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5G Core: How to Get There

A smart, stepwise approach for service providers to evolve from 4G to a full, 5G Next Generation Core Network.

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CONVERGING FORCES FOR CHANGE

The ongoing transformation of enterprises across industries is being fueled by mobile technologies and the need to offer innovative, personalized mobile services to customers. One of the consequences of this digital transformation is that virtually all enterprises are becoming digital service providers, with many considering owning and managing their own connectivity services. As a result, communications service providers (CSPs) face the challenges of addressing greater customer expectations and creating meaningful digital strategies that meet their customers' needs. These challenges often translate into a rethink of digital business models and customer experience approaches which impact network evolution. Overcoming these challenges is a substantial task for even the most innovative of CSPs, hence the "promise" of 5G and its potential to provide a big leap in network performance and new use cases. 5G is expected to be the platform that delivers the much-needed ubiquity, low latency and agility required by CSPs to thrive in an increasingly dynamic ecosystem.

CSPs should not, however, think of 5G as just another "G," but rather as an ecosystem in which they can bring together the mobile connectivity, service/device management, and monetization expertise that is at the core of their skill sets. Their unique capabilities and resources combined with vertical-specific applications for smart ecosystems will yield new innovative and highly customized services related to Smart Cities, Healthcare, Smart Homes, Industry Automation and Finance, to name a few.

The resulting business models must be able to:

- Scale, manage, secure, analyze and monetize billions of transactions and zettabytes of complex data generated by digital services and content;
- Manage billions of devices and machines as more people and 'things' become connected and communicate with each other;
- Leverage service-based architectures, customized and dynamic network slices to meet specific application requirements for connectivity, security, scalability, reliability, compliance, geography, and transaction and data management; and

- Simplify, secure and automate network, cloud functions and operational processes.

The most cost effective and efficient way to achieve those goals is through an integrated 5G and Cloud platform, as the Cloud and virtualization will play a critical role in next-generation service provider networks. Cloud-based platforms and services, and network virtualization technologies are essential for meeting stringent smart-system agility, scalability and performance requirements. Forward-looking providers are looking to public clouds as a way to accelerate time-to-market and contain total cost of ownership (TCO) for next-generation digital services. Public clouds offer global scalability and inherent security and reliability. They help service providers launch new digital services—quickly and cost-effectively—while maintaining strict control over branding and customer relationships. Public clouds also help service providers minimize upfront capital investments, avoid lopsided business models with long paybacks, and tightly align ongoing operating expenses with business demands. Best of all, they help service providers free up valuable budget and staff to focus on differentiated services to help monetize 5G buildouts and drive business results. The integration of 5G and cloud will also bring improvements to existing use cases around congestion relief, capacity constraints and fixed line displacement.

All in all, the evolution to a new 5G Core is different from previous mobile network generations, since 5G introduces a number of innovative and disruptive networking paradigms, many of which had not been applied to mobile networks in the past. Gone is the one-size-fits-all approach to network infrastructure, as 5G brings a service-based architecture, IT-centric cloud services, and an exciting new ability to personalize network ‘slices’ that match the specific requirements of industry-vertical applications to customer segments. This evolution will empower CSPs to launch and evolve custom-fit network slices-as-a-service rapidly—with lower capital and operating costs—and provide opportunity for new revenue-generating, customized digital business services. Given the diversity of requirements and spectrum needs, there are many options for 5G introduction.

This paper will discuss the practical approach CSPs can take to smoothly introducing 5G into their operations. The recommendations suggest an evolutionary path from 4G to 5G, including the steps that can be taken “today” to provide a 5G-like experience using the existing 4G networks, all while undergoing the evolution to a full 5G core. The recommended approach will allow CSPs to focus on investing in 5G business cases that will yield results in the near term, with plans to evolve as 5G technology proves itself in real-world applications.

