White Paper

Communication Service Providers (CoSPs), Mobile Network Operators (MNOs)

Intel-HPE Verified Reference Configuration for vRAN with VMware® Telco Cloud Platform™ RAN

Streamline and Optimize vRAN Deployments with the Intel-HPE Verified Reference Configuration on 4th Gen Intel® Xeon® Scalable Processors with Intel® vRAN Boost

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Intel Verified Reference Configurations (VRC) provide workload-optimized infrastructure solutions based on the Intel® Xeon® Scalable processor family, designed to address today's complex workloads across a wide variety of network-oriented use cases and verticals. This document details a Virtual Radio Access Network (vRAN) optimized reference implementation, developed in collaboration with Hewlett Packard Enterprise (HPE) and VMware by Broadcom.

By choosing this reference architecture for vRAN deployments, network operators and communication service providers can more securely and efficiently deploy vRAN solutions in their networks.

Intel VRC for vRAN

Deploying vRAN can be challenging due to the need for low latency, high bandwidth, and reliable performance across diverse network environments. Intel's VRC for vRAN addresses these challenges by bundling hardware and software into a unified reference architecture that simplifies design choices and reduces the time, effort, and expense associated with evaluating multiple options. This solution enables network operators, service providers, cloud providers, and enterprise infrastructure companies to deploy NFV applications more securely and efficiently than ever before.

Hardware Bill of Materials (BOM)

The vRAN solution is implemented on the HPE ProLiant DL110 Gen11 server, a compact and powerful server optimized for edge applications that demand high bandwidth and low latency, such as 5G cellular processing. This section outlines the critical components and technologies integrated into this hardware platform, which collectively ensure superior performance, scalability, and reliability for vRAN deployments.

Key Hardware Components:

- **4th Gen Intel® Xeon® Scalable Processors:** These processors provide robust compute power optimized for network and RAN workloads, featuring integrated vRAN Boost to enhance performance and efficiency specifically for vRAN deployments.
- **PCIe Gen5 Technology:** Provides enhanced I/O bandwidth crucial for high-speed data transfers, reducing latency and supporting the demands of vRAN.
- **Intel® Ethernet and Acceleration Technologies:** Embedded Data Plane Development Kit (DPDK) and BBDEV technologies optimize packet processing and offload tasks from the CPU, achieving low-latency performance.
- **Standards-Compliant Architecture:** Built on an open, standards-compliant infrastructure, ensuring flexibility and scalability for growing network needs.

HPE ProLiant DL110 Gen11 Server

The HPE ProLiant DL110 Gen11 Server, powered by 4th Gen Intel® Xeon® Scalable processors, is purpose-built for edge applications requiring high bandwidth and low latency, such as 5G vRAN deployments. Optimized for modern, scalable infrastructure, this compact server delivers exceptional compute performance and dense I/O capabilities, ensuring reliable and efficient operation from edge to cloud.

Figure 1. HPE ProLiant DL110 Gen11 Server

Key Features:

- **Edge-Optimized Performance:** Designed specifically for edge applications, delivering low-latency and high-bandwidth performance tailored for 5G vRAN workloads.
- **Compact and Scalable:** Combines a space-efficient design with scalable architecture, ideal for deploying in constrained environments while supporting future growth.
- **Advanced I/O Capabilities:** Equipped with PCIe Gen5 technology, offering enhanced I/O bandwidth and acceleration options to meet the demands of high-performance edge computing.
- **Integrated Security:** Built with advanced security features, including SPDM for component authentication and firmware resilience, ensuring data integrity and protection at the edge.
- **Enhanced Protection with HPE iLO 6:** Benefit from extended protection through the HPE partner ecosystem, leveraging HPE iLO 6 for robust security verification and enhanced system resilience.

HPE Hardware and Firmware Details

This vRAN VRC solution features a cutting-edge hardware configuration that combines the latest Intel processor technology with Intel platform innovations, including Ethernet and acceleration technologies. Integrated on the motherboard, these technologies deliver best-in-class, low-latency performance optimized for demanding workloads with the DPDK.

Note: For HPE ProLiant DL110 Gen11 drivers and firmware updates, visit HPE Support.

Intel BIOS Recommendation

Intel recommends configuring BIOS settings to Max Performance with a low latency profile to optimize the deterministic performance of the vRAN reference implementation. These settings are tailored for Intel® Xeon® processors in vRAN deployments. For detailed BIOS configurations specific to FlexRAN™ platforms, see the BIOS settings guide for FlexRAN™ Platforms.

