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network-slicing

The network slicing transformation journey

Starting and navigating the steps to success

Explore the potential of network slicing

Network slicing is a multi-billion-dollar market with immense possibilities to monetize 5G network investments within enterprise and consumer segments. This report guides you on a journey to design and build your networks' capabilities and prepare the organization to capture a substantial share of the network-slicing-associated business.

The use cases and ecosystem behind network slicing (NS) are taking off as we speak and are expected to generate around USD 200 billion in revenues for service providers by 2030 [1]. Most of this revenue will come from industry segments such as healthcare, government, transportation, energy and utilities, manufacturing, media, and entertainment.

NS enables a more customized connectivity experience, leveraging 5G Standalone (SA) and the high levels of automation from the 5G Core network, significantly reducing time-to-market (TTM) for new services. It will enable product owners to deliver new services that match the growing demands of companies, app developers, and consumers.

For service providers, NS is key in monetizing 5G SA and offering more tailored services to their customers. For companies, it offers a faster path to dedicated and customized services that would otherwise require a private network solution (which is more costly and complex to deploy and maintain, and requires regulatory permissions). For consumers, it provides premium services and more unique experiences.

Define a winning network-slicing strategy

A successful journey into NS relies on a solid business strategy as the foundation. This involves understanding and identifying current and future requirements and use cases, as well as market-sizing key opportunities and subsequent customer segmentation. The role of the service provider in the value chain with ecosystem partners also needs to be considered.

Determining the business strategy for NS starts by evaluating the economic and technical viability of the different opportunities. For that, three main questions need to be answered:

1. Which industry verticals and use cases have the most potential?
2. What are the technical requirements to realize these use cases?
3. What is the best way to quantify the total cost of ownership and decide on the viability of the business case?

Define the target industry verticals and use cases

In the **Top 10 industry segments**[2] report, we have outlined the areas with the highest revenue potential for slicing. However, it is very important that each service provider starts the NS journey by defining the segments most relevant to their market and building sufficient knowledge of the needs and challenges from these segments to develop a consistent go-to-market model.

The go-to-market model (GTO) includes prioritizing among industry and customer segments and targeting use cases. We recommend leveraging current customers and relations during this process, as it will be easier to start mapping potential use cases with existing partners. This will also help prioritize the opportunities that can provide a faster path to monetization.

Contents

[1] Ericsson and ADL study, "Network slicing: A go-to-market guide to capture the high revenue potential"

[2] Top 10 industry segments report (Ericsson)

Define the technical requirements to realize the selected use cases

The second step is to assess the present network capabilities to determine the feasibility of implementing the selected use cases and determining network evolution requirements.

We recommend starting by evaluating the technologies that enable the target use cases, such as public networks, mobile public NS, dedicated private networks, or hybrid networks (that is, a combination of mobile public NS and a dedicated private network). Today, many large enterprises and industries have a private network on the premises, like ethernet LAN or Wi-Fi.

Use cases will also have requirements depending on geography or network topology. Technically, this will be different if the services are used locally on an enterprise campus, such as a production plant or hospital, a city, or over a wider area, such as connecting automobiles or power grids.

NS requires a 5G SA network in place, which delivers all capabilities required for the efficient deployment of slicing. The 5G Core applications built as cloud native and its service-based architecture (SBA) allows deployments in a distributed, edge computing-based architecture. Moreover, it enables multi-slices for user equipment (UE) support and dynamic NS selection with, for example, User Equipment Route Selection Policy (URSP) functionality. Slicing support on the 5G RAN and Transport networks is also required to fulfill most of the slicing use cases and deliver premium-customized connectivity, enabling the dynamic optimization of resource allocation and service differentiation within and between slices.

NS represents isolated logical parts of the network, and its definition goes beyond simple feature activation on different network components. Deployment, operation, and life-cycle management of network slices require proper orchestration, and service characteristics always need to be ensured to fulfill different service-level agreements (SLAs). Therefore, the requirements and readiness of the Operations Support Systems (OSS), Business Support System (BSS), as well as the rest of the eco-system (e.g., devices, application developers) need also to be evaluated.

Validate the viability of the business case

The third step to define the NS strategy explores the GTM requirements for commercial viability. It includes choosing between direct B2B/B2C versus a B2B2X approach. A slicing product roadmap should be established to help determine the type of enablers needed going forward. The pricing strategy must be revised to preferably be value-based rather than cost-based.

A network TCO versus value proposition analysis needs to be conducted between the service provider and the enterprise to validate the value drivers and share inputs for estimating the mutual financial benefits.

Get ready to operate network slicing

Commercial and technical strategies risk failure if you are not ready to operate and commercialize at scale. This area should not be overlooked as it demands close interworking of BSS and OSS to manage the requirements of NS on demand.

