SOLUTION BRIEF

Intel Builders
Universal Customer Premises Equipment

Intel® Select Solutions for uCPE Infrastructure on CentOS

Universal CPE (uCPE) systems bring the powerful performance of Intel® Xeon® D processor-based systems to the edge of communication service provider networks for agile service provisioning. Intel Select Solutions for uCPE provide a foundation for the development of uCPE products with a solution reference design and verified performance.

Introduction

Enterprise adoption of cloud services sets the stage for digital transformation among communication service providers (CommSPs) and their ecosystem partners such as original design manufacturers (ODMs), independent software vendors (ISVs), telecommunications equipment manufacturers (TEMs), and system integrators (SIs). Customer premises equipment (CPE) based on network functions virtualization (NFV) is a key means of meeting the cloud and networking needs that arise from this transition.

Universal CPE (uCPE) systems provide a single platform dedicated to virtualized network functions (VNFs) such as WAN routing, virtual private networking, firewalling, intrusion prevention, session border control, carrier-grade network address translation, Wi-Fi, and software-defined WAN (SD-WAN). CommSPs use uCPE solutions to replace multiple fixed-function appliances, reducing their capital and operating costs while increasing their flexibility for service provisioning.

The business opportunity associated with uCPE is driving significant market growth. International Data Corporation (IDC) forecasts that the worldwide uCPE infrastructure market will grow to exceed US$3 billion for hardware and software by 2022.[1]

CommSPs have defined uCPEs in terms of compute, storage, and networking platforms designed to bring virtualized or non-virtualized (bare metal) services to small branch offices and small-to-medium-sized businesses. To support these platforms, Intel has developed the Intel Select Solutions for uCPE reference design, which provides a pre-validated set of solution components based on the Intel Xeon D processor, with a defined configuration designed to provide optimized, predictable results. The Intel Select Solutions for uCPE reference design provides a strong value proposition to TEMs, ODMs, ISVs, and SIs:

- **Product-ready reference design** results in faster time to market
- **Intel solution verification** reduces network evaluation time needed by CommSPs
- **Partnering with Intel** enables joint go-to-market solutions and strategies

uCPE Use Cases

Intel Select Solutions for uCPE are pre-validated to help streamline integration with a variety of service VNFs. SD-WAN has become one of the highest profile services because it automates the provisioning of WAN connections and enables branch offices to access corporate resources while also taking advantage of broadband internet access links for cloud service access. Because uCPE hardware is based on general-purpose computing technology, SD-WAN VNFs that are deployed on uCPE systems are more cost effective than previous-generation WAN systems based on proprietary hardware.

With Intel architecture-based servers supporting a wide range of performance and price points, enterprises can standardize networking and data security software services across differently sized facilities, even down to the smallest branch offices. Organizations with large branch-office networks, such as retailers and banks, can centralize the purchase of their key networking applications and work with their CommSPs to deploy the applications across their corporate landscape for consistency and centralized updates and policies.

For small businesses, Intel Select Solutions for uCPE can enable CommSPs to provision a single system that provides a wide range of networking and hosted services. CommSPs can also standardize on software used in hybrid cloud-CPE services, because the software can run on Intel architecture-based servers in both locations. In these hybrid cloud-CPE services, complex software functionality is hosted in the cloud and the uCPE is utilized for network connectivity and localized processing.

Intel Select Solutions for uCPE Reference Design

Intel has designed two product configurations as part of the Intel Select Solutions for uCPE reference design, as detailed in Table 1:

- **Intel Select Solutions for uCPE Base configuration:** This uCPE design is based on a four-core or greater Intel Xeon D processor and network and storage products from Intel, targeting value-based solutions with at least two virtual machines in a small-to-medium-sized business environment.
- **Intel Select Solutions for uCPE Plus configuration:** This uCPE design is based on a 14-core Intel Xeon D processor and specifies the network, storage, and integrated platform acceleration products from Intel to maximize virtual machine density.

Intel Xeon Scalable processors feature important platform technologies as part of a tuned configuration:

- **Intel Virtualization Technology (Intel VT)** provides hardware abstraction to allow multiple workloads to coexist and share common resources while maintaining full isolation.
- **Intel Boot Guard technology** is hardware-based boot integrity protection that can help prevent unauthorized software and malware takeover of boot blocks critical to a system's function.
- **Intel Trusted Execution Technology (Intel TXT)** is a hardware-based platform security technology that tests the authenticity of critical elements of a platform, operating system, and hypervisor against known good results.[3]

Table 1. Example hardware configuration for Intel® Select Solutions for uCPE Base configuration and Intel Select Solutions for uCPE Plus configuration.

