Solution Brief

Intel® Xeon® D-2700 Processors
Intel® Xeon® D-1700 Processors

High-efficiency Compute for Mid-range vRAN Deployments

Industry transformation to cloud-native architectures and virtualized radio access network (vRAN) deployments is accelerating. The Intel® Xeon® D-2700 and D-1700 processors are ideally suited to moderate-capacity vRAN provisioning, with software portability to other current and future Intel platforms, including Intel® Xeon® Scalable processors. Full-stack ecosystem enablement delivers value and performance for vRAN implementations.

Communication service providers (CoSPs) are adopting vRAN because of its scalability, cost, flexibility, and service agility. More broadly, vRAN and other virtualized network functions (VNFs) allow proprietary fixed-function equipment to be replaced by lower-cost, standards-based servers. Defining network functionality in software allows it to be decoupled from the underlying general-purpose server hardware, so instances of network functions can be spun up or down as needed in response to changing network conditions. These capabilities make more efficient use of infrastructure headroom, increasing capacity and protecting the user experience.

vRAN deployments have been gaining momentum and scale with Intel® Xeon® processors for high-end macro cells. There is a need to offer lower power, more highly integrated solutions that support smaller deployments from moderate capacity macro cells, to rural and outdoor small cells, to indoor small cells. The Intel® Xeon® D processors meet the requirements of these lower density deployments. The long-term benefits of virtualization are strategically critical as CoSPs prepare for the escalating volume and variety of mobile traffic expected as the buildouts of 5G and IoT continue, together with the rise of new media types such as 3D video and virtual/augmented reality. Providing differentiated services in an environment of plateaued average revenue per user (ARPU) requires new levels of agility, which vRAN can help provide.

Part of that agility vision involves the deployment of vRAN using cloud-native VNFs (CNFs), which are lightweight and compatible with modern development practices such as DevOps, continuous integration/continuous delivery, and microservices. That modernization helps accelerate time to deployment for new services and enables new network functionality to be deployed without making hardware changes. Helping further accelerate innovation and total cost of ownership (TCO) advantages, Intel provides a leadership role in the vRAN ecosystem, as represented in Figure 1.

Intel is a leader in network silicon, with nearly all early vRAN deployments running on Intel® architecture. Intel's ecosystem delivers vRAN on a global scale, with 400+ Intel® Network Builders partners and 43,000 developers trained on Intel network technologies.[1]

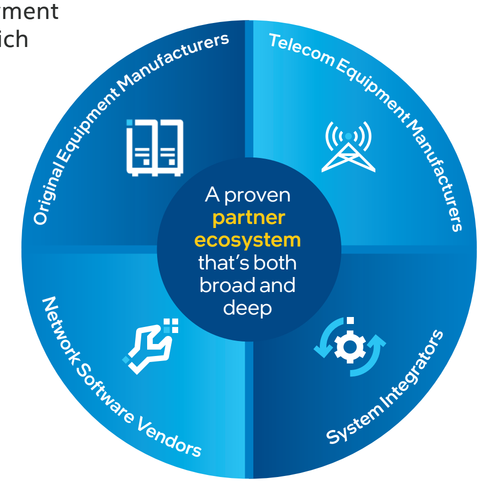

Figure 1. Intel's proven partner ecosystem around vRAN technologies.[1]

