SOLUTION BRIEF

Communications Service Providers
Cloud RAN

Aricent* Demonstrates 4G Cloud RAN Evolution to 5G Using FlexRAN

Aricent's cost-effective Cloud RAN offering leverages FlexRAN reference solution running on Intel® architecture servers to provide mobile network operators (MNOs) with a flexible, high-performance Cloud RAN solution that can evolve to support 5G networks.

Introduction

The need for mobile bandwidth has been growing exponentially, making it necessary for mobile operators to scale their wireless networks and use of advanced wireless technologies. Demand for mobile data is increasing, and with introduction of new technologies, the expansion of existing networks puts pressure on operators' capital and operational expenditures.

Mobile network operators (MNOs) are turning to network functions virtualization (NFV) to flexibly and cost effectively support increased demand for mobile data services. This virtualization is essential for emerging 5G networks that deliver significant increases in bandwidth. MNOs expect the availability of higher-bandwidth 5G networks will drive increased data service demand. One part of the 4G and 5G network that can benefit significantly from virtualization is the radio access network (RAN).

By virtualizing RAN functions, MNOs can move this functionality into the cloud (Cloud RAN). This is realized by replacing specialized hardware with general-purpose switches, storage, and servers powered by Intel® Xeon® Scalable processors. As the software is decoupled from the underlying hardware, the solution becomes more software-centric, which drives improvement in research and development cycle speeds and a reduction in total cost of deployment. Also, with Cloud RAN, MNOs can build out their infrastructure to support average cell loads instead of peak loads as new RAN services can be turned up quickly in the cloud data center.

Cloud RAN reduces cell-site hardware costs through the use of common off-the-shelf servers and increases the utilization of the CPU cores by pooling traffic from multiple cells, which better handles peak and non-peak data traffic. Cloud RAN solutions also help in centralizing processing across multiple cells (at radio resource management (RRM) or L2/PHY layer depending on deployment), improving the overall network performance. The architecture provides a virtually edge-free network using spectral efficiency improvement features, such as coordinated multi-point (CoMP) transmission and enhanced inter-cell interference coordination (eICIC).

Intel® Network Builders ecosystem member Aricent* is evolving its 4G Cloud RAN solution to support 5G networks.

The Solution

Aricent leverages its end-to-end product engineering services and world-class eNodeB software to enable RAN solutions based on the Cloud RAN architecture supporting FlexRAN reference solution architecture.

FlexRAN Solution
FlexRAN is a software-based radio reference architecture developed by Intel to enable Cloud RAN in a variety of flexible configurations. The block diagram in Figure 1 shows the FlexRAN PHY Application, which takes radio signals from the RF front-end and provides real-time signal and physical layer processing adapted for servers that use Intel Xeon Scalable processors and Intel Xeon D processors.

Supporting this functionality is the FlexRAN SDK, which provides optimized signal processing libraries for Intel® architecture CPUs; the FlexRAN Task Controller, which facilitates scaling across multiple CPUs; and the Data Plane Development Kit, which delivers platform services such as high-throughput packet forwarding and memory management. The FlexRAN platform is designed to run on WindRiver Titanium Server* as the NFV infrastructure.

