Solution Brief

FPGA
Virtualized Radio Access Network (vRAN)

Build an Open, Next-Generation Virtualized Radio Access Network (vRAN)

Unlock new use cases and increase network efficiency with Intel's broad set of offerings that include silicon, accelerators and Ethernet, combined with Altiostar's 5G-ready Open vRAN software solution.

ALTIOSTAR
Leading Network Transformation

Executive Summary

In an increasingly complex network landscape that includes co-existing 4G and 5G deployments, multiple centralized and distributed deployment models and several radio interface standards, communications service providers (CoSPs) need a way to increase agility, openness and flexibility while keeping deployment and maintenance costs under control.

Altiostar's open virtualized radio access network (Open vRAN) solution helps CoSPs meet their goals. The solution is based on the FlexRAN software reference platform and runs on commercial off-the-shelf (COTS) server hardware equipped with either Intel® Xeon® Scalable processors or Intel® Xeon® D processors. vRAN performance can be further enhanced by adding either an Intel® FPGA Programmable Accelerator Card (PAC) N3000 or an Intel® vRAN Dedicated Accelerator ACC100. The choice of acceleration technology depends on the use case, such as forward error correction versus fronthaul I/O.

Altiostar's Open vRAN solution is compatible with a wide variety of radio equipment and can be used with multiple frequency bands and configurations. With Altiostar's Open vRAN solution running on Intel® technology, CoSPs can avoid vendor lock-in, increase business agility and flexibility, and keep deployment costs in check.

Figure 1. To promote communications service provider (CoSP) innovation, Intel and Altiostar are collaborating to build an open and automated virtualized radio access network (vRAN) architecture. It combines the best of off-the-shelf network-transforming hardware, reference designs and optimized software.

Solution Benefits

- **Agility and openness.** Avoiding vendor lock-in means operators can quickly adapt their virtualized radio access network (vRAN) to new use cases or changes in radio interfaces.
- **Flexibility and scalability.** Intel® Xeon® Scalable processors and Intel® Xeon® D processors enable centralized unit/distributed unit (CU/DU) processing workloads, deployed at various network locations (central offices all the way to the cell site). In addition, various Intel® acceleration technologies, such as field-programmable gate arrays (FPGAs) and eASIC devices, can be deployed where necessary for a specific use case. Intel's broad set of offerings that include silicon, accelerators and Ethernet supports software flexibility, programmability and upgradability as wireless standards evolve.
- **Cost effectiveness.** Because the solution runs on industry-standard servers and an open, common software fabric, operators can optimize both capital and operational expenditures and can run varying workloads on a common hardware platform.
- **Ease of use.** Intel investment in the FlexRAN reference architecture (software architecture, software and companion hardware) makes it easier for vendors to develop off-the-shelf vRAN solutions using a general-purpose virtualized platform. This enables various radio access network (RAN) workloads including dynamic network slicing with a high degree of flexibility and scalability.

Business Challenge: Building an Agile Architecture with Low Total Costs

A major challenge facing CoSPs is building affordable software-defined networks. Operators seek to optimize operational expenditures, such as power and maintenance. They also need to reduce deployment costs associated with dark fiber, central office leasing and proprietary radio access network (RAN) equipment. One way to drive down costs is to use COTS hardware. In this way, CoSPs can co-host a wide variety of workloads on a common hardware platform. For example, as more edge workloads emerge, this traffic can run on the same hardware as other workloads. Other cost advantages include flexible sourcing and ease of upgrades.

In addition, radio interfaces are changing fast, with new standards coexisting with legacy radio technologies. The majority of RAN deployments must have the flexibility to adapt to different spectrums, capacities and use cases. CoSPs need to achieve network agility and scalability across end-points, fronthaul/backhaul infrastructure and data centers. vRAN technologies can help, but simply transitioning to vRAN isn't enough if the vRAN remains susceptible to lengthy upgrade cycles and vendor lock-in. Therefore, a successful vRAN deployment architecture must be highly tolerant of change, allowing speedy adoption of new technologies and use cases.

