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Review of Network Slicing Research in Diverse Standards draft-wang-nfvrg-network-slice-diverse-standards-00

Abstract

As one of the significant technology in 5G, there are diverse industry communities and standard organizations dedicated in a research of Network Slicing, such as IETF, 3GPP, GSMA, ETSI, etc.. These organizations and communities not only standardize network slicing architecture, management, requirements and so on, but also individually focus on specifying network slicing in their own ways, offering diverse specifications of it. Aiming at research on a overall review of network slicing standard, this document discuss diverse standards in various organizations and communities, furthermore, analyzing the emphasis and difference between them.

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1. Introduction

With the rapid development of 5G technology research and successful emergence of 5G market, network slicing is becoming one of significant technologies of 5G. The mechanism of network slicing is that divide common physical network infrastructure into diverse isolated virtual network resources to meet the high level demands from different vertical industry. With network slicing, providers are able to offer customized service to users in terms of bandwidth, latency, security and so on. Network slicing mechanism enables 5G to integrate diverse network resources and multi-domain technologies, to meet various demands from vertical industry, offering the best-effort network service. For instance, to achieve both determined latency and security requirements from some industry services, network slicing is likely to apply TSN[tsn] and blockchain technologies to satisfy the requirement. Meanwhile, network resources such as high bandwidth and dedicated network tunnel can be supplied here to meet the demands as well which are all integrate in this network slice.

As the key feature of 5G, the concept of network slicing is discussed in related standard organizations and communities. 3GPP release network slicing standard of architecture in specification [TR23.501]and management&orchestration in specification [TR28.801] .

3GPP also specify requirement, use cases and other related features of network slicing in different work groups. Also, being so important to network technology progress, network slicing has gotten a lot of attention and heated discussion in IETF. Several drafts are released and discussed in netslicing and COMS mailing list which will be talked in the following sections. Besides, there are other organizations are doing research in network slicing, such as European Telecommunications Standards Institute (ETSI), Broadband Forum (BBF), GSM Association (GSMA), etc. Each of them makes diverse definition and concern different areas of network slicing definition.

It shows that network slicing has been defined by multiple Standards Definition Organizations (SDOs) and communities. However, as a diversity of mission of each, the meaning and understanding of the network slicing concept are different from each other and there is no common definition. In the following part of documents, an overview of network slicing research aspect will be discussed. Furthermore, the emphasis and difference between each organization is analyzed as well. This is aimed at giving out clear viewpoints of network slicing understanding from these organizations.

2. Terminology

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 [RFC2119].

PLMN, Public Land Mobile Network, is a network that is established and operated by providers for the specific purpose of providing land mobile telecommunications services to the public.

NSSAI, Network Slice Selection Assistance Information. NSSAI provided by the Serving PLMN during a Registration procedure, indicating the S-NSSAIs values the UE could use in the Serving PLMN for the current registration area.

S-NSSAI, Single Network Slice Selection Assistance Information. S-NSSAI identify a network slice.

3. Overview of Network Slicing Standard Progress

In this section, an overview of network slicing standard progress will be given out.

IETF Network slicing is discussed in terms of specification of terminology, architecture[draft-geng-coms-architecture-02], use cases[draft-qiang-coms-use-cases-00], problem statement and other aspects related to network slicing. To map the gap between

technology-agnostic network slicing service requirements and specific implementation technologies, a technology independent information model is created. Furthermore, aiming at converging bottom-up and top-down approaches on a technology-independent common management plane, COMS (Common Operation and Management on network Slices) is defined and described here[draft-geng-coms-architecture-02].

3GPP Acknowledging network slicing as significant component of 5G process, 3GPP dedicated in making a thorough specification of network slicing concept since the very early time when they started considering 5G technology. Network slicing is specified in SA1 (requirements), SA2 (architecture), SA3 (security) and SA5 (network management) respectively, in which architecture and management will mainly be described the next paragraph.

ETSI ETSI analyses network slicing use cases defined in other SDOs and industry fora in Report on Network Slicing Support with ETSI NFV Architecture Framework [ETSI GR NFV-EVE], and give the description that how to map the use cases to the NFV architecture and concepts.

GSMA GSMA give the Concept of network slicing from a business way and indicate that how network slicing can serve and support 5G network in its report [GSMA-An-Introduction-to-Network-Slicing]

4. Detailed Diverse Network Slicing Standards

4.1. IETF

4.1.1. Network Slicing in IETF

In [draft-geng-netslices-architecture-02] , end to end network slice is defined as a cross-domain network slice which may consist of access network, transport network, (mobile) core network. The concept here of network slice is expanded to a wider area and comprises of several functional components. Driven by the multiple requirements from users, network slice instance may include several service components that each of which may require a set of network resources and attributes in form of a network slice.