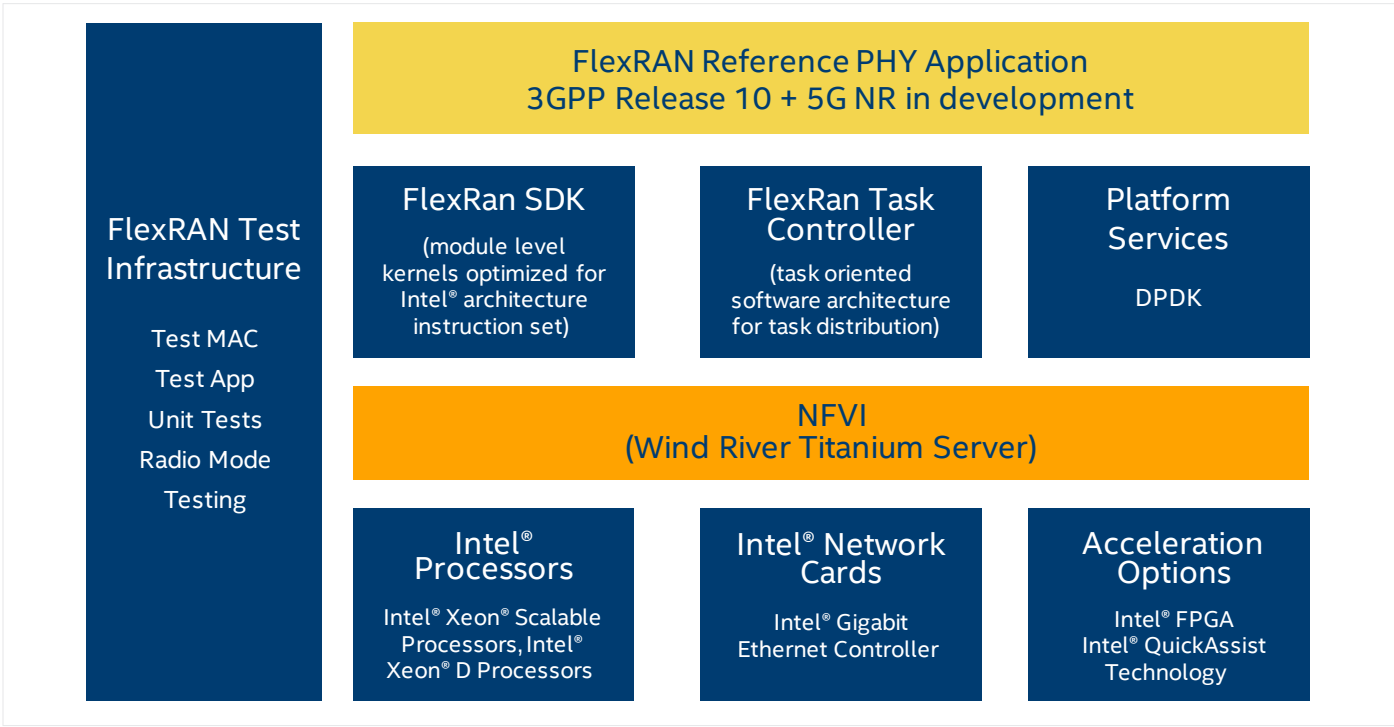

Figure 1. FlexRAN architecture

Aricent Cloud RAN Solution Based on FlexRAN
This FlexRAN solution was chosen by Aricent because it accelerates time to market for its solution. An important feature to the Aricent solution is FlexRAN's ability to enable and optimize macro- and small-cell solutions and support high-capacity and low-capacity use cases for rural and dense environments. The Aricent solution complies with all industry standards set by the 3GPP,* TIP,* and the Open RAN (O-RAN) Alliance,* making it interoperable with other vendor solutions.

Aricent offers mature and proven eNodeB software frameworks for realizing Cloud RAN solutions. For 5G, the Aricent Software Framework solution supports fronthaul interfaces including enhanced common public radio interface (eCPRI) and radio over Ethernet (RoE) based on the O-RAN interface specification. The company is working with Intel to integrate the software framework with Intel's sub-6 GHz and millimeter-wave reference solutions.

Aricent Cloud RAN benefits from network function virtualization (NFV) for the centralized processing of wireless functions.

As shown in Figure 2, Aricent offers a flexible architecture with different functional splits and fronthaul interface options. In this architecture:

- Central unit (CU) functionality includes operations, administration, and management (OAM), RRM/self-organizing network (SON), layer-three routing, and packet data convergence protocol (PDCP).
- Distributed unit (DU) delivers radio link control (RLC), media access control (MAC) and upper-PHY or complete PHY services (as applicable).
- Remote radio unit (RRU) corresponds to radio part and lower-PHY (as applicable).

