Vendor Profile

Capgemini Engineering's Big Bet on 5G and Edge Services

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IDC OPINION

Connectivity is becoming more important than ever to drive the next industrial revolution. Proliferation of connected and smart endpoints, rapid growth in the data generated from these endpoints, and requirements for low-latency, ultrahigh-speed output all require telecom operators/carriers, network equipment providers (NEPs), and end-user enterprises to relook at connectivity solutions. 5G wireless connectivity offers three key value propositions: enhanced mobile broadband (eMbb), support for massive machine type communications (mMTC), and provision for ultrareliable low-latency communications (URLLC). This means that 5G can serve lower-latency, higher-speed/higher-bandwidth applications and a denser device ecosystem than its predecessor connectivity options such as 3G and 4G. Low latency and faster throughput are achieved with the aid of "edge servers," which bring data processing closer to the endpoints/origin. While these reduce network latency, edge computing infrastructure and applications also ensure the reliability of the connection. Key considerations include the following:

- Suitable connectivity options are imperative for end-user enterprises to sustain this rapidly growing connected ecosystem that delivers best-in-class immersive user experiences and generates new revenue streams.
- Customer experience is a key theme that is driven by the adoption of next-gen digital technologies such as Internet of Things (IoT), artificial intelligence and machine learning (AI/ML), augmented reality and virtual reality (AR/VR), and mixed reality (MR). These are realized with the aid of a 5G connectivity solution.
- Edge solutions play a pivotal role in delivering upon 5G's value proposition and promise. This infrastructure can reside anywhere between the connected endpoints and the core network. It enables users to achieve ultralow latency and reliable connectivity, and it supports the growing connected devices while bolstering the security of the solution though distributing the connected devices.
- New 5G and edge deployments to modernize operations infrastructure and subsequent data analysis require strong domain-specific technology consideration, discussion, and implementation experience. Talent in this area is scarce and expensive.
- Digital engineering and operational technology (DEOT) service providers (SPs) bring their infrastructure, proprietary solutions and frameworks, domain-specific experience, and engineering talent to modernize their customers operations. Such relationships enable telecom operators, NEPs, and end-users enterprises with faster implementation and ROI realization of 5G and edge deployments.

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IN THIS VENDOR PROFILE

This IDC Vendor Profile is part of an ongoing series of digital engineering and operational technology (DEOT) service provider/vendor research program. This document demonstrates Capgemini Engineering's evolution toward 5G and edge solutions and services; the company's strategy, 5G and edge solutions, capabilities, and partnerships; and how that complements the 5G solutions and services of telecom operators/carriers, network equipment providers, and the technology road map of end-user enterprises.

The details of this IDC Vendor Profile are based on the discussion with and content shared by Capgemini Engineering.

SITUATION OVERVIEW

How 5G Can Be a Strategic Enabler for End-User Enterprises

5G connectivity has revamped the way that the technologies, solutions, and services of connectivity are seen by end-user enterprises. This new generation of wireless connectivity brings together connectivity technologies (CTs) into a strategic lens that is similar to that of information technology (IT) and operational technology (OT). The benefits that 5G offers to the end-user enterprises include the following:

- **High-speed connectivity and increasing bandwidth:** 5G connectivity services offer 10-100 times more throughput than its predecessor technologies, and it is expected to give a broadband-like mobile experience to end users. This makes 5G attractive for applications that require higher bandwidth and data rates to deliver their potential outcome.
- **Delivering lower-latency connectivity to mission-critical applications:** Mission-critical applications such as assembly line surveillance, real-time quality check, public safety, remote monitoring of the power grid, and remote delivery of healthcare are expected to benefit the most from 5G connectivity services. Low latency and reliable connection are some of the hygiene requirements for these applications to deliver optimal performance. 5G offers network availability greater than 99.999% and renders less than 5ms of end-to-end latency.
- **Supporting densely connected ecosystems:** With the proliferation of connected endpoints in the rapidly growing IoT ecosystem, breadth of connectivity across endpoints becomes a critical factor for optimal performance. 5G can support up to 1 million connected endpoints per square kilometer, making it the "go to" connectivity solution for rapidly growing urbanization.
- **Network slicing to facilitate application requirements:** One of the key benefits of deploying 5G is "network slicing" – the functionality that is facilitated by network virtualization to divide a single network connection into multiple distinct fit-for-purpose independent virtual connections. Each segment is built to provide customized levels of service tailored to a customer's individual network performance specifications.
- **Private 5G network and its applications to enterprise use cases.** Smart manufacturing, connected automotive, connected healthcare, smart mining, and so forth require a high-performance connectivity foundation. A private 5G network uses standalone 5G deployment that can address these use cases with tailored solutions that are secure and reliable and bring the required optimization powered by telecom operators/carriers and NEPs in conjunction with DEOT service providers.

- **5G network to reduce connectivity-related carbon footprint:** According to the Exponential Roadmap Initiative, 5G networks along with AI and other digital technologies are expected to reduce the carbon footprint by transforming legacy hardware and repurposing and redesigning the technology road map for the communications SPs and end-users.

5G's pervasive connectivity not only improves the operational efficiency and business agility of end-user enterprises but also acts as a key component to the user experience, which is directly tagged to the monetization of products and services. Ultrareliable connectivity enables efficient management of data packets and minimizes packet loss, which guarantees delivery of the immersive experience that end users expect from 5G.

