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Network Slicing can be a piece of cake

May 2018

One network slice doesn't fit all

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> "The more services we deploy with network slicing, the greater economic benefit we will see, enabling us to better serve our customers. In order to achieve this vision, it is important that the industry provides cost-effective solutions to support end-to-end orchestration and adds automation to the operations and management of network slices."[1]
>
> Maria Cuevas,
> Head of Mobile Core
> Networks Research at BT

What can you do when customers are requesting more than just a 'best efforts' service offering? When customers want a service tailored to their specific needs, will you be able to keep their business with 'vanilla mobile broadband'? New apps and service propositions are appearing faster than you can reboot your laptop, so customers want to be able to switch on a dedicated new service quickly too. Then they'll want to modify it to scale to accommodate new subscribers or more capacity. And that's before 5G is introduced, which creates endless opportunities, all requiring time to market measured in minutes, not weeks.

Network slicing is the technology that meets these aims, creating separate use-case-specific logical networks upon a shared physical infrastructure, enabled by technology advances in Network Functions Virtualization (NFV), Software Defined Networking (SDN) and Management and Orchestration (MANO). In essence, it means that connectivity becomes differentiated, enabling you to apply innovative business models and demonstrate additional value. Today's networks are effectively static, whereas tomorrow's needs are dynamic and unpredictable. Ericsson has a complete solution for network slicing, with all the key components in place. Available now, it will let you get started with network slicing, and elevate your offerings above mobile broadband.

This paper looks at the practicalities of network slicing and automation, how to support a multitude of new use cases, and how to simplify operations with services which are quick to provision, replicate, scale, upgrade and delete. The paper also considers the business support and monetization aspects required to generate revenue using this technology, and concludes with an example of network slicing collaborative work with a leading network operator.

[1] Ericsson Press release and paper: 'Ericsson study: How network slicing pays off'

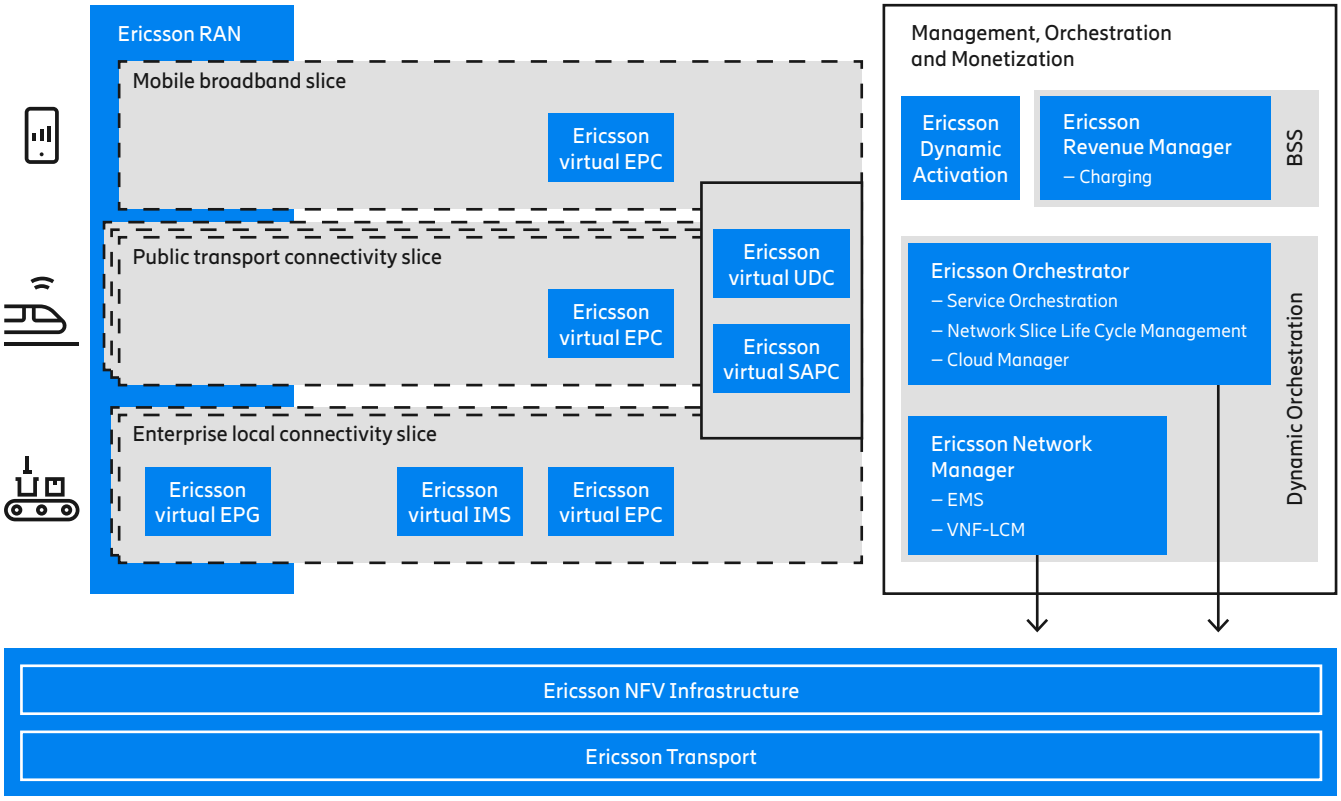
A complete network slicing solution

Ericsson offers a complete network slicing solution for 4G-based networks.