Network Slicing Management and Orchestration is comprised of:

Template Management: A complete description of the structure, configuration and the plans/work flows for how to instantiate and control the network slice instance during its life cycle.

NS Repository: A policy to describe how user select network slice or how multi-slice instance associated with one network slice.

Life cycle management and monitoring : Network slicing and slice instance must be full life cycle managed and monitored.

E2E Orchestration: E2E Slices Orchestration and its functionality which can be a)Coordinating a number of interrelated resources, b)Autonomically control of slice life cycle management, c)Autonomically coordinate and trigger of slice elasticity and placement of logical resources in slices, d)Coordinates and (re)-configure logical resources.

Domain Orchestration: In heterogeneous environment, network slicing is expected to orchestrate multiple domain technologies and resources to gain the most effective, dynamic and automatic functions.

NS Manager: Manager manages all access permissions and all interaction between a Network Slice and external functions which are specific for each network slice instance.

Resource Registration: Responsible for the management of exposed capability of the network infrastructure.

Under network slicing management and orchestration, the resource management which can be physical, logical and virtual resources will be mapped to the requirements and Capabilities users demands to create the related network slice instance. The Capabilities of network slicing includes reclusiveness, protection, elasticity, extensibility, safety and isolation.

4.1.2. Information Model

However, sometimes customers, being not able to know or not familiar with the underlying networking resources and technologies, expect a technology-agnostic interface. A information model here is in demand to fill the gap between technology-agnostic network slicing service requirements and specific implementation technologies.

The information model for network slicing here is required to offer the capability that describe the entities that compose a network slice, their functions and the mechanism how they serve the corresponding network slice. The information model provide the connectivity of undying technologies from providers and customers

requirements, and gives out a clear and complete informal diagrams of network slices entities and technologies in different domains.

4.2. 3GPP

Here we only disscuss the architecture and management of Network slicing in 3GPP, which are mostly related to [TR23.501] and [TR28.801]

4.2.1. Network Slicing in 5G

In 3GPP [TR23.501], a network slice is defined as an end to end logical communication network, within a Public Land Mobile Network (PLMN) and includes the Core Network (CN) Control Plane, User Plane Network Functions and 5G Access Network (AN).

A singal UE(User Equipment) may be served by multiple slices simultaneously through a single RAN. Correspondingly, network slices may vary for supported features and network functions optimisations because of different S-NSSAIs with different Slice/Service Types. So provider may select to deploy multiple network slices, but offering same service feature, to serve a group of UEs.

S-NSSAI, delivering identification and selection information of a network slice, is comprised of a Slice/Service type (SST) which refers to the expected Network Slice behaviour in terms of features and services and a Slice Differentiator (SD) which is optional information that complements the Slice/Service type(s) to differentiate amongst multiple Network Slices of the same Slice/ Service type. Network Slice instance can be associated with one or more S-NSSAIs, and an S-NSSAI can be associated with one or more Network Slice instances.SST value represents 3 service types that are eMBB (enhanced Mobile Broadband), URLLC (ultra- Reliable Low Latency Communications) and MIoT (Massive IoT) respectively.

Figure 1 is a network slicing architecture in 5G. For one network slice instance, UE selects a network slice by requesting a S-NSSAI via RAN (This will be given details in next section), and core network responds to allocate the corresponding slice.