5G CORE: INNOVATIONS AND CHALLENGES

5G replaces traditional mobile core network architecture with a new Service Based Architecture (SBA), borrowing heavily from IT networking technologies. SBA provides a set of loosely coupled services enabling modularity and reuse, allowing CSPs to be more agile and enabling rapid service delivery. The 5G core is defined to use SBA. SBA when properly applied enables loose coupling between service consumers and producers, allowing them to evolve independently. It also allows the service to be abstracted from not only the underlying hardware, but also from specific instantiations of services allowing a Network Function (NF) to scale without impacting its service consumers. There is no requirement for static configuration for interconnecting service consumers with producers; instead, this is performed through dynamic registration and discovery of services. Further, by separating processing from state and allowing NFs to be stateless, they can more easily be disposable, i.e. can be shut down and started up very quickly without impacting service. While this new architecture will enable more flexibility, agility and service deployment speed, it will require "soak time" to mature and address real deployment challenges.

Control-plane/user-plane separation (CUPS) is another architectural change that was introduced in 4G, however it takes center stage in 5G. 5G embraces CUPS as an integral part of its core architecture. CUPS requires careful network design in both the control plane distribution as well as transport networking for user plane in order to take the full advantage of its concept. As is, the 4G transport data network may not be configured optimally to take full advantage of CUPS.

Network Slicing

One of the most exciting concepts enforced in 5G is Network Slicing, which provides the opportunity for CSPs to tailor connectivity services to the precise requirements of any given application, user, device or context, by logically isolating virtualized network resources. When applied appropriately, Service Level Agreements (SLAs) may be attached that provide the building blocks of the business model. The Next Generation Mobile Networks (NGMN) provides a concise definition of network slicing as the following: "A Network Slice Instance is a set of run-time network functions, and resources to run these network functions, forming a complete instantiated logical network to meet certain network characteristics required by the Service Instance(s)". Network slicing is a highly dynamic process involving defining, instantiating, and selecting, scaling, and de-instancing slices. Hence, in order to fully support network slicing, resource and life-cycle management, orchestration, real-time selection and Key Performance Indicator (KPI) monitoring should be considered. The concept of a dedicated core network is not new and was introduced in 4G as DECOR feature. 5G however bakes network slicing into its core service and extends it to be end to end.

Policy

From a policy perspective, the 5G policy framework has expanded its functionality with a more coherent and unified policy across the network with the Policy Control Function (PCF) as its brain, providing all types of policies from the ones it traditionally provided in 4G (e.g. QoS, charging) to mobility management, network access and UE route selection. It is also enabling applications to dynamically route low latency applications to edge data networks all the while taking network data analytics and slice information into account to provide the most adequate policies to minimize network resource utilization while maximizing the user's quality of experience. A 5G policy solution will need to flexibly manage different domain specific policies; be granular enough to manage individual services and be capable of managing diverse services across slices.

THE 5G JOURNEY: WHERE TO START

Unlike previous generations of core and radio access technologies, 5G makes it possible to integrate elements of different generations into different configurations. Because of that, several options become available for evolving to 5G. CSPs should carefully consider the practicality of different options across many variables, including: fulfilling the requirements of their intended initial use cases; the interoperability and interworking of these options with the rest of their network; and the migration path for each of these options. Figure 1 provides a summary of the various deployment options of the new 5G Next Generation Core (5G NGC) also referred to as 5GC in the GSMA diagram below, and 5G New Radio (5GNR) alongside the Evolved Packet Core (EPC) and LTE in both Standalone (SA) and Non-Standalone (NSA) configurations.