Realization of RAN Split Option 7-x
There are multiple deployment options that can be realized for 4G LTE virtualized-RAN architecture (using FlexRAN architecture), and salient factors of the Aricent solution include the following:

- Support for both Ethernet-based fronthaul and common public radio interface (CPRI)-based fronthaul
- In Ethernet-based fronthaul, there are multiple deployment options that are available:

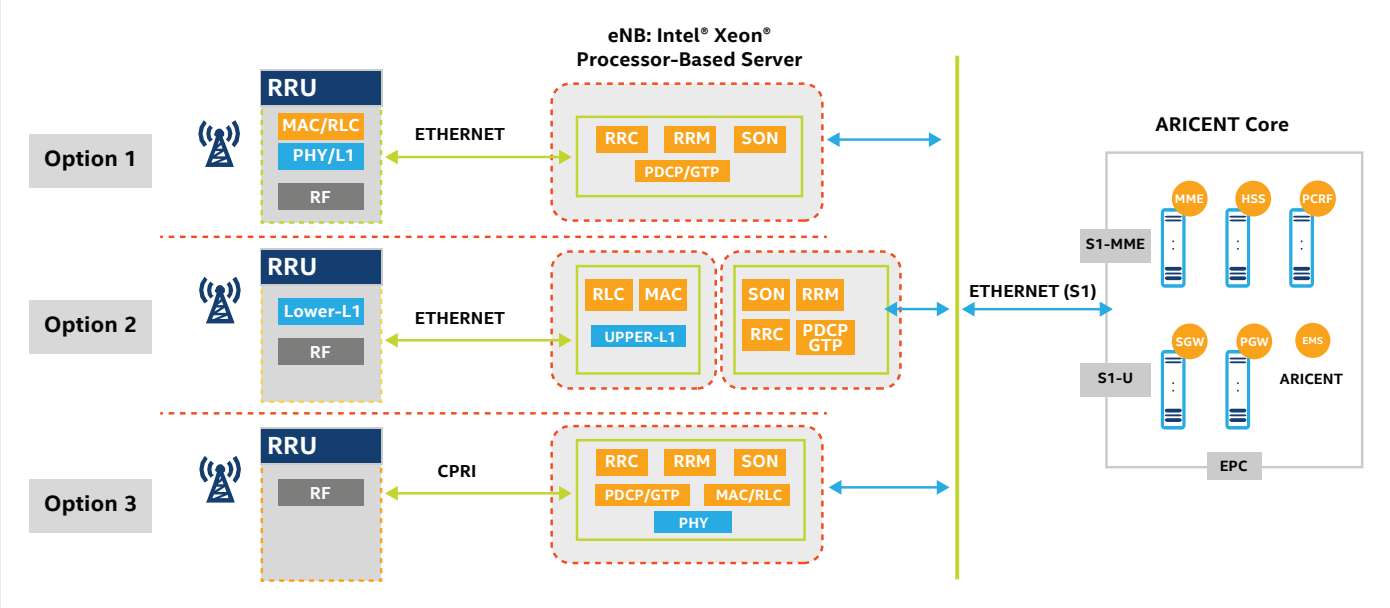

Figure 2. Aricent RAN split options*

- Option 1: CU+DU and RU-based architecture with Ethernet as fronthaul based on RAN Split Option 7.x
- Option 2: CU, DU and RU-based architecture with Ethernet fronthaul based on RAN Split Option 7.x (and option 2 split between CU and DU)

(OR)

- Option 3: CU+DU and RU-based architecture with CPRI as fronthaul based on RAN Split Option 7.x

The Aricent software architecture for an Option 2 type of split with RAN Split Option 7-x, running on an Intel Xeon processor-based server, is shown in Figure 3.