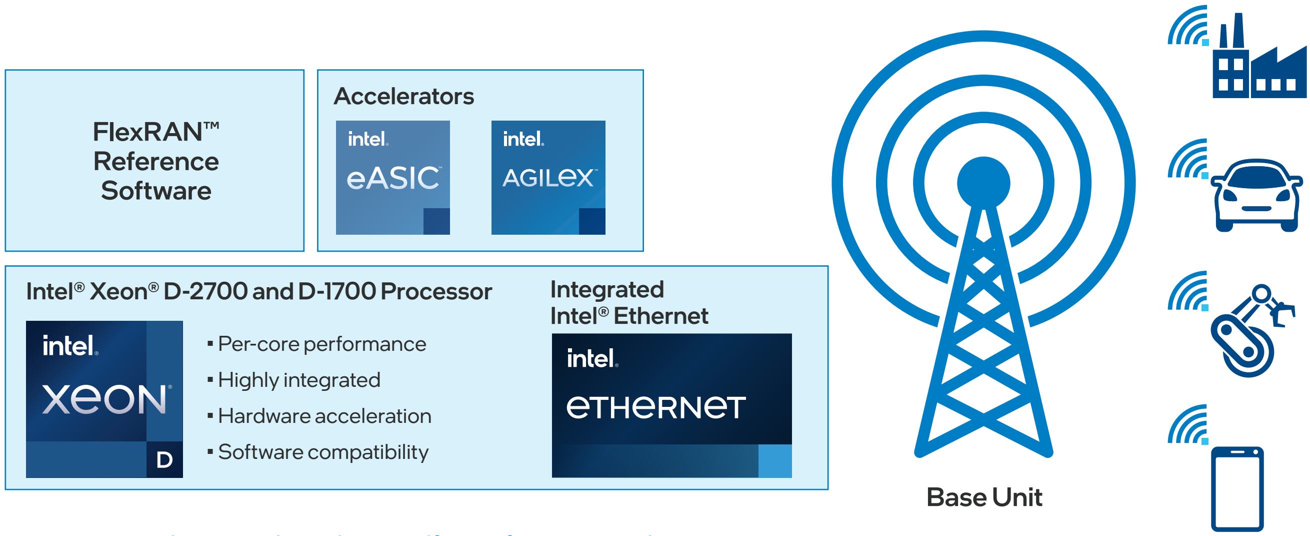

Figure 2. vRAN architecture based on Intel® Xeon® D-2700 and D-1700 processors.

Intel® Technology Portfolio for vRAN Deployment

The physical-layer signal processing executed by the vRAN software requires significant compute resources, and the higher transfer rates and stricter latency requirements in 5G compared to 4G make deterministic high performance more important than ever. Moreover, measures to optimize spectrum efficiency such as massive MIMO and beamforming add to the complexity of signal processing, increasing compute requirements. An example Intel technology stack for vRAN is illustrated in Figure 2.

One compelling value proposition for the development of vRAN software optimized for Intel architecture is that system hardware can be sized according to factors such as cell density, at a given radio configuration, at a given frequency, using a single, common software base. For example, moderately sized implementations could be deployed on Intel Xeon D processors, while capacity could be expanded using Intel Xeon Scalable processors, without code changes. This enables vRAN software vendors to use the same code base from high density macro cell deployments down to small cell, low-density use cases. Intel Xeon D processors are ideally suited for smaller macro cell deployments down to integrated small-cell RDUs with more cost and power constraints.

The same portability exists across multiple generations of platforms, enhancing the future-readiness of software investments as new processors are introduced, such as the forthcoming next generation of Intel Xeon processors, code-named Sapphire Rapids. Among other advances, that platform will feature enhancements to workload acceleration for applications such as vRAN. These generation-to-generation performance improvements support higher density deployments such as massive MIMO, while also lowering TCO.

The Intel® Xeon® D-2700 and D-1700 Processors

Delivered as highly integrated system-on-chip (SoC) packages, the Intel Xeon D-2700 and D-1700 processors are density-optimized compute engines that are well suited to the needs of vRAN deployments, with balanced performance, cost, and power efficiency profiles. The two variations of the platform enhance its scalability to vRAN implementations with varying levels of data plane throughput:

- **The Intel Xeon D-2700 processor** features up to 20 processor cores with thermal design power (TDP) up to 125 watts. This is the ideal solution for medium capacity macro cells such as multiple cells of 100Mhz 32T32R. It has higher memory speed and capacity, more PCI Express connectivity, and higher bandwidth hardware-based acceleration technology than the Intel Xeon D-1700 SoC. It also features integrated Ethernet and encryption/compression functionality.
- **The Intel Xeon D-1700 processor** is intended for lower-capacity vRAN implementations such as small-cell indoor and outdoor, with more power- and cost-optimized options. It provides a lower core count (2-10 cores) and lower TDP (25-85 watts) than the Intel Xeon D-2700 SoC, and it also supports options for integrated Ethernet and encryption/compression at lower bandwidths.