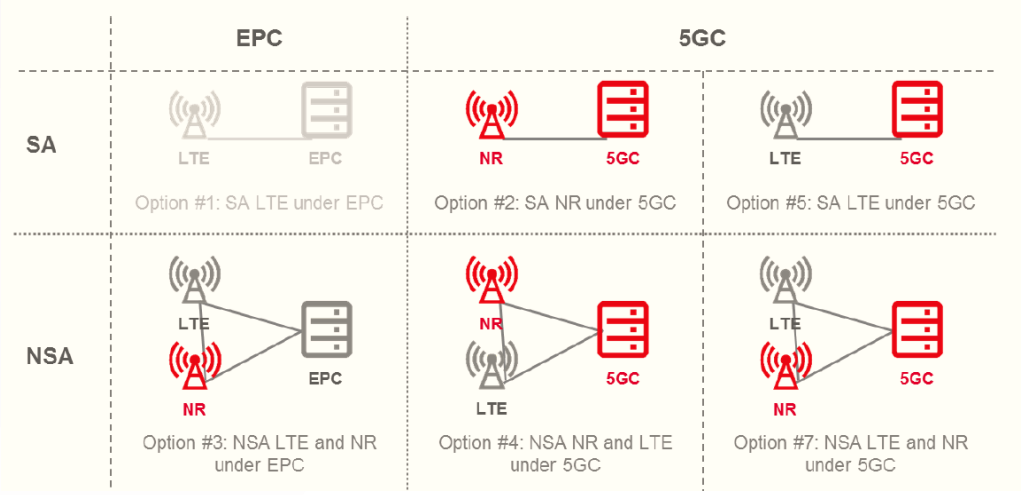

Figure 1: 4G and 5G Deployment Options (Source GSMA)

5G Deployment Options

- **Option 2:** 5G NGC with 5GNR
- **Option 3x NSA:** 5GNR is deployed alongside 4G LTE radio and both radios are supported by the existing EPC core
- **Option 4a:** NSA assisted by 5GNR and connected to 5GNGC (5NR primary, LTE secondary)
- **Option 7x:** 5GNR deployed alongside 4G LTE connected to 5G NGC using NG-C signaling

Incremental Approach to Monetizing 5G

Over the past decade, countless services have been implemented over the 4G EPC network. As a result, many view an EPC network as an "overstuffed" one-size-fits-all network. Hence, it is becoming increasingly complex, costly and time-consuming to deploy new services or modify existing services without incurring extensive and time-consuming testing cycles. Moreover, there are concerns that investments in the current EPC core will not be carried over to future 5G infrastructure. Many service providers want to monetize their 5G radio investments quickly by offering new "5G" services; as a result, forward-looking CSPs are investigating how to off-load their EPC by deploying separate overlay cores and utilizing dedicated core networks (DECOR) to introduce the network slicing concept to their 4G core.

Alternatively, CSPs may want to investigate offloading an initial 5G service from their 4G EPC core to a dedicated overlay core designed specifically for this 5G service. This will help lessen the impact of 5G traffic from an already overloaded 4G EPC network and allows CSPs to incrementally grow their business while protecting current investments. This approach could also provide customized dedicated core network services, such as edge-computing to enterprises that may require low-latency content delivery. Also with DECOR in place, CSPs can start to introduce Internet of Things (IoT) services and offload their IoT implementations to a dedicated core network.

Some service providers however, may pause at this stage and wait a bit longer before moving on to options 7x or deploying a 5G NGC (In the following section we will discuss in more depth option 7x and option 4a). CSPs will evolve to the next step at different speeds — for some moving to option 7x or option 4a with 5GC deployment could be considered a high-risk move, as it involves new technology, new devices, new protocols,

and many moving parts. An incremental approach enables service providers to try out initial 5G-like service deployments and better determine how to monetize new services while migrating to a 5G NGC.

This further opens the door for new digital business models, requiring a CSP monetization infrastructure that can scale to support extreme levels of usage-based charging transactions across multiple slices. Cloud-based monetization is a great option for CSPs who are looking for a cost efficient and agile strategy for new digital services. Since all cloud-based solutions are not created equal, service providers should look into cloud-based monetization that can also provide advanced artificial intelligence (AI) and machine learning (ML) cloud solutions. AI can be used to gather and analyze customer and machine data, predict what customers want, manage value transactions securely, and respond quickly with personalized offers.