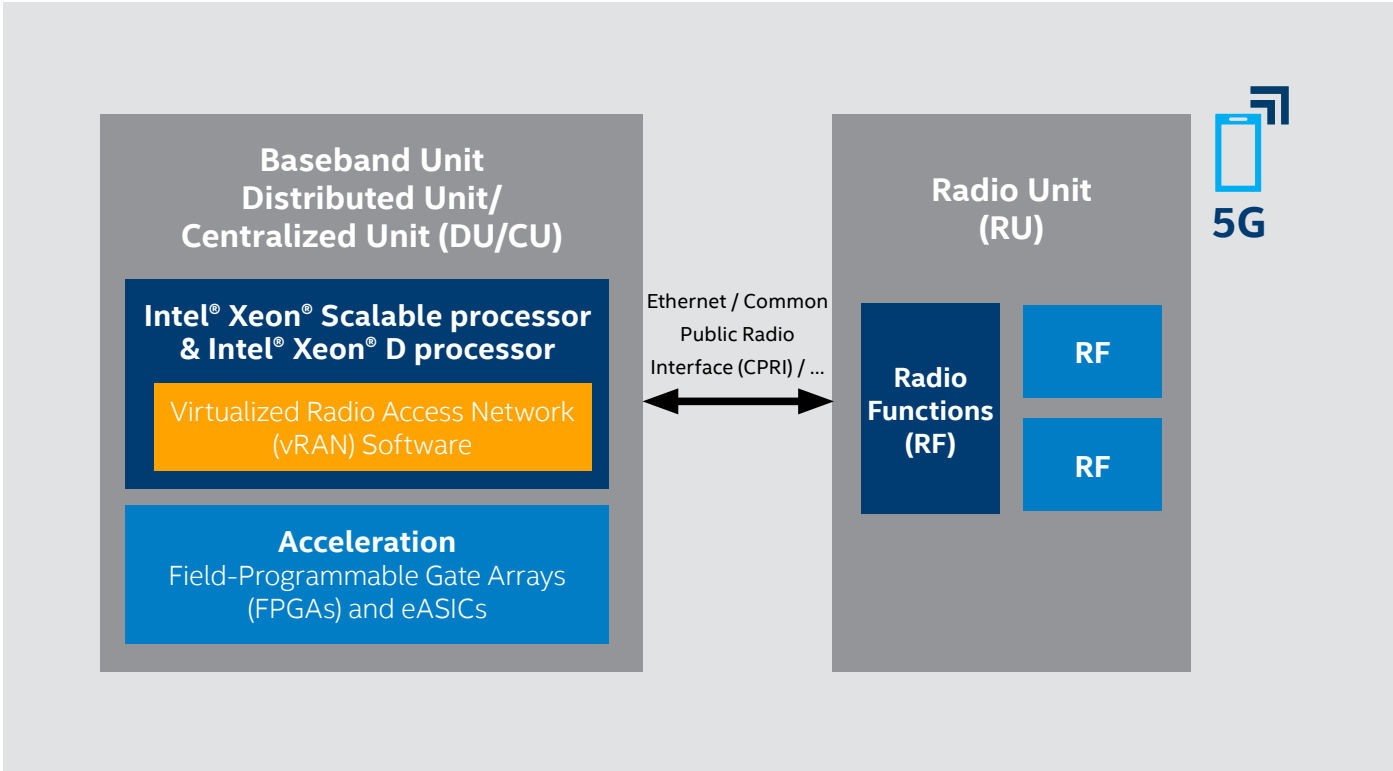

Figure 2. Basic open radio access network (RAN) deployment based on commercial off-the-shelf (COTS) hardware.

Typical Use Cases for Virtualized Radio Access Network (vRAN) on Commercial Off-The-Shelf (COTS) Hardware

The following examples illustrate where the Altiostar Open vRAN solution, running on Intel technology (see Figure 2), can bring value to CoSPs:

- **Macro** (4G/5G) deployments can be either centralized RAN (CRAN) or distributed RAN (DRAN). Intel® architecture-based servers equipped with Intel Xeon Scalable processors can accommodate various cell densities (for multi-sector deployments) for both 4G and 5G. Original equipment manufacturers (OEMs) are enabling solutions that can fit in racks at network edge sites, or servers that can fit into cabinets at the cell site. The processor of choice for macro deployments is typically either an Intel® Xeon® Silver processor or Intel® Xeon® Gold processor. To support macro cell capacity, FPGA-based accelerators are often used to offload new and emerging workloads at an early stage of the deployment. Before hardening its functions for further unit-cost reduction, Intel FPGA reference designs and IP help operators achieve a fast time-to-market trial or deployment.
- **Macro Sub-6 GHz** massive multiple-input, multiple-output (MIMO) configurations are becoming a popular choice for increasing cell capacity, especially for the C-Band deployments planned around the world. Intel® Xeon® processors can accommodate these more demanding workloads with software upgrades to existing standard MIMO implementations. Again, hardware accelerators such as FPGAs and eASICs can be used to offload specific functions as necessary.
- **mmWave (5G)** solutions targeting both indoor and outdoor hotspot locations can be enabled with Intel Xeon processors. Intel Xeon Scalable processors are typically targeted for indoor deployment and Intel Xeon D processors are typically targeted for outdoor deployments. As with other use cases, hardware accelerators such as FPGAs and eASICs can be used to offload specific functions as necessary.
  - **Rural** (4G/5G) deployments tend to be for lower cell densities. These deployments can use platforms based on either Intel Xeon D processors or Intel Xeon Scalable processors. Rural deployments can use a lower-core-count processor, compared to macro deployments. OEM solutions for rural deployments typically must factor in outdoor conditions. FPGAs are commonly used to handle real-time signal processing functions as well as fronthaul connectivity.
  - **Indoor** (4G/5G) deployments need scalability from small venues (measured in square feet) to large venues (measured in square meters). This means the deployment needs to consider modularity at the processor level (that is, scale from lower core count to higher core count) or at the platform level (single box to multiple boxes). Again, OEMs can enable such modularity to meet various use cases and hardware accelerators such as FPGAs and eASICs can be used to offload specific functions as necessary.

Solution Value: Agile, Open Architecture that Addresses Cost Concerns

Altiostar's Open vRAN solution (see Figure 3) uses a virtualized software solution running on COTS server hardware. It is an open solution based on the FlexRAN software reference platform that is compatible with a large number of macro, micro and pico remote radio head (RRH) units from various vendors and across multiple frequency bands and configurations, all managed by a common software fabric. With the Altiostar Open vRAN solution, operators can select a radio vendor that is not necessarily the same as the baseband vendor. This flexibility allows a truly diverse multi-vendor solution.

With Altiostar's solution, powered end-to-end by Intel technology, CoSPs gain interoperability, scalability and adaptability between 4G and 5G environments. This is a carrier-grade platform that can provide high availability, ultra-low latency and ease of maintenance. The open architecture drives down capital and operational costs by introducing an ecosystem of software vendors, hardware vendors and technology providers such as Intel. By working closely with the telecommunications ecosystem, Intel helps drive industry collaboration to address network transformation challenges.

Some of the Intel technologies used by Altiostar's Open vRAN solution include the following:

- **Boost performance** with Intel Xeon processors. Intel offers different SKUs and models to meet specific operator needs, depending on the location and the requirements in terms of power consumption and performance. For example, Intel has added new processors to its 2nd generation Intel® Xeon® Scalable platform. Some of these new processors are designed specifically for wireless network usages such as 5G user plane function and virtual broadband network gateway, among others. In deployments or locations where CoSPs desire a low-power solution, they can take advantage of Intel Xeon D processors. These processors deliver workload-optimized performance in space- and power-constrained environments.
- **Simplify deployment** with the FlexRAN software reference platform, developed and open sourced by Intel. FlexRAN supports implementation of software-based radio stations. FlexRAN is the main building block for Layer 1 (L1) functions in the RAN and is a key enabler for Altiostar's Open vRAN solution. FlexRAN includes optimized libraries for LTE and for 5G New Radio (NR) L1 workload acceleration. A full FlexRAN platform solution built on Intel architecture can perform the entire 4G and/or 5G Layer 1, 2 and 3 processing.
- **Increase flexibility** by choosing one or another of Intel's network acceleration technologies. They all offer the advantage of being commercially available, affordable and widely supported by the ecosystem. Product choice depends on the use case and a CoSP's business requirements.

– **Programmability.** The Intel FPGA PAC N3000 is reconfigurable, enabling CoSPs to adapt as standards evolve and new business requirements emerge. It can be used for forward error correction and fronthaul and midhaul I/O connectivity.

– **Affordability and space efficiency.** The Intel vRAN Dedicated Accelerator ACC100 is a fixed-function device (primarily used for forward error correction) that provides dedicated hardware acceleration. The ACC100 cannot be reprogrammed for different purposes. On the other hand, it delivers excellent power efficiency, a small footprint and low cost.