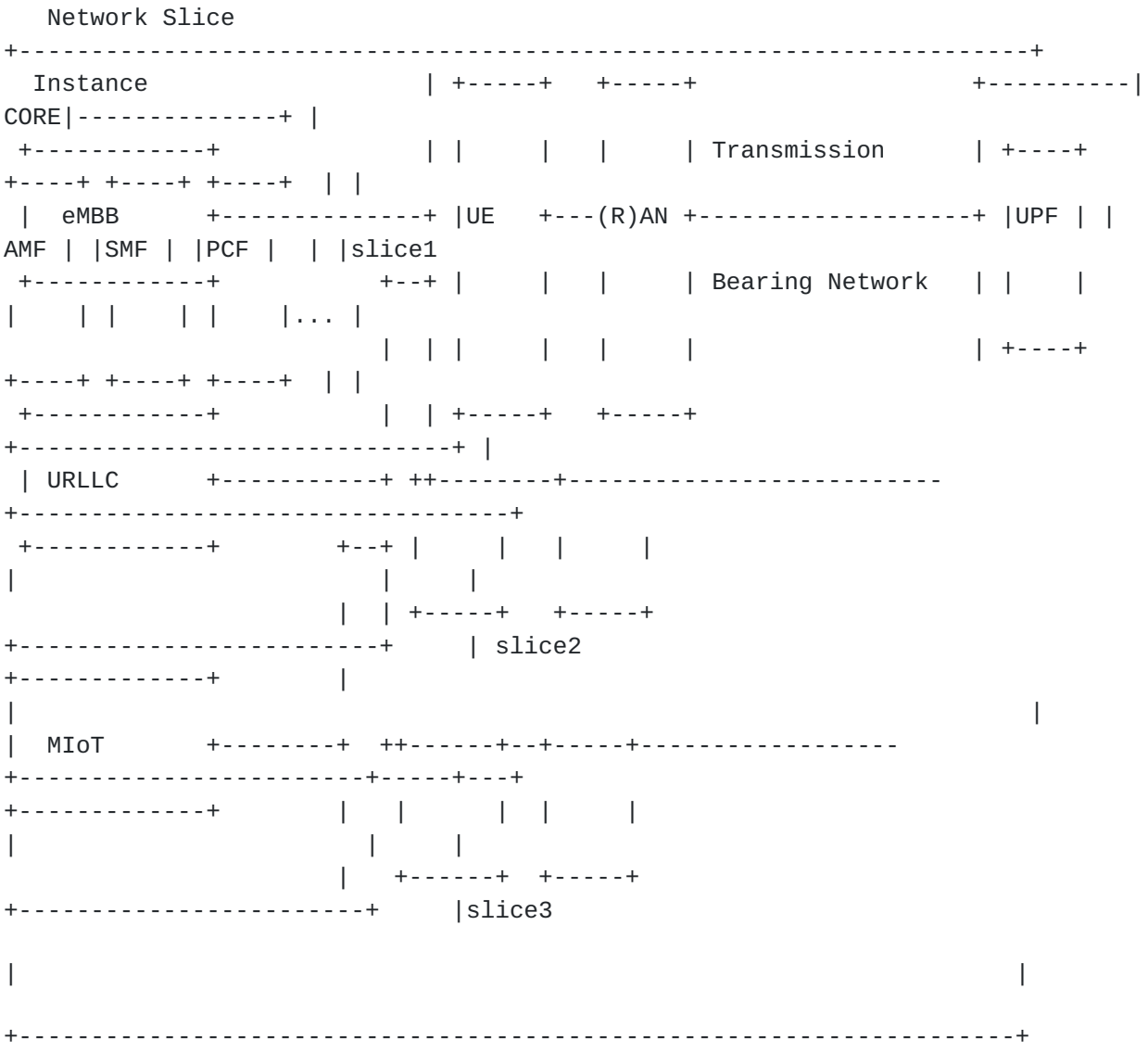

Figure 1

4.2.2. Network Slice Operation Procedure

The Network slicing operation procedure starts from UE registration, in which the selection of Network Slice instances for a UE is triggered by the first contacted Access and Mobility Management Function (AMF). After AMF selected by the AN receives the UE Registration request, UE signals a requested NSSAI to AMF, and AMF is expected to determine whether it can serve the UE by verifying whether the S-NSSAI(s) in the Requested NSSAI are permitted based on the Subscribed S-NSSAIs. If this case is permitted, AMF query the Network Slice Selection Function (NSSF), with Requested NSSAI, mapping of Requested NSSAI to Configured NSSAI. The NSSF returns to the current AMF the Allowed NSSAI for the applicable Access Type(s)

and UE, after receiving an Allowed NSSAI from the serving AMF, will store it.

As the one of the most important goals of network slicing configuration, the Protocol Data Unit (PDU) Session Establishment in a Network Slice to a DN allows data transmission in a Network Slice. The data transmission works after a PDU session to a Data Network is established in a Network Slice. Each PDU session corresponds to one core network slice and one RAN slice specifically.Here AMF is common to network slices serving the UE, but SMF and UPF are specific to each slice they associated to.