Ingredient	Intel Select Solutions for uCPE Base Configuration Hardware	Intel Select Solutions for uCPE Plus Configuration Hardware
Processors	Intel Xeon D-2123IT processor (four cores, 2.2 GHz, 60 w) or higher SKU	Intel Xeon D-2177NT processor (14 cores, 1.9 GHz, 105 w) or higher SKU
Memory	16 GB DDR4 2133 MHz, 4x 4 GB (16 GB Total) Minimum all 4 memory channels populated (1 DPC)	64 GB DDR4 2667 MHz, 4x 16 GB (64 GB Total) Minimum all 4 memory channels populated (1 DPC)
Network	2x 10 GbE integrated Ethernet ports	4x 10 GbE integrated Ethernet ports
Intel® QAT	Integrated Intel QuickAssist Technology,[2] or an Intel QuickAssist Adapter 8970 PCIe add-in card,[2] or equivalent Intel® C627 Series Chipset QAT Enabled PCIe add-in card[2]	Integrated Intel QuickAssist Technology, or an Intel QuickAssist Adapter 8970 PCIe add-in card, or equivalent Intel C627 Series Chipset QAT Enabled PCIe add-in card
Storage	Intel SSD Data Center S3110 256 GB 2.5" internal solid state drive (SATA or M.2)	Intel SSD Data Center S3110 512 GB 2.5" internal solid state drive (SATA or M.2)

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.

Verified Performance Through Benchmark Testing

All Intel Select Solutions are verified by Intel to meet a specified minimum level of workload-optimized performance capability. Verified Intel Select Solutions for uCPE meet or exceed design and testing standards for data throughput and specialized security, encryption, and compression performance that are essential in edge networking use cases. Three key testing standards are specified for Intel Select Solutions for uCPE:

- **Intel QuickAssist Technology**. Intel QAT establishes stringent performance standards for bulk crypto performance across a range of uCPE use cases including when applications are running simultaneously. This benchmark tests both compression and encryption algorithms measured with typical packet sizes.
- **OpenSSL Performance**. In addition to the bulk crypto performance, Intel Select Solutions for uCPE solutions must demonstrate a minimum OpenSSL throughput and sign operations performance requirements as measured by executing OpenSSL Speed Benchmark testing.
- **Packet Processing Performance**. Intel Select Solutions for uCPE deliver high data-plane throughput by means of optimizations made using the open source Data Plane Development Kit (DPDK). This performance is demonstrated using the DPDK L3 Forwarding sample application.

Table 2 shows minimum performance standards for cryptographic and compression operations by both the Base and Plus uCPE configurations. System builders, system integrators, and solution and service providers can further optimize the reference designs to achieve higher performance and additional capabilities.

Table 2. Minimum cryptographic and compression performance standards for Intel Select Solutions for uCPE.

Minimum Performance Standards		Base Configuration[4]	Plus Configuration[5]
Cryptographic and Compression Operations Performance with Intel® QAT	Compression (compress and verify) throughput[6]	13 Gb/s	55 Gb/s
	Encryption throughput[7]	20 Gb/s	100 Gb/s
	RSA throughput[8]	20,000 sign/s	100,000 sign/s
OpenSSL Performance	AES128-CBC-HMAC-SHA1	20 Gb/s	100 Gb/s
	RSA 2048	20,000 sign/s	100,000 sign/s

The Linux Foundation's Cyclictest application is used to measure system latency, which must meet the standards set out in Table 3. Test results reflect the difference between a thread's intended wake-up time and the time when it actually wakes. Cyclictest measures latencies that originate in hardware, firmware, or the operating system. System-latency testing of the Intel Select Solutions for uCPE is based on Cyclictest running in a virtual machine.

Table 3. Cyclictest performance requirements (executed inside a virtual machine).

Latency	1 CPU	8 CPUs
Minimum	<5 µs	<10 µs
Maximum	<10 µs	<15 µs

Intel Xeon Processor D-2100 Product Family

The Intel Xeon processor D-2100 product family is based on the Intel Xeon Scalable processor architecture and is optimized for low power consumption and high-density solutions, integrating essential network, security, and acceleration capabilities into the platform. Intel Xeon D processor-based solutions enable CommSPs to bring intelligent services to the network edge by offering low total cost of ownership and power draw, and delivering space-efficient commercial off-the-shelf servers. Key features include:

- **Enhanced memory**: Up to 512 GB of DDR4 ECC
- **Enhanced accelerators**: Integrated Intel QuickAssist Technology (Intel QAT) for accelerated compression and encryption/decryption
- **New extensions**: Intel Advanced Vector Extensions 512 (Intel AVX-512), a specialized instruction set for outstanding compute performance
- **Enhanced networking**: Up to four integrated 10 GbE Intel Ethernet adapters

Software and Firmware Stack

All Intel Select Solutions feature a workload-optimized software stack tuned to take full advantage of an Intel hardware foundation. The software and firmware configurations shown in Table 4 apply to both the Intel Select Solutions for uCPE Base configuration and the Intel Select Solutions for uCPE Plus configuration.