> Slicing is a fundamental shift in the way a network is deployed and offered. There is a strong need for service providers to prepare their organization to deploy, manage and sell NS.

They need to build capabilities in areas such as Agile and DevOps to add flexibility in ways of working, enhance vertical capabilities within the organization, and automate processes to manage NS at scale. All these require proper planning and some degree of organizational transformation—something that takes time. Hence, it should be started in parallel with technical and business planning.

Finally, in run-time, monitoring of SLAs and continuous lifecycle management is imperative to ensure the right network specifications are delivered as required.

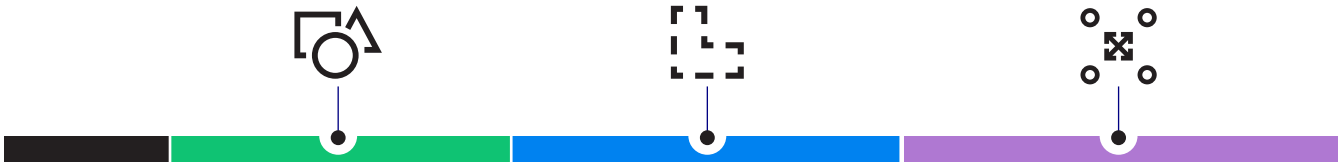
[2] Top 10 industry segments report (Ericsson)

Network slicing is a multi-step journey

Realizing NS in the network and exploring its business potential will be a multi-step business journey for service providers, a journey that will be anchored on their defined business strategy and their network's capabilities. This business journey starts with network connectivity as the major value proposition in NS use cases, but then with expanding the play in the ecosystem to get a bigger cut from the value chain.

The reasons behind this business journey being stepped are both commercial and technical. Commercial because it depends on aspects like local market demand, ecosystem readiness, use case scalability, and regulatory requirements. Technical because it depends on device maturity, e2e solution readiness, and local system integration maturity.

We see three main steps in the NS journey:
- Pre-configured slicing
- Dynamic slicing
- Exposed slicing



	Pre-configured network slicing	**Dynamic** network slicing	**Exposed** network slicing
Commercial maturity	• Trials and limited deployments • Service provider-driven demand	• Full-scale national or global deployment • Ecosystem-driven demand	• Full-scale national or global deployment • Innovative business models
Technical maturity	• Enabled by 5G SA • Manual deployment, scalability, and replicability	• E2E solution verification required • High degree of automation in deployment, operations, and scalability	• E2E solution verification required • High degree of automation with slice parameters managed by a third-party (e.g., enterprises or aggregators) through APIs

Pre-configured network slicing

For most service providers, the journey begins with pre-configured network slicing. With this, we mean a set of commercial and technical assets which enable service providers to showcase the technology, test the ecosystem and market demand without large investments and risks.

From a commercial point of view, pre-configured network slicing doesn't require a significant market demand or ecosystem readiness. In this phase, these aspects are mainly driven by the service provider, who proactively engages with selected ecosystem partners to showcase the value of 5G SA for specific verticals and to test initial business models. This imposes, understandably, natural limitations on the monetization of NS but gives service providers the opportunity to explore different possibilities of NS more freely.

The risk of scaling up the organization to run pre-configured network slicing is reduced for service providers. During this step, the business operations scope may be limited to trials and small-scale deployment, neither of which require a separate commercial operations team for the slicing business.

From a technical point of view, pre-configured NS does not require advanced capabilities in the devices or in the 5G SA network. The bare minimum is to have NSSMF support in the 5GC and NR, potentially with some basic RAN capabilities like Radio Resource Partitioning (RRP). On the mobile device side, there are some features that are becoming widespread, e.g., URSP (and/or L4S), which can be applied to provide more granular traffic handling capabilities. A drawback with pre-configured NS is that it requires a high degree of manual work to integrate, deploy, operate, and scale the technical solution.

URSP (User equipment Route Selection Policies) is a mechanism that enables traffic steering and the separation of services for devices when using network slices.

L4S (Low Latency, Low Loss Scalable Throughput) is a technology to reduce queue delay problems, ensuring low latency to Internet Protocol flows with a high throughput performance.

Dynamic network slicing

Once service providers have showcased the value of 5G SA to potential customers, tested the ecosystem, and tried business models, they have the prerequisites to advance to the next step in the journey—dynamic NS.

From a technical readiness point of view, dynamic network slicing implies a technical solution that has a high degree of automation in deployment, operations, and scalability. The focus here is shifted from device capabilities, and basic 5G SA features to dynamic cross-domain orchestration of network slices and related services, including infrastructure, application, transport, and service orchestration and assurance.

Considering the high degree of automation, dynamic network slicing allows for high use case re-usability globally, meaning many service providers can launch similar use cases in different geographies.