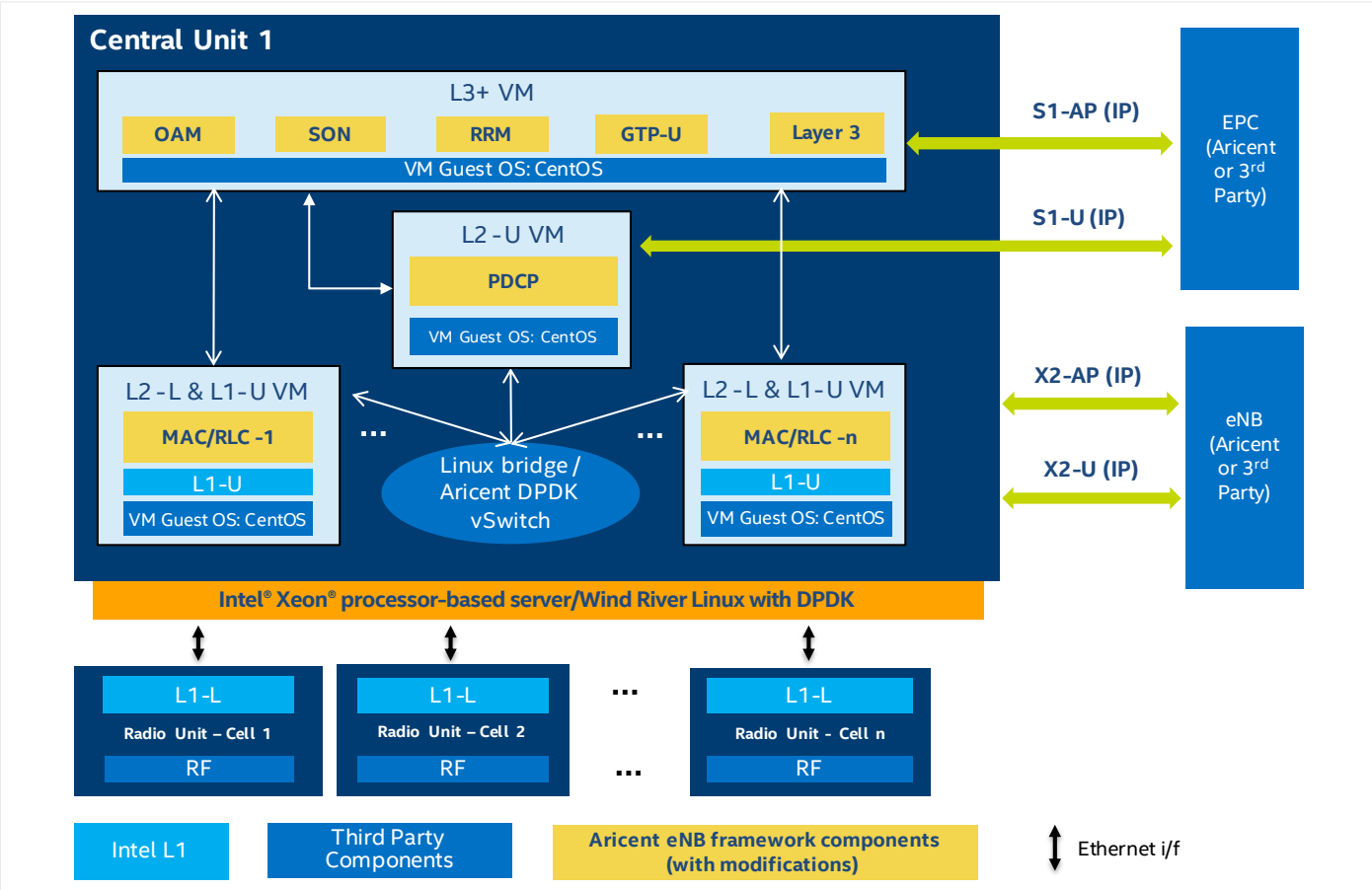

Figure 3. Aricent virtualized-RAN architecture*

The key aspects of the Aricent solution supporting OAM, RRM/SON, layer 3, layer 2, and layer 1 include the following:

- Single S1 and X2 interface endpoints on a CU for all the cells. S1-AP and X2-AP for all the cells terminate at L3+ VM on the CU.
- S1-U and X2-U terminate at layer 2 VM of the CU. Layer 2 can use the Data Plane Development Kit (DPDK) for data path acceleration. After upper layer 1 processing, data is forwarded to the respective cell's lower layer 1 running on DU.
- Multiple lower layer 2 instances, each serving multiple cells (with support for carrier aggregation).
- Aricent eNodeB stack components are built in a modular way to support virtualization and use the DPDK accelerator provided by Intel Xeon processor-based server to improve the system performance.
- Running stack components as part of different VMs gives the flexibility to scale up/down the solution across the central unit.
- Layer 1 can be flexibly split in upper layer 1 and lower layer 1 in the following ways:
  - Option 1: Complete layer 1 shall be running in RU.
  - Option 2: Upper layer 1 running on an Intel Xeon processor-based server and lower layer-1 running on RRU; upper and lower layer 1 interact using DPDK-enhanced transport mechanism.
  - Option 3: Complete layer 1 is running on an Intel Xeon processor-based server.
- Support for baseband unit (BBU) pooling framework in both layer 1 and layer 2 software for efficient usage of cores and improving the core-utilization factor.

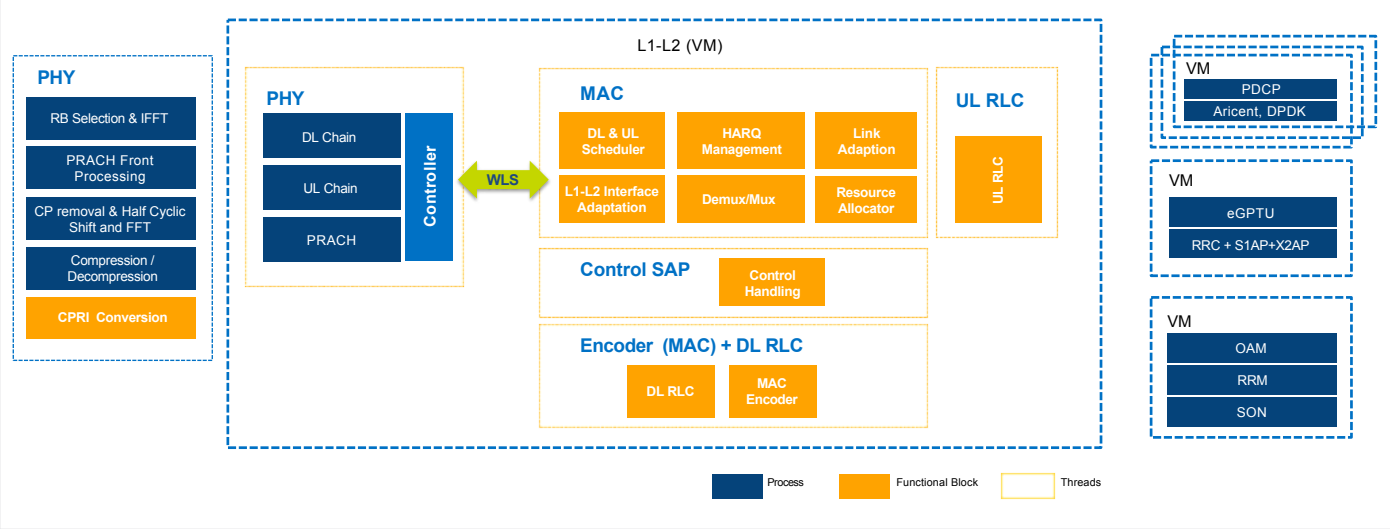

Figure 4. Aricent virtualized-RAN architecture*

The key benefits of virtualized RAN architecture include:

- Solution can be run on virtualized general-purpose processors (along with field programmable gate array (FPGA) for high-processing requirements like forward error correction, fronthaul processing, etc.).
- Efficient scaling of resources (and cores) and scalability of the solution to meet capacity/performance requirements.
- Load balancing of resources.
- Concepts of pooling are employed for efficient utilization of compute resources.
- Leveraging the concept of centralized processing at layer 2.

