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Intel Select Solutions for Virtual Radio Access Network (vRAN) on Wind River Studio

Intel Select Solutions for vRAN provide pre-validated reference architectures that help accelerate development for virtualized RAN architectures. Tailored hardware based on the flexible performance of the 3rd Generation Intel Xeon Scalable processors is complemented by a software stack based on Wind River Studio.

Introduction

5G is fueling a rapid transition to virtualization and cloud-native technologies, and many operators are embracing a shift to a virtualized RAN (vRAN) for greater agility. vRAN architectures offer many advantages, including the following:

- **Enhanced user experience and faster network performance**. Critical real-time tasks are optimized for performance and completed at the edge, closer to the end user for reduced latency, and resources such as processing, memory, and I/O are dynamically allocated.

- **Reduced costs, including both CapEx and OpEx**. Using standards-based infrastructure improves hardware utilization efficiency and reduces operating costs through reduced maintenance and power savings.

- **Flexible performance and agile adaptability**, as general-purpose infrastructure decoupled from specific workloads can transparently adapt when new network elements and services are added and dynamically respond to changing network requirements.

Intel Select Solutions for vRAN offer operators a streamlined path to deployment, with validated stacks of hardware and software built in conjunction with other industry leaders for flexible performance and enhanced security. Thorough verification of the hardware and software together helps reduce the time, effort, and expense associated with developing vRAN solutions.

Solution Overview

The foundation of the Intel Select Solutions for vRAN is a robust set of Intel architecture components that include the 3rd Generation Intel Xeon Scalable processor, the Intel vRAN Dedicated Accelerator ACC100, the Intel Ethernet Network Adapter E810, and Intel QuickAssist Technology (Intel QAT).

The Intel Select Solutions team subjects the reference architectures to rigorous regression testing in a lab environment to ensure high reliability in the overall solution. Intel validates the entire hardware and software solution stack defined in the reference architectures, eliminating the complexity typically associated with supporting multi-vendor solutions.

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Task Offload with Hardware Accelerator

Particular attention has been given during the development of the Intel Select Solutions for vRAN to reducing the overhead associated with Layer 1 forward error correction (FEC). The Intel vRAN Dedicated Accelerator ACC100 is a fixed-function accelerator that can offload high-bandwidth FEC processing as well as rate-matching and cyclic redundancy check (CRC) functions from the CPU when required, for both 4G and 5G workloads simultaneously, freeing up resources for other high-value workloads and expanding overall vRAN capacity.

Optimization with Intel FlexRAN Reference Architecture

The FlexRAN software reference architecture integrates the Intel vRAN Dedicated Accelerator ACC100 and defines the DPDK-optimized L1 pipeline that enables general-purpose servers to host 5G base station CU and DU functions. It provides optimized libraries for accelerating LTE and 5G NR Layer 1 workloads, including precoding, channel estimation, PRACH decoding, etc., and it further incorporates optimizations for massive MIMO (mMIMO) use cases.

The FlexRAN LTE and 5G NR FEC Software Development Kit complements the Intel® oneAPI suite of software development tools to facilitate rapid development of software-defined radio base stations that can be deployed anywhere in the network, from edge to core.

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/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 datacenter and service providers. Every Intel Select Solution is a tailored combination of Intel datacenter 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.

Configurations for Spectral Coverage

To provide flexible performance across implementation requirements, the Intel Select Solutions for vRAN reference architectures include both Base and Plus configurations. The two configurations enable customers to balance cost with functionality; a high-level summary is shown in Table 1.

Table 1. Intel Select Solutions for vRAN sample cell density KPI targets.

Benchmark	Plus
Peak Target Cell Density (Cores/Cell)	**3** x100 MHz 64T64R (16DL/8UL)
vRAN Use Case	Midband / mMIMO (100 MHz)

Intel Platform Technologies

The Intel Select Solutions for vRAN integrate advanced Intel technologies to enable flexible performance and data security. A significant contributor to the overall flexibility of the solutions, Intel's full breadth of platform ingredients help deliver low TCO, high performance, and confidence that the meet the needs of today and also accommodate the unknown demands of the future.

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 vRAN:

- **New balanced, scalable architecture** increases per-core performance, memory and I/O bandwidth to accelerate diverse workloads from the edge to the datacenter.

- **Increased core count and cache**, available in a flexible range of network-optimized SKUs from 20-36 next-generation cores and power envelopes from 135 W to 225 W, offering higher base frequency for greater VNF throughput and lower power for dense or constrained physical deployments.

- **New extensions to Intel Advanced Vector Extensions 512 (Intel AVX-512) instructions** accelerate bit-processing kernels that move and reorder blocks of data within the wireless signal processing pipeline.

Intel vRAN Dedicated Accelerator ACC100 powers PCIe Gen 3 x16 add-in cards offered by multiple vendors that improve throughput, capacity, and power efficiency of the Intel Select Solutions for vRAN by offloading FEC processing from the main processor. The accelerator is based on Intel eASIC™ technology, which provides lower unit cost and power consumption than Application-Specific Integrated Circuits (ASICs), while also offering faster time-to-market.