In this step, service providers have a clearer view of the customer journey, ecosystem partners, and relevant monetization models for the slicing business. When these components are in

place, the market demand for the slicing business becomes driven by the ecosystem's demands rather than the service provider's. It means that ecosystem players start to realize the value of 5G SA for their business and seek partnerships with service providers to address concrete use cases.

Growing demand from the ecosystem players as well as various business models with various partners creates the need for service providers to create a business operations unit dedicated to the NS business.

Exposed network slicing

The third and last step of the NS journey is exposed NS, which focuses on more innovative business models by exposing network attributes via APIs to the ecosystem players (aggregators and/or enterprises).

From a commercial point of view, exposed network slicing builds on the capabilities implemented by service providers in the previous step, including clear market demand, robust ecosystem cooperation, and scalable business operations. Additional commercial capabilities for exposed NS are defined by a concrete business scenario for network service exposure (e.g., a new business model to manage NS and related services externally).

From a technical point of view, exposed NS heavily relies on the technical enablers from the dynamic slicing solution with the extension of the exposure layer to expose network attributes and services to partners. Typical examples of these attributes include network slice lifecycle management, quality of service (QoS) management, device onboarding, and offboarding.

This step though, is not one that any service provider will take. It will depend on their business strategies and the desired position they want to claim in the value chain. It will also have strong dependencies on the demands of the local ecosystem and the maturity of the market to adopt the benefits of network service exposure.

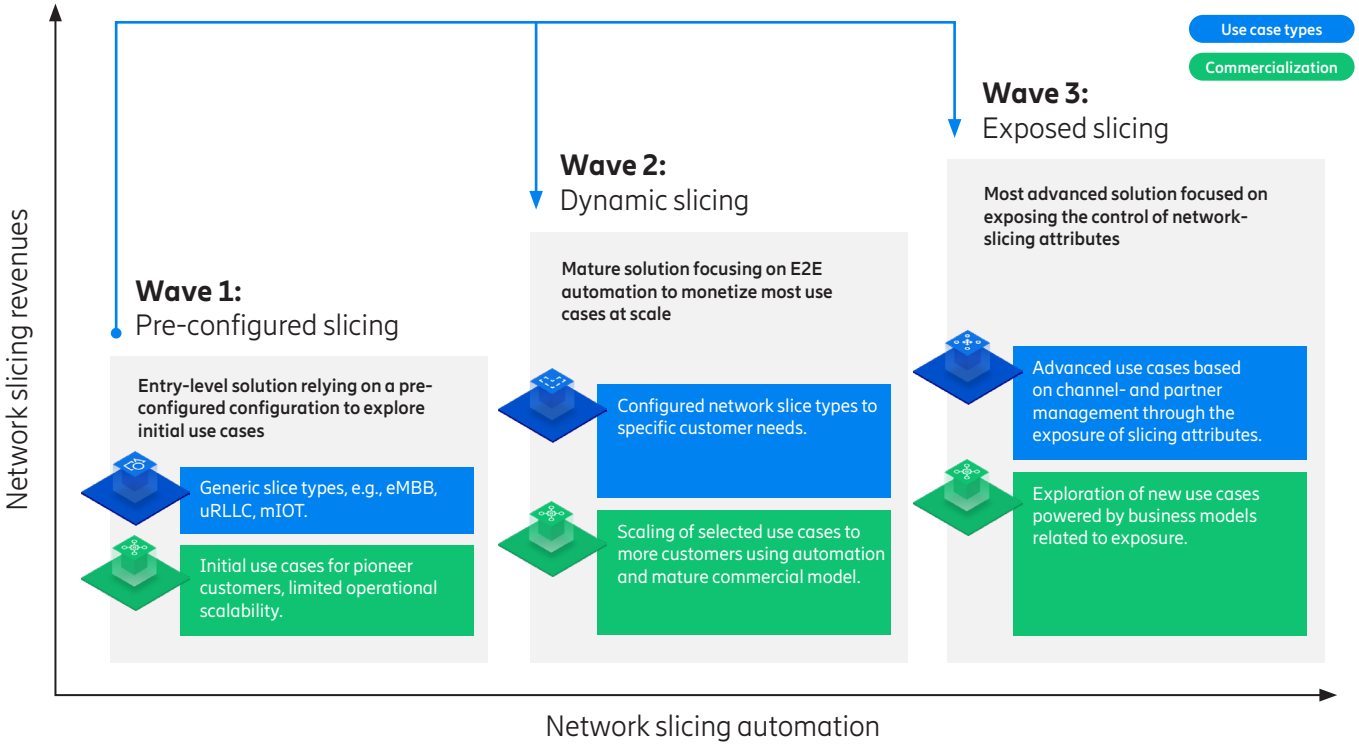


Figure 1 Network slicing stepped business journey

A practical example: **Mobile cloud gaming**

The network slicing journey for the mobile cloud gaming use case.

