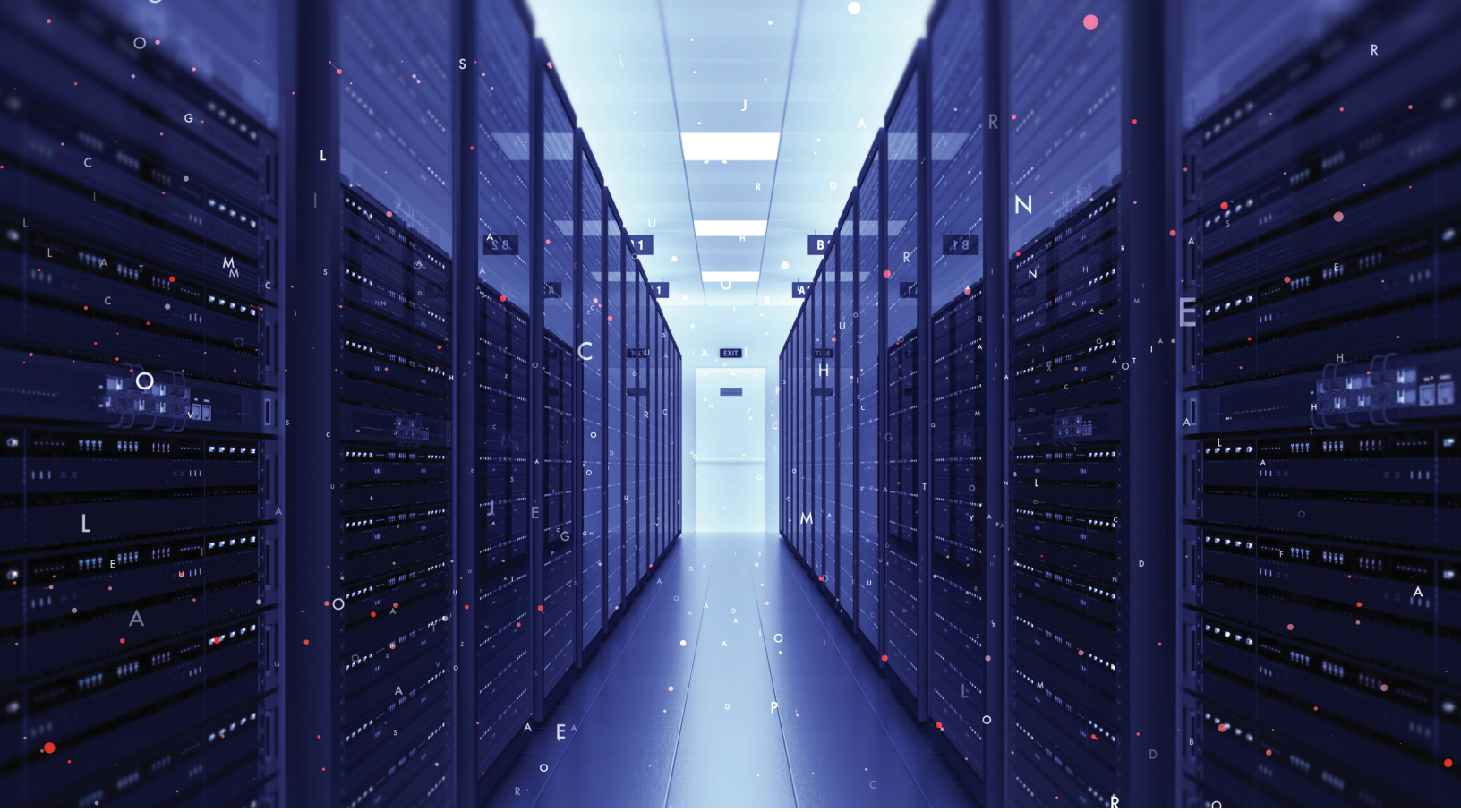
SAMSUNG

Samsung is Paving the Way to 5G with Virtualized RAN



With a laser-sharp focus on reducing costs, today's forward-looking mobile network operators (MNOs) are looking for ways to leverage the benefits of IT infrastructure in their networks.

