Network Slices Network Slicing Use cases

IETF *revision of v0.01*

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*Abstract of the contribution:*

*This document discusses IETF work needed for Network slicing*

Abstract

Network Slicing paradigm enables creation of partitioned network infrastructure to provide isolated network platforms for various service verticals. The motivation behind Network Slicing (NS) is to allow deployment of new services without causing or experiencing any disruption due to other already running or deployed services in the network. The purpose of this document is to focus on use cases that benefit from the usefulness of network slicing.

{mainmatter}

# Introduction

Network Slicing (NS) is a widely discussed paradigm and is a mandatory requirement in 5G to meet the diverse service requirements in different 5G service scenarios. NS refers to the managed partitions of physical and/or virtual network resources, network physical/virtual and service functions [@!RFC7665] that can act as an independent instance of a connectivity network and/or as a network cloud [@!I-D.gdmb-netslices-intro-and-ps]. In 3rd Generation Partnership Project (3GPP) [@?TR23.799] defines "Network slicing enables the operator to create networks customized to provide optimized solutions for different market scenarios which demands diverse requirements, e.g. in the areas of functionality, performance and isolation". Draft [@!I-D.gdmb-netslices-intro-and-ps] defines network slicing in a broad context and suggests related problems and work areas. Other organizations like Next Generation Mobile Networks (NGMN) [@?Network-Slicing-Concept] and ITU-T FG IMT-2020 [@?FG-IMT2020-Gaps] also present their separate definitions of NS.

To maximize resource utilization and minimize infrastructure cost, services will need to be deployed simultaneously, next to each other over a shared network as against the traditional monolithic model. Service operators can utilize or benefit from Network Slicing through multi-tenancy, enabling different customized infrastructures for different group of services across different network segments and operating them independently. Moreover, NS is also able to guarantee the isolation between different network slices. The operation of the data packets traversing one network slice must not adversely affect the service operation in other network slices sharing the same underlying packet network.

This document describes use cases, where service operators can utilize or benefit from Network Slicing through multi-tenancy, enabling different customized infrastructures for different group of services across different network segments and operating them independently. Although 5G will drive NS based deployments, the scope of the document is not limited to 5G; it covers example scenarios specified from 5G vision as well as generalized scenarios that can be applied to existing infrastructures.

## Requirements Language

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in RFC 2119.

Additionally, the key words "**MIGHT**", "**COULD**", "**MAY WISH TO**", "**WOULD PROBABLY**", "**SHOULD CONSIDER**", and "**MUST (BUT WE KNOW YOU WON'T)**" in this document are to interpreted as described in RFC 6919.

## Terminology

* V2X (Vehicle-to-everything): Is a communication of information from a vehicle to any other entity that may be a user end-device, network element or application end point.
* ITS (Intelligent Transportation Systems): Considered an aspect of Internet of Things creates a transport network. The network provides services relating to transport and traffic management systems through flow of information between sensors, smart devices and humans.
* Over-the-top (OTT): A service, e.g., content delivery using a CDN, operated by a different operator than the NSP to which the users of that service are attached.
* Industry vertical: A collection of services or tools specific to an industry, trade or market sector. Also, referred to as Service Verticals in this document.

# Network customization for diverse services

## Overview

[Note: To discuss diverse set of service attributes]

Often services specify a broader resource requirements to perform normally whereas the underlying infrastructure is generally best-effort. Traditionally, basic service guarantees are associated with resource attributes such as:

* Latency
* Bandwidth/Burst or other bit rates.
* Security

In addition, other attributes as mentioned below are embedded into the infrastructure to improve over all quality of experience

* Redundancy
* Reliability
* Authentication

More recently, other service attributes have become significant such as

* Continuity during mobility
* Purpose-built network functions.
* Service placement

It should be possible for the providers of any service to continuously evolve, adapt, and differentiate themselves through purpose-built infrastructures with minimal impact on network deployment and operations. The motivation behind 5G Network slicing paradigm is exactly that. By creating logically partitioned network infrastructures, isolated platforms for various industry verticals can be provided. NS is envisioned to enable new service deployments without having to build new network infrastructures or causing disruptions to other already deployed services in the network. In regards to NS, there are two primary characteristics, a) Strict demand for network resource, b) Network Customization.