Mobile cloud gaming can be defined as an extension of cloud gaming (where the rendering is happening in the cloud, and the content is streamed to the gaming console) to a mobile device. This means that the gameplay for mobile cloud gaming is based on outdoor players using 5G connectivity instead of Wi-Fi.

The value chain for mobile cloud gaming can be narrowed down to four actors:

- Game developers and publishers (e.g., Niantic, Ubisoft, Nintendo, EA)
- Gaming platforms (e.g., Sony PS Plus, Xbox Live, Blacknut, GeForce Now)
- Connectivity providers (e.g., Service providers)
- Device manufacturers (e.g., Samsung, Apple, Xiaomi)

Cloud gaming is experiencing an exponential growth in the leading markets (Asia-Pacific and North America) thanks to the democratization of requirements to play games with advanced graphics and gameplay.

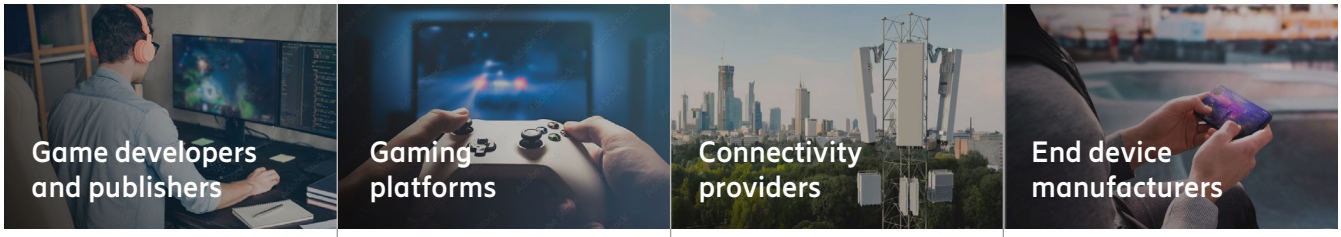


Figure 2 Ecosystem overview for mobile cloud gaming

Mobile gaming with pre-configured network slicing

With pre-configured network slicing, mobile cloud gaming is typically implemented as a performance boost for gamers playing on a mobile phone in a limited geographical area like a park or a mall. Typical user experience includes a low-latency performance boost for a limited number of hours after the purchase.

It's enough to have one ecosystem partner (gaming platform) to enable mobile cloud gaming with pre-configured network slicing.

The true value of NS is in connecting customer pain points with the capabilities 5G SA may bring. That's why the main task the gaming platform and service provider has to perform is to explain the value of 5G SA to the end customer, comparing 5G SA with other access technologies (e.g., Wi-Fi).

If a cloud game showcases 5G SA capabilities and the customer value is clear, the next important commercial component is to have a business model. The business model can be either B2C (the service provider sells a slicing-based data plan to the consumer) or B2B2C (the gaming platform resells a 5G slicing-based data plan as an add-on to their games). The business model choice depends on multiple factors, including price sensitivity, co-marketing, and integration between the service provider and the gaming platform. For example, the simplest business model is B2C, with two transactions for a customer (a gaming platform plan and performance boost). The more complex business model is a bundled offering when performance boost is initiated as an in-app purchase.

Mobile gaming with dynamic network slicing

Dynamic NS allows for the dynamic onboarding of new devices, as well as for the dynamic changes of QoS parameters on the go. Consumers of mobile cloud gaming may switch from one device to another (e.g., phone to tablet), preserving a low latency experience and game progress. Secondly, if a gamer moves from one area to another (e.g., from the park to the office), the same low latency is preserved even if the gamer enters a more congested environment.

The initial business model choices for NS slicing are the same as in the pre-configured NS case. As ecosystem partners become stronger and more mature, more advanced business models may emerge, e.g., bundling a gaming platform subscription and performance boost.

From a technology point of view, dynamic NS may require an E2E solution verification across all actors in the ecosystem. Typical ecosystem players include device manufacturers, connectivity providers, gaming platforms, and game publishers.

To summarize, dynamic NS includes advanced business and technology enablers that pave the way for the monetization of the mobile cloud gaming use case. Depending on the business size, the number of ecosystem partners, and business model complexity means service providers may consider expanding their slicing business operations with a dedicated operations team.

Mobile gaming with exposed network slicing

Exposed NS is an extension of dynamic NS, with a focus on exposing network attributes externally and controlling network parameters through external calls via APIs.

Continuing with the example of mobile cloud gaming, from an ecosystem point of view, the value of exposed NS lies within exploring new ways of creating and consuming mobile cloud gaming use cases. For example, game developers and publishers may offer advanced gaming experiences for consumers, including live, multiplayer, personalized, high-quality, and reliable gaming services with simple and flexible monetization. Gaming platforms get advanced game development and design tools to open new gameplay possibilities in a device-agnostic and network-agnostic way. End device manufacturers may extend the support for existing device ecosystems through diverse types of devices and form factors that ensure smooth and reliable gameplay for the consumer in a network-agnostic way.

