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5G Network Slicing - Revenue by Slice

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Abstract

The majority of businesses have primarily relied on one shared network for non-critical work, including conference calls, email, online service portals, local office Wi-Fi, digital payments and other applications. However, as more devices require connectivity as part of the Internet of things (IoT), businesses are exploring connectivity use cases that align with high availability and scalability, charting the path to network slicing.

Communication Service Providers (CSPs) are gearing to adopt/ explore new business potentials through end-to-end network slicing that will enable new and innovative use cases across all Industry verticals. From a business perspective, a slice can fulfil a specific business case or deliver focused outcomes for using a combination of all the relevant network resources, functions and other existing assets. When selecting target industry segments and corresponding use cases for CSPs, there are several things to consider. First of all, there needs to be a solid enterprise strategy around industries or verticals to target and the local market possibilities. With network slicing, CSPs can roll out services and support applications in quicker time to market mode, and this helps them address industry-specific services around Railways, Healthcare, Emergency services, Airways and Smart cities, to name a few. Slicing guarantees a certain level of QoS and allows service providers to configure the network to meet specific security needs. As service content varies across end customers, slicing provides more effortless scalability and simplified network management for enterprises. This paper captures the background, related work in network slicing, its benefits, delving into a few use cases, significant security issues and also highlighting its commercial potential.

Keywords: 5G, Multi-Access Edge Computing (MEC), Network Functions Virtualization (NFV), Network Slicing

Introduction

Communications is at the forefront of business advancement of all industries gearing up for flexible and high-performance services that are highly secure and carry distinct value propositions. Network slicing in 5G is one of the most promising services which will leapfrog the richness of 5G into the next realm (Subedi et al., 2021). An Industry study highlights a Network slicing business potential of around USD200 billion or more in 2030 with robust annual growth (Ericsson & AD Little, 2020). A 5G network is expected to address a diverse set of performance and expected services requirements through its multi-service network capabilities. Slicing a single physical network into multiple isolated logical networks has emerged as a key to realising this vision. The Information and Communications Technology (ICT) industry worldwide is at the edge of significant transformations that will change and impact the way enterprises work currently. Here, support for different traffic classes gets improved through a 5G Network slicing scenario (Zhang, 2019). In today's ultra-competitive markets, ICT technologies help organisations across industries verticals create and enable game-changing value propositions that are market disruptive and business-oriented.

Objective

This report highlights the effectiveness of 5G Network slicing in addressing industry demand for a secure and dedicated network while capturing a few use cases illustrating the logical architecture overview and highlighting a few challenges that CSPs and regulatory bodies need to consider.

Network Slicing overview

It can be suitable to term Network Slicing as a standard where the service provider creates logical networks or partitions marked with relevant resources, isolated with each other and a topology that is fine-tuned to address the business requirements while adhering to the uniqueness of network demand. In a way, it utilises the in-demand network resources from non-critical use cases while monetising the enterprise business aspect by deploying resources on a need basis.

In a typical sense, slicing covers all key aspects of 5G networks: the radio, the transport, and the core. This brings out its stark difference with VPNs, where data traffic is routed through an encrypted virtual tunnel over a physical

network resource. In contrast, the available resource is partitioned in slicing. The elements of this separation are not limited to the user equipment (UE), which could be a handset or a fixed-wireless access point or an IoT sensor. In a way, a network slicing adheres to the defined and well laid out network features like eMBB, mMTC, URLLC that addresses the specific needs of consumers, OEM and ISVs. The use cases of network slicing will vary for different business scenarios like industrial automation, digital twins, autonomous vehicle, emergency services and law enforcement agencies.

A logical and tailored 5G core network slicing can be provided in an agile and adaptable manner for services or an industry vertical (Fulton III, 2019). SDN and NFV are the heart of Network Slicing. The control and data plane of the core network are usually separated by SDN technology. While the control plane is centralised to facilitate operations management, a data plane can be distributed (Li et al., 2017). For example, in low-latency services, the data plane is mainly spread out on the network edge fusing with Multi-access edge computing (MEC), an ETSI-defined network architecture concept. According to services demands, NFV technology provides the required virtualised network functions for the data plane of the core network slices. The need for scaled services is well addressed by virtualised network functions which can be on-demand too.