5G Roadmap with FlexRAN

Aricent and Intel have also collaborated in the 5G FlexRAN to develop a virtualized RAN solution based on 3GPP Rel-15 specifications for both sub-6 and mmWave scenarios, with the plan to leverage the 4G FlexRAN architecture as a baseline and enhance it to meet 5G requirements. Non-standalone (NSA) mode is currently under verification followed by support for standalone (SA) mode.

Ethernet-based fronthaul is being considered for 5G virtualized-RAN deployment and like 4G case, the focus is on RAN Split Option-7.x (and in some deployments have Option-2 and Option-7.x split).

The high-level software deployment model for 5G NSA (combining 4G and 5G FlexRAN) is shown in Figure 5. In the below architecture, CU and DU shall be running on Intel Xeon processors, with PHY/layer-1 running in an Intel Xeon server along with the RRU (for Option-7.x split).

To support use-cases and scenarios with low-latency requirements, Aricent multi-access edge computing (MEC) solution can also be integrated as part of CU for 5G based deployments.

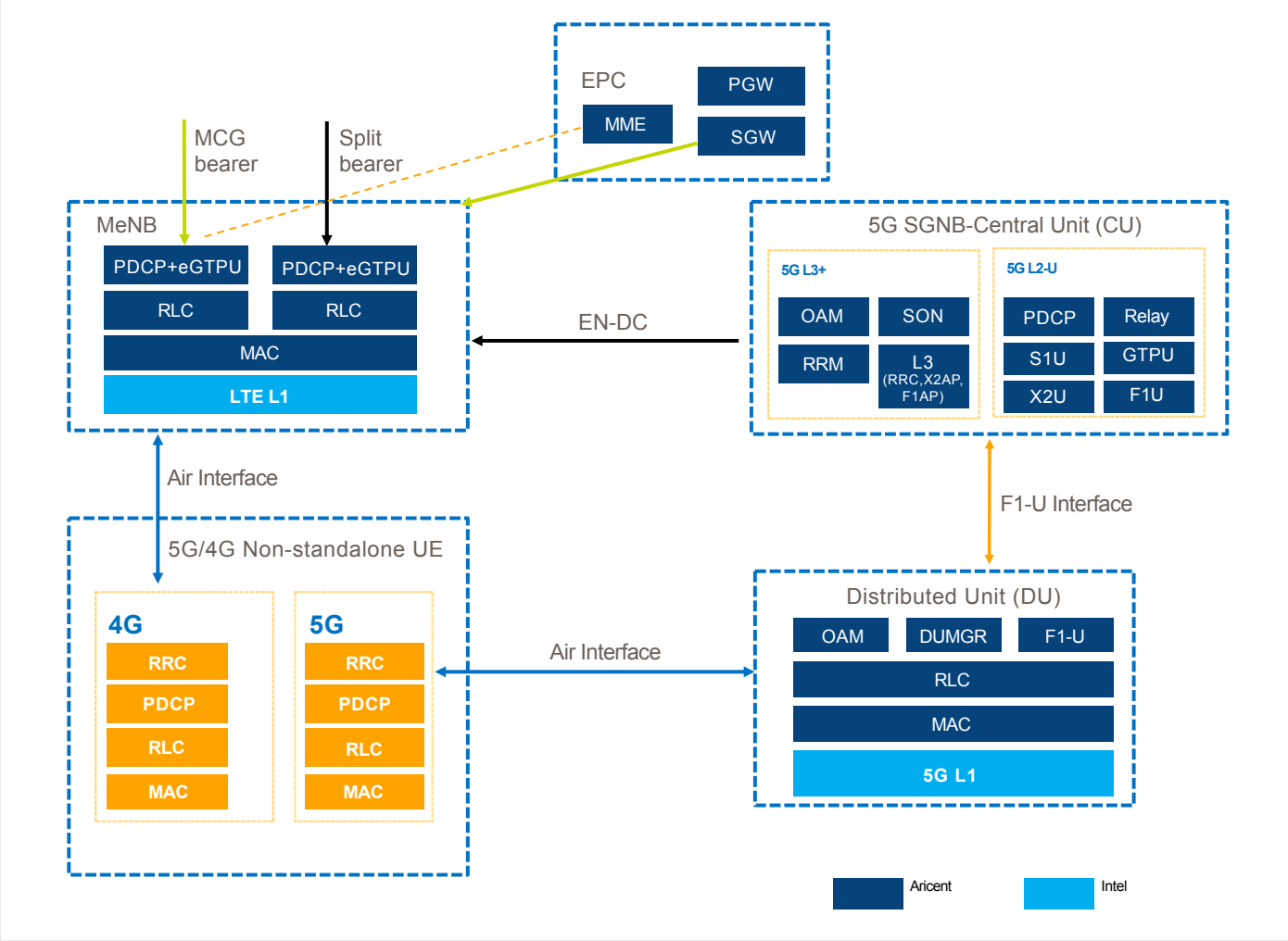

Figure 5. 5G non-standalone software deployment*

Support for Artificial Intelligence/Machine Learning in RAN
With networks becoming more complex, it is important to make the network more intelligent and autonomic. This can be achieved by applying artificial intelligence (AI) and machine learning(ML) techniques to the network. Some of the areas where AI can be applied include the following:

- Operations support system (OSS) plane
- Core network (CN)
- Multi-access edge computing (MEC)
- RAN

Within the RAN, the application of AI/ML can be categorized into two areas: real-time processing and non-real-time processing.

The ML model for real-time processing functionality includes beam-forming, link-adaptation/power control, and other closed-loop functionality procedures that involve the air-interface, while the ML model for non-real-time processing functionality includes handover optimization, mobility management, quality of experience (QOE) optimization, and related RRM/SON procedures.

As part of the 5G virtualized-RAN roadmap, Aricent plans to integrate the ML models within CU and DU and provide an integrated solution to customers on Intel®-based platforms.