Exposed NS requires deep collaboration within the mobile cloud gaming ecosystem and can only be achieved once the business and technology components of dynamic NS are in place.

With regards to monetizing this use case, exposed NS is an enabler of new customer experiences on top of typical gameplay on a mobile device, including Live AR filters for 5G SA gamers, multi-servic e provider experience with shared gaming platform, game broadcast to social media followers, etc.

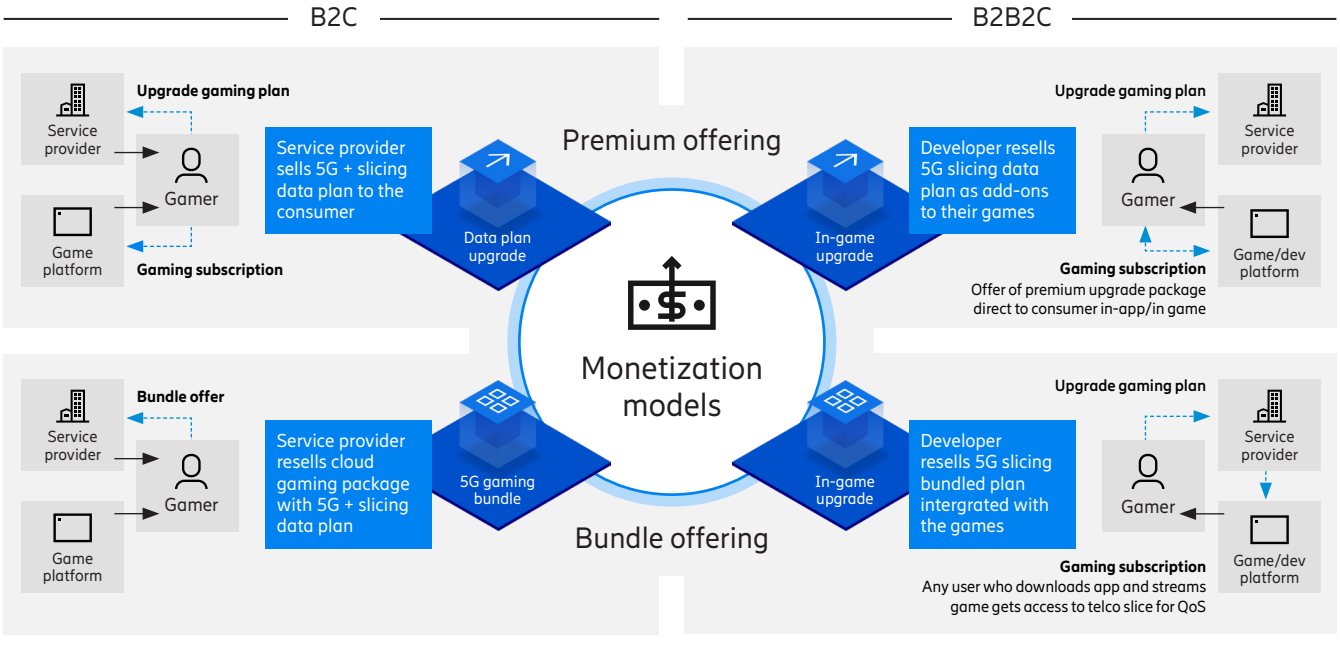


Figure 3 Business models for mobile cloud gaming

The essential building blocks of end-to-end network slicing

Setting up a well-designed network-slicing solution must involve an integrated approach that considers the different building blocks required to create a flexible, efficient, and secure network infrastructure that can meet the diverse needs of different applications and services.

To set up a NS solution, several capabilities are required in the different domains of the network. We call them building blocks of an end-to-end NS architecture[3]. This chapter provides a short overview of the most directly connected domains.

OSS and BSS

OSS and BSS must work together in harmony, tightly integrated to ensure information flows in real-time through OSS/BSS to the network and vice versa. OSS and BSS enable the management of SLAs according to contracts. This requires assurance and analytics capabilities based on business policies, SLA fulfillment, and operations. As both the specific KPIs and the approach to monitoring them will differ between slices, there will be a growing need for customization.

Orchestration enables automation of every step from order through to activation on the network, including instantiation and provisioning all necessary network functions (NFs). For example, it automatically configures all cell sites, generates the configurations to meet SLAs and automatically provisions the respective cell configurations to realize specific use cases. Policies and NF selection are adapted based on slice load and the number of slices supported to react to operational conditions while fulfilling SLAs.

As use cases, deployment, and business models diversify, it must be possible to customize and repeat the actions of the OSS and BSS layer, which drives the adoption of model- and intent-driven approaches, where templates and policies dictate actions. These templates reflect the SLAs and are used to orchestrate NF deployments, the system capabilities, configuration, and policies. This is essential for speed and cost-efficiency.