Technologies like Software Defined Networks (SDN) and Network Function Virtualization (NFV) in their core networks began delivering improved operational benefits, and now, MNOs are beginning to apply those SDN/NFV learnings in earnest to the 5G Radio Access Network (RAN).

Given the dominance of RAN equipment in the network, some believe that virtualization and disaggregation will optimize the component costs and equipment operations to ensure that 5G networks deliver value to stakeholders. MNOs around the world are deploying Samsung vRAN equipment to gain the operational advantages of IT-based architecture while maintaining the high-grade telco quality needed for 5G environments. This paper explores the drivers and the approach that Samsung is taking to deliver the virtualized RAN to leading network operators.

IT Advantages of Virtualization and Disaggregation

- Eliminates vendor lock-in by removing custom hardware-based implementations
- Increases new function velocity with CI/CD
- Creates flexible network architectures to meet any need
- Provides dynamic scaling and dimensioning as and when needed
- Optimizes resource utilization with pooling

Samsung vRAN Solution Characteristics

Samsung's vRAN solutions offer mobile operators a variety of network solutions that can improve the flexibility of the network as well as reduce both CAPEX and OPEX. Operators are exploring a transition to RAN from the "integrated cell site" which includes baseband, radio and antenna components as RAN offers additional flexibility and cost saving opportunities.

Field-Proven Telco Quality

- Implements field-proven wireless algorithms
- Applies advanced techniques on x86 platforms
- Delivers real-time processing that meets strict timing requirements
- Ensures reliability, scalability and resiliency that provides telco-grade performance

Characteristics that Improve Cost of Operations

Mobile operators are looking for new RAN solutions to help lower their operating costs while maintaining and improving the high reliability and availability that businesses and customers expect from wired connections. These new 5G networks will operate in multiple spectrum ranges, allowing them to efficiently and automatically transition capacity across different spectrum for increased throughput. In addition, MNOs need to manage RANs that have a higher cell density to meet coverage and capacity needs, as well as enable ultra-low-latency connectivity afforded by 5G. MNOs can reap significant operational efficiencies using virtualized software-based architecture.

1. Dynamic Capacity Allocation Optimizes Network Resource Utilization

Samsung's virtualized components can automatically scale on demand to meet the needs of unexpected traffic loads, and with cloud-controlled orchestration, the centralized hardware resources can support RAN, edge connectivity, and back-office functions without any manual intervention. This dynamic control allows network operators to direct available processing resources to the software-based tasks the network currently needs. If RAN traffic patterns change, the MNO can allocate the virtualized RAN resources on the fly to meet the new demands. During off-peak hours, operators can assign the same resources to handle operations support tasks, like key performance indicator (KPI) analysis. This flexible scalability means that operators can build an adaptable network that can direct capacity to any point in the system without incurring additional capital expenses. The ability to automatically adjust resources to meet traffic demands is a primary benefit of vRAN.

2. Resource Pooling Improves Response to Traffic Demands

In the virtualized RAN, pooling of baseband resources allows the network to use only the resources necessary to meet network demand. The disaggregated nature of Samsung's vRAN offers the ability to assign new resources where and when needed to distribute real-time-sensitive resources near radios while centralizing general control-related functions that can be pooled for highly efficient platform utilization. The pooling approach enabled by disaggregation eliminates the need to purchase capacity that may be infrequently used. Pooling offers MNOs the ability to optimize capital expenses by purchasing only the hardware and software needed in the region, as pooled components automatically scale to meet the needs that exceed standard demands in the region.