Available now, the solution comprises Ericsson offerings in virtual Evolved Packet Core (vEPC), virtual User Data Consolidation (vUDC), virtual Service-Aware Policy Controller (vSAPC), virtual IMS (vIMS), Radio Access Network (RAN) network slicing functions, Management and Orchestration, NFV Infrastructure (NFVi), Business Support Systems (BSS) and Catalog, and professional services.

Having a complete solution means that you can be sure all aspects of the network slicing and automation transformation will be taken care of. Ericsson works in a collaborative manner, leveraging experience gained from other deployments around the world, addressing a wide spectrum of use cases with an almost infinite range of possible service characteristics and performance requirements.

Figure 1: Deployment examples of a complete Ericsson solution for network slicing



Using network slicing to build use-case-specific networks

Network slicing uses virtualization to combine network resources and build separate logical networks for specific purposes which address individual use cases, industries, or enterprises.

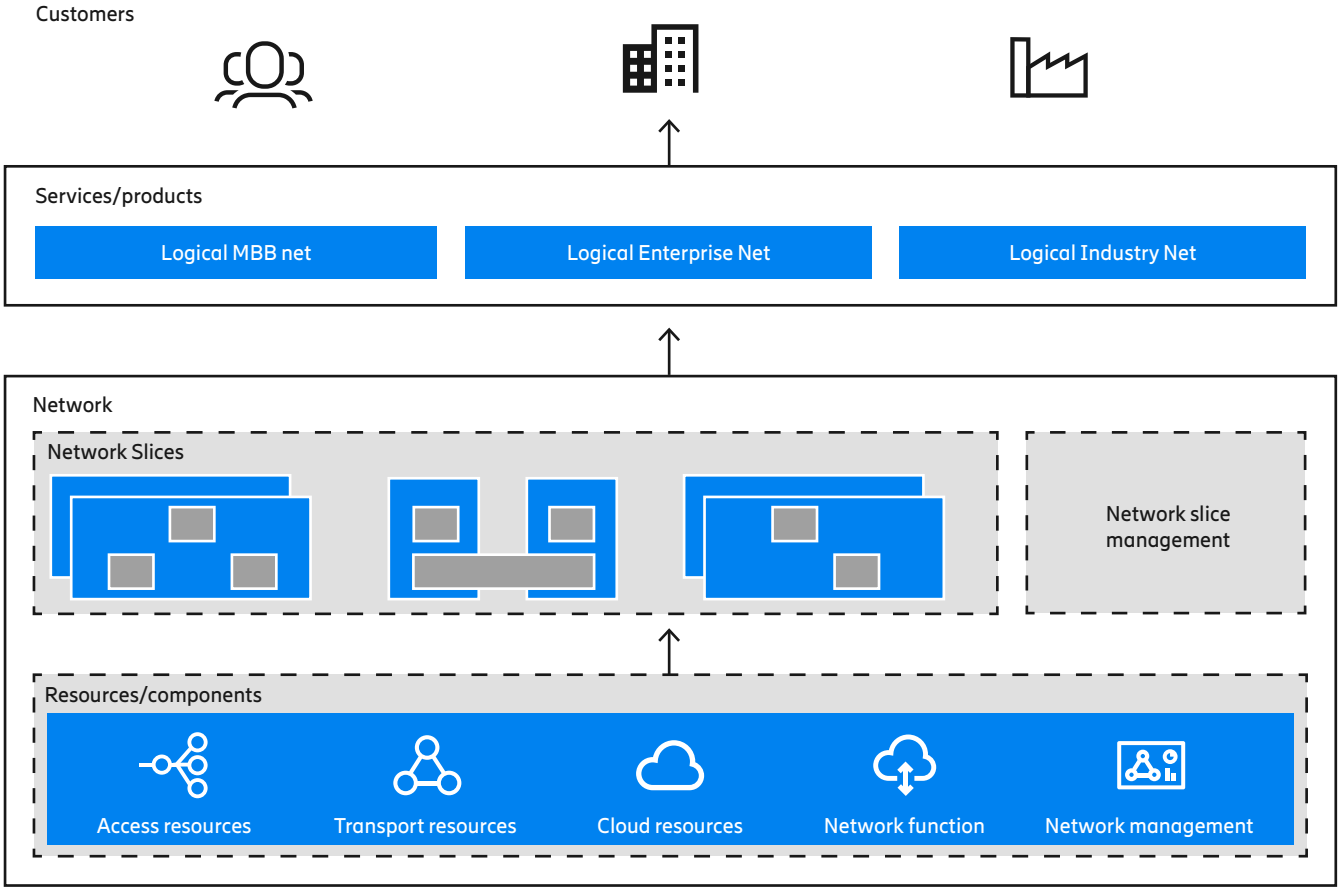
Each logical network or network slice shares the same physical network infrastructure and support systems, but is effectively distinct and isolated. This separation can be used to provide guaranteed resources for mission-critical applications, with critical traffic dedicated to a particular network slice, or special properties such as low latency, lower cost or massive scale. Orchestration automates the creation, modification and deletion of the individual services, while also handling the assignment of the underlying resources.