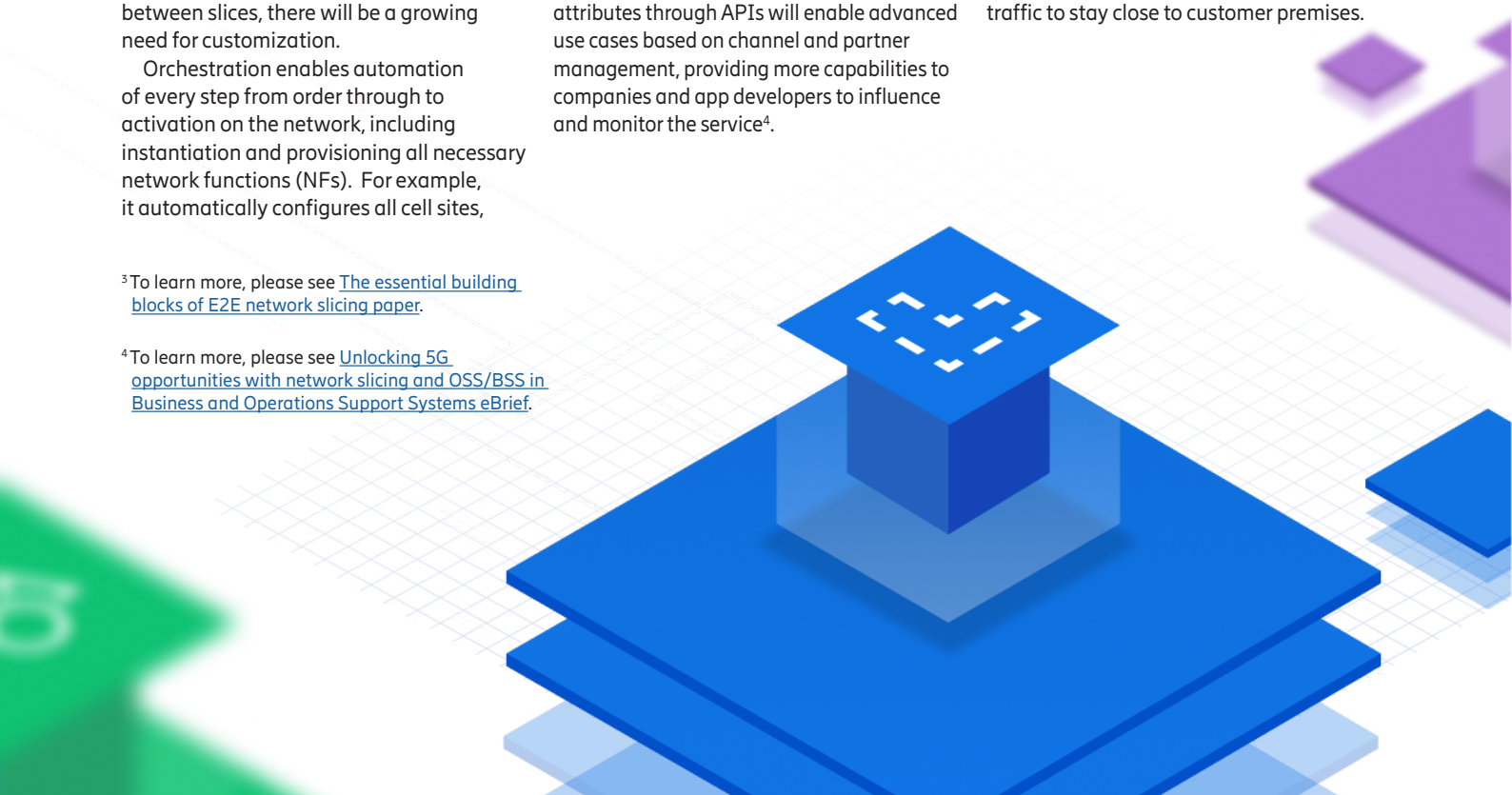
The exposure of the control of NS attributes through APIs will enable advanced use cases based on channel and partner management, providing more capabilities to companies and app developers to influence and monitor the service[4].

Core

The 5G Core network has many 3GPP-defined enablers of network slicing. It allows service providers to segment the network, allocating dedicated or shared user plane, control plane, and data layer NFs to support particular services and deploy multiple logical networks for different service types over one common infrastructure. Furthermore, it includes capabilities like URSP to dynamically place a UE on a slice, and to steer traffic from one slice to another according to defined policies, maximizing QoE on a single device. The user plane function (UPF) is the most valuable NF to dedicate to slices because it ensures low latency through distributed deployment. This permits the user data traffic to stay close to customer premises.