3. Link Acceleration Increases Capacity of Baseband Servers, Reducing OPEX

The RAN's baseband functions are computationally complex and processes are intense. From channel estimation and detection to interference cancellation in MIMO, the ability to distribute these functions across different cores increases the efficiency of baseband processing. Baseband processing includes the scheduling of these traffic flows, and the timing to complete each service is critical. Downlink (network-to-user) user data from the virtualized central unit (vCU) passes through a chain of processes in the virtualized distributed unit (vDU) to become physical layer packets, and all processing must complete before the start of the designated timeslot for that packet. On the uplink (user-to-network), the vDU must transform the received signals into the appropriate bit stream, demodulate and decode the channel, and acknowledge receipt to the device within a given time budget. Samsung leverages Intel's Advanced Vector Extension (AVX) instruction set to complete many of these signal processing functions efficiently. To further increase the capacity in the vDU, Samsung opts to offload CPU-intensive tasks with repetitive structures, like forward error correction (FEC) and low density parity check (LDPC), to hardware accelerators on commercial-off-the-shelf (COTS) servers. With higher processing capacity in the vDU, MNOs can support more traffic on fewer vDUs, resulting in lower expenses.

4. Automation Brings Operational Efficiencies

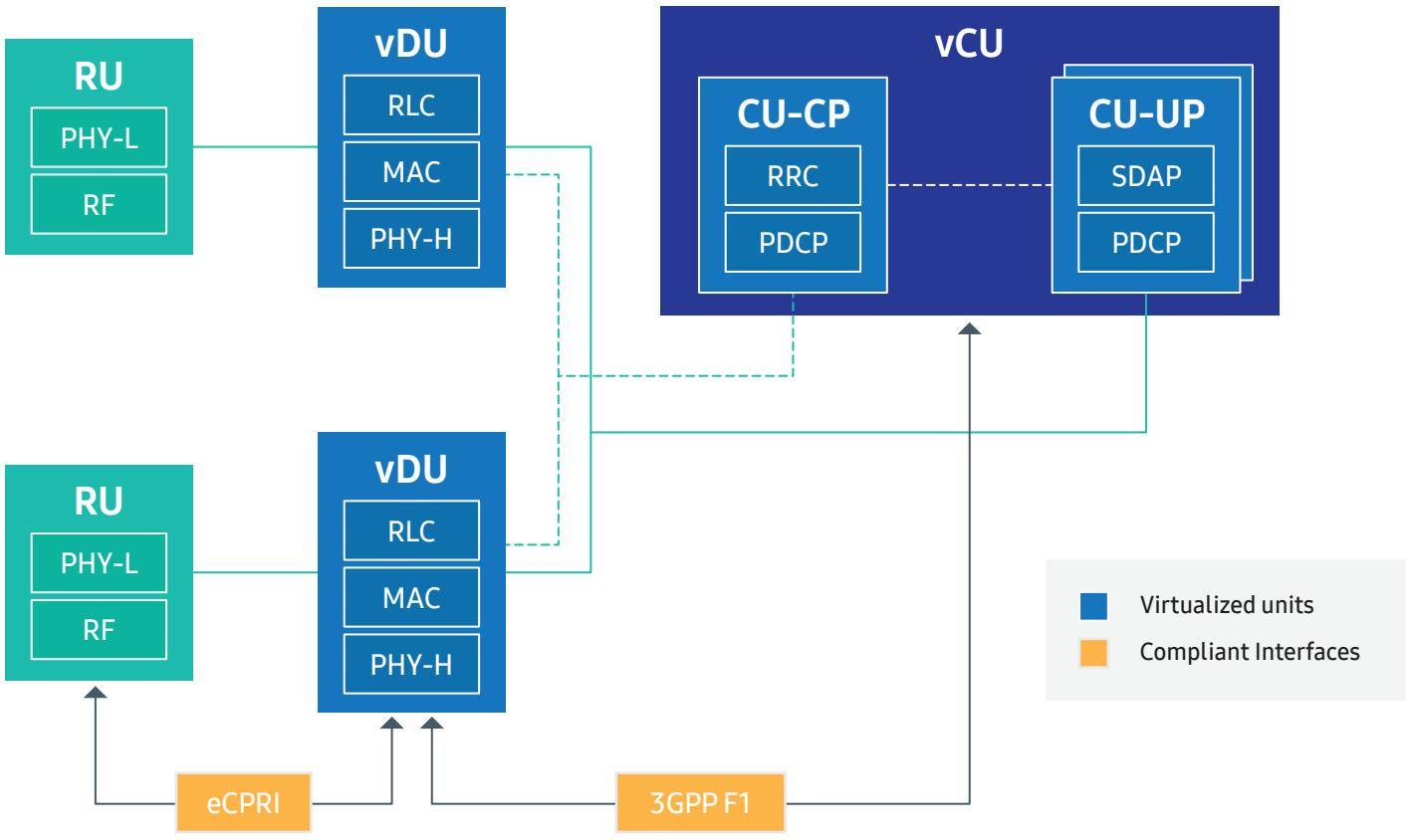
Automation is another technology that Samsung designed into their RAN components. In the virtualized solution, the cloud-controlled system can monitor specific KPIs, and when appropriate, can automatically allocate resources to bring operations back within network tolerances without human intervention. This automation reduces the hundreds of hours of human effort spent tracking, analyzing, and managing the cells. And with MNOs using more radios and more spectrum, the need to control equipment that has different operational abilities across multiple spectrum bands makes automation a fundamental requirement. Not only does automation minimize the possibility of human errors, it also reduces the human-capital costs of managing a mobile network.