Networks are traditionally built to realize services, and so are network slices. However, a network slice is not a service in itself; it exists to realize one or more services created. In a special case, where network slices are created for industries or enterprises, as a 'wholesale' type of service, a network slice can map directly to an individual service. A network slice is a logical network serving a defined business purpose with a particular set of characteristics, and comprises all the required network resources configured and connected together.

Resources can be physical or virtual, and either dedicated to a particular slice, or shared between slices. The resources are not necessarily all produced by the same provider. Some may be sourced from other providers, enabling aggregation, or roaming for example.

Management functions provide life cycle functions to compose, create, modify and remove network slices. In certain cases, a network slice may itself contain management functions which provide 'exposure' or visibility and control of the network slice to customers.

Figure 2: Logical network offerings delivered using network slices



Network slicing in the Core Network
Consider the example of a network slice created to support a network operator's IoT traffic, to keep this traffic type distinct from the general mobile broadband traffic, which will be provisioned and billed as a separate commercial service.

Ericsson's IoT Core can be deployed as a network slice consisting of all the virtual network functions (VNFs) required and optimized to support the specific IoT use case needs. Typically the VNFs include Mobility Management Entity, Serving Gateway, Packet Data Network Gateway, Policy Control and Charging Rules Function, Common User Data Base, Home Location Register and Subscriber Servers and Service Capabilities Exposure Function. Other examples of currently-used network slice definitions include Enterprise Core, VoLTE/Wi-Fi Calling, Distributed Cloud and Mobile Broadband.

Ericsson's packet core[2] products are optimized for network slice deployments with a small initial footprint, and decoupled or integrated deployment options between network functions. They also feature independent scaling of user and control planes to adjust optimally to the resource needs of individual use cases.

Network slicing in the core network is based upon the concept of a Dedicated Core Network (DCN) or 'DÉCOR'. This feature provides the ability to separate core networks for different services, and serving specific groups of subscribers or devices with common needs. It is possible, for example, to isolate specific User Equipment (UE) or subscribers, or to provide a DCN with specific security, Quality of Service (QoS) or resilience characteristics. The network operator determines which DCNs serve the UE usage types. More than one UE usage type can be served by the same DCN.

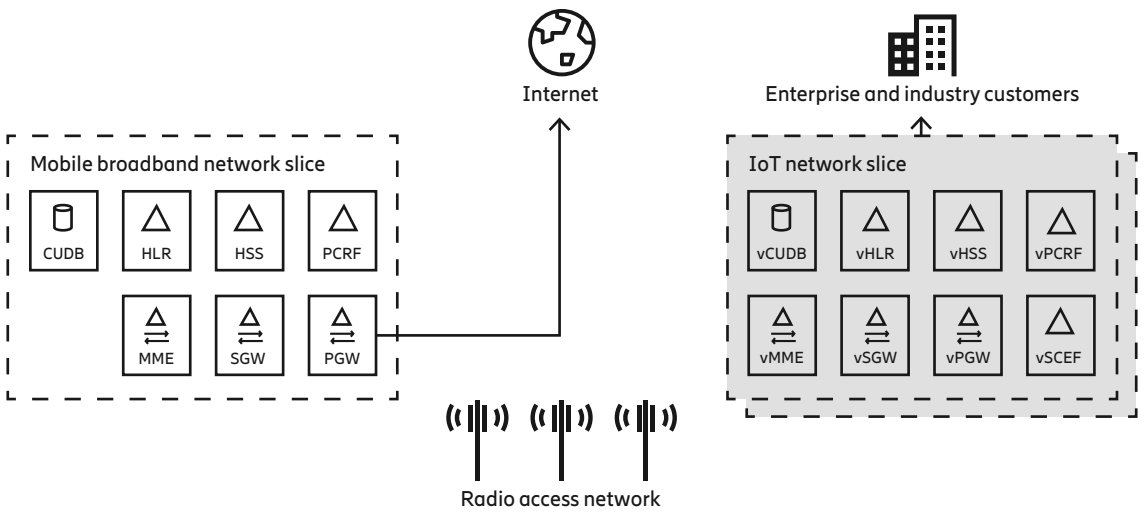
Ericsson's UDC,[3] policy control and network slicing are developed together to help support new revenue stream generation, and create unique user experience levels; especially those created by 5G. Like Ericsson's packet core, Ericsson's UDC and policy control products are developed in line with the 3GPP 5G Core standards. They embrace cloud native technology, and are based upon Service-Based Architecture (SBA) where core network services are able to register themselves, and subscribe to other services, enabling new and flexible service development paradigms. The services are also exposed to the Revenue Management Catalog where they become building blocks, used to create and monetize new revenue streams.

