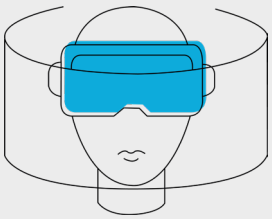
Capgemini engineering

# CAPGEMINI ENGINEERING 5G SOLUTIONS FOR NEXT-GENERATION CARRIER NETWORKS

## Introduction

2G brought mobile voice. 3G gave us widespread data services. 4G delivered high-bandwidth applications to smartphones. But 5G is a game changer. It's an application enabler that allows a far greater number and variety of endpoints to connect — in particular, Internet of Things (IoT) devices — to create business value. 5G networks can also use network slicing and scaling to use resources optimally. With 5G, applications can now take full advantage of ultra-low latency connectivity to provide high-bandwidth, high-performance services to users.

5G has several industrial, medical and consumer uses that are now being widely deployed within enterprises and various mobile environments. These include robotics for industrial automation and medical services, along with virtual reality (VR) for consumers and businesses. All of these applications require high bandwidth and low latency to provide optimal user experiences. For instance, many vendors offer high-resolution, low latency VR devices for security applications. Industrial automation, sensor arrays and telematics also require high data capacity and many connected devices. 5G-based solutions improve the performance of many complex edge applications. They will also help create the next wave of real-time, high-bandwidth applications that require remote management and control or real-time synchronization, like autonomous driving.



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## 5G advancements can be divided into two categories:

1. **Application-Centric Performance**

    a. Network slicing enables higher capacity and supports applications at the edge of the network via multi-access compute

    b. The C-RAN solution moves compute to the edge enabling low-latency applications

2. **Network Agility**

    a. Improves management and efficiency of network infrastructure and platform components

    b. Leverages network function virtualization (NFV) based architectures, stateless solutions and software-defined networking (SDN) based routing resulting in an agile network that enables high bandwidth and elastic scaling

Capgemini Engineering understands that in the current scenario, there are multiple views on 5G-band implementation. Some carriers are deploying sub-6 GHz bands such as 2.3 GHz band for 5G rollout, while some are leveraging millimeter waves such as 28 GHz and 39 GHz.

The sub-6 GHz band is best matched for mobility since it has better penetration. The millimeter-wave bands work best for higher-capacity outdoor applications, such as fixed wireless connections. Millimeter solutions are not a good match for indoor solutions due to issues with wall penetration.

3GPP released the non-standalone specifications for 5G in December 2017 and the standalone specifications in June 2018. Capgemini Engineering has successful field-proven solutions for both specifications for access as well as for the 4G core network. We have leveraged these to create solutions for both 5G access and 5G core. For 5G access, the 5G new radio (NR) non-standalone is the initial target along with different options of C-RAN. For the core network, the 5G next-generation carrier (NGC) architecture is adapted to serve a highly scalable solution that can be sliced and used for multi-access edge computing (MEC) deployments.

## Accelerate product development

The Capgemini Engineering 5G Solution was developed to support network equipment manufacturers (NEMs) and communications service providers (CSPs) that plan to build their own 5G solutions to fast track their next-generation product roadmaps. We developed the Capgemini Engineering 5G Solution so NEMs and CSPs could leverage this service in 'plain vanilla' deployments, while at the same time, providing them with opportunities to modify the solution with a variety of 'secret-sauce' options, in order to create differentiated services.

5G deployments vary widely. They might utilize the sub-6 GHz band for mobility or microwave bands for fixed usage outdoors. They can also be used for low throughput, such as infrequent data transmitted from IoT devices, or can be used for very high throughput applications, like video surveillance cameras or streaming audio and video. Of course, one architecture does not fit all applications, which is why Capgemini Engineering created our solution to be deployed for a variety of uses with equal ease.

This deployment variability presents a unique opportunity for NEMs and CSPs. By developing a 5G solution that enables new 5G-dependent business cases, CSPs can deploy new services rapidly and leapfrog competitors. The Capgemini Engineering 5G-ready solution is designed to fast-track next-generation deployments based on a virtualized, scalable architecture. It can deliver multiple services and serve a variety of applications simultaneously. This allows for the optimal use of resources and accelerated lead-times for deployment. Also, services can be rolled out at different times in different geographies.

Capgemini Engineering solutions help CSPs deliver high-value services that leverage MEC or are focused, for example, on IoT, low-latency or V2X solutions efficiently and optimally. This allows operators to offer data connectivity and 5G services to application vendors, allowing vendors to monetize both the applications and application usage.

