NG.141 Guidelines for URSP
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1 Introduction

1.1 Overview

This document aims to provide a standardised view on making use of UE Route Selection Policy (URSP) in 5G System (5GS).

References are made to 3GPP specifications covering the 5GS, as well as other GSMA NG PRD's, such as GSMA PRD NG.113 [1] where 5GS Roaming Guidelines are specified. 3GPP Release 15 is taken as a basis unless otherwise stated.

1.2 Scope

This PRD presents material about URSP as specified by the 3GPP, covering UEs connected to either to 5GS or EPS. This document includes industry-aligned guidelines on how to configure URSP and use URSP rules in different use cases. In particular, the document discusses which Traffic Descriptors and which Route Selection Descriptors to use for these use cases. Also, this PRD provides a description of Traffic Categories and additional information to assist the industry make use of Traffic Categories.

Industry alignment between network operators, UE vendors, and network vendors may require profiling of existing 3GPP specifications.

1.3 Abbreviations

Term	Description
5GC	5G Core
5GS	5G System
AMF	Access and Mobility Management Function
APN	Access Point Name
DNN	Data Network Name
HPMN	Home Public Mobile Network
HOS	Home Operator Services
IMS	IP Multimedia Subsystem
MBB	Mobile Broadband
MNO	Mobile Network Operator
NAS	Non-Access-Stratum
NEST	Network Slice Type
NSSAI	Network Slice Selection Assistance Information
NSSF	Network Slice Selection Function
OEM	Original Equipment Manufacturer
OS	Operating System
PCF	Policy Control Function
PCO	Protocol Configuration Option
PDU	Protocol Data Unit

Term	Description
PRD	Permanent Reference Document
SD	Slice Differentiator
SMF	Session Management Function
S-NSSAI	Single Network Slice Selection Assistance Information
SSC	Session and Service Continuity
SST	Slice/Service Type
TS	Technical Specification
UDM	Unified Data Management
UE	User Equipment
URSP	UE Route Selection Policy
VPMN	Visited Public Mobile Network

1.4 References

Ref	Doc Number	Title
[1]	PRD NG.113	5GS Roaming Guidelines
[2]	RFC 2119	“Key words for use in RFCs to Indicate Requirement Levels”, S. Bradner, March 1997. Available at http://www.ietf.org/rfc/rfc2119.txt
[3]	RFC 8174	Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words, B. Leiba, May 2017. Available at https://www.rfc-editor.org/info/rfc8174
[4]	PRD NG.114	IMS Profile for Voice, Video and Messaging over 5GS
[5]	3GPP TS 23.501	System Architecture for the 5G System
[6]	3GPP TS 23.502	Procedures for the 5G System
[7]	3GPP TS 23.503	Policy and Charging Control Framework for the 5G System
[8]	3GPP TS 24.526	User Equipment (UE) policies for 5G System (5GS)
[9]	3GPP TS 24.501	Non-Access-Stratum (NAS) protocol for 5G System (5GS)
[10]	PRD NG.116	Generic Network Slice Template
[11]	PRD TS.62	UE Requirements Related to Network Slicing using URSP

1.5 Conventions

“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 [2] and clarified by RFC8174 [3], when, and only when, they appear in all capitals, as shown here.”

For documents not containing normative requirements, this section may be deleted.

2 A Brief introduction to Network Slicing

Network slicing is a mandatory feature of the 3GPP 5G System (5GS), i.e., there is at least one network slice in the network and every UE uses at least one network slice. As defined in 3GPP TS 23.501 [5], a network slice is a logical network that provides specific network

capabilities and network characteristics. The use of network slices is profiled for the user network interface of an IMS voice capable device on 5GS in GSMA PRD NG.114 [4] and for roaming in GSMA PRD NG.113 [1].

In some use cases a UE can just use a single network slice, and one or more PDU Sessions (to different DNNs) in this network slice to support different services as needed, see Section 4. For example, a UE may use one PDU Session for Internet access and another PDU Session for IMS services. The reader should refer to GSMA PRD NG.114 [4] for more details. For other use cases, a UE may use two or more network slices, each with one or more PDU Sessions, see also Section 4.

A Single Network Slice Selection Assistance Information (S-NSSAI) identifies a network slice in a PLMN. The S-NSSAI contains at least one Service/Slice Type (SST) and can include a Slice Differentiator (SD). The SST may be either a Standardized SST taking one of the values specified in Table 5.15.2.2-1 of 3GPP TS 23.501 [5] or an operator-specific SST. A NSSAI is an array of S-NSSAIs and identifies the set of the corresponding network slices.

A UE can provide a Requested NSSAI) in the Initial Registration or in a Mobility Registration Update to indicate to the network the network slices that it is interested in. The Requested NSSAI is determined by the UE as specified in Section 5.15.5.2.1 of 3GPP TS 23.501 [5]. The network may provide an Allowed NSSAI to a UE (i.e., the network slices that the network allows the UE to use) and, if applicable, also indicate that a subset of the Requested S-NSSAIs are rejected S-NSSAIs (i.e., network slices the UE cannot use, for example, if not available at the current UE's location). If a list of rejected S-NSSAIs is provided, the UE should not request these S-NSSAIs again depending on the criteria associated with the cause for rejection in Registration procedure or in a UE Configuration Update procedure. See section 5.15.5.2.1 of 3GPP TS 23.501 [5] for further details regarding Allowed NSSAI and rejected S-NSSAI.