Intel Ethernet Network Adapter E810 delivers efficient, workload-optimized performance at Ethernet speeds up to 100 Gbps. These adapters are able to accelerate the Intel Select Solutions for vRAN with packet-classification sorting optimizations for high-bandwidth workloads. Future enablement for Dynamic Device Personalization (DDP) could dynamically control the Ethernet controller's programmable packet-processing pipeline, delivering up to a 3x throughput improvement.[1] Multiple DPP profiles specify workload-specific optimizations, add protocols where they can improve efficiency, and define parameters for packet-handling and processing.

Intel QAT is a hardware acceleration technology that provides lookaside cryptographic and compression/decompression co-processing services for the CPU. Intel QAT is built into certain Intel processor platform chipsets and can be added to a server as an additional PCIe adapter and is included via PCIe-based add-in card options. Use of Intel QAT is optional for Intel Select Solutions for vRAN, depending on the use case.

Base and Plus Hardware Configurations

Intel has drawn on extensive industry collaborative partnerships to refine hardware requirements for the reference architectures included in the Intel Select Solutions for vRAN. To provide flexible performance across implementation requirements, the reference architecture includes both Base and Plus configurations, as detailed in Table 2.

Table 2. Intel Select Solutions for vRAN Base and Plus hardware configurations

Ingredient	Intel Select Solutions for vRAN Base Configuration Hardware	Intel Select Solutions for vRAN Plus Configuration Hardware
CPU	3rd Generation Intel Xeon Gold 5318N processor (one socket, 20 cores) or higher SKUs	3rd Generation Intel Xeon Gold 6338N processor (one socket, 32 cores) or higher SKUs
Memory	128 GB (16 GB DIMM/Channel recommended)	
Intel Ethernet Controller:	1x E810-CAM2 or CAM1 based NIC for 100Gb/s throughput: e.g., 1x E810-XXVDA4 or 1x E810-CQDA2	2x E810-CAM2 or CAM1 based NIC for 200Gb/s throughput: e.g., 2x E810-XXVDA4 or 1x E810-2CQDA2
Acceleration	1x Intel vRAN Dedicated Accelerator ACC100 Intel QAT (optional)	
Storage (SSD/NVMe)	At least 2x 480 GB for boot (Intel SSD, Intel Optane™ SSD, or M.2 equivalent)	

Software and Firmware Stack

The Intel Select Solutions for vRAN include a comprehensive, workload optimized software and firmware stack based on Wind River Studio. Wind River Studio also includes a production-grade Kubernetes cloud platform for managing edge cloud infrastructure. Contact your Intel representative for access to a detailed design specification for each configuration. These specifications and associated test plans are posted to the Intel Resource and Design Center.

The solution details each software stack component in order to reduce chances for incompatibilities, eliminate errors, and provide for reliable and high-performance operation. Variables specified include minimum supported versions of the following key items:

- Intel processor microcode update versions
- UEFI firmware (BIOS)
- Host and guest operating system versions
- Intel Ethernet Controller E810 firmware and drivers
- Intel Optane SSD firmware and drivers

BIOS and Platform Settings

Settings for platform technologies and BIOS are shown in Table 3. All settings are required unless otherwise noted.

- **Intel Virtualization Technology (Intel VT)** provides hardware abstraction to allow multiple workloads to coexist and share common resources while maintaining full isolation.
- **Intel Trusted Execution Technology (Intel TXT)** helps protect the integrity of the execution environment by checking it against a known good image at startup to rule out tampering.
- **Intel Boot Guard** is hardware-based boot integrity protection that helps prevent unauthorized software and malware takeover of boot blocks critical to a system's function.

Table 3. Platform technologies and BIOS settings.

Intel Virtualization Technology	Intel CPU Virtual Machine Extensions (VMX) Support	Enable
	Intel I/O Virtualization	Enable
Intel Trusted Execution Technology		Enable (recommended)
Intel Boot Guard		Enable for Base Enable (recommended) for Plus
BIOS	BIOS Profile	Maximum Performance
	Intel SpeedStep® technology	Disable (Config TDP, Level 2)
	C-States	C6 Enable
	Intel Turbo Boost technology	Enable
	Intel Hyper-Threading technology	Enable

Conclusion

The Intel Select Solutions for vRAN give wireless network operators the ability to accelerate time-to-market of next generation vRAN architectures based on 3rd Generation Intel Xeon Scalable processors and the Intel vRAN Dedicated Accelerator ACC100. These validated designs offer an efficient and flexible way to develop vRAN solutions to create a strong foundation for new services, applications, and deployment models.

Learn More

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

3rd Generation Intel Xeon Scalable processors:
intel.com/content/www/us/en/products/processors/xeon/scalable.html

Intel Select Solutions are supported by the Intel Network Builders Program:
networkbuilders.intel.com/intelselectsolutions/network

Wind River Studio Operator Capabilities: **windriver.com/studio/operator**

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