For BIOS settings recommended for VMware® Telco Cloud Platform™ RAN deployments refer to: Checklist to validate Network Function (DU/CU) deployments.

Hardware	Description
Processors	20-core or 32-core, 4th Gen Intel® Xeon® Scalable Processor with Intel® vRAN Boost
Memory	8x 32GB Dual Rank DDR5 @ 4800MHz, 1 DIMM per channel, Total Memory 256GB
Network Interface Card (NIC)	Quad Port 25GbE Intel® Ethernet Network Adapter E810 XXVAMDA4 (Gen 4 x8)
Storage	2x 960GB SSD NVMe solution as boot device

Table 1. Hardware Details

Solution Software

The solution deployment is on VMware® Telco Cloud Platform™ RAN 4.0 with the following FlexRAN™ Reference Software revision.

Installation Guide for VMware® Telco Cloud Platform™ RAN

VMware by Broadcom offers comprehensive documentation on various supported deployment methods for the Telco Cloud Platform for Radio Access Network installations.

The following guide describes the overall process for installing and configuring the platform required to run the FlexRAN™ software application: VMware® Telco Cloud Platform™ RAN Platform Deployment Guide.

Component	Version
DPDK	23.11
FlexRAN	24.03
VMware® Telco Cloud Platform™ RAN	4.0
Guest OS Image	Photon OS™ 5 RT Kernel 6.1.10-10.ph5-rt

Table 2. Software Components and Versioning

Performance

The performance metrics of the vRAN reference implementation are critical to ensuring that it meets the expected benchmarks without anomalies. The FlexRAN™ software plays a pivotal role by providing hardware acceleration for Forward Error Correction (FEC) baseband processing in layer one applications, which is essential for optimizing performance in vRAN deployments. The implementation is expected to meet the Key Performance Indicators (KPIs) outlined in the FlexRAN™ Performance Report for the relevant release.

Performance Baseline

To validate the performance of the vRAN implementation, several key applications must be executed once the platform is configured according to the BOM, BIOS settings, and Software Stack specifications detailed earlier. The performance baseline assessment focuses on metrics such as latency, memory bandwidth, and jitter, ensuring the system operates within the expected parameters for optimal vRAN functionality.

Memory Latency Checker (MLC)

The first application to run is the Memory Latency Checker (MLC), which is used to measure memory latency and bandwidth performance.

To download the latest version of MLC, visit the Intel® Memory Latency Checker download page. After downloading, unzip the tarball package, navigate to the Linux folder, and execute the MLC application using the command: `./mlc`

Key Performance Metric	Local Socket (Base)
Idle Latency (ns)	108.1
Memory Bandwidths between nodes within the system (using read-only traffic type) (MB/s)	208666.2

Table 3. MLC Key Performance Metrics

Peak Injection Memory Bandwidth (1MB/s) using all threads	Base Solution
All Reads	208705.6
3:1 Reads-Writes	181177.6
2:1 Reads-Writes	177803.8
1:1 Reads-Writes	164817.4
Stream-triad like	172345.3
Loaded Latencies, read-only traffic delay=0 (ns)	150.36
L2-L2 HIT latency (ns)	8.1
L2-L2 HITM latency (ns)	8.1

Table 4. MLC Test Results

Cyclictest

Cyclictest is a key benchmarking tool used to measure the real-time performance of a system, particularly its latency characteristics. In the context of vRAN configurations, Cyclictest is utilized to evaluate the system's ability to maintain low latency and consistent response times, which are crucial for reliable network performance.

For vRAN configurations, the worker node must demonstrate that the system latency for the wake-up time of threads remains below 15 microseconds for at least 12 continuous hours. This sustained performance ensures that the system can handle the stringent timing requirements of vRAN workloads without degradation.

FlexRAN™ Software Benchmarks

The FlexRAN™ Reference Software serves as a proxy workload to validate that the performance and latency of the Device Under Test (DUT) meet the expected standards from internal testing. The software supports a variety of test cases designed to emulate RAN workloads, including narrow band, massive MIMO, and configurations with varying numbers of cells in both timer mode and O-RAN Mode testing.

For these tests, the FlexRAN™ container is deployed on Photon OS™ RT Guest, running on the Container-as-a-Service (CaaS) workload cluser within the Telco Cloud Platform. Figure 2 illustrates the testing methods supported by Intel FlexRAN™ software, including both timer mode and O-RAN mode.

