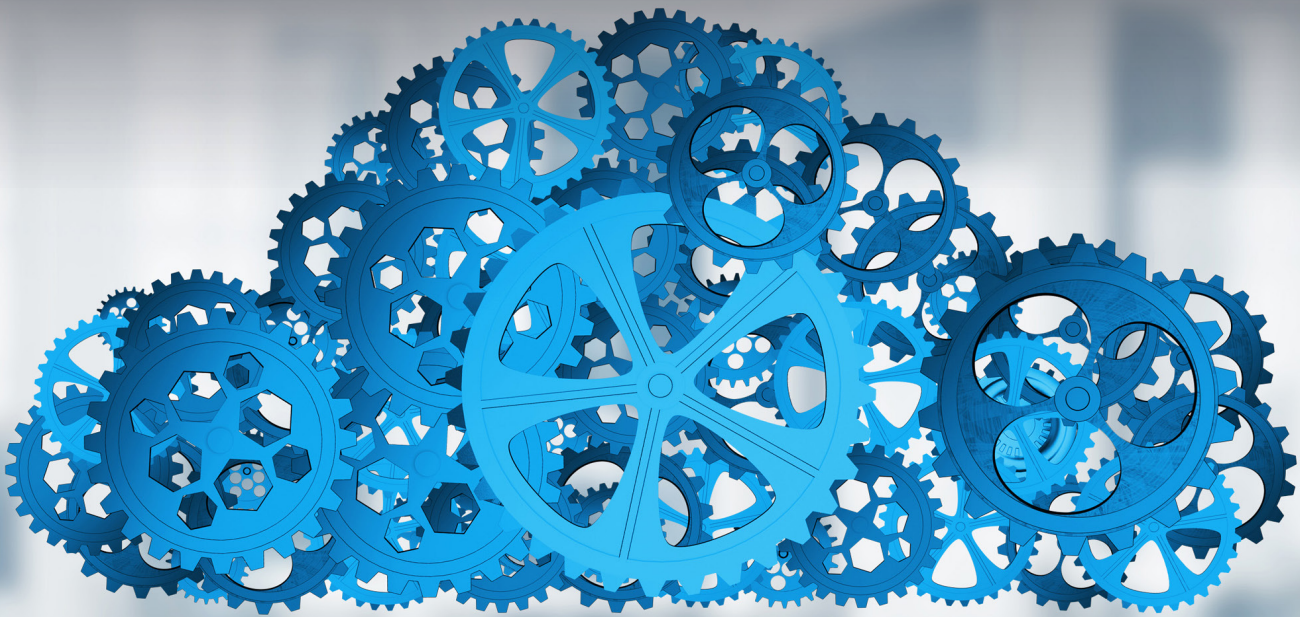


VIRTUALIZED RAN SOLUTIONS AND SERVICES

Capgemini Engineering's cost-effective offering
supports vRAN, OpenRAN and O-RAN architectures



Understand the terrain

Demand for mobile bandwidth has been growing exponentially, making it necessary for mobile operators to scale their wireless networks, which increases the need for advanced wireless technologies to enable this growth. However, whilst mobile data use is increasing, revenue is not rising at the same pace, because the expansion of existing networks and the introduction of new technologies, come with large CAPEX and OPEX investments that may take years to payback.

In this challenging environment, the Virtualized Radio Access Network (Virtualized RAN) has emerged as the optimal technology choice to help operators scale without financial burdens.

Virtualized RAN based architecture supports virtualization of RAN (vRAN) by using standard IT servers, switches, and storage. The network orchestration becomes decoupled from underlying hardware, making it more software-centric. That speeds up R&D cycles, product upgrades, and deployment of new products into the network, reducing total cost of ownership.

Further, virtualization introduces greater elasticity in resource utilization which allows operators to allocate and control resources in more managed ways, thereby helping manage peak load and improving overall network load situations.

Other than the cell site and hardware cost, the Virtualized RAN architecture can provide a virtually edge-free network by enabling spectral efficiency improvement features, such as CoMP and Enhanced Inter-Cell Interference Coordination (eICIC). This speeds up the network by reducing the density of cells, which would often interfere with each other.

Capgemini Engineering is working with multiple partners to deliver different Virtualized RAN architecture based solutions in different Telecom Infra Project (TIP) workgroups, such as vRAN Fronthaul, OpenRAN. The Capgemini Engineering Virtualized RAN offering comprises enabling software, product engineering services, and solution integration.



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Build for the next step

Capgemini Engineering leverages its end-to-end product engineering services and world-class gNB/ eNodeB software to enable RAN solutions based on the Virtualized RAN architecture. The Capgemini Engineering Virtualized RAN solution accelerates time-to-market for OEMs. It enables and optimizes macro and small-cell solutions and supports high-capacity and low-capacity use cases for rural and dense environments.