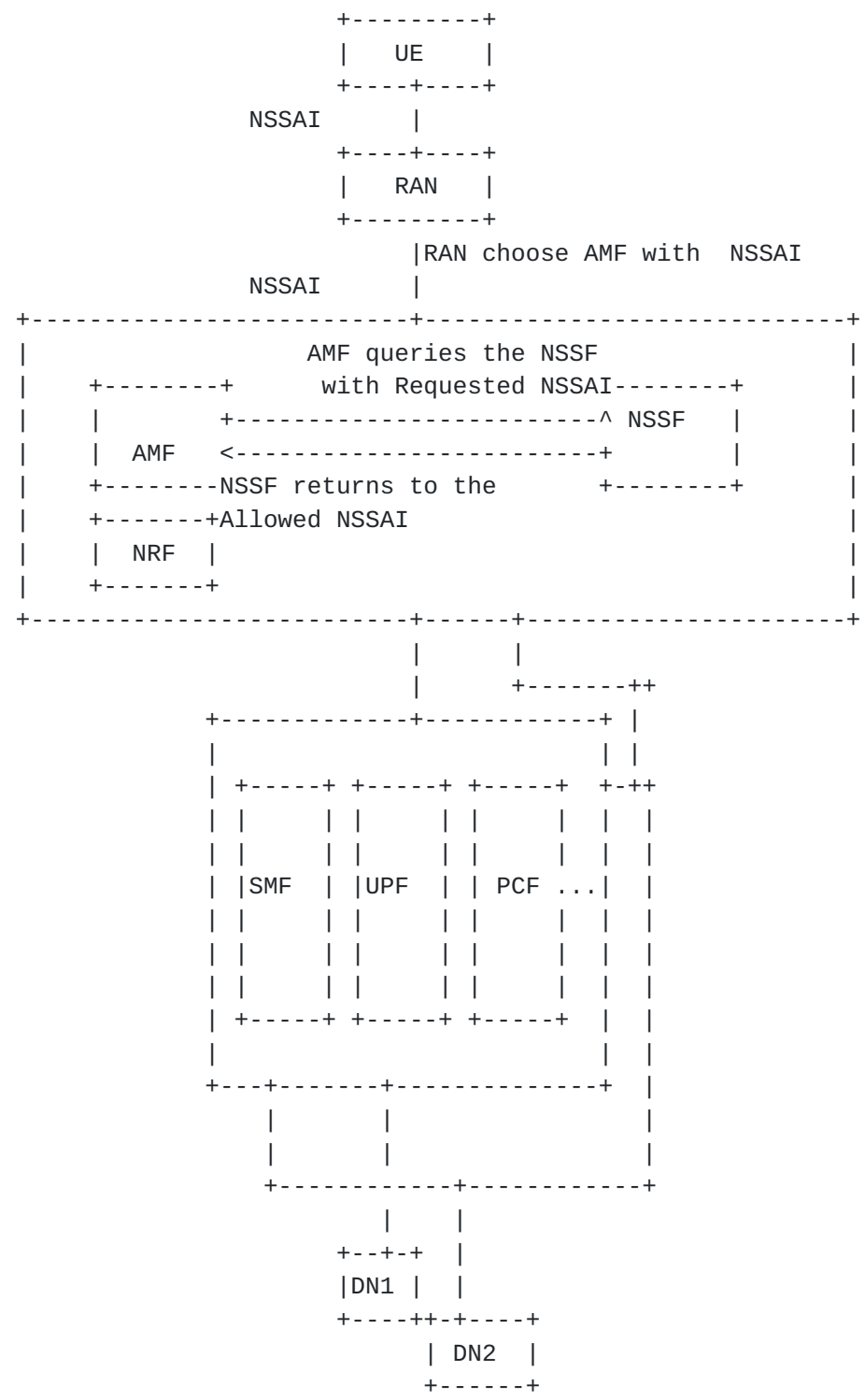

Figure 2 Network Slice Operation

4.3. ETSI

Rather than defining the standard of network slicing as well as other organizations, ETSI focuses on the mapping of the network slicing to NFV concept and describe how NFV architecture support it under the standards of diverse organization such as 3GPP.

Under the 3GPP defination of network slicing, ETSI defines NFV-NS that represent the virtualized resources for the slice subnet and their connectivity to physical resources. ETSI also describe Os-Ma-NFvo interface point that offer the interaction between the 3GPP slicing management and NFV-MANO, which is also related to a couple of management determination from NSMF and NSSMF.

4.4. GSMA

In [GSMA-An-Introduction-to-Network-Slicing], GSMA give the Concept of network slicing from the point of view of business customers that "Network slicing is the embodiment of the concept of running multiple logical networks as virtually independent business operations on a common physical infrastructure in an efficient and economical way." And they define that customisable network capabilities include data speed, quality, latency, reliability, security, and services. It is also mentioned that different operators can share the same network slice in GSMA description.

5. Conclusion:Different Understanding and Emphasis of Each Organizations

Based on the above description of network slicing and its entities from different organizations, it is not hard to find that they provide a different understanding of network slicing concept and have their emphasis of research on it:

In 3GPP, network slice is deployed in RAN, UPF and CN for a mobile network. Network slice instance is created by the cooperation between RAN and CN, which is more like a customized sliced function in core network. But the connectivity part, transmission network between CN and RAN is not sliced.

IETF anticipates to define an broader applied end-to-end network slicing for not only mobile network, but also other networks forms which may not includes CN or RAN. Therefore, the transmission network is considered as part of network slice resource/instance which can be sliced as well. This may ask for a orchestration of multiple domain technologies in transmission network and a information model to expose the relating tech capabilities.

ETSI mainly focuses on the mapping between NFV function and network slice based on the network slicing definition from current organizations, while GSMA define network slicing in a general and business way.

All of the descriptions from diverse organizations is attempting to give a comprehensive and typical standard for network slicing.

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