www.idc.com/getdoc.jsp?containerId=prUS44231418.

[2] "Second Generation Intel® Xeon® Processor Scalable Family Technical Overview." https://software.intel.com/en-us/articles/second-generation-intel-xeon-processor-scalable-family-technical-overview.

[3] "Intel® Advanced Vector Extensions 512 (Intel® AVX-512) Overview." https://www.intel.com/content/www/us/en/architecture-and-technology/avx-512-overview.html.

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