Conclusion

Aricent works with original equipment manufacturers to develop and customize their LTE and 5G solution supporting FlexRAN architecture. By customizing the RAN solution as per FlexRAN architecture, Aricent virtualized-RAN based solution can deliver significant business value, including:

- Reducing risk through feature-rich and carrier-grade offerings.
- Accelerating time-to-market.
- Solution availability on generic platforms.
- Extensive partner ecosystem with RRH suppliers.
- End-to-end product engineering services for Cloud RAN including consulting, design, development, integration, testing, support, and maintenance for a one-stop solution for all engineering needs.
- Built-in flexibility for faster market response.

About Aricent

Aricent is a global design and engineering company innovating for customers in the digital era. We help our clients lead into the future by solving their most complex and mission critical issues through customized solutions. For decades, we have helped companies do new things and scale with intention. We bring differentiated value and capability in focused industries to help transform products, brands and companies. Based in San Francisco, frog, a global leader in innovation and design, is a part of Aricent. Aricent is a part of the Altran Group.

About Intel® Network Builders

Intel Network Builders is an ecosystem of infrastructure, software, and technology vendors coming together with communications service providers and end users to accelerate the adoption of solutions based on network functions virtualization (NFV) and software defined networking (SDN) in telecommunications and data center networks. The program offers technical support, matchmaking, and co-marketing opportunities to help facilitate joint collaboration through to the trial and deployment of NFV and SDN solutions. Learn more at http://networkbuilders.intel.com.

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Find out more about what Aricent software frameworks solutions can do for your company. To set up a call or meeting with an Aricent expert today, email marketing@aricent.com.