[3] To learn more, please see The essential building blocks of E2E network slicing paper.

[4] To learn more, please see Unlocking 5G opportunities with network slicing and OSS/BSS in Business and Operations Support Systems eBrief.



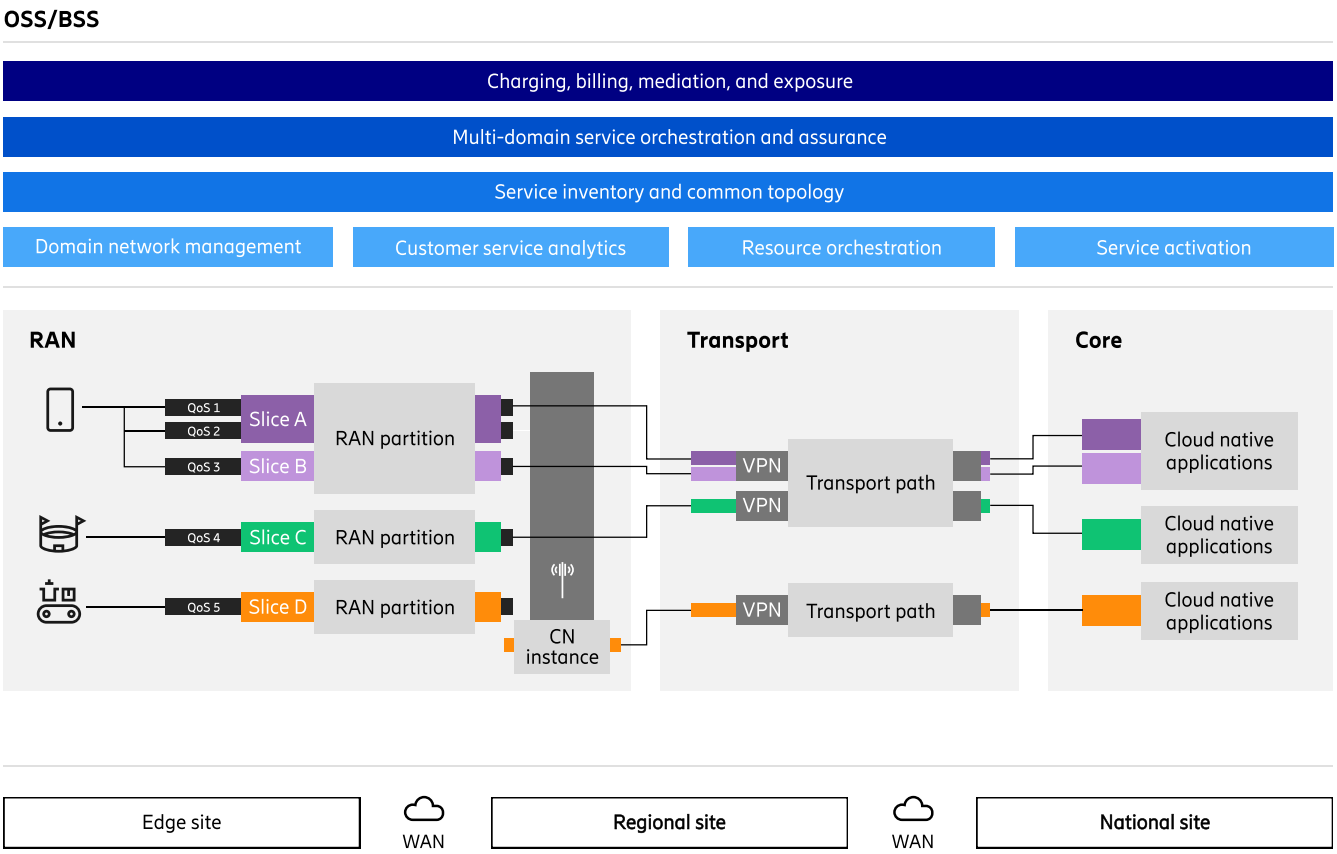


Figure 4 Network slicing building blocks—high-level view

Transport

Traffic from one network slice, or a group of network slices, should be mapped into transport resources using proper identifiers and match the required SLA for the slice or group. There are multiple enablers in the transport domains to support network slicing use cases, and it's important to consider the transport infrastructure's capabilities and capacity when selecting which enablers to use. For the vast majority of use cases using standard transport services for the network slices, or group of network slices, e.g., VPNs over IP-MPLS, SR-MPLS, SRv6, and differentiated services, QoS principles will give adequate support in the transport domain. For network slices (or groups) with multiple internal traffic classes, the use of H-QoS at the transport edge nodes can be beneficial. For network slices or groups of network slices with highly specific SLA requirements, e.g., URLLC services, addition of traffic steering principles may be necessary if the transport network consists of multiple possible paths.