## Strict Resource Demand Concept {#resource-demand}

Several services are sensitive to response times and/or amount of bandwidth, e.g. realtime interactive multimedia, high bandwidth video feed or remote access to an enterprise network. Failure to meet these criteria leads to service degradation.

Moreover, newer scenarios from different industries are evolving due to these factors - a) everything connected, b) technological advancements in sensors, IoT, robotics and multi-media, c) innovations in social network interactions (including both human-human or human-machine). These may impose even stricter and more specific set of resource and connectivity requirements on per service basis. The challenge lies in utilizing common network infrastructure and judiciously allocating available infrastructure resources.

## Network Customization Concept {#customization}

Network slicing is enabled through customization. Customization gives control to the operator (of a slice) to create, provision, change and consume network resources to suit their service demands. It requires ability to decompose resources from an underlying network infrastructure and logically aggregate them to tailored a part of network into a slice. These customizations are not only in the context of the network characteristics but also include network functions.

## Scope of use cases

Network slicing by itself is not a new concept nor its benefits are limited to 5G. While writing use cases following were considered -

* A Network Slicing aware infrastructure allows operators to use part of the network resources to meet stringent resource requirement as in (#resource-demand) or exploit dynamic customizations as described in (#customization). Finally, there will be scenarios that require both customization and strict resource requirements.
* The document doesn't specify whether a network slice consists of a single or multiple service(s). At the simplest level one service may correspond to a slice, however, it is possible that many services may become part of the same slice for the purpose of isolated data or context sharing.
* Use cases below are discussed from 2 perspectives -

a. Newer scenarios: that should absolutely meet strict resource requirements, as if they use a dedicated infrastructure. The example use cases are categorized further in (#Demanding-NS). b. Existing Scenarios: Several already deployed or existing examples that would further benefit when deployed through Network Slice paradigm are discussed in (#Using-NS).

Use cases

for each use case the answers to the following questions:

* What is the use case?
* How is it addressed today?
* How would you like it to be addressed in the future?
* What do you want the IETF to deliver?

# A Generalized Network Slice as a Service

[Liang]

# Network Slicing in 3GPP Mobile Network

## Use Case Context

A Network Slicing framework based on IETF protocols can be used as a core part of the network virtual infrastructure of a 3GPP 5G network and its associated management and control plane. The general description of the 3GPP 5G system and its Network Slicing aspects can be found in particular in [\_3GPP.23.501], [\_3GPP.23.502] [\_3GPP.38.801], [\_3GPP.33.899], and [\_3GPP.28.500]. We summarize in this section some architectural aspects to provide context to the use cases. Please see Appendix for details.

[Terminology] move there?

In the following text we will use the terms "Complete 3GPP Network Slice" to refer to a "Network Slice Instance" used by 3GPP, and "3GPP Network Slice Subnet" to refer to "Network Slice Subnet Instance". Moreover, we consider that the (IETF) Network Slice concept is a generalization of the "3GPP Network Slice Subnet", i.e. the "3GPP Network Slice Subnet" is a particular Network Slice which happens to be part of a 3GPP network.

## 3GPP Network Management Use Case

#### Create or Terminate a 3GPP Network Slice Subnet

The operator’s OSS/BSS provides a description of a Network Slice to the Orchestrator, which, through the Virtual Infrastructure Manager, configures compute and network elements to create a Network Slice holding a specific set of interconnected virtual and/or physical network functions. User plane Network Slices include one or more bidirectional paths between network functions (i.e. one or more service function chains). Control plane Network Slices can either include a set of service function chains or alternatively can interconnect multiple network functions in a virtual network. In all cases, Network Slices are defined with a variable set of reserved KPIs, including minimum and maximum throughput, delay, packet loss, etc.

