

# Virtual RAN (vRAN) with Hardware Acceleration

## Layer 1 FEC acceleration increases 4G/5G vRAN cell capacity for both 4G and 5G compared to a software-based approach.

### vRAN in 4G/LTE and 5G deployments

Many operators are embracing a shift to virtualized Radio Access Networks (vRANs) that run baseband unit (BBU) features in virtual machines (VMs) on industry-standard, commercial off-the-shelf (COTS) servers. This change is a transition away from traditional, dedicated hardware to general-purpose computing platforms located in a central location or at the network's edge near the radio tower.

By using a common hardware platform across the network, the same software code base can be used regardless of vRAN location, giving Communications Service Providers (CoSPs) high levels of deployment flexibility and software reusability. Network services can be changed or upgraded quickly, enhancing the customer experience and shortening the time-to-market for new services. vRAN provides dynamic scalability to increase or decrease capacity based on the volume of traffic in the network.

Implementing the principles of network functions virtualization (NFV), vRAN can help CoSPs keep up with 4G/LTE/5G capacity demands and launch differentiated offerings in a highly competitive mobile services market. Deploying service offerings at the edge of the network can improve real-time response and reduce backhauling traffic to the network core to support those services.

### Intel's FlexRAN Implementation

With the FlexRAN software reference architecture, Intel is offering a blueprint to quicken development of vRAN solutions, helping equipment manufacturers and operators reduce time, effort, and cost. FlexRAN enables fast development of software-based radio stations that can sit on any part of the wireless network from edge to core.

The block diagram in Figure 1 shows the FlexRAN layer 1 (L1) PHY application, which takes radio signals from the RF front-end and provides real-time signal and physical layer processing on servers built with Intel® Xeon® Scalable processors and Intel® Xeon® D processors. The FlexRAN reference architecture performs the entire 4G and/or 5G layer 3, 2, and 1 processing with help from an Intel FPGA or a dedicated hardware accelerator, thereby making more processing power available to increase channel capacity and edge-based services and applications.

The FlexRAN SDK provides optimized signal processing libraries for Intel® architecture processors. The FlexRAN Task

Controller facilitates scaling across multiple processors, and the Data Plane Development Kit (DPDK) delivers platform services such as high-throughput packet forwarding and memory management. The FlexRAN platform is designed to run on various operating system vendor (OSV) layers supporting NFV and container network functions (CNF).

Intel Xeon Scalable processors are designed for cloud-optimized, virtualized networks, such as a macrocell deployment or an indoor vRAN that serves an entire building. High performance Intel Xeon D processors are ideal for equipment with space and power constraints, like multi-access edge or distributed computing nodes deployed closer to the radio antenna where they may be exposed to harsh environmental conditions.

### Forward Error Correction (FEC)

One of vRAN's most compute-heavy tasks is the L1 forward error correction (FEC), also referred to as channel coding. More specifically, the codes defined in 3GPP for data channels are turbo code for LTE (36.212) and LDPC for 5G NR (38.212). These sophisticated channel codes are critical to get the most efficient performance from wireless communication systems in terms of throughput, retransmission (error rate), and cell capacity adapted to a given wireless channel condition.

The iterative decoding process for these channel codes is supported with optimized software running on Intel Xeon processors; however, for high-throughput deployment, this processing may consume a significant number of cores that otherwise could be better used for other processing and compute workloads.

### RAN Layer 1 FEC Acceleration

L1 FEC workloads in FlexRAN architecture can be offloaded using one of two types of Intel hardware acceleration products: Intel® FPGA Programmable Acceleration Card (Intel® FPGA PAC) N3000 and Intel® vRAN Dedicated Accelerator ACC100.

Intel FPGA PAC N3000 provides a flexible and scalable option by supporting both L1 FEC and fronthaul connectivity via an Ethernet interface. The ability to program the FPGA enables CoSPs to quickly add new workloads to capture emerging 5G use cases. Intel vRAN Dedicated Accelerator ACC100 is a high-capacity, low-power, and low-cost solution dedicated to L1 FEC offload in large-scale deployment for both 4G and 5G.