Both platforms complement the rest of the technology portfolios that providers may use for larger deployments, enabling reuse of macro cell software implementations. Both are certified to operate in extended temperature ranges, adapting them to special-purpose deployments such as pole-mount form factors, which are often used in integrated small cell RDUs.

Small cell use cases can range from smaller enterprise deployments to larger venues such as outdoor stadiums. Intel Xeon D SoCs are well suited for both split cell and integrated DRU designs, which scale with pin-compatible Intel Xeon D processor SKUs to support options with four, six, eight, or 10 cores. Often deployed at the edge, they can combine 5G vRAN with low latency along with data analytics and artificial intelligence (AI) to drive operational efficiencies.

Integrated Intel® Ethernet

Intel Ethernet integrated into the Intel Xeon D SoC increases power efficiency and provides up to 100 Gbps of throughput, with connectivity options from 1GbE to 100GbE. Features and capabilities that are particularly valuable to vRAN deployments include the following:

- **Application Device Queues (ADQ)** enable specific applications to reserve any number of dedicated Intel Ethernet hardware queues, ensuring predictable performance for vRAN workloads.
- **Dynamic Device Personalization (DDP)** supports multiple profiles that each specify optimizations and packet-handling parameters for specific traffic types, for increased throughput and traffic prioritization.
- **Remote Direct Memory Access (RDMA)** allows memory transfers between hosts to bypass the operating system, reducing processor overhead and increasing throughput.

Integrated Intel® QuickAssist Technology (Intel® QAT)

Providing hardware-resident capabilities for acceleration of security, authentication, and compression workloads, Intel® QAT provides a software-enabled foundation for increased performance and efficiency that can benefit vRAN network functions. Public key encryption (PKE) algorithms such as transport layer security (TLS) that are widely used in vRAN implementations are historically compute-intensive processes performed by software. Likewise, compression and decompression functions can consume significant processor resources that could otherwise be applied to more useful work.

Intel QAT offloads crypto and compression workloads onto purpose-built hardware acceleration engines, increasing throughput and freeing resources on the main processor. Because it is integrated with the Intel Xeon D-2700 and D-1700 processors, Intel QAT is more power-efficient than previous Intel QAT solutions based on discrete hardware such as PCI Express cards.

Intel Enablement for vRAN: Open RAN and the FlexRAN™ Reference Software

Open RAN (O-RAN) is an industry initiative to develop open standards for RAN interfaces that enable greater interoperation between software elements and non-proprietary white-box hardware provided by different vendors. Intel is an active O-RAN Alliance contributor, working to help expand the ecosystem to new participants and technology development, thereby fostering more innovation and marketplace options.

One of the chief ways that Intel participates in open networking for vRAN is through its FlexRAN™ reference architecture, a hardware and software reference solution that guides customers to efficiently implement cloud-native vRAN services on Intel architecture. The FlexRAN architecture takes advantage of platform features of the Intel Xeon D-2700 and D-1700 processors to enhance vRAN efficiency, with the intention to drive down the number of processor cores required for a given workload. With this improved utilization, CoSPs can enhance the CapEx and OpEx benefits of their vRAN deployments. FlexRAN software offers a proven 4G and 5G baseband PHY reference design for DU virtualization, with the benefits summarized in Figure 3.

FlexRAN software provides control and user plane separation that allows the two to scale independently, which is a primary requirement for scalability, particularly as data plane volumes increase dramatically with 5G mobile traffic growth. The reference software's flexible, highly programmable control plane provides robust support for real-time RAN workloads and portability across ecosystem solutions. It includes optimizations made to the data plane based on the data plane development kit (DPDK), a set of libraries and drivers that increase throughput by offloading TCP packet processing from the OS kernel to user-space processes.