Potential requirements:

* A Network Slice can be a service function chain or a virtual network
* A Network Slice can be associated with a variable set of resource reservation with regards to KPIs such as minimum and maximum throughput, delay, packet loss, etc.

### A Complete 3GPP Network Slice

The operator creates a Complete 3GPP Network Slice by composing together smaller Network Slice subnets together, which the 4

highest-level Network Slices being: a RAN Network Slice, a Core Network slice holding user plane (UPF) and control plane (SMF) network functions, as well common Core Network functions. Those common core network functions (AMF, PCF, etc.) may be placed in multiple Network Slices since they can have different scaling properties.

The Common CN Function Network Slices (including AMF) may be shared or dedicated to a given SMF. In the shared case, there will be traffic flows terminated within a dedicated CN slice (e.g. SMF) and the shared function. RAN Slices may similarly be shared or dedicated. In the shared case, each user traffic flow passing through a shared RAN slice will then pass through one out of multiple dedicated CN slices interconnected with this shared RAN Slice. In both (RAN and CN) shared cases, there should be reserved resources within the shared Network Slice, to ensure that the whole flow has reserved resources.

NS is not a required feature in 3GPP, especially not all Core Network functions are required to belong to a slice with a specified level of service. In some cases, common network functions like AMF and PCF may be implemented outside of a Network Slice, or, equivalently, in a Network Slice with no specified QoS.

A wide variation of cases, associating "n" Network Slices with "m" network services or applications involving "p" end devices, is supported. For example: a single slice instance could be associated with multiple IoT applications, each connected to multiple devices. In another example, an application may split its end users in 2 service categories with different SLAs, using different Network Slice instances.

Network Slice life cycle should support the following operations

Creation and Termination of slices by an operator -

Potential requirements:

* Network Slices can be composed of smaller Network Slices which can be dedicated or shared.
* Functions in Network Slices can interact with network functions outside of a Network Slice.

#### Activate or Deactivate a Complete 3GPP Network Slice

Each Network Slice can be created in a deactivated state, and can be later switched between activated and deactivated state. This can provide multiple advantages, e.g. speeding up procedures, and enabling using a pool of unused resources. Activation or deactivation of a Complete 3GPP Network Slice can then be orchestrated as the activation (resp. deactivation) of individual Network Slices, possibly in a given order.

Potential requirements:

* A slice can be created deactivated, and can be switched between activated and deactivated state.
* Update a Complete 3GPP Network Slice

The operator can modify the configuration (e.g. network or compute capacity or capability) of one of the Network Slices composing the Complete 3GPP Network Slice, while it is in use. Example of such operations include:

* Increase the capacity of NFs
* Update the configuration of NFs
* Add, replace or remove a NFs
* Add, replace or remove a Network Slice

Some operations affecting a shared slice may not be possible without affecting other Network Slices, and may be replaced by other operations: for example, instead of changing the configuration of a shared AMF to accommodate the needs of a SMF, another Network Slice with an AMF may be created or activated, and replace the original AMF’s slice for this SMF.

Potential requirements:

* Ability to add, replace, remove NFs, and Network Slices without affecting service, assuming that the network service’s design enables this.

#### Monitor Network Slices

The 3GPP management system monitors performance of individual Network Slice level and coalesce performance data for the whole Complete 3GPP Network Slice. Individual Network Slice level performance data is also useful to decide to scale up or down services within those slices. Performance data (or events) includes user and control traffic load data. It can also include QoS/SLA data, e.g. indicating whether services were provided at expected QoS/SLA level. Alarms notifications can be individually enabled. Events and alarms from a shared Network Slice contain enough information to be attributed by the 3GPP management system to one of the Complete 3GPP Network Slices that contain this shared Network Slice.

Potential requirements:

* Performance monitoring (measure of KPIs and alarms) occurs at Network Slice level.
* Performance monitoring should be able to identify flows which are shared with other Network Slices, and enable matching performance data with those flows and Network Slices.