Our solution complies with all industry standards set by the 3GPP, TIP, and O-RAN, making it interoperable with other vendor solutions:

- Capgemini Engineering offers mature and proven gNB/ eNodeB software frameworks for realizing the Virtualized RAN solutions

- Capgemini Engineering has a strong ecosystem for Virtualized RAN in collaboration with different physical layer-1 software partners. Our solution is agnostic to any platform and also encompasses the functional split option
- For 5G, the Capgemini Engineering software framework solution supports fronthaul interfaces (eCPRI and RoE) based on the O-RAN interface specification
- Capgemini Engineering Virtualized RAN benefits from network function virtualization (NFV), the centralized processing of wireless functions, and the management, and orchestration (MANO) architecture

As shown in the figure below, Capgemini Engineering offers a flexible architecture with different functional splits and fronthaul interface options.

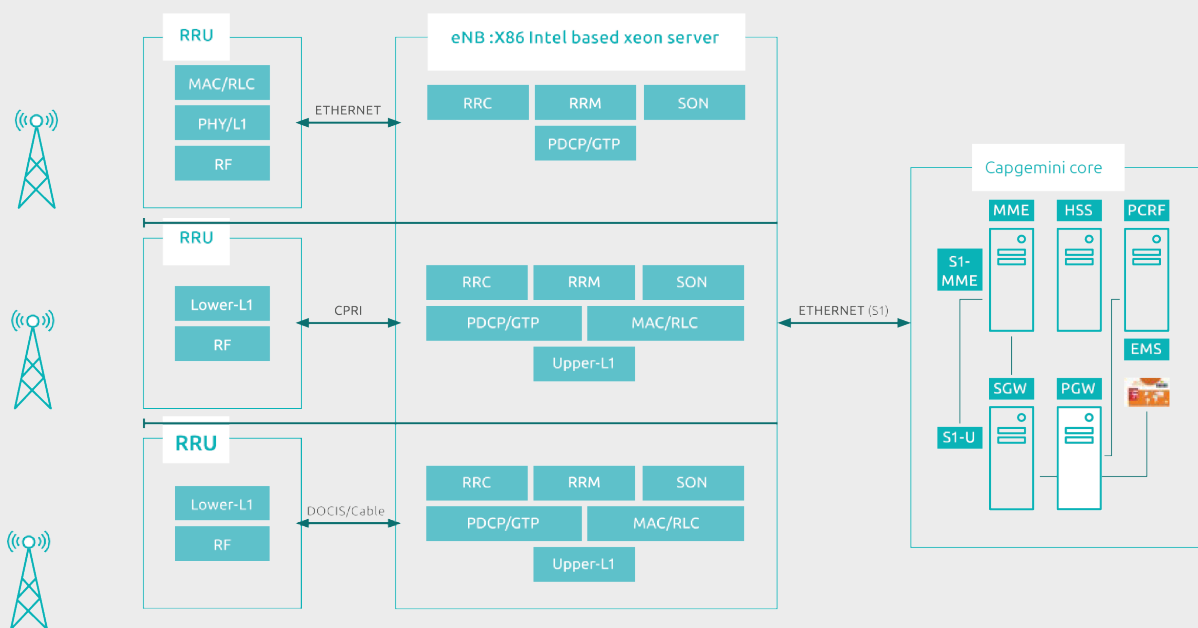


Figure 1: Flexible architecture with different functional splits and front haul options

Virtualized RAN architecture for 4G

In this architecture, the Capgemini Engineering layer-3+ (layer-3, RRM, OAM, SON) and layer-2 (PDCP, GTP-U, RLC, MAC) software runs on the central server using general purpose processors, also referred to as CUs or BBUs. Upper layer-1 runs on the CU whereas lower layer-1 and RF components run on an RRU or DU. Highlights of this architecture include:

- 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 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 L2 (RLC/MAC) instances, each serving multiple cells can be configured
- Ethernet and DOCSIS interfaces are supported between the CU and the DU

