# Network Slicing: Grabbing a Bigger Slice of 5G Revenue with Cloud Native Charging Systems

While network slicing has become a hot topic recently in the communications industry, the concept isn't completely new. For years, mobile network operators (MNOs) have offered different network experiences to their customers, from greater availability for enterprises to faster download speeds for high-volume users. Yet, how those experiences will be created, deployed and managed changes completely with network slicing, as customized network services can be deployed in minutes rather than months. With this newfound network agility, there will potentially be as many different network slices as there are different kinds of mobile applications: a slice for V2X, another for online gamers, a third for connected appliances and so on.

Network slicing is an integral part of the 5G experience. As more devices, more traffic and more applications enter the flow of mobile network traffic, MNOs will need to both optimize and monetize that traffic. At the same time, MNOs will need to differentiate themselves as value-added partners rather than bit-pipe providers, which network slicing will allow them to do as networks evolve to the 5G Core. The ability, for example, to dynamically spin-up new mobile services for live events or offer enterprises different network experiences for person-to-person communications and machine-to-machine communications is critical to the success of 5G.

## Network Slicing Charging Considerations

The requirements of a real-time charging system are much different in a 5G world than they are in the world of 3G/4G. Latency, for example, becomes an important consideration in 5G, just as delivering data to a semi-autonomous car is more latency-sensitive than uploading your smartphone photos to the cloud. The location of the charging system also becomes increasingly significant. While most converged charging systems (CCS) are centralized in the core network, highly mobile applications such as V2X may require charging systems to be decentralized and pushed out to the network's edge for faster response.

A few examples of the kinds of 5G applications that will require unique network slice pricing models include:

- An MNO reselling its services to a mobile virtual network operator (MVNO)
- Dynamic network slices for live sporting events, with different pricing models used for premium event-specific content and more general data sessions such as web-browsing
- Device communications that require emergency priorities, such as heart monitors or home alarms
- Online gaming slices that may have different pricing levels based on time of use (e.g., a lower charge during off-peak periods)

There are two other key design considerations for CCS in a 5G world: scalability and interoperability. The global shift to 5G will bring unprecedented growth in terms of the volume and variety of traffic on mobile networks. The growing popularity of video on mobile devices, augmented/virtual reality, in-car communications and the billions of connected devices expected with IoT will multiply the number of chargeable events and the granularity of those events exponentially.

## A Step-by-Step Look at Network Slicing

Standards specifications for network slicing first appeared in 3GPP release 15 with further additions expected in release 16 (2020). Widescale deployment of network slices, however, likely won't arrive until 2022 when 3GPP release 17 is commercialized. In the meantime, MNOs can look to early tier-one adopters, relevant industry consortiums (such as the Cloud Native Computing Foundation and Next Generation Mobile Network Alliance), cloud native solution vendors and hyperscalers to compile their own best practices for network slicing deployments.

Experience to date has shown there is a considerable amount of complexity in creating a network slice. To illustrate how detailed this process can be, consider the following example (see Figure 1), which provides a step-by-step overview of how network slicing is instantiated for enterprise and retail customers.