#### Slice Management Exposure

3GPP networks may in some cases expose partial 3GPP Network Slice management to third party Communication Service Providers (CSP), who may in turn consume this service or provide it to their own customers. Using this management interface a third party can request the creation of a Complete 3GPP Network Slice using specifications of NFs, isolation, security, performance requirements (such as traffic demand requirements for the coverage areas, QoS for service).

When a 3GPP operator exposes management data (e.g. fault management data, performance data) about a Complete 3GPP Network Slice shared by multiple customers of a CSP, exposed management data of each customer is isolated from each other.

Potential requirements:

* Management data should enable identification of individual flows in such a way that it can be match to different customer groups.

#### Support for Multi-Domain Network Slice

To support roaming, a 3GPP operator configures one or more Complete 3GPP Network Slice to be selected to support roaming subscribers, to act as visited Complete 3GPP Network Slices. Operators configure the interconnection of a home Complete 3GPP Network Slice in one domain and a visited Complete 3GPP Network Slice in the other domain. Performance data is sent from the visited domain to the control function in the home domain.

Potential requirements:

* Support secure inter-domain interconnection for exchanging user plan traffic and performance data.

## Operational Use Case

# Services with Resource Assurance

## Enhanced Broadband

Today, video consumes the largest amount of bandwidth over the Internet. As the higher resolution formats enter mainstream, even more bandwidth will be needed to stream 4K/8K/360 degree formats.

The scenario in this section are discussed in regards to need for demands beyond best-effort network delivery, in particular requirements due to growth in data rate capacity, connection density and interactive media. These are equally applicable to both fixed and mobile networks.

### Media delivery networks



Fig 1: Traditional Streaming Media Infrastructure

### Enhanced Media Streaming Description

Today the video output format is HD with 1080p resolution with few services delivering up to 4K. Both Video-on-demand and live-linear channels (streaming live event feed) can be supported. Most often media services are delivered using streaming platforms (Fig 1).

#### Factors Influencing Enhanced Broadband Use Cases

Media delivery comprises of different functional components, as shown in figure 1 above and often an overlay or OTT infrastructure is used. The deployment requires acquiring content, transcoders and CDN servers and decoders to support different delivery formats All these may be considered specialized service functions in media streaming infrastructure. The entire operation is (a) not flexible in terms of resources placement (on premise vs cloud vs proximity to destination) (b) is built on best-effort of available resources, (c) Is reactive when the congestion occurs leading to client-server based end to end stream optimization derived from network conditions.

#### Traditional Media Streaming Service Verticals

There are 3 categories of media or content distribution

1. Video on Demand (VOD)
2. Live streaming/Linear channels
3. Video conferencing

While a and b are one way content consumption, Video conferencing requires 2-way or multi-way connection. It may consist of either person-person or person-group video communication.

#### New Verticals - Virtual Reality (VR)/Augmented Reality (AR){#ar-vr}

Virtual Reality(VR)/Augmented Reality(AR) is the future use case of eMBB services. A 360-degree video is mostly low resolution, requiring ~25 Mbps network bandwidth for streaming. For a network based AR/VR bandwidth required will be in the order of Gbps and latency less than 10 milliseconds for a fully immersive experience such as cloud-based VR gaming, fully-interactive media experience.

However, media processing for AR/VR will still be identical to in-network processing functions as shown in figure 1 and corresponding latencies could lead to downgrade of user experience. Therefore, upon request for an AR/VR stream a special infrastructure is required that differs from best-effort network.

### eMBB Type Slices

A purpose-built network slice for eMBB streaming shall ensure to minimize processing overheads, it may be done by placement of network functions closer to subscribers.