Solving the Challenge of Handover in 5G

Maintaining mobile connectivity as the user transitions between cells is one of the most challenging tasks for the RAN, and operators want to minimize handovers. However, 5G can operate in very high frequencies, commonly referred to as millimeter wave spectrum, and while these frequency bands provide high throughput, they do so at the expense of coverage. For efficient 5G operations in these higher bands, the MNO will likely deploy many cells for more frequent handovers for mobile users.

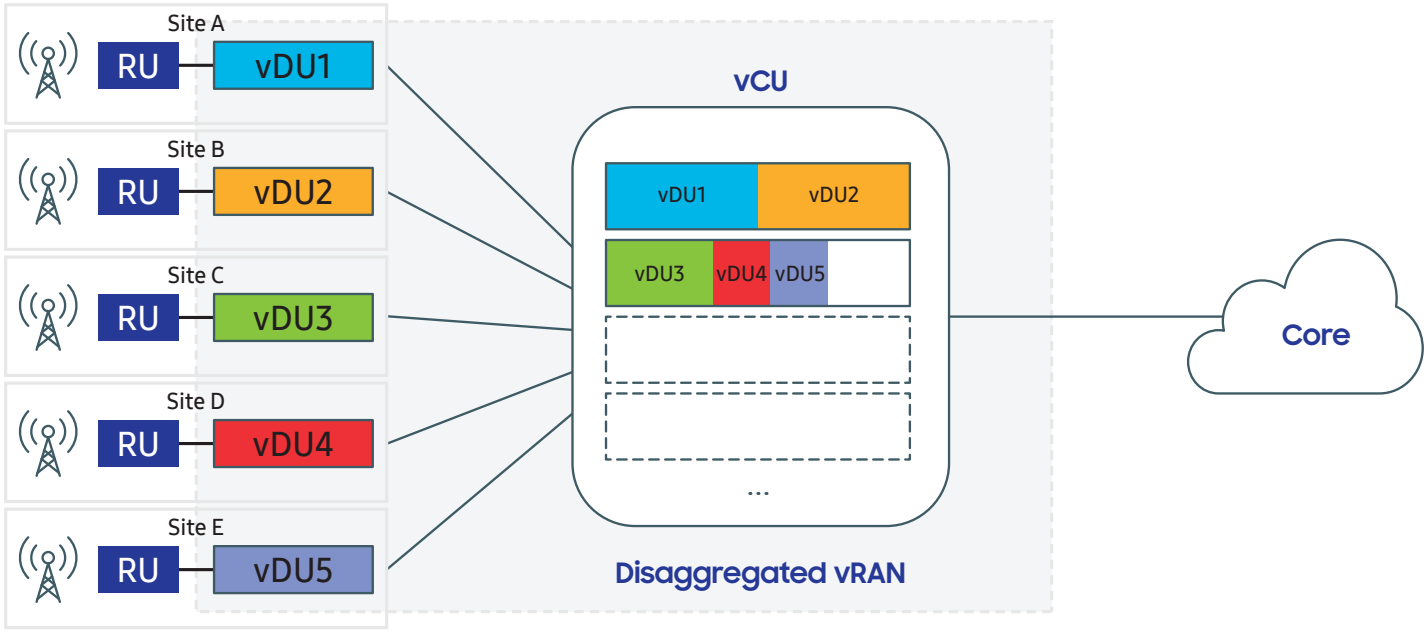
At the same time, higher frequency bands also allow the use of broader bandwidth carriers, so gNBs need to handle considerably more traffic processing capacity compared to previous base stations. Dual Connectivity, which is widely used in current 5G networks, increases the system's capacity needs, as devices may send and receive traffic from two different base stations. Instead of inefficiently processing the load on a distributed unit (DU), the centralized unit is a better option, as it is a more accessible site where resource pooling and sharing can better handle the task. For these reasons, 5G deployments are best served by a separated centralized unit (CU) that is more centrally located from the DU.