Service-Oriented Architecture

The 5G ecosystem primarily composed of software supporting disaggregated networks that lay on virtualised machines interfacing with third party programs and applications through industry defined application programming interfaces (APIs). The integrity of the open-source software and its supply chain, where the work is in progress, is a typical concern highlighted by various forums. Cloud native principles are the core of 5G architecture, where services are seamlessly created, managed, and dynamically communicated. All underlying systems are properly authenticated with privacy & security access policies to prevent unauthorised access to resources and dynamically instruct the system on hacking or a DOS attack (Maestre Vidal et al., 2017). In the 5G sliced network architecture, users will access network-specific services. Like in any architecture, 5G to is prone to software or hardware vulnerabilities addressed through disaggregation and failover mechanism setup. Like in any basic network, hardware and software (applications & OS) vulnerabilities also exist in a 5G architecture. It would be apt to state here that SDN and NFV principles are the core of 5G slicing principles, and they come with their unique attributes and shortcomings.

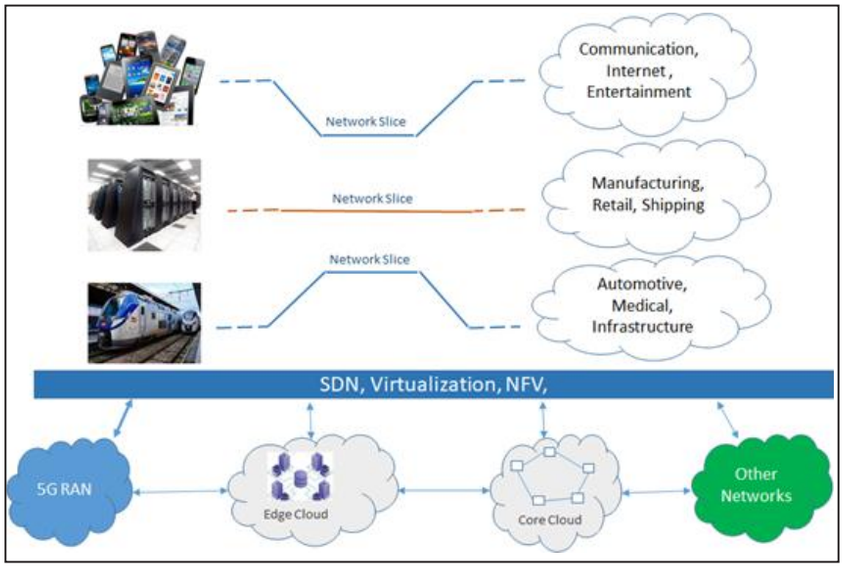

Fig. 1: Physical Layout of a 5G Network Sliced Network (What is 5G Network Slicing? A Definition — SDxCentral.Com, 2018)

The business outlook fairly balances the telecommunications service provider and the cloud hyperscalers. Firstly, this means how significant players like Telefonica, Vodafone, T-Mobile/Sprint, Telstra will compete against cloud service providers (Amazon AWS, Microsoft Azure, Google Cloud Platform, IBM Cloud)

for various applications and data that supports 5G slicing. Secondly, these CSPs will redefine or rather re-architect their network to address the needs of end enterprise customers' needs, e.g. in private networks control of assets while securing the integrity of their network infrastructure (Alleven, 2021; Fulton III, 2021).

Slicing Business Potential and Few Cases

The network slicing global market size is estimated to reach $921 million by 2027 (Gaikwad & Rake, 2021). The current COVID pandemic has significantly pushed demands for high-speed broadband services, leveraging mobile networking technology growth and the need for remote access services in several industries. The current pandemic will drive the demand for 5G use cases such as work from anywhere, remote healthcare, education, and robotics which further augment the network slicing market.

In addition, as the businesses around the globe have started to reopen, CSPs are shifting their focus to 5G rollouts and are accelerating investments in network slicing. At Mobile World Congress - 2020, 5G network slicing and business opportunities were adopted as a GSMA foundry project for its immense business potential.

5G is more enterprise business model-driven, and here, new opportunities and use cases across sectors will be possible by creating virtual networks with varying degrees of segregation upon ask and purpose. This varying degree of business needs and technical requirements has impacted the way these networks are designed, optimised and managed, and this is bound to have implications on network complexities (Basilier et al., 2021).

Industries, in particular, are looking to leverage the power of technology in the 5G era to further their market development activities. Here, network slicing business models are holding on to these business growth expectations. With the promise of massive IoT and ultra-reliable/low latency services, enterprises are gearing to boost digital transformation.

The IoT era has the potential to transform industry and society, and with 5G round the corner, countless new business models have become a possibility. In its report, AT Kearney (Bilstein, 2018) has given an overview of monthly prices customers are willing to pay as they move to 5G, which directly impacts slicing service potential.