New UDC and policy control capabilities add dynamic controls to network slicing such as dynamic slice selection, database slicing and service and data exposure. These help you to incorporate and manage subscription and service differentiation dimensions using network slices. High usability is provided for most common operations, with web-based APIs and configuration tools offering a holistic, easy-to-use environment.

Dynamic User Equipment and Network Control and Dynamic Network Exposure represent two Ericsson offerings which will provide subscription and service differentiation in different network slices. They make networks more autonomous, and ensure efficient use of resources, including network slices.

Network slicing in the RAN
Ericsson RAN supports differentiated QoS levels for critical applications and network slices. The Quality of Service level is further enhanced with Radio Resource Partitioning which increases service reliability by securing a minimum level of bandwidth for a given network slice. To increase reliability even further, Ericsson's Advanced Subscriber Group Handling grants access to additional network capabilities that further enhance service quality. Ericsson has also implemented flexible counters that observe QoS levels for each Network Slice to ensure that service level agreements are met.

Figure 3: Examples of optimized network slices serving MBB and IoT customers



[2] Ericsson paper: 'To be first in 5G, first get to the core'
[3] Ericsson paper: 'Building networks of things

Step-by-step network slice creation

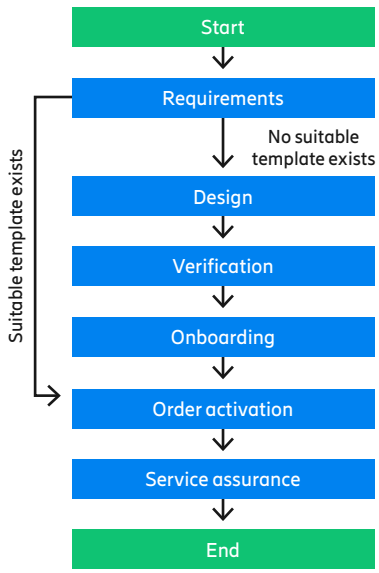
Let's look at the business process of creating a network slice, and bringing it into commercial service.

Network slicing needs to add value, so it's important that the process lowers time to market, time to customer, and operational costs, as well as tailoring service characteristics such as delay or capacity, or meeting isolation requirements. The process can be split into six steps, from the identification of service requirements to eventual service assurance.

Network slice 'blueprints' or 'templates' can be used to simplify the whole process. If a template exists to meet the new network slice's needs, then the creation process can be greatly shortened, and savings achieved. This is especially true for actions that need repeating multiple times such as creating multiple network slice instances from the same template, or repeated actions such as scaling or bulk upgrade operations. Using templates also reduces errors by reducing human interaction, increases efficiency and lowers operational costs.

Step 1 - Requirements: This step determines the necessary input parameters for creating and configuring a network slice. The more flexibility that is built into the requirements gathering, and template definitions, the more streamlined the process becomes.

Figure 4: Network slice creation process



A key function of this step is to check if a template already exists for the type of network slice being created. If so, the following three steps (design, verification and onboarding) can be skipped by proceeding straight to the ordering step. Thus, the following three steps are only necessary when customer requirements differ from what can be achieved using pre-defined templates. The aim is to have a catalogue of services and network slice templates which allow the 'skipping' to happen as often as possible, achieving savings through replication and automation. There will always be cases where new templates need to be created, which increases the need for process optimization in these steps too.

A decision tree can be used within the network slice creation process, and a series of questions asked, such as: 'Do you have specific latency requirements?', 'Does this service require particularly high availability?'. The decision tree will identify suitable templates, should they exist. You would expect to use the design step only when efforts to find a suitable template have not been successful. Even then, the design step can use the 'closest match' template as a starting point.

Step 2 - Design: The fact that the new service is going to be created within a dedicated network slice simplifies the design task because there are fewer dependencies and consequences to consider. There is no risk that the new service can impact any other service sharing the same resources. For example, if the new service requires a new feature or modified configuration in a Virtual Network Function (VNF), this change cannot have unforeseen impacts on other services, because the impact is limited to the network slice being configured. The modularity and programmability associated with network slicing streamline the design process. Design components can be selected from a menu, and the inherent programmability ensures their immediate usability.

Step 3 - Verification: The reduction in the number of service cross-dependencies reduces the number of verification cases, by virtue of the isolation of the network slice. Fewer verification cases means fewer regression tests, and the whole task of verification is simplified and requires less time. Interestingly, network slicing can be used to facilitate testing. Network slice 'sandboxes' can be created, even in a live network, where new features and capabilities can be tested independently while minimizing risks to live traffic and services.