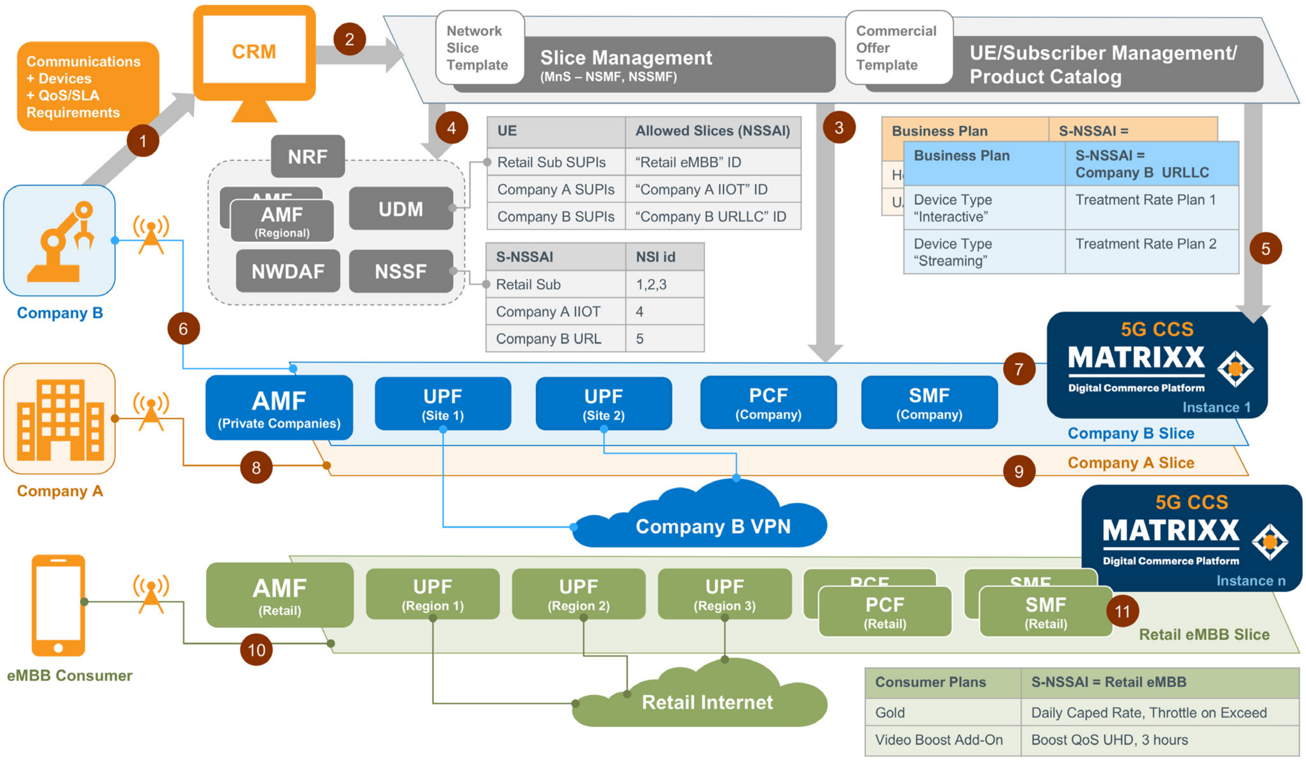


Figure 1. A summary of the instantiation process of network slices for enterprise and retail subscribers

**Step 1.** Company B, a manufacturer with two sites in different regions, requires two unique communications services: a low-latency connection between sites to control sensitive machinery, and a connection for real-time site surveillance equipment. They contact an MNO to see if the operator can provide specialized, dedicated connections for these different scenarios between their manufacturing sites.

**Step 2.** The MNO maps out Company B's business requirements in the operator's customer relationship management (CRM) system and translates these into technical and commercial requirements that are used to create a network slice template and a commercial product template.

**Step 3.** The information contained in the network slice template is then used by the Management Services (MnS) layer to create a network slice that aligns with Company B's requirements. In this case, the Network Slice Management Function (NSMF) and Network Slice Subnet Management Function (NSSMF) determine that Company B requires dedicated edge User Plane Functions (UPFs) hosted in the MNO's private data centers and deployed close to Company B's sites to meet security and latency requirements. It is also determined that the Policy Control Function (PCF) and Session Management Function (SMF) do not need to be dedicated resources (these can be shared with other company slices in a shared Network Slice Subnet Instance). Depending on Company B's quality-of-service (QoS) requirements, the management functions could use public cloud resources to spin-up the network slice resources. Since both manufacturing sites are located in regions where the MNO has existing radio coverage, the MNO can dedicate bandwidth to the sites using dedicated numerology, beamforming spectrum and/or other techniques, such as configuring the bandwidth through a self-organizing network (SON). For rural areas with no land-based radio connectivity, non-land-based alternatives could be considered. Depending on the specific use case, Company B could be designated as a non-public network (NPN), thus preventing devices not associated with this NPN attempting registration with the network.

**Step 4.** The functions contained within the MnS layer will now provision the network elements (e.g., the Unified Data Management element) to enable device registration, including associating the device to the Single-Network Slice Selection Assistance Information (S-NSSAI) associated with Company B slice. The Network Slice Selection Function (NSSF) will be provisioned with the mappings between the S-NSSAI and the physical slice as indicated by the Network Slice Instance (NSI) ID. In this example, Company B's devices are eSIM enabled, allowing the operator profile within the eSIM to be programmed on those devices remotely (e.g., Over-the-Air (OTA) techniques could be used by the MNO on the next device power-up).

**Step 5.** Once the network slice has been successfully instantiated end-to-end, an appropriate offer(s) is created by the MNO on the CCS. It uses information in the commercial offer template to map to the commercial product catalog which will then map to the technical product catalog offered by the CCS. This is key to monetizing the usage and lifecycle service operations of the network slice. These derived offers for the slice, presented in the form of a new enterprise offer(s) on the CCS, are then assigned to the devices that will use the slice. Therefore, there will be different QoS levels and usage characteristics for a high-bandwidth surveillance device versus an ultra-reliable, low-latency machine using the same slice. These provisioning operations will be API-driven, so each offer can be tailored to a company's specific requirements using CCS constructs such as the technical product catalog and offer templates.