5G's Impact on Telecom Operators/Carriers

This next-generation wireless connectivity has also orchestrated a paradigm shift in offerings from telecom operators/carriers, which include:

- **Enablement of new services offerings.** 5G's value proposition toward high-speed, ultrareliable, low-latency connectivity and its support for a growing ecosystem of connected endpoints over its predecessors can enable new service opportunities. Telecom operators/carriers can bring new service offerings that can be targeted toward specific enterprise audiences with specific network KPIs to support their operations.

- **Virtualized infrastructure.** 5G infrastructure is built on virtualized network functions (VNFs) such as virtual radio access network (vRAN) and virtual evolved packet core (vEPC). This allows operators/carriers to reduce the capex and opex, dynamically scale the network infrastructure and services, and deploy new services faster (owing to the cloud-native architecture of the core).
- **Flexible deployment modes.** One of the key advantages of 5G is that it can be deployed on a non-standalone or standalone basis. In non-standalone 5G deployments, telecom operators/carriers can leverage existing 4G/ LTE infrastructure to roll out 5G RAN with the help of LTE EPC, thus avoiding a complete rework of the network, and can take a transitionary road map. On the other hand, standalone 5G deployments can enable service providers to bring a full range of 5G features to facilitate enterprises' connectivity needs, which are needed for specific applications such as smart manufacturing, autonomous and connected automotive, and smart grid with 5G private network offerings.
- **Support for service-based architecture (SBA).** Unlike previous generations of wireless connectivity services such as 3G and 4G, 5G supports service-based architecture for the network functions. This breaks down monolithic network elements into customizable microservices, which allows telecom operators/carriers to rapidly deploy services and seamlessly integrate third-party applications to the core network.
- **Democratization of network equipment.** White-box designs for radio units, baseband units, routers, and switches are expected to reduce hardware cost and improve service innovation for telecom operators/carriers while ensuring flexibility, scalability, and interoperability among NEPs.
- **Network slices and new services.** Network slicing enables telecom operators/carriers to bring in new services, depending on the requirements from the end users. Telecom operators/carriers can customize these slices at the enterprise level and design their offering specific to end users' applications.

Change in Dynamics for the Network Equipment Providers

While telecom operators/carriers play a vital role in delivering 5G solutions in collaboration with DEOT service providers, NEPs are expected to witness a paradigm shift in their market dynamics as well. In detail:

- Service-based architecture of the core and democratization of the radio unit, baseband, and other hardware can reduce the dependency on traditional monolithic infrastructure to run 5G VNFs to commercial of-the-shelf (COTS) hardware.
- This market change is expected to increase competition through new entrants in the 5G space while ensuring interoperability, which reduces the entry barrier for NEPs in a telecom operator/carrier's network ecosystem.
- Existing NEPs can bring new and augmented solutions that telecom operators/carriers and DEOT service providers can use to deliver vertical-specific applications.
- New entrants can bring purpose-built hardware solutions that can be used as a plug-and-play for telecom operators/carriers and DEOT service providers to deploy.
- Network gears' energy usage constitute a significant share of a telecom operator/carrier's operating cost. From this cost and carbon neutrality standpoint, 5G's cloud-native deployment enables NEPs to work with DEOT service providers in bringing products with reduced carbon footprint and power usage.

DEOT service providers play a pivotal role in realizing the benefits that an end-user enterprise can get from 5G solutions by offering services related to consulting, design, development, integration, orchestration, managed services, and so forth in collaboration with telecom operators/carriers and network gear vendors. In similar lines, telecom operators and network gear vendors can also utilize DEOT service providers to build and test 5G infrastructure and solutions that can enable interoperability among stakeholders while ensuring flexibility and scalability, which are imperative to 5G solutions.

Tailoring Connectivity Using Private 5G Network

With abovementioned benefits, 5G connectivity services can be a game changer for communications SPs, DEOT services providers, and end-user enterprises across verticals. 5G will support next-generation technologies and business models across vertical-specific use cases and enable enterprises to bring new service innovations. Use cases such as smart factory automation, connected/autonomous vehicle, AR/VR applications in retail, and smart infrastructures including smart stadium/auditoriums are enabled by 5G connectivity services. One of the true potentials of this connectivity solution can be realized in private 5G networks and services that are custom built for industry-specific applications or use cases. Here, end users can acquire the spectrum, infrastructure, and services that can be designed and deployed by a DEOT service provider. The following benefits make private 5G a more beneficial proposition for end-user enterprises:

- It involves customization of bandwidth and latency requirements based on the specifications required for the use case/application coupled with increased reliability.
- Private 5G networks can also allow enterprises to scale the ecosystem to support more devices and incorporate heterogeneity depending on the devices' data processing and storage requirements.
- Lack of physical infrastructure is a key advantage of private 5G deployments over Wi-Fi, especially for manufacturing shop floor or power plant. In case of change in the shop floor layout, the connectivity can remain seamless.

- It includes reducing the threat by establishing enterprise-specific security policies and allowing easy orchestration of governance and compliance for the IT/OT ecosystem.
- From management of the network and connectivity services, the enterprises get more control over their connectivity services. These private 5G networks can also allow more customized network slices for application requirements.

Private 5G network deployments in end users' sites are getting significant traction owing to their attractiveness toward smart manufacturing, factory automation, robotic swarm intelligence in warehouses, critical connected care, measuring production output in offshore oil exploration, and so forth. Engineering and OT service providers together can bring an assessment toolkit for 5G readiness and leverage for the end users and their partnerships with NEPs, software platform vendors, cloud hyperscalers, industrial solution providers, and so forth to develop a carrier-grade 5G connectivity solution for their enterprises customers. Here, DEOT service providers can add a layer of cognitive computing/AI and security and incorporate necessary customization that are required to address enterprises' business problems.