## Capgemini Engineering 5G solution

Capgemini Engineering is a leading provider of 5G NR/ LTE RAN and core network solutions that enable NEMs and CSPs to develop differentiated products in an agile manner. The Capgemini Engineering 5G solution is developed to help NEMs stay ahead of the technology curve and foster innovation.

Figure 1 provides a 5G architectural overview as defined by 3GPP. It displays how the legacy 4G network is enhanced to use 4G along with a 5G radio in a non-standalone mode and then migrated to complete 5G access using a standalone mode.

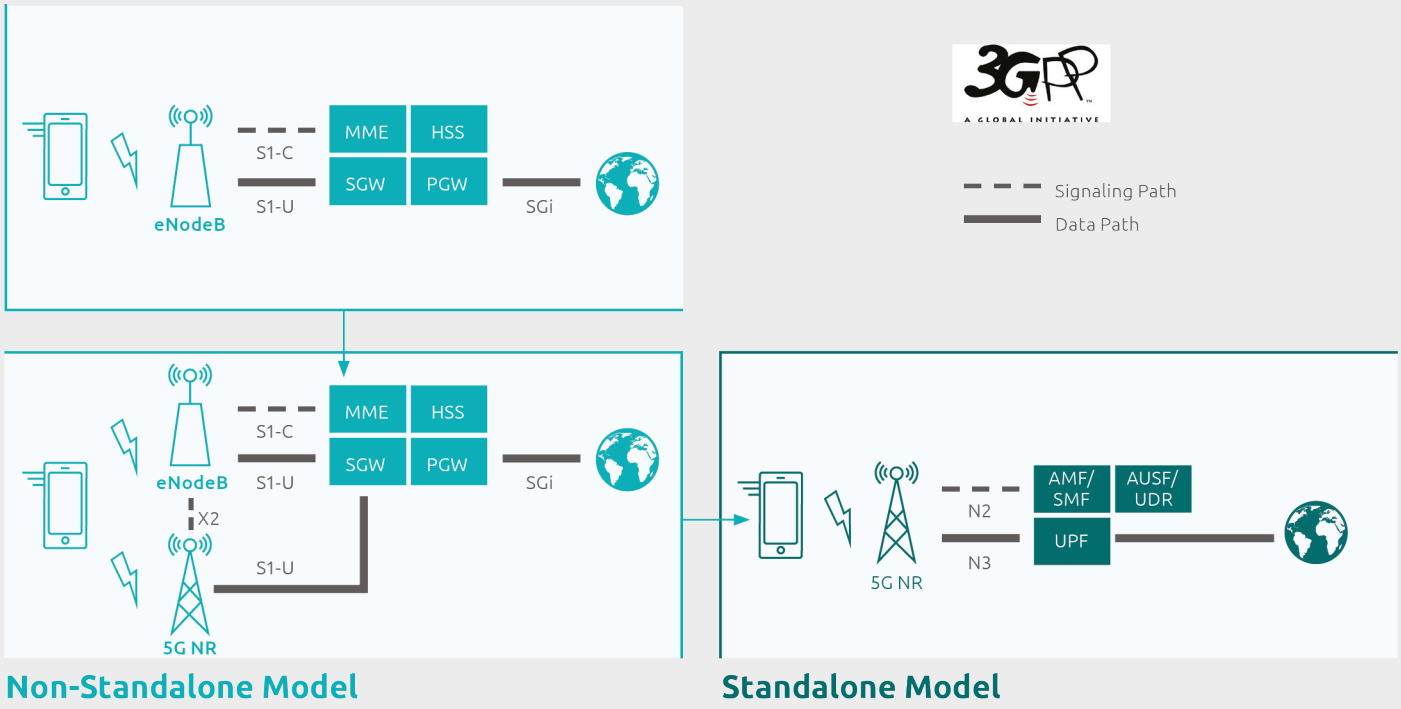



Figure 1: 5G Architecture
*Source: Capgemini Engineering*

## Capgemini Engineering 5G RAN offering – key aspects

The Capgemini Engineering 4G RAN solution has Layer 2 and Layer 3 of eNodeB, which is pre-integrated on hardware offered by various vendors. Capgemini Engineering also offers professional services to create a field-deployable eNodeB for small cells and macro networks for NEMs. Recently, Capgemini Engineering observed an industry trend to move a part of eNodeB to virtual macines (VMs) or local detacenters to better utilize the network usage.

3GPP has devised multiple options to split the 5G NR for C-RAN solutions, each of these has some benefits. Some architectures are beneficial for highly dense areas, such as cities, and some for less dense areas, such as rural areas. Capgemini Engineering is exploring most of these solutions as we see value for carriers in different deployments utilizing split architectures.