Step 4 - Onboarding: This step refers to the uploading into the production system, and validation, of templates and other artefacts such as virtual machine (VM) images for example, needed by the orchestration system in the next step. Once again, the isolated nature of network slices reduces the risk of interfering with other services, and increases implementation speed. The BSS Catalog is updated to include the new network slice templates, so that the offer modelled can be completed and an order created.

Step 5 - Order activation: As the customer order is processed, resources are checked to make sure that the order is deliverable, and increased automation in the sales-force automation (SFA) tools and BSS Catalog reduces switch-on times and cost. Isolation between the network slices can minimize risk, as the activated changes cannot impact other existing resources. Due to lowered risks, and efficiency gains, operations departments will be more willing to accept order activations in an automated manner, avoiding manual steps and approvals delays.

Step 6 - Service Assurance: Service assurance can be simplified and optimized, as each network slice can have its own performance targets assigned, in accordance with established Service Level Agreements (SLAs). Maintenance operations can be performed with reduced risks to other services, due to the network slice isolation. Upgrades can be performed in an increasingly risk-reduced manner, and a more 'DevOps-like' environment can be considered, especially in a network slice that is expected to require frequent updates, due to rapidly changing service requirements.

Automating the provisioning process

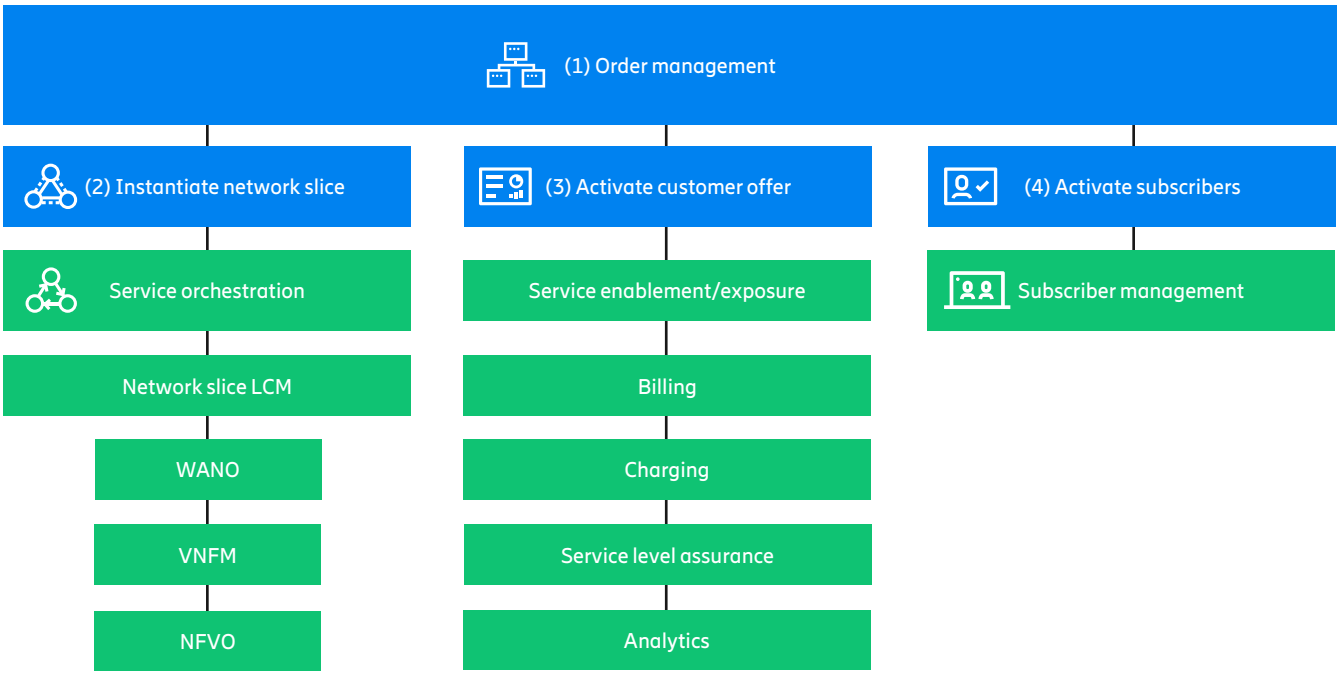
Network slicing uses NFV and orchestration to maximize the efficiencies of a shared infrastructure, while ensuring isolation and performance characteristics for each network slice.

Orchestration automates the creation and modification of the individual services, while also handling the assignment of the underlying resources. To realize the benefits of network slicing, we make the assumption that physical infrastructure is, by default, shared. That includes cloud infrastructure, transport and access networks. In some cases, there may be overriding requirements that dictate the need for dedicated infrastructure within a slice. What really define, or constitute individual network slices, are the 'shares' or instances 'carved out' or designated from the underlying infrastructure. Management, orchestration and monetization capabilities define and keep track of network slice resource allocation, take care of the life cycle management of the slices, and turn them into sellable offerings.