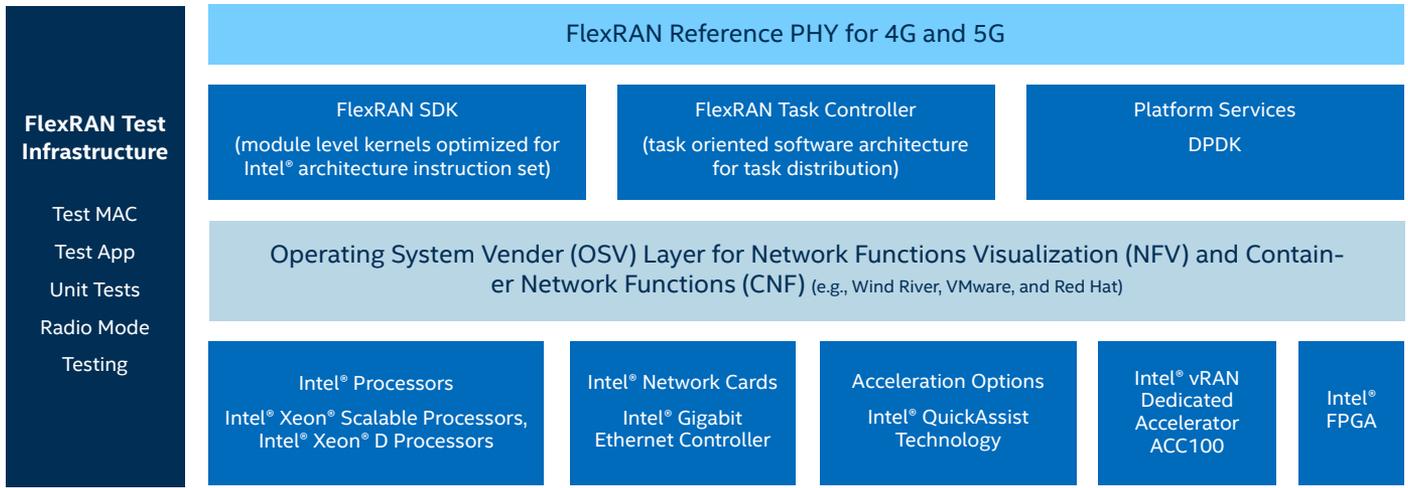


Figure 1. FlexRAN Architecture

Both of these accelerators natively support deployment in a virtualized environment (container or VM) based on single root I/O virtualization (SR-IOV) and Intel® Virtualization Technology for Directed I/O (VT-d). SR-IOV and VT-d are exposed to L1 software using a generic, light-weight interface within DDPK (bbdev). These accelerators significantly increase the cell capacity and performance of second-generation Intel Xeon Scalable processors and Intel Xeon D processors running RAN L1 workloads.

### Accelerator Features

Intel FPGA PAC N3000 is an FPGA-based, programmable card that connects to a processor using a x16 PCIe 3.0 interface. The card can be used to implement any fronthaul standard (e.g., CPRI, IEEE1914.3, eCPRI, and xRAN/ORAN) and lower-layer channel coding functions such as Turbo (4G) and/or LDPC/Polar (5G) channel coding.

The Intel vRAN Dedicated Accelerator ACC100 is a single-chip, dedicated device that also connects to the processor via an industry-standard x16 PCIe 3.0 interface, as shown in Figure 2. The chip works seamlessly with Intel FlexRAN software to provide API and tools support, allowing users to quickly adapt to evolving workloads and industry standards.

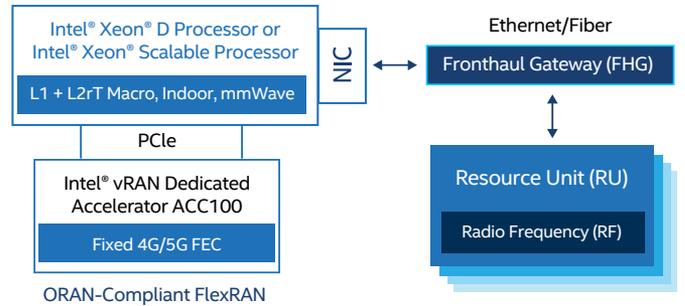


Figure 2. Intel Hardware Accelerator with Intel® vRAN Dedicated Accelerator ACC100

### Conclusion

vRAN offers many benefits, including flexible, dynamic orchestration; software-defined coordination; dynamic resource pooling and load balancing; and more granular quality and reliability of service across the network. Intel is delivering a full suite of hardware and software to help the industry develop high performance, scalable vRAN solutions for 5G networks.



For more information about Intel solutions for 5G, visit <https://www.intel.com/content/www/us/en/wireless-network/5g-overview.html>.

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