Capgemini Engineering has various options for eNodeB C-RAN solutions. A similar architecture is being suggested by 3GPP for 5G NR, and Capgemini Engineering is transforming its eNodeB to comply to 5G NR for these architectures.

Capgemini Engineering 5G Access Network Software Framework is

- 3GPP compliant gNB Solution and supports protocol layers* - MAC, RLC, PDCP, eGTPU, F1U, X2U, XnU, SDAP, RRC, F1AP, XnAP, NGAP, X2AP.
- gNB Software is available pre-integrated with Layer-1 from Capgemini Engineering partners on Intel Xeon, ARM, Qualcomm, Octasic, Picocom and NXP SoC platforms.
- The Capgemini Engineering gNB solution supports both NSA, SA modes in sub6 and mmW spectrums and can be flexibly deployed in different 3GPP and ORAN specified CU-DU-RU splits for small and large scale capacity solutions.
- Figures 2 shows the CU/ DU option 2 & DU/RU 7.2 split architecture of Capgemini Engineering 5G solutions.
- This solution supports MIMO up to 16 layers and modulation schemes up to 256 QAM, for high throughput solutions.
- Solution is performance optimized and is currently being deployed by OEMs accross various geographies.
- It also comes with NR OAM, which can be used to configure, provision, control and monitor the gNB Software.