* Resource scaling: eMBB resources should be allocated dynamically because bandwidth is expensive and requirements are high, such vertical service operators may not want to pay for unutilized bandwidth. Therefore, slices should adjust in negotiated chunks of scale both bandwidth and service functions. For example, if a stream is viewed by 8 people initially, the resource for 20 users is allocated. It will subsequently grow or shrink in chunks of resource for 20 subscribers.
* The transport aspects of eMBB has multiple aspects
  + Fan-out network: user to access network resource slicing constrain specification
  + Point to Point or virtual network: resource specification for content acquisition to distribution network.
* Latency Guarantee varies for live streaming, on-demand streaming and connected AR/VR streaming
* Slice priority: eMBB slices must also be consideration that the resources allocated does not compromise availability of emergency services.

See Figure 2 below for a reference slice



Figure 2: reference eMBB slice

### Network Operator’s View

A typical eMBB slice flow from a network operator is as follows

* There is an eMBB slice offering template/form. A service vertical provider requests
  1. Regional network locations of CDN and location of acquired content.
  2. Describes transport requirements for its own distribution network comprising of connectivity between content acquisition and Fan-out points.
  3. A granularity of transport resource chunk.
  4. It may request access to subscriber database from multiple access network types (mobile, fixed) creating value add for both service provider.
  5. For each access type resource requirement is specified.
* Registers self with access rights to resource monitoring and negotiation loop. Slice operator has an abstracted view of its own slice instance topology.
* Network operator has end to end (acquired content to cached content to user) visibility across different domain segments and corresponding transport resources. A well-coordinated network slice protocol enables resource allocation across different segments.



Figure 3: Transport provider network operator view.

See Figure 3 for reference

## Massive machine to machine communication

## Ultra-reliable low latency communication

## Critical Communications

Critical communications are used during emergency situations. Often referred to as mission critical, the communication has to be reliable and non-disruptive. Different scenarios of critical communications relate to public safety responders, military, utility or commercial applications, mainly using reliable voice or short data messaging over wireless communication systems. First responders such as firefighters, paramedics and other responders, for their daily and emergency communications needs to be able to communicate without disruption.

### Public Safety Infrastructure

#### Current Improvements

Traditional technologies for emergency communications are narrow band radio networks such as Land Mobile Radio (LMR) systems. They are terrestrially-based professional push to talk wireless communications systems commonly used for critical communications by public safety organizations such as police, firefighters, and other emergency response organization. LMR and related systems such as TETRA or P25 have dedicated frequencies and channels assigned to individual groups of users for instant connection through a simple interface.

Next-generation public safety communications are planned to be built with enhanced broadband voice, data and video communications services beyond narrowband LMR with broadband LTE networks for high speed data (ref 22.179 and FirstNet).

#### Challenges for Enhanced Critical communication

3GPP defines, on-network critical communication can be established with the help of a network infrastructure to manage the call. It can also be off-network, where the UEs communicate directly to each other. The scope does not discuss point to point off-network communication as it is not relevant to the topic.

Most important challenges for on-network communications include

* Expensive to deploy a separate broadband network: The coverage of a separate network at the scale of area, state or nationwide that is interoperable is not cost effective, especially as new communication technologies emerge, public safety systems should be able to adapt easily to state of the art.
* Lack of flexibility in terms of adding new value added services or ability to take advantage of commercial services.
* Ability to support basic mission critical such as voice reliably: Loss of information in voice communication is completely unacceptable.

### Enhanced Critical Service Type Slices

The traditional critical communications use dedicated separate infrastructures in order to be reliable and non-disruptive. In contrast, LTE based mechanisms acquire different bearer QoS Class Identifier (QCI) for different type of barriers (data, voice, video).

The eMC (enhanced mission critical) network slices benefit from the following:

* Insertion and authorization of subscribers in a group communication: In a critical infrastructure, the subscriber authentication may be done earlier at the entry point automatically through slice selection functional entity.
* Pre-allocated QCIs: Generally, QCIs are requested on per session basis which could slow down overall call control setup and is undesirable for emergency services. When operating in a slice, these resources maybe reserved ahead of time in a coarse-grained manner instead of per session.

MC Network slices are relatively straight forward as it only concerns with guaranteed bit rate (GBR) on per media basis and management of groups. The MC network slice need an ability to request transport services based on GBR for reliable communication.