Intel has introduced CentOS with real-time extensions to the Intel Select Solutions for uCPE infrastructure to support usages with high determinism requirements. For example, this evolution enables developers of solutions for 5G networks that must operate within strict latency parameters, powering real-time insights for data-driven decision making. Ongoing development and extension of Intel Select Solutions matches solution architectures to the emerging needs of the technology marketplace.

Table 4. An example software stack for the Intel Select Solutions for uCPE Infrastructure on CentOS. (With ongoing testing and optimization collaboration, version levels and components are subject to change over time.)

		Ingredient	Software Version Details
Firmware		BIOS	February 2019 release data and later
		MCU	0x200005A or later
		X722 NIC FW	V3.3
		XXV710 NIC FW	V6.80
Host	APPs	DPDK	19.02
	OS	CentOS	CentOS 7.6 (3.10.0-957.5.1.rt56.916)
	Hypervisor	KVM/QEMU	3.0.0
	Libvirt	Libvirt	Libvirt 5.0.0
	Drivers	Intel QAT	L.4.5.0-00034
		I40e	2.7.29
		Ixgbe	5.5.5
Guest	APPs	DPDK	19.02
	OS	CentOS	CentOS 7.6
	Drivers	I40evf	3.6.15
		Ixgbevf	4.5.3

Ecosystem Enablement

In addition to the reference design, Intel Select Solutions for uCPE benefit from a substantial ecosystem of solutions developed to run on the CentOS foundation. For example, both ADVA Ensemble Connector and Red Hat Enterprise Linux are from the same foundation Linux elements. Choosing this popular distribution allows other commercial distributions to focus on application integration at the higher layers of the stack, improving time to market and easing industry adoption. For added I/O flexibility, the program has a network of options including xDSL, PON, DOCSIS, T1/E1, voice, wireless, and more. Global ODMs that are part of the ecosystem have experience and expertise in manufacturing these uCPE devices.

Conclusion

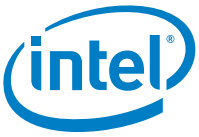
The uCPE market is expected to grow rapidly as CommSPs work with enterprises and small businesses to adopt these systems as part of their business strategies. The Intel Select Solutions for uCPE reference design provides the market with the platform, software, and ecosystem required to get to market quickly with a differentiated product. At the heart of the reference design is the Intel Xeon D processor, which offers the performance, acceleration features, security features, and built-in Ethernet connectivity needed for cost-effective, high-performance uCPE systems.

Learn More

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

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

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



[1] IDC Worldwide vCPE/uCPE Forecast, 2018–2022 at https://www.idc.com/getdoc.jsp?containerId=US44484617.

[2] Recommended for the configuration, but not required.

[3] No product or component can be absolutely secure.

[4] Testing conducted by Intel on May 18, 2018, with the following hardware and software (base) configuration: 1 node, 1x Intel Xeon D-2146NT processor; total memory 16 GB, 4 slots/4 GB/2133 MHz DDR4 RDIMM; Intel Turbo Boost Technology enabled; 256 GB Intel SSD SATA; 2x 10 GbE; ucode: 0x200005A; OS/Software: CentOS* 7.6.

[5] Testing conducted by Intel on May 18, 2018, with the following hardware and software (plus) configuration: 1 Node; 1x Intel Xeon D-2177NT processor; total memory 64 GB, 4 slots/16 GB/2667 MHz DDR4 RDIMM; Intel Turbo Boost Technology enabled; 512 GB Intel SSD SATA; 4x 10 GbE; ucode: 0x200005A; OS/Software: CentOS 7.6.

[6] Performance to be measured at 8 KB packet size.

[7] Performance to be measured at 4 KB packet size.

[8] Performance to be measured at 2 KB packet size.

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 www.intel.com/benchmarks.

Performance results are based on testing as of June 18, 2018, and may not reflect all publicly available security updates.

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/selectsolutions.

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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