Specific test cases, such as 6389 and 18220, must be conducted under timer mode on the specified system configuration. The outcomes of these tests should be compared against the published FlexRAN™ performance report to determine pass/fail status.

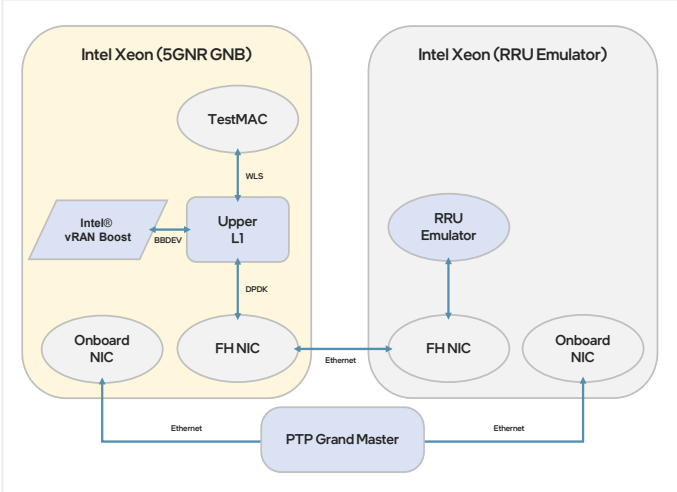

Figure 2. O-RAN Testing Mode

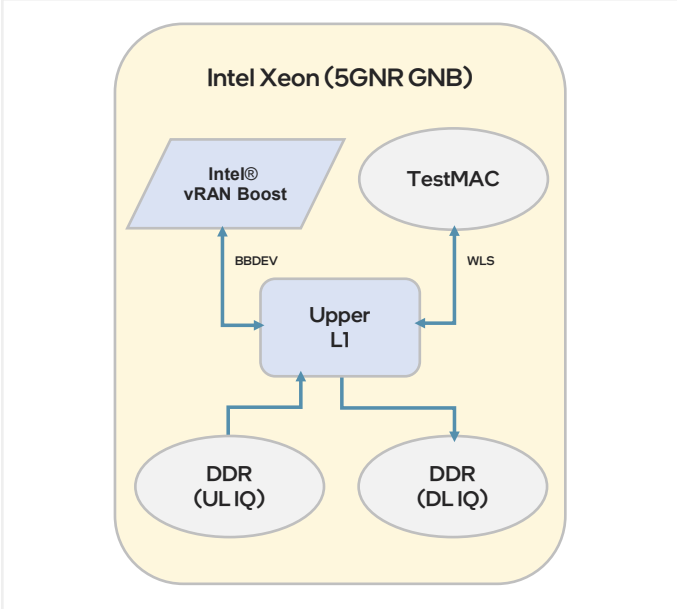

Figure 3. Timer Mode Testing

VMware by Broadcom provides a sample test network function (testnf-du-flexran) in the Cloud-native Network Function (CNF) catalog, which can be readily deployed using VMware® Telco Cloud Automation™. This CNF supports running FlexRAN™ tests in both xRAN mode and timer mode, with options for both FEC accelerator and soft FEC configurations. For detailed guidance on onboarding and instantiation, please refer to the following documentation: TestNF DU FlexRAN Onboarding and Instantiation.

Conclusion

This Intel vRAN Verified Reference Configuration (VRC), based on 4th Gen Intel® Xeon® Scalable processors with Intel® vRAN Boost and HPE ProLiant DL110 Gen11 servers, delivers significant performance and scalability advantages for modern network environments. These processors are optimized specifically for network and RAN workloads, featuring integrated FEC Accelerator offload and Intel® Ethernet E810 Network Controllers, which provide high throughput for both front haul and back haul traffic.

By combining architectural enhancements, high memory, and I/O bandwidth, this Intel VRC offers a robust and efficient foundation for vRAN deployments. The integration with HPE's edge-optimized hardware and VMware® Telco Cloud Platform™ RAN enables network operators and service providers to deploy NFV applications with greater security, reliability, and cost-effectiveness. As networks continue to evolve, this VRC designed in collaboration with HPE and VMware, serves as a critical enabler of next-generation vRAN solutions, providing the tools and technologies needed to meet the demands of increasingly complex and data-intensive workloads.

Learn More

HPE ProLiant DL110 Gen11 server

VMware® Telco Cloud Platform™ RAN

4th Gen Intel® Xeon® Scalable Processors with vRAN Boost

FlexRAN™ Reference Architecture for Wireless Access

100GbE Intel® Ethernet Network Adapter E810

Intel Verified Reference Configurations

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