Edge Powering 5G Connectivity Services

Edge computing infrastructure is a key catalyst for the enhanced service experience that 5G offers. 5G's value proposition toward ultralow latency, high bandwidth, and support for densely connected endpoints can be practically realized with the aid of edge computing infrastructure. Multi-access edge computing (MEC) brings data processing and storage for applications nearer to the edge of the network or simply to endpoints (where the data is generated). In this way, the latency is significantly reduced, and distributed processing networks enable support for massively connected ecosystem and allow communications SPs and DEOT SPs to develop, deploy, and host applications nearer to the endpoint, so that end-user enterprises and consumers can realize an enhanced user experience. IDC believes that increasing incorporation of AI/ML workloads, growing demand for bandwidth-intensive and latency-sensitive applications, and ability for the ecosystem to scale owing to increasing number of connected endpoints are expected to drive workload processing at the edge locations.

5G connectivity services are complemented by multi-access edge computing and can facilitate complex application and incorporation of digital technologies into enterprise IT. Some of the critical use cases for 5G and edge services are:

- **Automotive.** 5G and edge can be key enablers for connected/autonomous vehicles, which are gaining traction. These are fitted with device edge for transactional data processing. Next-generation autonomous cars are expected to drive the need for 5G connectivity and edge services to facilitate high-bandwidth and low-latency attributes such as vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-everything (V2X) information exchanges; precrash sensing; and an adaptive driver assistance system (ADAS).
- **Manufacturing.** Smart manufacturing will witness significant benefits from 5G MEC. Applications such as end-of-line quality control in a production process, which was traditionally a manual activity are automated in a smart manufacturing setup through localizing the image processing in MEC locations.
- **Oil and gas (O&G).** 5G and MEC can also bring value to oil and gas exploration and the utilities sector. Increasing complexities across the exploration process, distributed pipelines, extreme temperatures in LNG, configuration terminals, and complex refining create the need for adoption of 5G and MEC among the O&G companies.

- **Media and entertainment.** Next-generation sports stadiums and concert halls can deliver a superior experience to audiences by leveraging 5G with MEC. 5G and MEC can enable real-time facility monitoring, push notifications through mobile apps, AR/VR experience, digital signages, sales of merchandise/refreshments and hassle-free delivery, securing audience data, and maintaining data governance and compliance.

5G connectivity and edge computing are expected to fulfill the need for a superior customer experience. This is also creating new revenue streams through new service innovations across the enterprise. Hence, digital engineering and operational technology SPs can foster service opportunities across communications SP and end-user enterprise space by designing, developing frameworks, building use cases and applications, deployment, integration, orchestration, and so forth.

Company Overview

Capgemini Engineering is an integral part of the Capgemini Group, headquartered in Paris, France. As a global service provider in engineering and research and development (R&D) services, Capgemini Engineering combines broad industry knowledge and next-generation technologies in digital products and software to enable the convergence of the physical and digital worlds. The service provider harnesses the power of data to foster innovation, create new experiences and deliver new sources of value. Coupled with the capabilities of the rest of the group across consulting, technology, professional, and outsourcing services, it enables its clients to accelerate their journey toward the digital industry where Capgemini brings together next-generation digital capabilities (such as AI/ML, 5G, edge, IoT, and cloud) to cultivate innovation across various dimensions of its client's business.

Capgemini Engineering has more than 55,000 engineers and scientists in over 30 countries across sectors including aeronautics, space, defense, naval, automotive, rail, infrastructure and transportation, energy, utilities and chemicals, life sciences, communications, semiconductor and electronics, industrial and consumer, software, and internet.

Capgemini Engineering is a full-scale DEOT service provider with a portfolio of offerings across networking, connectivity, and IT/OT solutions and services. Several decades of experience in designing, developing, deploying, and managing connectivity solutions and services have enabled it to quickly venture and establish its presence in 5G and edge solutions in the services market. Capgemini Engineering is relying on the "Intelligent Industry" strategy and its presence across 11 verticals to support 5G and edge industrial use cases.

Company Strategy

Capgemini Engineering's 5G and Edge Solutions Value Propositions and Offerings

Capgemini Engineering's 5G and edge strategy is in sync with the company's vision toward fostering innovation at scale and engineering new and differentiated smart products to optimize operations, create new customer experiences, and deliver new sources of value. Capgemini Engineering's strategy is focused on the next industrial revolution, bolstered by its data-driven, innovation-steered, and customer experience–centric approach across next-generation digital technologies.

Capgemini's Intelligent Industry is the "next generation" of digital transformation that is inspiring a vision of a very different future for enterprise clients. The rise of new digital technologies has been making a disruptive impact on the traditional industry value chains. Harnessing these into their value chain becomes imperative for the industries. Intelligent Industry fosters synergies between the worlds of digital and engineering to help its clients build intelligent products, operations, and services at scale

– with digital inside everything, digital continuity throughout the life cycle, and digital convergence with its ecosystem. The Intelligent Industry strategy has three key components:

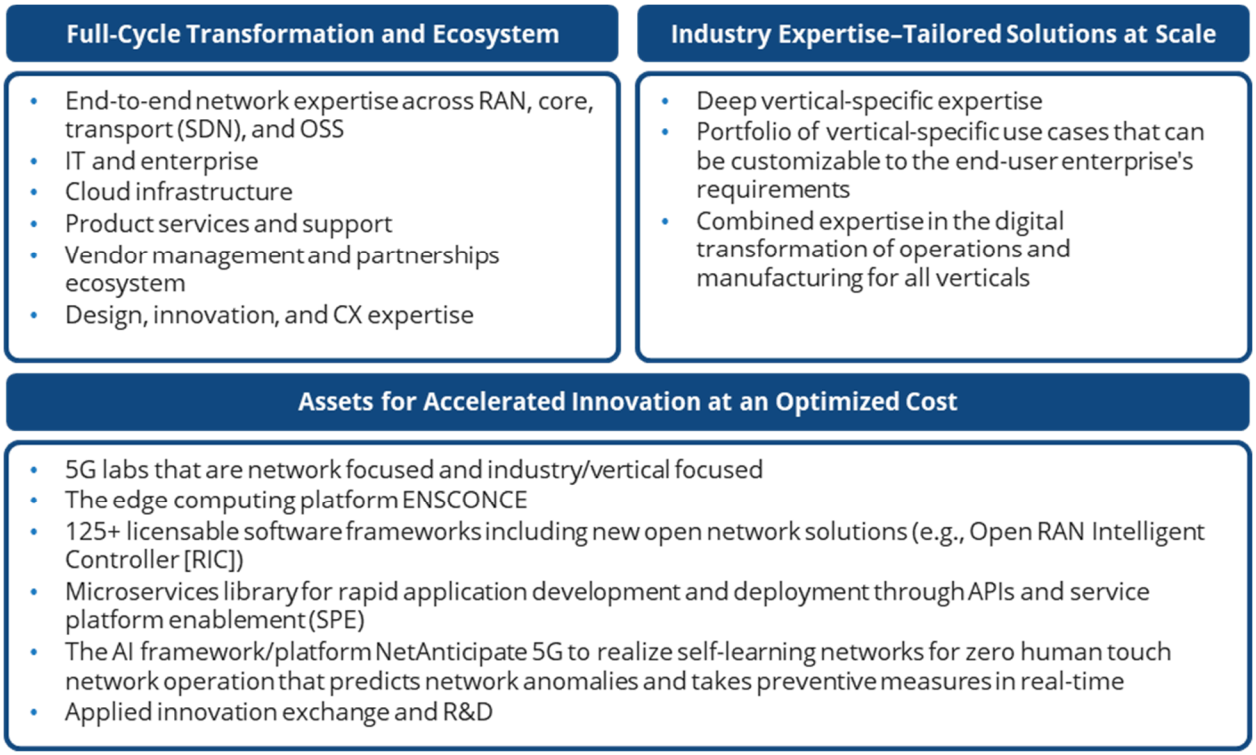
- **Intelligent products and systems**. Smart and connected products utilizes cloud, edge, AI/ML, and so forth to continuously improve, owing to a real-time feedback system.
- **Intelligent operations**. Traditional operations are becoming smart with next-generation digital technologies, thus changing the design of the value chain and making it more efficient and cost effective.
- **Intelligent services and support.** With products and operations becoming connected and smart, services and support are becoming important constituents of superior customer experience delivery.

Two of the key technologies driving Intelligent Industry – 5G and edge computing – will impact industries by transforming organization dynamics and driving innovation. 5G and edge computing are the foundation of a data-driven transformation. They will change the way everyone – companies, governments, and consumers – interacts and does business, leading to increasing innovation and services. This, in turn, will pave the way for many more innovative use cases such as robots, automated machines, greater factory automation, and AR/VR delivered at scale and cost effectively through a multipurpose network of unprecedented flexibility.

From the value proposition perspective, Capgemini Engineering brings its expertise across technical capabilities, strategic partnerships, and licensable assets. A combination of these enables end-to-end value delivery, integration, and orchestration services to NEPs, communications SPs, and end-user enterprises across industries. Figure 1 showcases Capgemini Engineering's value proposition for 5G and edge solutions and services.

FIGURE 1

Capgemini Engineering's 5G and Edge Value Proposition



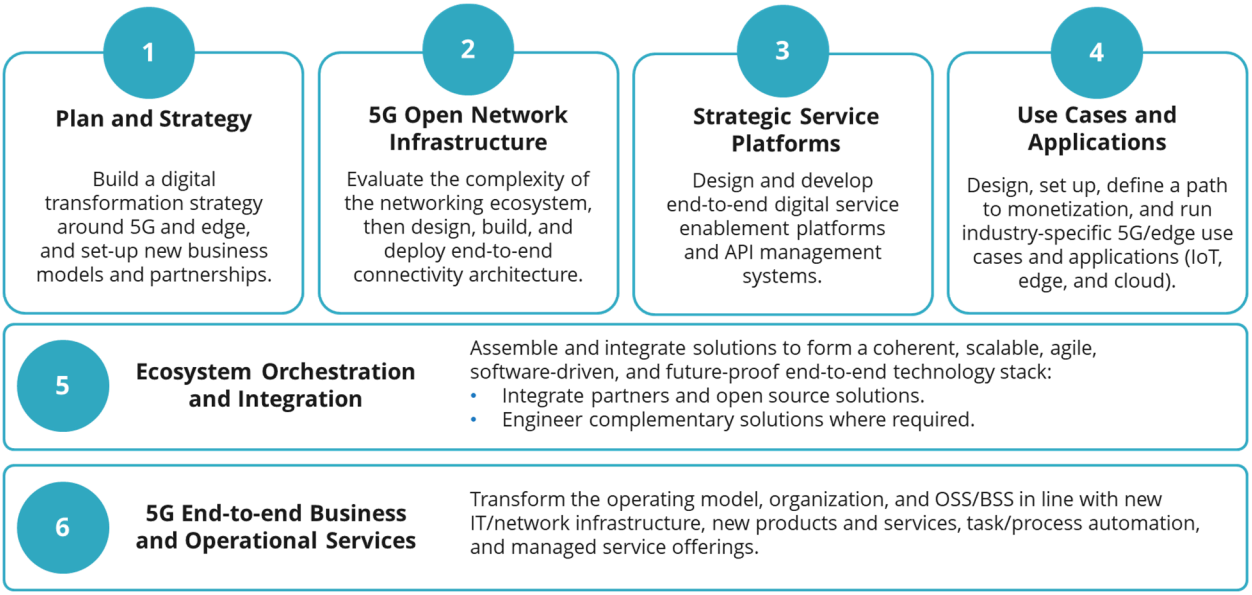
Note: This figure was created in collaboration with Capgemini Engineering.