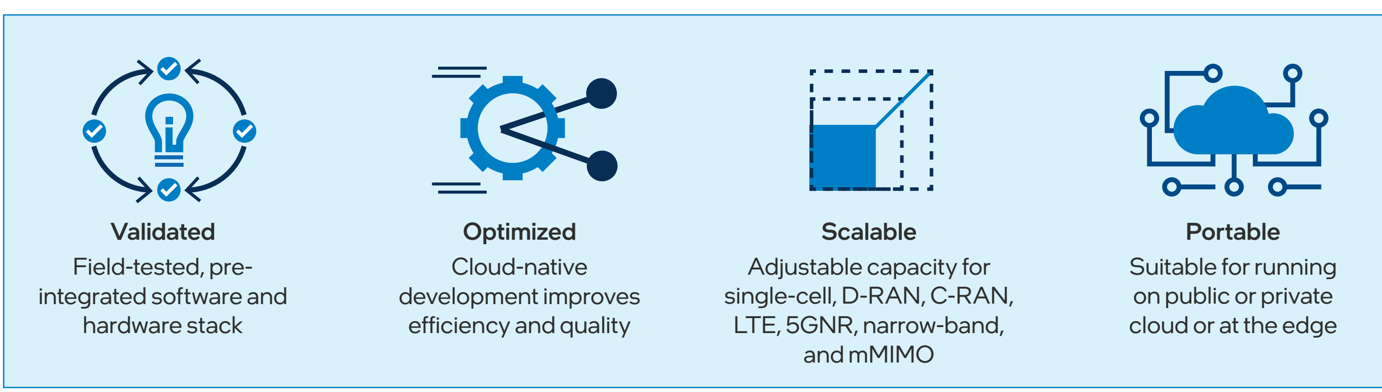

Figure 3. Benefits of FlexRAN™ reference software.

Intel® Architecture-based Hardware Acceleration for vRANs

Intel provides a range of hardware accelerators that improve compute throughput for specific workloads, including VNFs and deep learning. In particular, the Intel® vRAN Dedicated Accelerator ACC100 offloads the computationally intensive processes that support Layer 1 forward error correction (FEC) from the main processor. Using match-detection of parity bits to verify intact signal transmission, FEC is widely used to improve transmission efficiency over noisy or unreliable channels. FEC offload reduces system overhead by freeing up computation resources for signal processing and other edge services. Intel is involved in the development of additional accelerator reference designs for adoption by original design manufacturers, based on other Intel hardware acceleration silicon including eASICs and FPGAs.

Intel Xeon D processors offer Intel® Deep Learning Boost (Intel® DL Boost), Intel® oneAPI Deep Neural network library (oneDNN), and Intel® Advanced Vector Extensions 512 (Intel® AVX-512) for accelerating machine learning (ML) and AI workloads. These ML capabilities enable optimization for features such as Radio Resource Manager (RRM) that can maximize spectrum efficiency with real-time predictive analytics in a 5G Media Access Control (MAC) schedule. AI capability enables cloud-native vRAN implementations to combine data analytics and AI for edge applications, autonomous networks, security detection, and many other use cases.

Conclusion

Intel Xeon D processors provide density-optimized high performance and power efficiency for cloud-native vRAN deployments. The SoC platform integrates Intel Ethernet for advanced connectivity and bandwidth optimization. It also offers hardware acceleration to improve throughput of key workloads such as deep learning and VNFs, as well as industry enablement such as FlexRAN reference software that helps customers achieve fast time to market with the cost, flexibility, and agility benefits of cloud-native vRAN.

More Information: www.intel.com/xeond

[1] Intel Corporation infographic. "Intel is Paving the Way for vRAN Transformation." https://www.intel.com/content/www/us/en/wireless-network/paving-the-way-vran-transformation.html, retrieved December 3, 2021.

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