IoT services have their challenges around connectivity with various devices and performance-related difficulties when it comes to IoT services.

Ericsson and BT did a study (Fig. 2) on the business value of 5G slicing vs dedicated network in terms of Capex, Opex and Revenues over five years, and the results were pretty obvious.

- Revenue Generation: Is the key outcome of the Network slicing function apart from the direct and indirect impact on capex efficiencies and cost take out themes.
- Mitigate Complexity: It is also assumed that investments made for automated network slice orchestration are paid back quickly, which mitigates any risk of complexities of slice management.
- Services Scaling: Immediate business results can be reaped even with a small number of network slicing service launches, which increases in scale with the adoption & launch of new services.

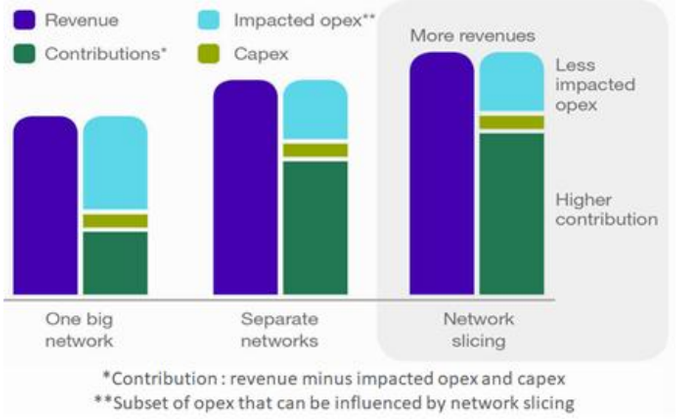

Fig. 2: Business Potential through Network Slicing Vs. Traditional Networks (Ericsson, BT Study)

Healthcare

Remote surgery is "the classic example" of the value of network slicing. With life often literally on the line, remote surgery requires low latency, a high-reliability environment that is also highly secured.

Use cases around safety and efficiency positively impact 5G growth and drivers around addressing ever- challenging climate and pollution issues which were taken up in the recently concluded Glasgow Climate meet. For example, emergency ambulance services or disaster relief services over secured public networks using slicing provides assured and prioritised access. Coverage and quality are also key factors where emergency services can use shared network assets. ("GSMA Report--Network Slicing Use Case Requirements," 2018).

Smart Cities

The city of the future, which is aware, responsive, and automated, can benefit from network slicing. Take autonomous municipal drones that might respond to an emergency or monitor traffic or in a national defence situation.

These will require low latency to ensure real-time responsiveness; near-instant response times but not fast data rates. The city's more traditional cloud-based needs, like providing portals for a range of social services, will rely on fast data rates, however, without necessarily needing low latency.

As an enterprise telecom customer, the smart city, the intelligent world, and the smart government can all benefit from the selectivity and adaptability of network slicing. The operator can generate revenue for each of these slices. They're essential in fast-moving municipal environments and emergencies.

As a case, in California wildfire, the firefighting teams could quickly look at the data, and their devices and apps could prioritise their needs on the fly through all the 5G slices available. They could communicate with the operations centre, get data and directions immediately back, and then be communicating with the teams, even drones, to help fight the fire and prevent its spread.

Smart cities also create new opportunities for further partnerships beyond carriers and municipalities. For example, Telefonica is working with Spanish automaker seat on 5G-connected car use cases for safer driving in cities, leading to a multi-party public-private partnership.

Augmented Entertainment

Imagine IPL cricket leagues taking advantage of network slicing to provide VR and AR capabilities. "Imagine you're standing on the sideline or field level at the IPL game or walking through a preferred gallery, or sitting in the front row at a stadium concert, broadcast live through augmented or virtual reality technology."

Pulling off such an offering requires coordination and specialisation to relive that scene on the field. It needs such diverse technical features as varied IP multicast deployment, high-density computing for processing the AR/VR video, and specific bandwidth and latency. The whole experience doesn't lag and makes users feel nauseous. Enterprise has to keep investing in finding them and unlocking them.