Source: IDC, 2022

Capgemini Engineering’s offerings for 5G and edge services include four vertical and two transversal pillars, which are detailed in Figure 2

FIGURE 2

The Pillars of Capgemini Engineering's 5G and Edge Solution Offering



Note: This figure was created in collaboration with Capgemini Engineering.

Source: IDC, 2022

These offerings are supported by open source frameworks and middleware, which allow Capgemini Engineering to deliver differentiated services at scale. Capgemini have created more than a unique set of licensable software frameworks that enable telecom operators/carriers to accelerate the development and launch of their products and solutions, covering the entire end-to-end network ecosystem from legacy to next-generation technologies. Capgemini supports new intelligent 5G services with AI, ML, RAN automation solutions, and building blocks for open networks. These software frameworks can be categorized across the following:

- **5G/edge frameworks.** Capgemini has more than 70 software frameworks for wireless technologies supporting end-to-end 5G disaggregated open networks including Open RAN (gNodeB) Intelligent Controller, 5G core network (non-standalone/standalone), transport network, and xApps. They also cover 3G/4G RAN and core network frameworks for layers 2 and 3 (CU and DU) for small cell, microcell, and macrocell; core networks for private networks; and vRAN architecture such as virtualized CU/DU on multiple platforms (AWS, VMware, etc.).
- **Networking frameworks.** Capgemini has more than 60 software frameworks for networking technologies supporting RAN, core, enterprise, datacenter, metro, and transport networks across layers 2 and 3 control plane solutions. These are pre-integrated with Broadcom and Marvell NOS for virtual appliances and white boxes (DCSG, fronthaul, and vOLT)
- **Edge, cloud, and orchestration frameworks.** Capgemini has more than 10 frameworks for cloud and network function virtualization (NFV), which include NFV management and orchestration (MANO), VNF manager, the edge computing platform ENSCONCE for telecom operators/carriers and the industrial and automotive industry, the uCPE platform, micro VNF management for enterprises, and the AIOps platform for enabling AI/ML workloads.

- **Automotive frameworks.** This set of offerings includes more than 10 cellular V2X (C-V2X) frameworks for connected vehicles, audio-video bridging, Betula Bluetooth automotive grade stacks, Bluetooth mesh networking, and so forth.

The deployment and/or migration of connectivity solutions for telecom operators/carriers and for end-user enterprises and industries can be quite intricate and time consuming. Capgemini Engineering's software frameworks act as a catalyst in the rapid development and deployment of 5G and edge services, allowing telecom operators/carriers, NEPs, and end-user enterprises to market their services faster. Apart from the standard software frameworks, Capgemini Engineering has been developing connectivity solution platforms for industry vertical-specific use cases as well. Some of the areas of focus are automotive, factory automation, aerospace and defense networks, datacenters, public safety, industrial, and utilities. From 5G standpoint, Capgemini Engineering has software frameworks across end-to-end 5G ecosystem from radio network to the core and edge. These frameworks are hardware agnostic, modular, and flexible to deploy, which reduce the development time and accelerate go to market by 30–60%.

Capgemini Engineering's Edge Computing Framework — ENSCONCE

ENSCONCE is an edge compute platform from Capgemini Engineering. In detail:

- It is a scalable, cloud-native, edge application runtime and orchestration platform that allows developers to deploy applications across the edge compute clusters (geographically spread) with the use of SDK and APIs.
- This platform also allows interoperability among edge compute clusters of multiple operators.
- The application platform contains runtime and management layer to host and manage edge computing applications. At an overall level, this allows offloading data processing from the core to the edge locations, which in turn can deliver latency-sensitive applications in a jitter-free manner. ENSCONCE achieves hardware acceleration and platform optimization using Enhanced Platform Awareness (EPA) components.
- Capgemini Engineering's smart 5G connectivity platform combines ENSCONCE and 5G RAN/core framework (all in a box) to address the different network needs that arise from high-throughput, low-latency applications across both public and private networks. Figure 3 details Capgemini Engineering's 5G connectivity platform and ENSCONCE edge platform.