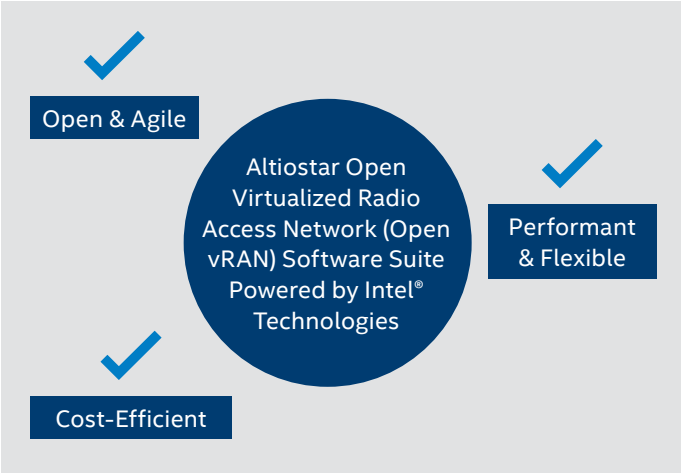

Figure 3. The collaboration between Intel and Altiostar has resulted in an open virtualized radio access network solution that solves many network transformation challenges.

Solution Architecture: Flexible Virtualized Radio Access Network (vRAN) on Commercial Off-The-Shelf (COTS) Hardware

Altiostar's Open vRAN solution runs on COTS servers powered by Intel Xeon processors. It provides an ultra-low latency data path through intelligent offload of selected workloads, using one of Intel's network accelerators (see Figure 4).

CPU Architecture: Scale and Flexibility
Intel Xeon Scalable processors are Intel's leading platforms for cloud-optimized servers. With an open architecture that scales and adapts to the demands of emerging applications, the platform provides a future-ready foundation for servers that can deliver cloud economics, be highly automated and responsive, and support rapid and more secure delivery of new and enhanced services.

Intel® Xeon® D-2100 processors deliver data center processor architecture in a form factor optimized for cloud edge computing solutions. The CPUs bring the architectural innovations of the Intel Xeon Scalable platform to a system-on-a-chip (SoC) processor for low-power, high-density, small footprint solutions, integrating essential network, security and acceleration capabilities.

Programmable Network Acceleration
The Intel FPGA PAC N3000 is highly customizable and allows the optimization of data plane performance to achieve low costs while maintaining a high degree of flexibility. The flexibility of the N3000 allows the card to handle both FEC offloading and I/O connection. In many use cases, this two-in-one solution can reduce the use of the very limited Peripheral Component Interconnect Express (PCIe) slots on the server, thus reducing the total system cost.