The Various Migration Paths to 5G

OPTION 3X

Many CSPs begin their 5G journey by deploying option 3x Non-Standalone Architecture. In this architecture, the 5G New Radio is deployed alongside a 4G LTE radio and with both radios supported by the existing EPC. Option 3x is the initial deployment option that helps CSPs get started on 5G and accelerate their time to market for new 5G services**.** In this scenario service providers can leverage their existing EPC deployment and adopt an incremental approach towards their 5G capital and operational expenses. Option 3x is based on LTE-assisted signaling, which is done through the LTE radio to the User Equipment (UE). The 5G radio will only establish a user plane connection to the EPC core via signaling from the LTE radio. Going from Option 1 (EPC+LTE) to Option 3x is fairly clear and straight forward. However, the path to get from Option 3x to Option 2 (5G NGC + 5NR) is currently unclear. Although there are different options that could potentially be the next step after Option 3x, the differences in these options revolve around the extent of changes and the number of moving parts. Of all the options, options 7x and 4a are the most considered options after option 3x.

– Upgrade IP Transport for Greater Bandwidth

  The existing IP data network providing transport for the user plane may need to be upgraded in order to improve the quality of service (QoS) for 5G new bearers and to accommodate bandwidth and data rates supported by 5GNR. While designing the improved data network, it is important to consider that 5G will inherently support the separation of the Control and User Planes (CUPS). CUPS enables service providers to flexibly place the separated control and user plane functions to support diverse deployment scenarios without affecting the overall functionality provided by the EPC entities.

– Upgrade Policy and Charging Rules Function to Support Additional 5G Attributes

  Since the new 5G radio supports higher data rates, a CSP should upgrade their PCRF (Policy and Charging Rules Function) to support additional QoS and PCC parameters in order to take advantage of higher data rates of the 5G NR and have more flexibility to offer personalized and customized services to their customers.

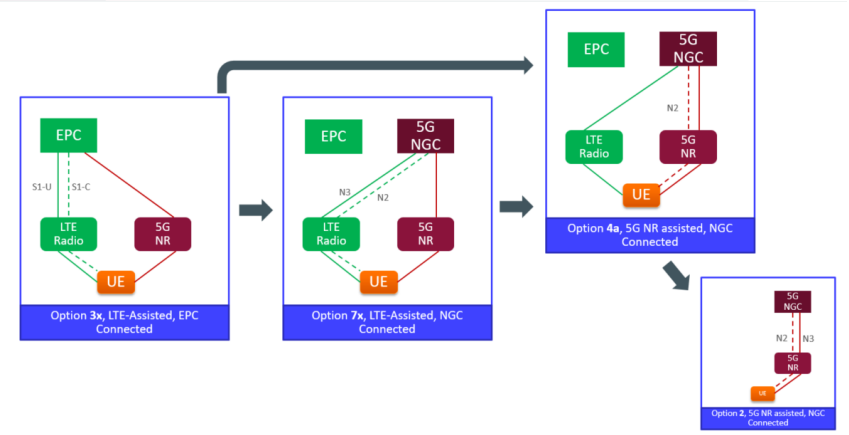

Figure 2: Evolutionary path from options 3x

OPTION 7X

Option 7x brings in 5G NGC while still utilizing existing LTE radio for control – hence "LTE assisted". This option is similar to option 3x with the LTE radio being the master and 5G NR being secondary, but it uses 5G NGC as opposed to EPC. In this option, the LTE eNodeBs need to be upgraded to support connecting to 5G NGC, i.e. supporting N2/N3, so do the UEs as they need to support connecting to 5G NGC via Non-Access Stratum (NAS) signaling. This option enables the operator to leverage the 5G NGC and deploy 5G services by incrementally upgrading the LTE radio and 5GNR from an EPC connected model (option 3x) to a 5G NGC connected model (option 7x). This option will co-exist with option 3x for some time while the network and UEs are upgraded, but it brings the operator closer to the final deployment configuration. .