Capgemini's Smart 5G Connected Platform

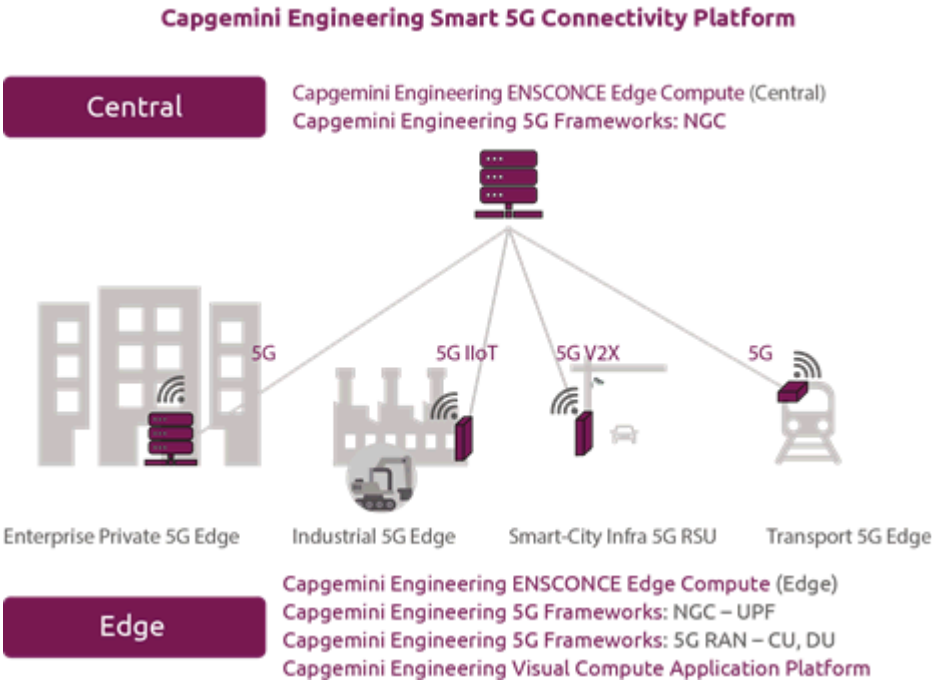
Capgemini has also developed a smart 5G connected platform that is targeted for Smart Cities and industrial private network applications. It is a scalable, cloud-native, edge application runtime and orchestration platform that combines the power of Capgemini ENSCONCE (edge computing) and 5G end-to-end network element frameworks – Open RAN-based 5G RAN and NGC. The 5G frameworks are integrated with silicon vendors and hardware partners, along with accelerated networking and AI inference with hardware offload to GPUs, ASICs, FPGAs, and VPUs. It also includes V2X stacks. As a result, the platform combines "all in a box:" edge computing + end-to-end 5G network and with AI to support easy IoT deployment needs. It poses significant final advantages:

- Enables application developers to seamlessly deploy applications and platform optimizations
- Leverages the benefits of low-latency computing and network differentiation
- Manages the deployment of edge clusters across geographies
- Interconnects multiple operators' own edge compute platforms

- Provides the benefits of hardware acceleration with the use of enhanced platform awareness (EPA) components

FIGURE 3

Capgemini Engineering's 5G Connectivity Platform and ENSCONCE Edge Platform



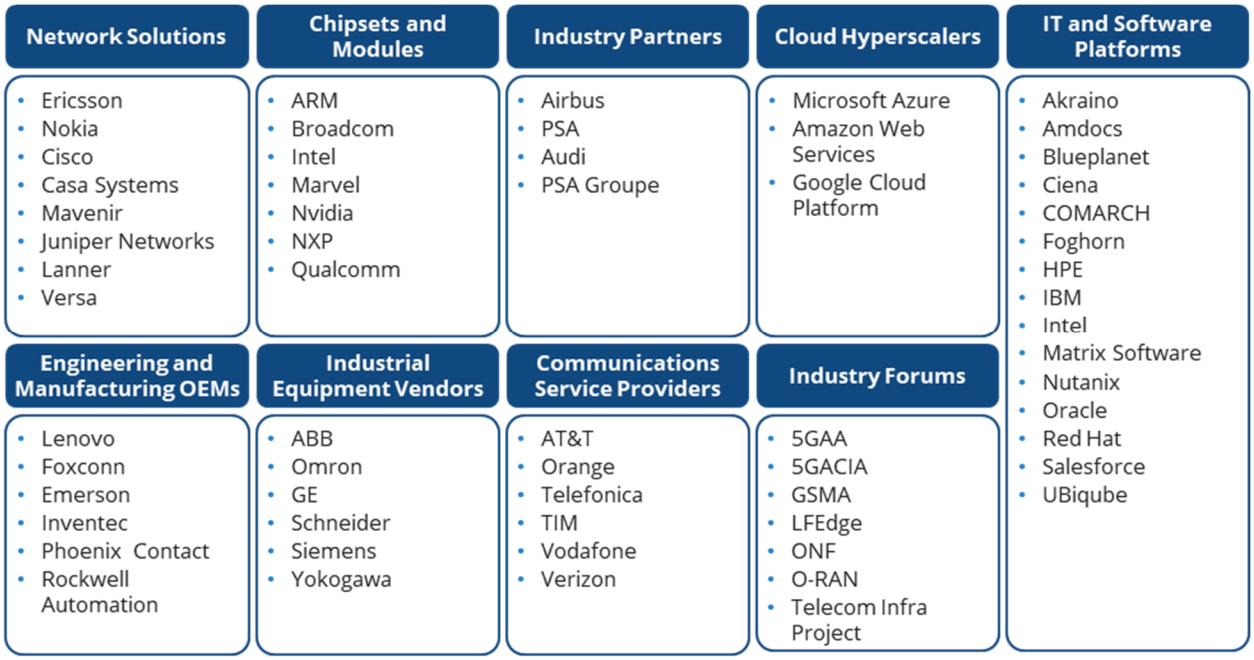
Source: Capgemini Engineering, 2022

Capgemini Engineering's Partnerships in Delivering 5G and Edge Services

5G connectivity solutions are not monolithic in nature, hence Capgemini Engineering has partnered with a set of network solution vendors, chipset manufacturers, technology/software platform vendors, engineering and industrial technology vendors, cloud hyperscalers, standards bodies, and communications SPs to build case studies and deliver the company's solutions to the end users. Figure 4 provides a list of Capgemini Engineering's 5G and edge solution partnerships.