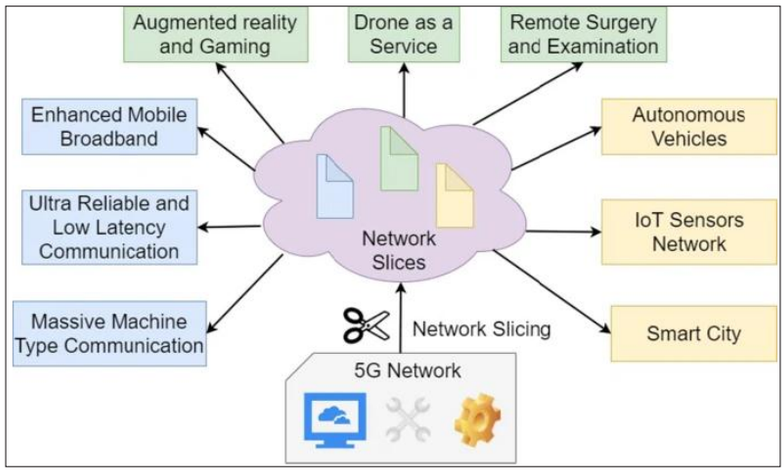

Fig. 3: Different Use Cases of 5G Network Slicing (Subedi et al., 2021)

In Fig. 3 - different use cases by 5G network slices. Slices with similar requirements are grouped, and various colours show different slices.

In a report in the TM forum, there is an information guide to network slice monetisation where it dwells into a few challenges faced by communications service providers (CSPs) and slicing model mapping to the FAB model of Frameworx (Taffee, 2021).

Security

The logical separation of network resources acts as a tool to mitigate security attacks, e.g., in the event of a cyber-attack, one slice can be isolated from other slices, limiting the attack on one slice only, leaving other slices unaffected. Similarly, network resource utilisation is optimised if attacks are directed upon a certain part of the network. Slicing thus ensures that communication needs under critical situations are addressed on priority and that multiple services within one logical network do not increase the vulnerability (Telenor, 2018; Network Slicing, 2018).

The analysis of network slicing security is in the exploratory phase, and there is a lot to be discovered about the slicing concept and underlying security risks. It is well established that concepts of isolation and end to end security are interconnected (Network Slicing, 2018). Moreover, it is dependent on the business model and the outcome of the trust model. In (Ting et al., 2019), the author has highlighted possible security threats to network slicing as one of the 5G enabling technologies. Therefore, it is essential to have stringent isolation as a prerequisite for the end-to-end security of a slice and each sub-slice.

Open-source technologies will have an immense impact on Network Slicing business cases as Network providers and OEMs/ISVs are increasingly relying on distributed source code to hasten the building of new solutions and reduce the total cost of ownership.

Slicing business uptake has its challenges which is the focus of regulators and Industry bodies. Some of these challenges include, (not limited to):

– Commercial models.

– Design and deployment scenarios.

– Industry-specific demanding SLAs/OLAs.

– Market inroads strategy and vertical functional expertise.

– Technical dependencies.

– Regional Regulatory considerations.

– Security and Privacy rules.

A network slice enables an enterprise to have a flexible, logical and network performance tailored to its specific and demanding use case requirements. This creates a need for a commercial and business model which should be coherent and capitalise on the value of network slicing.

Regulatory considerations have their play; e.g. net neutrality in a region could prevent CSPs from providing tiered service optimisation in some circumstances (Izydorek & Tadayoni, 2019). Since there is a logical separation to data traffic, there could be a disparity in traffic offered to businesses on financial aspects, which may dispute applicable net neutrality rules, limiting service providers' ability to suitably optimising and monetise the slicing case. In the case of mission-critical use scenario, the challenge of local vertical-specific regulation may get into the way of slicing potential, thereby adding to terrain's complexity and posing some concerns for slicing acceptance. Also, there would be issues around illegal content from third parties' networks where CSPs are generally not liable. There are specified rules and procedures that address such identified forthcoming processes when CSPs report the use of illegal content. Also, issues specific to each slice deployment need to be looked into. Over the last few years, the global economy has relied on cross-border data interexchange, which has raised questions on data privacy. Global frameworks such as APEC Cross-Border Privacy Rules [CBPR] in this case have helped to give a shape to privacy standardisation which may get challenged by local data residency and data integrity rules.

Conclusion

For CSPs, the network slicing market potential would be around USD 300 billion by 2025 (*Network Slicing Market | 2021 - 26 | Industry Share, Size, Growth - Mordor Intelligence*, n.d.). It would be paramount to have a grounded enterprise strategy for GTM and established techno- commercial capabilities around. To address this, there have to be use cases that are scalable and replicable, besides developed relationships around OEMs/ISV's ecosystem which can cohesively contribute to solution building. The journey of growth opportunities has started for CSPs with market acceptance, and with technology getting mature, it would rapidly scale in the coming years. Closer interworking between regulatory, ecosystem players and end-user enterprise will usher in optimised

business models which are cost-effective, scalable and highly secure.

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