A reference network slice below shows an MC organization providing service agreement that would be a network slice template with resource specification. The eMC slice sets up different subnetworks of different subscriber groups and manages its membership. These subnets are realized into the infrastructure across different domains through a network slice transport mechanism. The MC network slice must be capable of active resource monitoring to prevent congestions to ever occur as well as request additional transport resources in case of emergency event occurance.



Figure 4: Reference for Mission Critical Network Slice.

# Network Infrastructure for new technologies

## ICN as a Network Slice

[Ravi]

ICN as in Information-Centric Networking is a culmination of multiple future Internet research effort from various parts of the world, now being pursued under IRTF’s research task group called ICNRG[ICNRG].

### Information Centric Networks Description

Information-Centric Networking (ICN) addresses Internet’s network architectural design gaps based on evolving applications requirements and end user behaviour which is significantly different from what IP was designed. ICN is a non-IP paradigm based on name-based routing and offers many desirable networking features to applications such as, caching, mobility, multicasting and computing in a manner different from traditional content delivery. ICN architecture is in line with the move towards service-centric architectures enabled through frameworks like SDN, NFV, and Edge Computing.

#### New Verticals – ICN aware service delivery {#ICN}

Services over ICN slices can take advantage of its features such as: 1) In ICN, applications, services and content are addressed using names, hence end host resolution services like DNS can be avoided, this achieves name resolution to edge content or services without additional RTT delays; 2) Service flows will be offered mobility and multicasting support, as the networking is session-less and optimized towards efficient movement of named data and not the end hosts; 3) Services can be deployed at the very edges with ease as ICN routers are compute friendly, this is because names in the forwarding table resolve to both content or service instances; 4) Further saving bandwidth in the upstream link through opportunistic caching is an inherent feature of ICN, this also leads to energy efficient networking.

#### Considerations for Information Centric Network Applications

When offered as a programmable and customizable logical network slice, ICN based services can be offered through a network slice in parallel with traditional IP based services. ICN can be realized as a slice [5G-ICN] based on the choice of data plane resource offered by the operators in different segments of the network such as the access, core network or central data centers. While the same resources can be used to support services over IP, proper resource isolation shall allow it to co-exist with ICN slices as well. [TBD – different kind of services that ICN can offer – e.g. IoT, multimedia]

ICN assumes that the network slicing framework is built upon a programmable pool of software and/or hardware based data plane resources. The pool of resources comprises of

* Hardware decoupled network functions, that may be containers or VMs.
* Deeply programmable hardware resources include GPU, FPGAs [ClickNP], Smart NIC [Netronome] operated using P4 abstractions, that are supported over x-86 platform. Programmable hardware may also include commercial chips supported using P4 or POF allowing one to realize high performing novel data planes. [references]

### ICN Type Slices Asks

In ICN applications are content based and traditional IP based reachability is not used. An ICN slice shall be a programmable ICN-domain, in which content learning and distribution will be done through new ICN aware routing and data plane protocols. As a result, it should be possible to deploy network functions such as ICN routers and content servers that serve and speak ICN protocols.

### Network Operator’s View

A basic ICN slice can be simply manifested as a resource isolated logical network. An ICN slice relies heavily on programmability and virtualization frameworks. Through a network slice template -

* ICN service providing entity could specify specific locations (edge of network domains) to deploy ICN-routers or other ICN-NFs (ICN aware network functions).
* An ability to establish connectivity between ICN network elements in all segments and create an ICN based topology.
* Mechanism to carry ICN user traffic over the infrastructure [say it better]
* In addition, bandwidth and other network resources may be requested.

How multiple services will be deployed within an ICN aware slice need not be exposed to the network operator.

# Appendix

## Network Slicing in 5G/3GPP

A Network Slice is a complete logical network including Radio Access Network (RAN) and Core Network (CN). It provides telecommunication services and network capabilities, which may vary (or not) from slice to slice. Distinct RAN and Core Network Slices will exist. A device may access multiple Network Slices simultaneously through a single RAN.