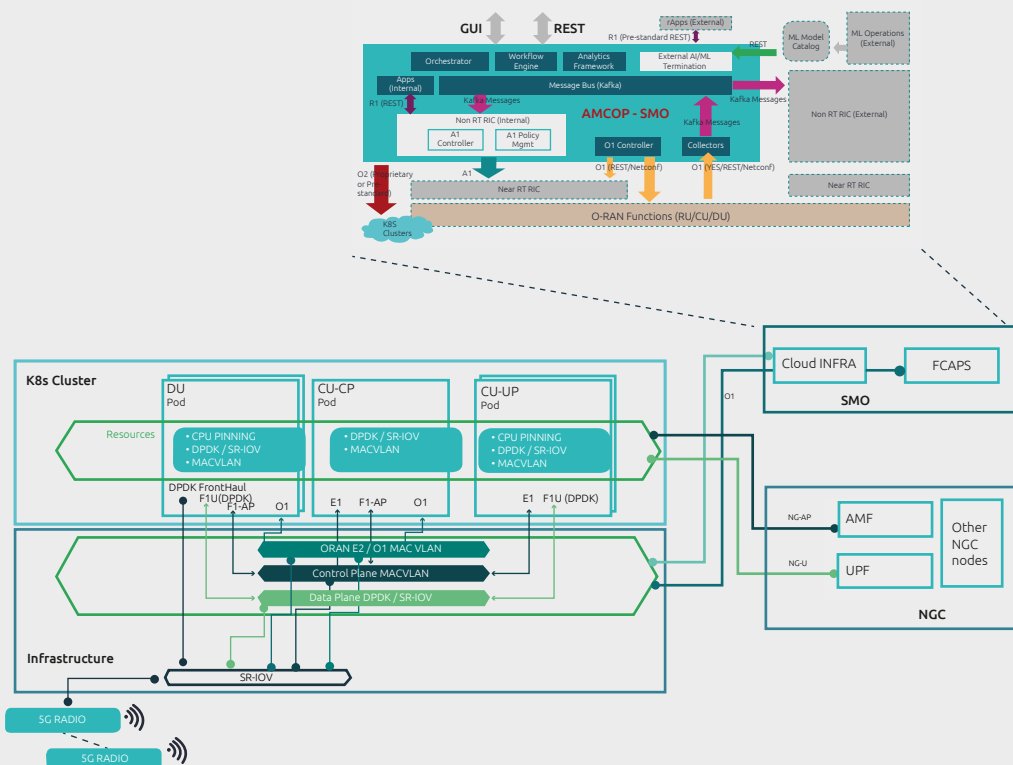


Figure 2: Capgemini Engineering multi pod deployment architecture
 Capgemini Engineering gNB service is based out on multi POD architecture as specified below.

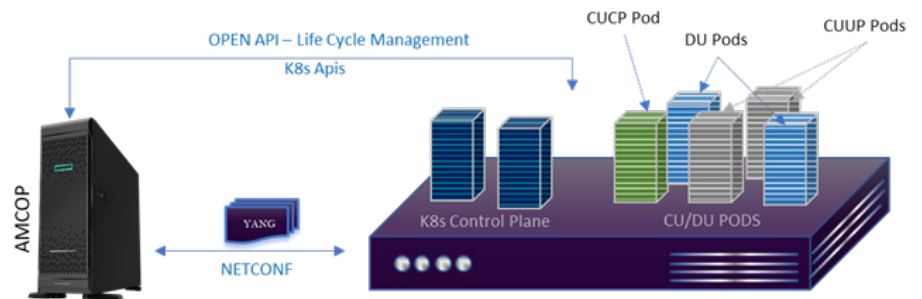


Figure 3: Virtualized CU/ DU on community Kubernetes

Virtualized RAN architecture option for 5G

Capgemini Engineering gNB service is based out on multiple POD architecture as specified below.

- CU-CP Pod – L3, RRM, OAM and RRC services
- CU-UP Pod – PDCP and GTP service
- DU Pod – RLC, MAC and upper L1
- Virtualization of gNB: O-CU, O-DU, SMO as per O-RAN defined architecture
- O-CU, O-DU modelling as docker containers - 3 pod architecture (CU-CP, CU-UP, DU)
- Solution is easily deployable on different cloud infra.
- Use of community Kubernetes as underlying VIM
- Orchestration and management of O-CU/O-DU via SMO -- Onboarding, instantiation, termination, upgrade
- E2E service with successful Cell setup and throughput working with Capgemini ViNGC.
- FCAPS management via O1 interface between SMO and gNB.
- Usage monitoring and Health check of vCU / vDU pods via SMO
- Capgemini Engineering Virtualized RAN further supports deployment of multiple instances of CU-UP and DU to increase the load capacity of data plane.

Make your move

Capgemini Engineering works with original equipment manufacturers (OEMs) to develop and customize their LTE and 5G solutions based on the C-RAN architecture. By customizing the RAN solution to meet their specific needs, Capgemini Engineering 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 the physical layer-1 and RRH suppliers
- Extensive testing and deployment in some of the most demanding markets in the world
- End-to-end product engineering services for Virtualized 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 Capgemini Engineering

World leader in engineering and R&D services, Capgemini Engineering combines its broad industry knowledge and cutting-edge technologies in digital and software to support the convergence of the physical and digital worlds. Coupled with the capabilities of the rest of the Group, it helps clients to accelerate their journey towards Intelligent Industry. Capgemini Engineering has more than 55,000 engineer and scientist team members in over 30 countries across sectors including Aeronautics, Space, Defense, Naval, Automotive, Rail, Infrastructure & Transportation, Energy, Utilities & Chemicals, Life Sciences, Communications, Semiconductor & Electronics, Industrial & Consumer, Software & Internet.

Capgemini Engineering is an integral part of the Capgemini Group, a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided every day by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of over 340,000 team members in more than 50 countries. With its strong 55-year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fueled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering and platforms. The Group reported in 2021 global revenues of €18 billion.

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