Network slices comprise different kinds of resources or assets. Pure 'infrastructure shares' consist of bandwidth allocation, or scheduling policies for example that define a network slice characteristics. Network applications such as Ericsson EPC, Ericsson UDC or Ericsson SAPC can have independent, per-slice instances. Management, orchestration and monetization capabilities can be defined per network slice, permitting independent operations and management, and customized monitoring and analytics. Configuration, Fault, Performance and Subscriber Management functions provision subscribers and their devices, and map them to the network slices serving them. Commercial offering management consists of BSS and Service Exposure. This creates a sellable offering, based on a network slice and its hosted services, and exposes network slices and their services to the customer and their business applications. All these resources can be set up dedicated to a single slice, or shared by two or more slices. Fundamentally, it comes down to a trade-off between the isolation benefits against costs.

The full expectations of network slicing will not be realized without automating the process of provisioning and modifying slices and services. Without orchestration, you will need to repeatedly create network slices manually, and struggle to achieve the promise of fast time to market and service agility. A simplified automated process model is shown in figure 5. Order Management initiates the process with receipt of an order (1) from the BSS sales-force automation tools and then processes the network slice creation through three consecutive steps. The first step is to instantiate a network slice using service orchestration (2), then activate the customer offer by invoking a number of more commercially related elements such as charging and service level assurance. Then it's possible to activate subscribers (4) using subscriber management tools.

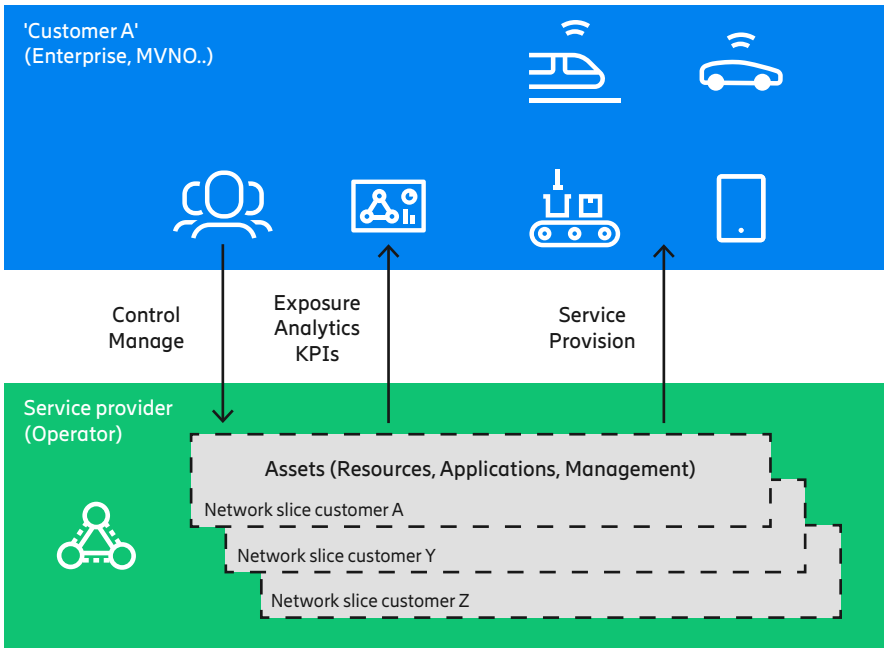
Figure 5: Simplified automated provisioning process model



Creating Business-to-Business offerings

The isolation and independence of network slices opens up attractive new possibilities that you can offer to industry or enterprise customers.

Figure 6: Providing customer control over network slices



Each network slice can be used as an entirely self-sufficient and autonomous 'container' with all the functions and resources required for independent service. With this new 'Network as a Service' (NaaS) business model, customers can be granted visibility of their network slice, and then modify it to suit their changing needs, or create new network slices quickly to seize a new business opportunity. This model has some similarities with the mobile virtual network operator (MVNO) model, but is significantly more powerful in terms of flexibility, automation, and the ability to customize the services delivered.

In a simple example, the capacity of a network slice could be expanded to accommodate anticipated demand created by a major sporting event. Instead of needing prior cooperation between the customer and the network operator, and re-provisioning by the network operator, the customer would be able to perform the required service changes themselves. Through the introduction of virtualization and orchestration, customers can be offered control of the assets within their network slices, and even create network slices on demand and characterize them for their specific needs.

It's important to note that end-user services, consumed by individual devices and applications, are realized within the network slice, independently of the network operator. The network slice may therefore contain instantiated management functions needed to supply or maintain the end user service. In some business models, the NaaS customer may even take full operational responsibility for this service, using in-slice management functions.