OPTION 4A

Option 4a is similar to option 7x but differs by having the 5G NR as the master radio instead of LTE, hence the term "5G assisted". This option becomes desirable as 5G NR coverage increases and is wide enough to be the master radio.

There are two viable paths:

- Option 3x => Option 7x => Option 4a => Option 2
- Option 3x => Option 4a => Option 2

Migrating directly from option 3x to option 4a requires a wider deployment of 5G NR to justify it being the master radio, therefore it may be a larger step than migrating first to option 7x and then to 4a. Nonetheless, it is certainly a viable option and possibly the better option depending on the 5G radio coverage.

Regardless of the path taken, a new 5G core is needed. Oracle Communications provides solutions that address the 5G Core options described above, laying the foundation for 5G Core signaling. This can help CSPs focus on providing 5G Core applications and managing the introduction of UEs and services.

BENEFITS OF THE 5G NEXT-GENERATION CORE

Although 5G option 3x along with augmentation technologies such as CUPS and DECOR can be used to emulate services expected from the 5G Next Generation Core, there are a number of benefits in migrating from option 3x toward option 7x or option 2/4 with 5G NGC, such as:

- Service Based Architecture (SBA)
  - Extensibility, ease of deployment of customized or non-3GPP defined network functions

  - Reduced complexity, simplifying the exposure of network capabilities to enterprises and reduced time to market for new services
- Flexible Slice Selection
  - DECOR is restrictive and provisioning based
- Slice procurement and life-cycle management
  - Industry initiatives – standard based approach to slice management
  - Ability to procure and deploy 3rd party slice
- Native separation between control and user plane
  - Separation of control/user plane is natively supported
  - Ease deployment of low latency communication via Mobile Edge Computing (MEC)

Taken as a whole, there are substantial collective benefits that make deployment of the 5G NGC a desired route to take.

4G AND 5G INTERWORKING

It is inevitable that the 4G LTE core and the 5G core networks will coexist for several years. Interworking between the two systems is going to be critical. Given the shift to Service Based Architecture (SBA) and cloud native architectures in 5G, it is important to keep 5G network functions and services as independent from 4G functions as possible to realize the new 5G architecture's potential for agility and rapid service delivery. The introduction of an interworking function that could shield point-to-point based interfaces (e.g. Diameter-based) from 5G network functions by translating between Diameter and service based interfaces is a tool CSPs could and should rely on for various interfaces.

It is paramount to support a seamless handover between the EPC and 5G core networks, and ensure that service continuity is maintained. This may result in a tighter integration of certain components across the two cores but such tight integration should be limited to the minimum required.

From a network slicing perspective, a 5G network slice should view the EPC environment as an extension of a 5G common control framework. This approach presents a common, consistent and uniform view of the EPC to all 5G network slices – regardless of what services the slices are providing. Without this uniform view, each 5G slice may separately reach out to the EPC core through different service models as well as different service expectations from the EPC based on the service that slice is rendering. This can potentially cause data, procedurals, policies as well as service conflicts among 5G slices as well as the 5G common core.

CHOOSING THE RIGHT PARTNER FOR YOUR 5G JOURNEY

It is critical to choose a 5G partner with a heritage of understanding the challenges of evolving communications networks, including leveraging 4G networks while evolving to the 5G NGC. It is also important to select a partner with deep IT and Cloud expertise and experience to meet the 5G tenets of: network simplification, open and cloud native architectures.