Management and orchestration of the transport domain using SDN controllers and transport orchestrators connected to the RAN and Core management domains are recommended to ensure efficient network slice mapping to transport resources and SLA fulfillment over multiple transport domains.

RAN

RAN Slicing plays a significant role in strengthening E2E network slicing support for resource management and orchestration in the Radio Access Network. It can dynamically optimize the radio resource allocation and service differentiation within and between slices for guaranteed SLA fulfillment.

Important functional areas in the QoS implementation for Radio Resource Management are link adaptation (LA) and scheduler configuration, radio resource partitioning, and admission control. With slice awareness in these areas, the available resources can be allocated according to the traffic conditions to meet the service performance requirements for different traffic categories.

Network slicing in the RAN also provides a granular level of observability to see the network performance for a given network and/or the level of resource utilization for each network slice. Such detailed observability is crucial for effective network slicing orchestration.

Summary

The time is now. Get ready for the network-slicing transformation journey that will enable you to monetize 5G services that offer new value to a growing and more complex consumer and enterprise demand.

The use cases and ecosystem behind NS are taking off. Most of its revenues are expected to come from industry segments such as healthcare, government, transportation, energy and utilities, manufacturing, media, and entertainment.

From a business perspective, NS is key to monetizing 5G services as it introduces a new way of seeing and thinking about the services' design and deployment, with high levels of automation to reduce time-to-market (TTM) and increase the offered services' value.

But to reach this stage, it is fundamental to define a solid business strategy to guide the NS journey, which involves understanding and identifying current and future requirements and use cases, as well as market-sizing key opportunities and subsequent customer segmentation. The role of the service provider in the value chain with ecosystem partners also needs to be considered.

When defining your NS business strategy, we recommend considering these three steps:

1. Define the target industry verticals and use cases.
2. Define the technical requirements to realize the use cases.
3. Validate the viability of the business case.

Commercial and technical strategies risk failing if you are not ready to operate and commercialize at scale. This area should not be overlooked, as it demands close interworking of BSS and OSS to manage the requirements of NS on demand.

Network slicing is a multi-step journey

Realizing NS in the network and exploring its business potential will be a multi-step business journey guided by both commercial and technical decisions. Commercial because it depends on aspects like the local market demand, ecosystem readiness, use case scalability, and regulatory requirements. Technical because it depends on devices' maturity, E2E solution readiness, and local system integration maturity.

We see three main steps in the NS journey:
- Pre-configured slicing
- Dynamic slicing
- Exposed slicing

The essential end-to-end network slicing building blocks

To set up a NS solution, several capabilities are required in the different domains of the network. We call them the building blocks of an end-to-end NS architecture[5]. On a high level, we can divide them per domain as: OSS/BSS, Core, Transport, and 5G RAN.

- OSS and BSS: The enablers here relate to the SLAs in contracts. This results in the requirement of assurance and analytics capabilities based on business policies, SLA fulfillment, and operations. As both the specific KPIs and the approach to monitoring them will differ between slices, there will be a growing need for customization. Orchestration capabilities in this domain enable automation of every step. The monetization of NS also happens in this domain.

- Core: The 5G Core network has many 3GPP-defined enablers of network slicing. It allows service providers to segment the network, allocating dedicated or shared user plane, control plane, and data layer network functions (NFs) to support particular services and deploy multiple logical networks for different service types over one common infrastructure.

- Transport: Traffic from one network slice, or a group of network slices, should be mapped into transport resources using proper identifiers and match the required SLA for the slice or group. There are multiple enablers in the transport domains to support network slicing use cases, and it is important to consider the transport infrastructure's capabilities and capacity when selecting which enablers to use.

- RAN: RAN Slicing plays a significant role in strengthening E2E network slicing support for resource management and orchestration in the Radio Access Network. It can dynamically optimize the radio resource allocation and service differentiation within and between slices for guaranteed SLA fulfillment.

Network slicing provides enormous possibilities to monetize 5G network investments beyond enhanced Mobile Broadband (eMBB) to both enterprises and consumers. Service providers that are aware of this stepped journey, and start building their networks' capabilities and preparing their organizations to make the most of each step, are the ones that will capture most of its associated business.

[5] To learn more, please see The essential building blocks of E2E network slicing paper.

Glossary

5GC	5G Core
APN	Access point names
CaaS	Container as a service
CN	Core network
DC	Data center
DNN	Data network name
EPC	Evolved Packet Core
MANO	Management and orchestration
MBB	Mobile broadband
NF	Network function
NR	New Radio
NSA	Non-standalone
PNF	Physical network functions
QoS	Quality of service
RAN	Radio Access Network
RRP	Radio resource partitioning
S-NSSAI	Single-network slice selection assistance information
SA	Standalone
SLA	Service level agreement
TCO	Total cost of ownership
UPF	User-plane function
WAN	Wide area network

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