Although NaaS has been proved as a successful business concept, we are moving into a new era of possibilities, and use cases will regularly break new ground. Ericsson's Continuous Delivery and Deployment[4] for software updates will play a key role in expanding possibilities and automation as quickly as possible through regular, incremental functionality upgrades.

[4] Ericsson paper: 'Continuous delivery and deployment of software in the telecoms world.'

Monetization using Business Support Systems

Making money from network slicing is very dependent on flexible and powerful business support systems, to enable the rapid creation of completely new services and offers.

One of the key issues is how quickly the business support systems can be adapted to handle the new technologies, slices and services. Ericsson Revenue Manager has been designed from scratch to replace customization with configuration, using adaptive business logic. The challenge is not just how to charge for network slices but how to provide a platform for business innovation on a massive scale. Whether we are talking about IoT, healthcare, autonomous vehicles, virtual reality apps, or any of the other technologies enabled by network slicing, the challenge is how to support many innovators, each wanting their new business model to work instantly and flexibly.

Ericsson Revenue Manager is configured to support network slicing and permits a new service offer to be built on top of technical capabilities with easy-to-use graphical tools. First the underlying technology parameters for the network slices are added, then offers can immediately be created to make use of these new parameters in rating decisions. The new service can be configured in Revenue Manager and be ready for deployment to live customers - all in a matter of minutes.

Ericsson Revenue Manager includes SFA and Catalog and transforms the business process around introducing new capabilities, and allows you to quickly introduce not just your services, but services provided by third party partners. With the 'Network as a Service' business model, new capabilities could mean providing capabilities to partners to help them manage and monetize their relationship with their customers. Capabilities might include providing access to location information or usage analytics, or a more complete offering involving rating, charging, and billing for partners' services.

Using 'clusters' to realize opportunities

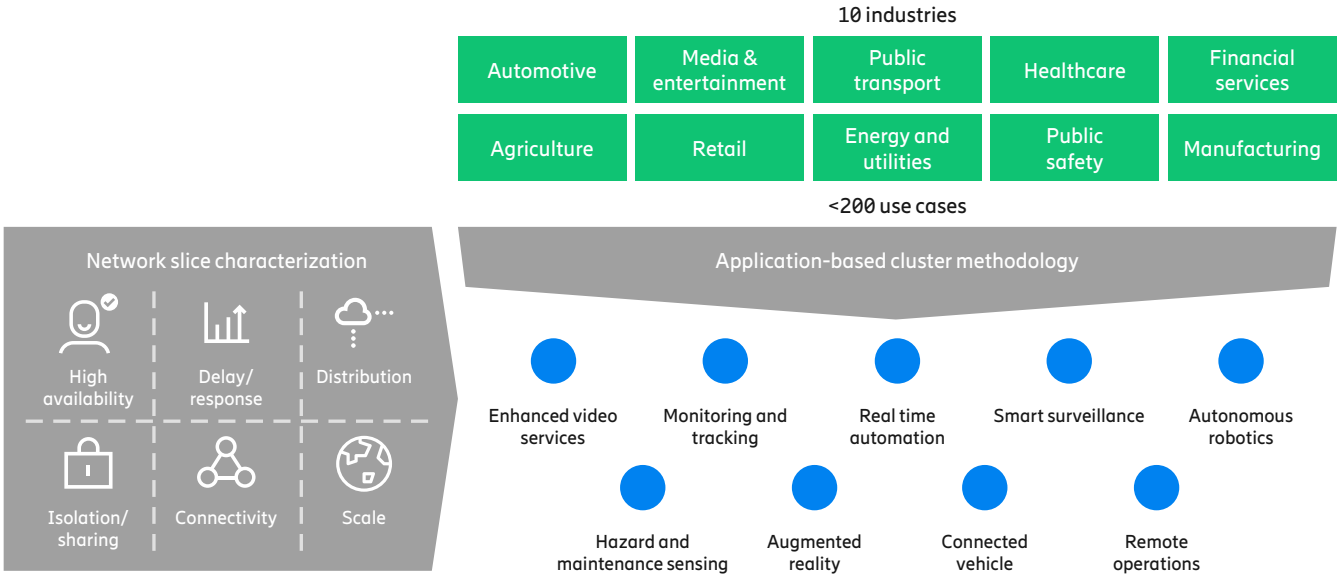
In our report: 'The guide to capturing the 5G industry digitalization business potential'[5], we collected insights from a thorough analysis of over 200 5G use cases, guiding you on how to start IoT business today and grow with 5G.

The report presents nine use case clusters across 10 industry sectors. By addressing clusters of use cases, risk and reward can be spread across several industries and larger revenue pools. Instead of looking at Manufacturing, Healthcare and Agriculture industry verticals (and others), we focus on use case clusters such as 'Autonomous Robotics' or 'Augmented Reality'. This approach enables shared investments and resource allocation across industry verticals and is very well suited to the use of network slicing. That's because each cluster is defined by characteristics such as mobility, data speeds, latency, and service availability. Opportunities of the same application type, such as 'monitoring and tracking' use cases are identified across all industry verticals, which increases the scalability and market scope of the network slices created.