FIGURE 4

Capgemini Engineering's 5G and Edge Solution Partnerships



Note: This list is representative and may not be comprehensive.

Source: Capgemini Engineering, 2022

While Capgemini Engineering has built partnerships with technology vendors and platform providers, it has been involved with the 5G industry consortia such as LF Edge, O-RAN ALLIANCE, Telecom Infra Project, 5G Automotive Association, 5G Alliance for Connected Industries and Automation, and TM Forum. These relations across industry bodies allow Capgemini Engineering to participate in designing, developing, and testing 5G standards and bring in more flavors of next-generation innovation across the table to both communications SP and enterprise 5G offerings.

Constant Innovation Across Centers of Excellence and 5G Labs

Centers of excellence and innovation labs play a pivotal role in building and augmenting a DEOT service provider's 5G and edge solution offerings across technology and business models. Capgemini Engineering has three such 5G labs in France, India, and Portugal. These labs are either network engineering focused or industry focused.

5G Industry-Focused Lab — France and India

- This type of 5G lab focuses on vertical-focused solutions such as smart factory, smart retail, smart utilities, smart wind farm, smart healthcare, and Smart City.
- Services include ideation and journey framing, PoC and minimal viable product (MVP) development, and capabilities building.
- Capgemini is also expecting to launch its third industry-focused lab on the U.S. West Coast in September.

5G Network Engineering-Focused Lab — Portugal

- This lab is focused on telecom operators/carriers and NEPs.
- Key services include interoperability and integration, testing and certification, and lab hosting services.

Use Cases Crafted for Overall Connectivity and 5G and Edge Solutions

Developing vertical-specific use cases has been an integral part of Capgemini Engineering's connectivity solution strategy. To increase 5G and edge solutions adoption, Capgemini engineering has been working on a range of 5G and edge services use cases:

- **Manufacturing/energy and mining.** Remote assistance, computer vision-based quality control and anomaly detection, remote training with instructional overlay in AR, and so forth
- **Automotive and transportation.** AI-enabled ride-hailing services, smart taxi, and assisted driving (which includes intelligent speed adaption and smart lighting/road blocking)
- **Healthcare and life sciences.** Mobile clinic and connected ambulance, real-time queue information, and so forth
- **Smart City.** AI surveillance systems, pandemic control, real-time tracking of public transport, urban traffic management, smart billboards, digital signages, and so forth
- **Entertainment and retail.** Immersive experience (video 360 and AR), 5G live betting, smart ticketing, monetization of participant's data in special events, immersive shopping, hands-free visitors, and so forth

Capgemini Engineering is developing new use cases on smart factory automation, remote healthcare, public safety, and smart retail practice. To accelerate new use cases for 5G, Capgemini Engineering has established labs in Paris and Mumbai that anchor the minimum viable product development across smart manufacturing, utilities, retail, and Smart City initiatives.

5G use cases are not monolithic and require expertise across key ecosystem players such as technology vendors and platform providers, telecom operators/carriers, NEPs, industrial vendors, and standards bodies. Capgemini Engineering's long-term relationships with these entities in the market allow the company to codesign and develop innovative cases that can not only address the current problem in hand but also create a connectivity solutions road map going forward. The software frameworks that are mentioned previously are customized according to micro-requirements for the use cases across the verticals and are deployed at scale.

Capgemini Engineering's Case Studies on 5G and Edge

Case Study 1

In December 2021, 5G Automotive Association conducted a live trial of new driver and pedestrian safety technology that enables real-time notification of roadway hazards using 5G/edge networks. Some of the major objectives to this trial which include:

- Interoperability among MNOs (How can a vehicle with radio access from MNO A use MEC applications operated by MNO B?)
- Global operational availability (How can an MEC application operate in the same way across all MNOs?)

- Multi-MNO with roaming (How can two MNOs seamlessly transfer the V2X service from one operator to the other as the car OEM moves from one geography to the other in a roaming scenario?)
- Increased adoption of 5G and C-V2X use cases in Smart City initiatives

Telecom Italia, Telefonica, and BT/EE demonstrated their NSA 5G capabilities and edge cloud solution to deliver connected car use cases for their customers. All three operators hosted Capgemini's ENSCONCE MEC platform, built upon Intel Smart Edge Open toolkit, Intel Distribution of OpenVINO toolkit, and Intel hardware to enable connected car use cases at the edge. Harman International and Capgemini provide the virtual RSU and RSE solutions, respectively, to realize various V2X use cases with location-aware and AI inferencing technologies.

A similar trial was conducted in Virginia in March 2022 with a similar objective in mind, where Verizon and TELUS exhibited URLLC 5G networking capabilities with the aid of Capgemini's ENSCONCE MEC platform.