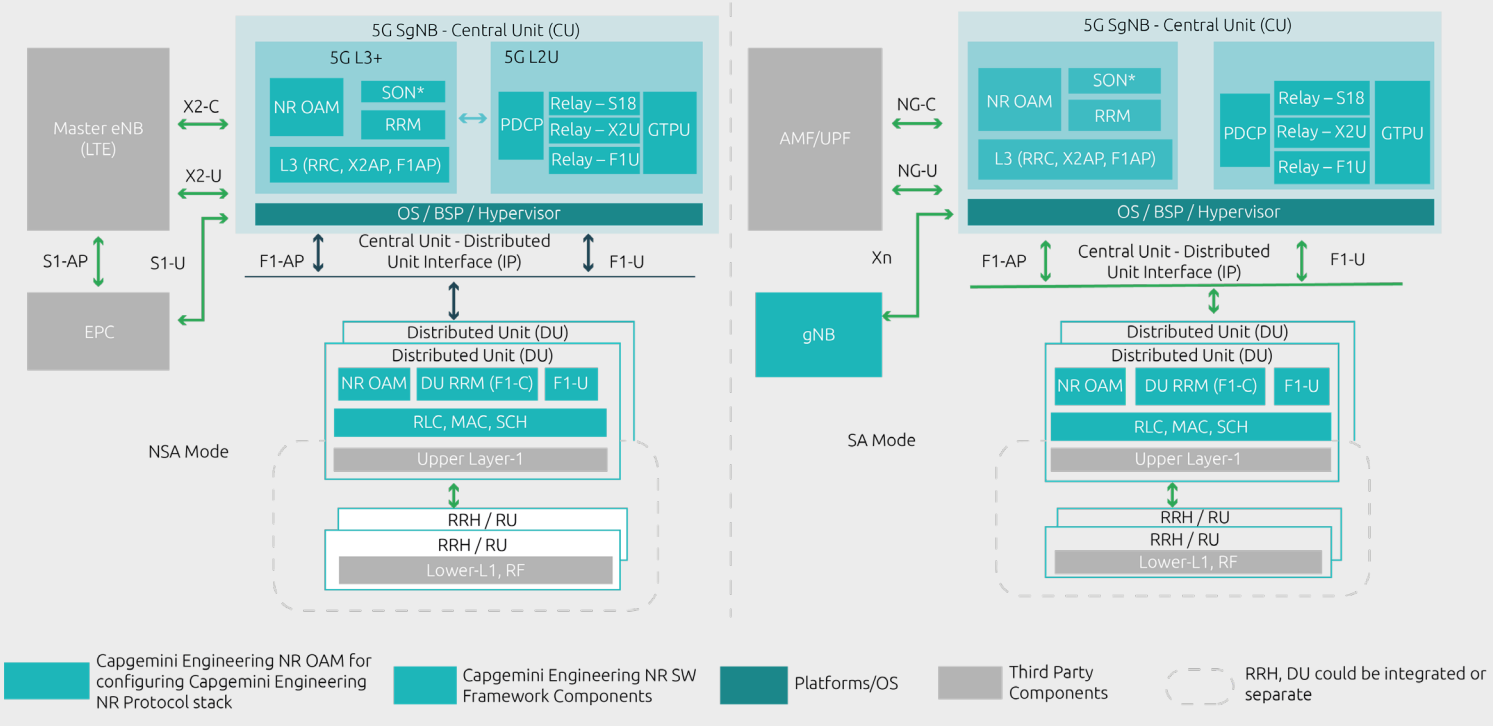
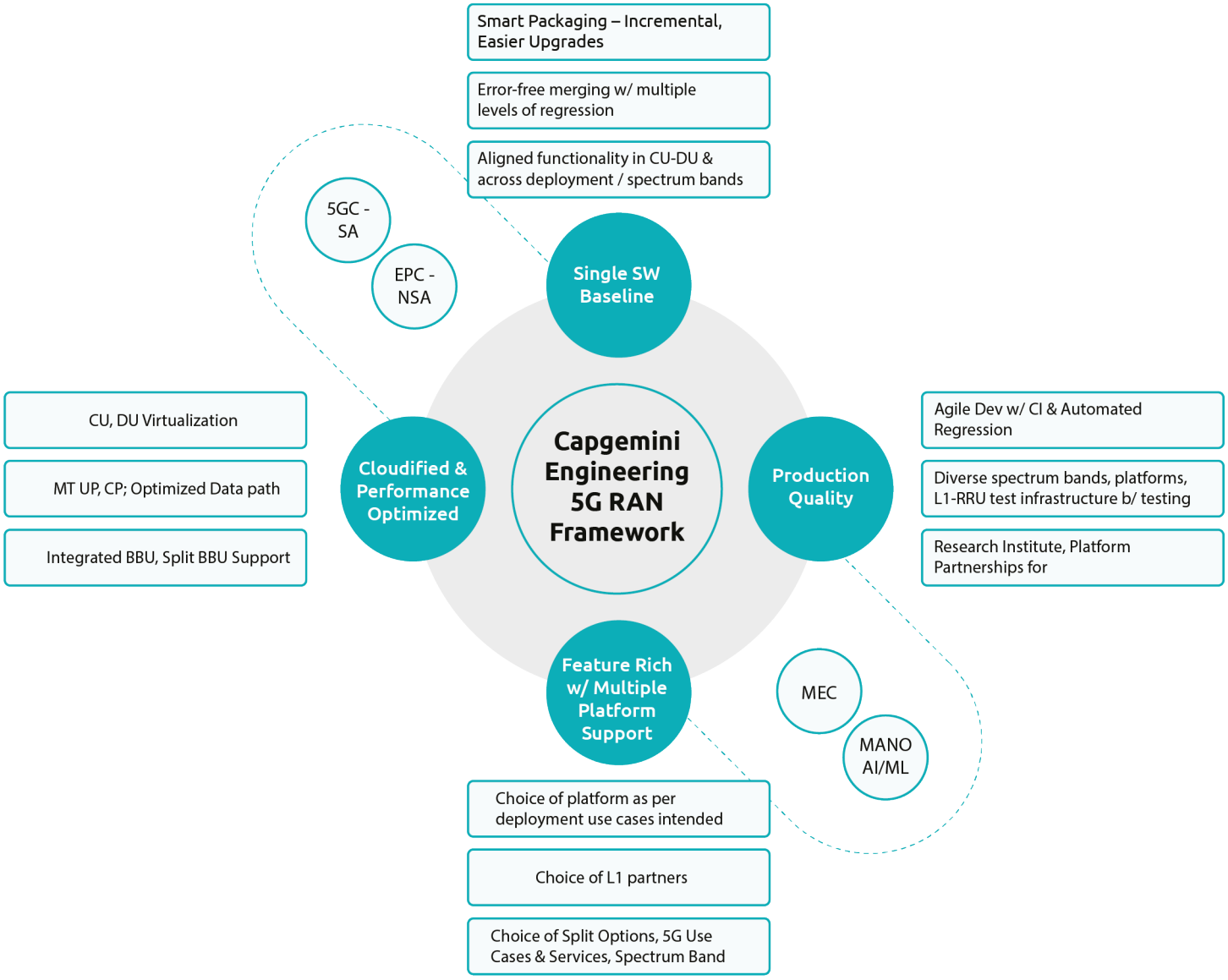



Figure 2: Note: Above view is a logical module view of Capgemini Engineering NR Software Components vis-à-vis gNB Solution.

## Why Capgemini Engineering?

- Available pre-integrated on different platforms with different L1 partners
- Virtualized & Performance Optimized
- Feature rich, scalable solution with support for different splits & deployments
- Single Software baseline for different spectrum bands, duplex models & deployment modes (NSA, SA) allowing incremental feature upgrade
- Easily customizable
- Source Code Solution Available
- Deep expertise in Access Networks in product development and services including design of baseband and radio unit hardware for 4G and 5G NR



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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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