Let's examine the Augmented Reality cluster and example network slice characteristics. The analysis of the network features and performance metrics required is divided into 'local area and mission critical', and 'wide area and mass adoption' cases. For the Local Area augmented reality cluster, where use cases in the Manufacturing and Healthcare sectors dominate, there is a need for very high availability, security, low latency and high data rates. This can be achieved through service separation with stringent quality of service guarantees, enabled by network slicing. Separate network slices for 'Local Area Augmented Reality' can be prepared as templates and offered by telecom service providers to both Manufacturing and Healthcare industries.

Similarly, network slices can be prepared for 'Wide Area Augmented Reality' offerings toward the Media & Entertainment industry. The associated business models depend on the role in the value chain the telecom service provider wishes to assume. If the telecom service provider takes a network developer role (connectivity and infrastructure provisioning) and offers 5G-enabled augmented reality solutions to third party application providers, then one of the most common business models would be revenue sharing. For telecom service providers assuming a service enabler role (connectivity and infrastructure provisioning and service enablement) their primary customers would also be third party application providers, but the most likely business model would be based on as-a-service fees, or by transaction. Finally, for telecom service providers becoming augmented reality service creators (connectivity and infrastructure provisioning, service enablement, and application and service provisioning), with end users as their main customers, it would be a subscription-based service model. Thus, network slices enable and automate business opportunity realization, and move the business opportunities of telecom service providers into entirely new domains.

Figure 7: Clusters and network slice characteristics help target opportunities effectively



[5] Ericsson paper: 'The guide to capturing the 5G industry digitization business potential'

Putting network slicing to work

Network slicing is crucial to securing the performance of critical communications in a shared network, carrying mission critical and lower priority public communications.

In a recent demonstration, Swisscom collaborated with Ericsson to show how network slicing can support critical railway communications upon a public network carrying mobile broadband traffic.

The demonstration exhibited RAN slicing functionality and Quality of Service control, combined with Ericsson's 5G core network functionality and Operations Support Systems (OSS), securing the performance of critical communications applications. Specifically, it showed how high definition video traffic, used for remote surveillance of platforms and tracksides, and from cameras carried in the front of trains, can be isolated with performance guarantees. Assurances are required when trains are in areas with only moderate radio signal coverage, or during periods of particularly high mobile broadband traffic loading. Although capacity demands from critical communications are low, RAN radio resource partitioning can be used to maximize available capacity for other lower-priority demands, without affecting performance guarantees.

Swisscom is also instrumental in driving the '5G for Switzerland' program.[6] Ypsomed, the leading developer and manufacturer of injection and infusion systems for self-medication and a renowned diabetes specialist is also a member of the program and aims to gain experience of 5G technology early, to prepare for the new age of mobile-networked production. Ypsomed is interested in maximizing the potential offered by 5G in aspects such as extremely high bandwidths, wirelessly-networked production and integrated data processing. Network slicing will be vital for manufacturing operations, where individual applications can receive reserved, guaranteed network capacity or allocated bandwidth. Even a brief network fluctuation can lead to a break in production and costly stoppages.

In summary

Through virtualization, network slicing creates distinct and isolated logical networks for individual use cases, apps or business needs, built upon a shared physical infrastructure. It's useful to recognize the power of network slicing to realize new business opportunities, rather than focusing too much on the underlying technologies involved.

Network slicing is a new paradigm, and introduces a completely new way of specifying services and delivering them in a flexible, agile and automated way. Ericsson can provide a full solution, including the orchestration and BSS capabilities needed to automate the process of network slice creation and quickly address the swathe of emerging business opportunities.

Ericsson's comprehensive solution is available now, so the time is right to deploy network slicing with 4G, build experience with delivering services in a completely new way, and prepare to maximize the full business potential of 5G. Network slicing will be a significant transformation, with a gradual introduction and maturation, developing new capabilities and adapting to new business models. Always a first mover with new network-related technologies, Ericsson is here to guide you through the upcoming evolution and make sure it's a piece of cake.

> "With Ericsson's network slicing functionality and complementing features, we can leverage existing infrastructure and assets. In addition to offering mobile broadband services, we will be able to configure dedicated network slices for various industries, meeting the needs of manufacturing, railway, and public safety companies."
>
> Heinz Herren,
> Chief Technology Officer and
> Chief Information Officer, Swisscom

[6] Swisscom press release: 'Ypsomed is the first industrial partner at "5G for Switzerland"'

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans Networks, Digital Services, Managed Services, and Emerging Business and is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's investments in innovation have delivered the benefits of telephony and mobile broadband to billions of people around the world. The Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.

www.ericsson.com

Ericsson
SE-164 80 Stockholm, Sweden
Telephone +46 10 719 0000
www.ericsson.com

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