Case Study 2

Vodafone Spain and Capgemini have collaborated to improve 5G engineering and product development processes in Spain. The objective of this engagement is to explore the arrival of new solutions that are supported by 5G in industries such as manufacturing, logistics, transportation, mobility, healthcare and administration across Smart City initiatives to ensure the required scalability and faster time to market. This collaboration is also expected to make Spain the benchmark in the use of this connectivity technology. Further:

- Capgemini's 5G use cases lab and proprietary frameworks (detailed in previous section) are utilized to reduce the time to market for the products and services, improve implementation time, and explore new differentiated opportunities across the previously mentioned verticals.
- Initiated in 2018, Capgemini has worked with Vodafone across several projects including "5G Red.es Andalucía Pilot" where the operators and the engineering service provider has executed more than half of the use cases.

Case Study 3

Vodafone, a United Kingdom-based telecom operator, deployed the United Kingdom's first Open RAN site in Bath, Somerset, which can carry live 5G traffic. It is the first site out of 2,500 planned as a part of the U.K. government's objective to accelerate the development of an Open RAN ecosystem. Vodafone delivered the Open RAN solution in collaboration with Samsung, Wind River, Dell, Intel, Keysight Technologies, and Capgemini Engineering.

Key highlights of the solution are Samsung's vRAN solutions; Dell's open hardware servers; Intel Xeon processors, workload acceleration, and connectivity solutions; and Wind River Studio for management of containerized Open RAN CU/DU workloads, automation, orchestration, and life-cycle management of network functions.

One of the rudimentary elements of Open RAN is interoperability of the multivendor ecosystem. Capgemini Engineering and Keysight Technologies have provided testing and integration services in the Vodafone lab to ensure this interoperability among solutions from different vendors. This stage will verify Open RAN–compliant vendors and hence enable faster deployment. It is expected that Open RAN 4G and 5G antennas from Samsung and NEC will be deployed mid-2022.

FUTURE OUTLOOK

Being relatively new, 5G and edge solution deployment can be challenging for end-user enterprises to address. While the previous generation of wireless technologies had centralized architecture and deployment was relatively easier, 5G's democratization of infrastructure and distributed and service-based architecture brings new challenges, which require a more comprehensive approach by the DEOT service providers, telecom operators/carriers, and NEPs so that the end user does not run into unwanted connectivity service-related complications. In detail:

- First, it is important to evaluate how 5G can benefit the enterprise. It should improve operational efficiency and customer experience, add new services, reduce costs, and so forth against the cost of buying and maintaining 5G/edge solutions.
- Enterprises' connectivity road map must include 5G and edge to maximize the benefits of deployment. DEOT service providers with a proven track record of building a road map for enterprises may become an effective choice for telecom operators/carriers and end-user enterprises.
- Two key challenges of 5G over the company's previous generations are its distributed nature of radio network and workload processing and diversified architecture in terms of hardware, middleware, platforms, and so forth. Any 5G solution is partner driven. A DEOT SP's breadth of partnerships (across NEPs, chip manufacturers, IT/technology vendors, application vendors, hyperscalers, communications SPs, etc.) is an important consideration.
- In line with the partnerships, DEOT service providers must build platforms/solutions for 5G deployment that allows interoperability across telecom operators/carriers and NEPs. This is facilitated by widely adopted open standards, which are imperative in 5G deployments. This will allow network gear vendors to access larger ecosystems of the operators, and operators can equip their offerings with the best possible hardware and software and maximize value delivery to end users.
- Developing new and innovative use cases for telecom operators, NEPs, and end users is a key differentiator for DEOT service providers. To gain competitive edge, these service providers are making strategic investments toward tailoring and deploying 5G networks that can cater to all three segments.
- DevOps, distributed cloud, and cloud-native developments are key to the success of platforms. Along with these, capabilities toward cognitive computing, artificial intelligence, and machine learning, along with superior UI/UX capabilities, form a winning combination for 5G and MEC-based services. It is imperative for the DEOT service provider under consideration to demonstrate these capabilities.
- Security, compliance, and governance are some of the hygiene aspects of any 5G and edge deployment. It is imperative for the end-user enterprises to opt for DEOT SPs with proven capabilities and/or partnership with technology vendors with expertise in security solutions and compliance frameworks.

ESSENTIAL GUIDANCE

Advice for Capgemini Engineering

- Create cognizance of how connectivity services are an integral part of an enterprise's IT/OT value chain and how 5G and edge can deliver long-term benefits.
- Grow your portfolio of services while maintaining the balance between customizability of the solutions and services and standardized monetizable platforms.
- Improve the agility and scalability of the 5G and edge solutions across vertical-specific applications. The best practices of one industry vertical/technology area within 5G and edge should be replicated to others.
- Harness and retain talent from related fields, as talent is an imperative aspect in 5G solutions development and deployment and it is hard to find.
- Engage your 5G labs with the world's premier educational institutes, as this can enable the company to bring in new talent in the field of 5G research and development.
- Explore the possibilities of joint ventures or M&As in the niche areas that can be specific to technology or vertical-specific applications.

LEARN MORE

Related Research

- *Getting Deep into 5G and Edge Services and Their Implication to Enterprise's Operations* (IDC #US48533322, February 2022)
- *Worldwide Digital Engineering and Operational Technology Services Provider Showcase Report* (IDC #US45853420, December 2021)
- *Digital Engineering and Operational Technology Services Case Studies – Part 2* (IDC #US48334821, October 2021)
- *Market Analysis Perspective: Worldwide 5G Monetization and Adoption Strategies, 2021* (IDC #US47286521, September 2021)
- *Market Analysis Perspective: Worldwide Digital Engineering and Operational Technology Services, 2021* (IDC #US48245818, September 2021)
- *Worldwide Product Engineering and Operational Technology Services Forecast, 2021-2025* (IDC #US47699022, July 2021)

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