Oracle Communications: A Strategic Partner for 5G Deployments

NSA 5G DEPLOYMENT OPTIONS

Oracle Communications' 5G solutions enable CSPs to maximize their investment in NSA 5G deployments as well as assist in the migration from Option 3x towards full integration with the 5G NGC. CSPs can utilize signaling-based solutions that enable them to take advantage of 5GNR and deploy 5G-like network slices. Oracle's solution are designed to support the migration from 4G to 5G, while eliminating the need for large up-front investments, resulting in CAPEX and OPEX reductions. In addition, these solutions enable a rapid time to market of 5G services and most importantly the monetization of those services.

5G NEXT GENERATION CORE

The Oracle Communications 5G NGC vision is to enable CSPs to build a robust and scalable core in which they can deploy a multitude of Network Functions without having to worry about the underlying frameworks, with special focus in the following areas:

- Routing and selection services
    - Establishing a robust, scalable, secure and optimized service-aware routing and selection framework that includes services such as registration and discovery, slice selection and binding support.
- Policy and charging
    - Providing a unique user-friendly policy design and runtime experience to enable CSPs to quickly deploy new policies and services, while ensuring the reliability of existing services through a fully automated test framework. The solution will be flexible enough to manage different domain-specific policies and granular enough to manage individual services.
- Data management
    - Providing database infrastructure for managing both structured and unstructured data within the 5G network.
- Service Level
    - Exposing network functions and 5G services in a secure and reliable way to both trusted and un-trusted entities.

The Oracle Communications 5G NGC is based on the principals espoused by the Cloud Native Computing Foundation (CNCF) with seamless integration in open source orchestration and automation frameworks as well as a range of popular cloud services sponsored by the CNCF. Oracle's 5G solutions are developed using DevOps principles and designed to support zero-manual-touch management. All Oracle 5G NGC lifecycle actions are governed by automated CI/CD workflows.

Given Oracle's extensive experience in IT technologies and the Cloud, Oracle Communications is in a unique position to apply the lessons learnt from both Cloud and Telecommunications technologies and apply it to 5G implementations.

One such example is how Oracle applies leading edge Cloud technologies such as machine learning and artificial intelligence to IoT data security solutions. This provides real-time information to the end user on what is causing the malfunction, all the while working hand-in-hand with network equipment on the ground to protect the core network as well as IoT platform/applications from corrupt data and malicious attacks. Cloud-based analytics and machine learning can feed into policy management and slice selection systems to augment capabilities with more dynamic and proactive actions. This kind of 'Ground-to-Cloud' solution enables CSPs to leverage the power of the Cloud where it makes sense in their applications while protection their current investments.

SUMMARY

Deploying a 5G Next Generation Core is no easy task. 5G replaces a traditional mobile core network architecture with a new Service Based Architecture (SBA), allowing the CSPs to leverage service re-use. It also allows service producers and consumers to evolve independently, enabling CSPs to incrementally and rapidly introduce new capabilities with lower risk and effort. While this new architecture will enable more flexibility, agility and service deployment speed, it will require “soak time” to mature and address real deployment challenges. Hence many phased roll outs of 5G start with the deployment of option 3x Non-Standalone Architecture allowing CSPs to first take advantage of the 5G NR for early use cases such as Fixed Broadband Service and Enhanced Mobile Broadband. As outlined in this paper, there are several migration paths towards 5G. These start with option 3x, along with augmentation technologies such as CUPS and DECOR to emulate services expected from 5G NGC while CSPs move to a full 5G NGC roll-out.

Oracle provides innovative signaling-based solutions in NSA option 3x 5G deployments to take advantage of 5GNR as well as 5G-like network slices. This strategy allows CSPs to focus on investing in 5G business cases that will show early results. In parallel, Oracle also helps CSPs build a robust SBA signaling framework as a foundation for their 5G NGC with best-in-class Oracle 5G Core Network Functions. Oracle’s 4G and 5G solutions help service providers reduce capital outlays, streamline operations and free up resources to focus on differentiated services.

To Learn More about Oracle Communications’ 5G Solutions, visit www.oracle.com/communications

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Integrated Cloud Applications & Platform Services

5G Core, How to Get There
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