The device may provide Network Slice Selection Assistance Information (NSSAI) parameters to the network to help it select a RAN and a core network part of a slice instance for the device. A single NSSAI may lead to the selection of several slices. The network may also use device capabilities, subscription information and local operator policies to do the selection.

A NSSAI is a collection of smaller components, Session Management NSSAIs (SM-NSSAI), which each include a Slice Service Type (SST) and possibly a Slice Differentiator (SD). Slice service type refers to an expected network behavior in terms of features and services (e.g. specialized for broadband or massive IoT), while the slice differentiator can help selecting among several Network Slice instances of the same type, e.g. to isolate traffic related to different services into different slices.

A PDU session is a 5G concept for an association between the device and a data network, which can be IP, Ethernet or Unstructured (i.e. transparent to the 5G system). The device will associate an application with one out of multiple parallel PDU sessions, each PDU session correspond to one core Network Slice and one RAN slice. Different PDU sessions may belong to different slices. More precisely, an application will be associated with a SM-NSSAI (as mentioned above, this includes a slice service type and may also include a slice differentiator), and data for this application will be routed to a PDU session associated to this SM-NSSAI.

Part of the control plane, the Common Control Network Function (CCNF), is common to all or several slices. It includes the Access and mobility Management Function (AMF) as well as the Network Slice Selection Function (NSSF), which is in charge of selecting core Network Slice instances. Besides those shared functions, different Network Slices may also have dedicated control plane functions such as the Session Management Function (SMF), which manages PDU sessions. User plane functions are dedicated to each slice. The RAN selects a CCNF for a new PDU session. CCNF may initiate the redirection of service for a device towards another CCNF, initially at session setup, or later on.

In figures 1 and 2 we attempt to represent the use of NS in 3GPP logical architecture (those figures are our interpretation and are not directly adapted from the report). Figure 1 represents the role of NSSAI in network selection. Figure 2 represents the major network functions and interfaces in the context of RAN and Core Network Slicing. The terms used in these diagrams were introduced earlier. System description and diagrams in section 4 of [[\_3GPP.23.501]](file:///C:\xavier\workspace\IETF\Topic%20Virtualization\2017%20-%20draft%20-%20ietf98%20-%20Network%20Slicing%20Use%20Case\UPDATE\draft-defoy-netslices-3gpp-network-slicing-01.html#_3GPP.23.501) can provide additional context.

+-------+

| |

|Device |

| |

RAN uses NSSAI +---+---+

to select CCNF |

\ |(NSSAI)

\ |

+---+---+

| +-------------+

CCNF uses NSSAI | RAN +---------+ |

to select slice | | | |

or redirect to +---+---+ | |

another CCNF | | |

\ |(NSSAI) | |

\ | | |

+-------+--------+ | |

| Common Control | | |

| Plane Network | | |

| Functions | | |

| (CCNF) | | |

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| | | | | | | | | | |

| | |CP NF1| | | |UP NF1| | | |

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| | |CP NFn| | | |UP NFn| | | |

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+------------------------------------+

Core Network Slice Instances

**Figure 1: Network Slice Selection in 3GPP architecture**

CCNF Network Slice Instance

+-----------------+---------------------+

| | |

| | |

| +--------+ | +--------+ |

| | Control| | | Control| |

+--------+ Plane +----------+ Plane | |

| | | AMF... | | | SMF... | |

| | +--------+ | +----+---+ |

| | | | |

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| | | | |

+---+--+ +-----------------+ | |

|Device| | | | |

+---+--+ | | | |

| | | | |

| | +--------+ | +------+-----+ |

| | | | | | User Plane | | +---------------+

+--------+ RAN +--------+ Functions +------+Data Network or|

| | | | | | | | The Internet |

| +--------+ | +------------+ | +---------------+

| | |

| | |

+-----------------+---------------------+

RAN Slice

**Figure 2: Network Slices in 3GPP architecture**