**Step 6.** When a Company B device registers/attaches to the MNO's network, the regional Access and Mobility Management Function (AMF) will determine which AMF is appropriate for the requested slice. The derived AMF can then use the charging services of the CCS to determine whether the device has the right business relationship to use this slice or not.

**Step 7.** When a device in Company B needs to initiate a data session, a protocol data unit (PDU) session will be established, and the AMF will select which SMF to use for the appropriate slice. The AMF selects the physical slice using information in the PDU session request from the device and the services of the NSSF. The selected SMF can use the charging services of the CCS assigned to that slice to track and monetize that data session. The specific offer and the device's ID will be used to determine how a session will be charged as well as set the appropriate QoS Class Identifier (QCI) levels (this will be retrieved from the CCS by the PCF through policy counter value settings).

**Step 8.** Now, when another company, Company A (which has already had its slice created beforehand), connects to the MNO's network, its AMF will also be determined. The AMF will use the charging services of the CCS to determine whether Company A's device is authorized to use the network in that region.

**Step 9.** When one of Company A's devices tries to initiate a data session on the network, the PDU session establishment procedure will start, causing the AMF to determine which SMF/slice the device will use. The slice's SMF can use the charging services of the CHF/CCS assigned to that slice — again, based on Company A's requirements and agreements with the operator — to determine the session charges and appropriate QCI settings.

**Step 10.** Now, let's say that an MNO's consumer connects to the network. The regional AMF will again determine the AMF to assign to that user's device depending on their allowed slice(s), in this case, one that handles the consumer eMBB slice. The AMF will use the charging services of the CCS assigned to the consumer eMBB slice to determine if the device is authorized to use those network services in the region.

**Step 11.** When the consumer wants to initiate a different kind of data session, the PDU session management procedure will again be invoked.

The flow will play out just as it did in Step 9, with the SMF (using the services of the CCS and PCF) determining the appropriate charges and QCI levels, depending on the application that the device is using.

As can be seen, even a single network slice has multiple touchpoints in the network that require complex configurations and workflows.

## Network Slicing and 5G Transformation

Most network operators will approach their 5G transformation in three distinct phases. Phase one addresses the question, *"How do we scale the network?"* MNOs understand that 5G will require higher bandwidth, higher availability and lower latency, so their initial focus is usually on expanding their network capacity by modernizing their RAN infrastructure, maybe introducing approaches such as OpenRAN. Phase two focuses on the important aspect of, *"How do we monetize our network?"* This involves transforming the network core using a webscale, cloud native architecture that supports microservices, containers, service orchestration and automation to accelerate innovation and reduce costs. Crucially, service monetization via the CCS sits at the heart of the monetization of ALL 5G services, including consumer, business, B2B2X, IoT and slice-based offerings. The final phase typically involves the management of the network, and could be summed up as, *"How do we optimize our network?"* This is where network slicing comes into play, as creating optimal slices for different customers and applications is essential to managing the wide range of services that 5G networks will support, from real-time medical applications and self-driving cars to internet-connected kitchen appliances.

The idea, of course, is that no two network slices will look exactly the same. There will be static slices (pre-configured, covering large use cases such as eMBB), dynamic slices (slices instantiated on-demand via API calls), vertical slices (industry-specific such as a healthcare slice) and broad, horizontal slices (for general consumer appeal applications such as cloud gaming). Slicing will also be at the heart of a new wave of commercial innovation. Partner business models such as B2B2C and B2B2B, where partner offers are shared via an existing, configured slice, or the partner requests a slice to deliver a new service on-demand, will become prevalent. An MNO may, for example, deploy a static network slice for nationwide mobile broadband consumers with guaranteed SLAs that remain largely consistent from year to year. That same MNO may also create hundreds of temporary dynamic network slices to support high-density mobile broadband at live events that last less than 24 hours. Each enterprise customer could have multiple slices: one for person-to-person communications and another for MTM communications. Those slices could vary significantly depending on the industry; a life-saving medical device will have a much lower tolerance for latency than a wireless thermostat.

## Conclusion

5G is much more than an incremental improvement in the speed and size of mobile communications. It is a reinvention of the mobile network experience that elevates the role of service providers from communications enablers to communications innovators. 5G transformation is likewise more than building out extra RAN capacity or aligning your core network with the cloud. Network slicing has an important role to play in 5G networks, and the CCS has an important role to play in network slicing.

Just as network slicing presumes that one-slice-fits-all strategies no longer apply in the 5G world, MNOs need to re-evaluate their CCS platforms through the lens of 5G's heightened requirements for scalability, flexibility, business agility and interoperability.

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