Samsung offers a flexible vRAN architecture that utilizes a CU, DU, and a radio, based on 3GPP compliant interfaces as depicted in the diagram below.



Samsung's Virtualized Architecture

Samsung's new access system architecture solves these issues with a disaggregated RAN design that complies with 3GPP-defined baseband split option 7-2, including contributions from the O-RAN Alliance known as Option 7-2x between the Radio and the vDU. Likewise, Samsung uses a standards-defined F1 interface between the vDU and the centralized vCU. The new software-based architecture breaks the current baseband functions into tasks that optimize 5G RAN service operations, which also automatically scale resources when needed.



Option 7-2x

Radios:

From the air-interface side of the RAN, Samsung's Radios communicate with the user equipment (UE) operating within the coverage area of that radio. The Radio supports RF functions, which instruct the antenna on how to communicate with the UE in its field. The Radio also supports the real time-sensitive Low-Phy component of the radio stack, which contains applications like Fast Fourier Transformation (FFT) signal processing and resource element mapping. The Radio uses enhanced Common Public Radio Interface (eCPRI) to support higher traffic loads than prior protocols between the radio and controller.

Distributed Unit:

The Samsung vDU is a containerized implementation of the real-time sensitive baseband functions. The vDU provides the modulation and layer mapping of signals for user-bound traffic. For network-bound traffic, it performs the channel estimation and equalization and maps the received frequencies back into the time domain for transport to the application.

Centralized Unit:

The Samsung vCU is a virtual machine (VM) based implementation of the non-real-time centralized baseband functions. The vCU allows pooled resources to scale on-demand at the direction of the orchestrator in support of capacity on each connected DU. For example, the figure above represents four vCUs supporting five sites, where one of the vCUs controls two remote DUs. The standard defined F1 interface on the Samsung vCU supports control and user plane separation (CUPS). These virtualized capabilities offer proven stability and performance based on deployments in Korea and North America.

5G vRAN Ecosystem:

Samsung and the entire ecosystem continue innovating new capabilities to improve vRAN technologies for MNOs. This ecosystem allows for the creation of products from organizations with expertise in specific domains, enabling faster time to market for high-tech solutions. By collaborating with leading-class suppliers, Samsung leverages those functional experts to incorporate best-in-class products to offer vRAN solutions that meet customer demands.

Samsung's vRAN Architecture Delivers for 5G

Samsung is providing mobile network operators with solutions that use virtualization in many parts of their network today to help enable cost efficiencies. In 2017, Samsung started working with operators around the world to develop and operate the flexible and future-proof virtualized RAN. Network operators deploying virtualized cells in 4G LTE networks are seeing the cost savings of centralized RAN, and they believe that further virtualization can bring more benefits. These 4G sites can coexist with 5G and require only a software upgrade to transition to 5G vRAN. Samsung firmly believes this future-proof virtualized RAN solution with open, standards-compliant interfaces, will form the cornerstone for global 5G innovation, as it will offer network operators the flexibility and adaptability to develop and deliver new, innovative services.

SAMSUNG

6625 Excellence Dr
Plano, TX 75023

Sales: 1.877.556.9469
Service & Support: 1.800.737.7008

samsungnetworks.com