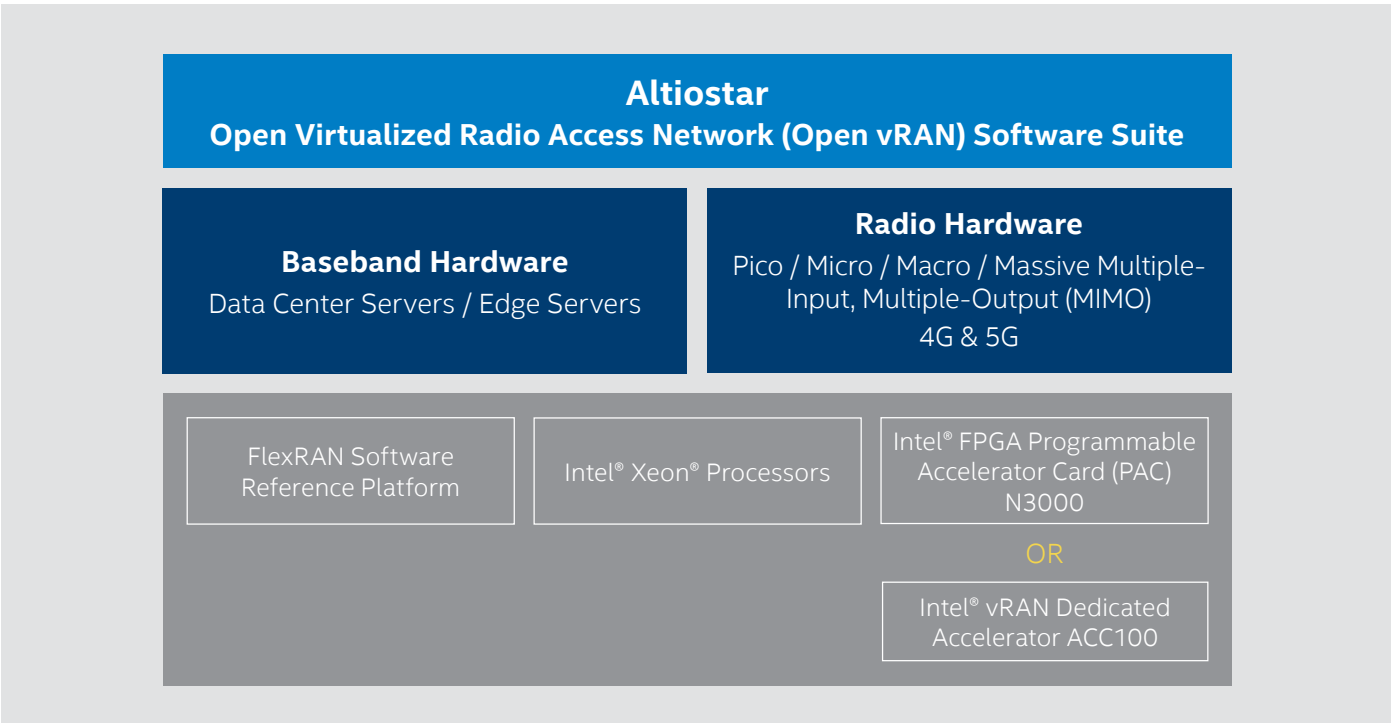

Figure 4. Altiostar's open virtualized radio access network (Open vRAN) software solution—powered by Intel® technology—supports a wide variety of 4G and 5G vRAN use cases and is compatible with equipment from many vendors.

Dedicated Network Acceleration

The Intel vRAN Dedicated Accelerator ACC100 generally provides lower unit-cost and lower power consumption compared to FPGAs and faster time to market and lower non-recurring engineering cost compared to standard-cell ASICs.[1] The ACC100 is integrated with the Data Plane Development Kit (DPDK) and offers an eminently affordable approach to 4G and 5G forward error correction. It also provides a PCIe 3 interface to the processor.

Three Sample Use Cases for Accelerated vRAN

vRAN deployments can be used for both 4G and 5G use cases. The following three use cases illustrate how Altiostar's Open vRAN solution, combined with Intel technology, can help deliver the vRAN performance CoSPs need:

- **4G turbo coding offloading.** Turbo processing can be offloaded to an accelerator to free up CPU cycles and reduce communications latency. Such offloading can be handled by a dedicated hardware accelerator or by a programmable accelerator.
- **5G low-density parity-check (LDPC) coding offloading.** Similar to turbo codes, LDPC codes can be offloaded to an accelerator—either a dedicated device or a programmable one—to improve network performance.
- **Fronthaul/midhaul I/O connection (4G/5G).** An FPGA can offload complex I/O connectivity to the radio units. It can also be used to offload real-time L1 processing, such as Fast Fourier Transform (FFT), Inverse FFT (iFFT) and Physical Random Access Channel (PRACH).

Several CoSPs have already adopted Altiostar's solution to deploy vRAN. Altiostar's solution is based on the FlexRAN software reference platform, which takes advantage of industry-standard servers powered by Intel® processors and accelerators.

Conclusion

Intel's broad set of offerings that include silicon, accelerators and Ethernet products combines with Altiostar's Open vRAN software solution to accelerate vRAN performance. Intel enables ecosystem vendors such as Altiostar to deliver vRAN solutions that address network transformation challenges. CoSPs that deploy vRAN using such a solution can achieve both business agility and low total costs. As a result, they gain the ability to take advantage of new opportunities to increase revenue and gain a competitive edge.

Learn More

You may find the following resources helpful:

- **Altiostar Open vRAN solution**
- **Intel® FPGA Programmable Accelerator Card N3000**
- **Intel vRAN Dedicated Accelerator ACC100**
- **FlexRAN Software Wireless Access Solutions**
- **2nd generation Intel® Xeon® Scalable processors**
- **Intel® Xeon® D processors**

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