The Requested NSSAI and the Allowed NSSAI can include up to 8 S-NSSAIs. The Configured NSSAI and Pending NSSAI can include up to 16 S-NSSAIs (see 3GPP TS 24.501 [9]).

The UE subscription information must contain at least one default S-NSSAI and at most eight default S-NSSAIs. The default S-NSSAIs are used when the UE performs a registration without including any S-NSSAI value in the Requested NSSAI or when the Requested NSSAI is incorrect (e.g., the requested NSSAI includes S-NSSAIs that cannot be provided together in the Allowed NSSAI, or that are not part of the Configured NSSAI). Upon receiving the registration request, and after receiving the local information and subscription data from the Unified Data Management (UDM), the Access and Mobility Management Function (AMF) uses the UDM data and the result of any NSSAA to determine which S-NSSAI to add into Allowed NSSAI; the AMF may also interrogate the Network Slice Selection Function (NSSF) for the purpose of determining the Allowed NSSAI.

When available, the UE can use the URSPs to identify the S-NSSAIs to include/add to the Requested NSSAI and to determine the validity of a rule checking against the Allowed NSSAI. More details on these aspects are further discussed in Section 3.

3 URSP basics

3.1 General

UE Route Selection Policy (URSP) is a 5G feature that enables the Mobile Network Operator (MNO) to use URSP rules, which instruct the UE to map matching uplink application traffic (user data traffic) to PDU session connectivity parameters or to route the application traffic outside of a PDU session. The UE may need to know a set of parameters (e.g., Single – Network Slice Selection Assistance Information (S-NSSAI) and Data Network Name (DNN)) to be used in a PDU Session establishment. URSP rules can be provisioned on the UE or provided by the network to the UE.

While in the 3GPP specifications it is not mandatory for the UE to support URSP, the GSMA has profiled in GSMA PRD NG.114 [4] that the support of URSP, as specified in Section 6.6.2 of 3GPP TS 23.503 [7], is mandatory for UEs supporting IMS voice over 5GS (e.g., a smartphone using 5GS). This embraces the support of URSP rules and the support of the UE Configuration Update procedure for transparent UE Policy delivery, which is used to provide URSP rules to UEs.

Note: The UE Configuration Update procedure for transparent UE Policy delivery is part of the UE Policy Association Establishment and UE Policy Association Modification procedures defined in Clause 4.16.11 and 4.16.12 of 3GPP TS 23.502 [6].

3.2 URSP rules

URSP includes a list of URSP rules. Please refer to 3GPP TS 23.503 [7] and 3GPP TS 24.526 [8] for a complete description of URSP. Each URSP rule contains:

- Rule Precedence: Determines the order in which an URSP rule is enforced in the UE.
- Traffic descriptor: Used to determine whether the rule matches. A match can be based upon, e.g.
    - Application descriptors: Operating System Identifier (OSId) and OS specific Application Identifier(s) (OSAppId(s))
        - According to 3GPP, the OSAppId is an identifier associated with a given application and uniquely identifying that application within the UE for a given Operating System (OS).
        - OSAppIds are OS-specific and not specified by 3GPP.
    - Destination IP or non-IP descriptors: this can be, e.g., destination IP address or prefix, destination port number, or protocol ID.
    - DNN.
    - Domain descriptors: destination FQDN or regular expression which are used as a domain name matching criteria.

- Connection Capabilities: See section 5.2 in 3GPP TS 24.526 [8] for the format and some values of the Connection Capabilities. Traffic Categories are encoded within the Connection Capabilities IE. One or more values can be provided.

- List of Route Selection Descriptors: It may contain, e.g.
  - Session and Service Continuity (SSC) Mode Selection: One single value.
  - Network Slice Selection: One or more S-NSSAIs.
  - DNN Selection: One or more DNNs.
  - PDU Session Type Selection: One single value (e.g., IP4v6 or IPv6)
  - Access Type preference: Indicates the preferred Access Type (e.g., 3GPP or non-3GPP).
  - Route Selection Validation
    - Time Window: Indicates the time window when the matching traffic is allowed.
    - Location Criteria: Indicates the UE location where the matching traffic is allowed.

DNN can be in both Traffic descriptor and in Route Selection Descriptor according to 3GPP Release 17 TS 23.503, allowing thereby to replace a DNN provided as Traffic descriptor.

The UE can be pre-configured with URSP rules by an MNO as well as be provisioned with URSP rules by the Policy Control Function (PCF, see 3GPP TS 23.503 [7]). If the UE is provisioned with URSP rules, the pre-configured URSP rules are not evaluated.

At most one of the provisioned URSP rules can be defined as the default URSP rule and at most one of the pre-configured URSP rules can be defined as the default URSP rule. The default URSP rule contains the “match all” Traffic descriptor (see clause 4.2.1 of 3GPP TS 24.526 [8]) and has the lowest priority (i.e., highest precedence value), see clause 6.6.2 of 3GPP TS 23.503 [7].

In addition to pre-configured and provisioned URSP rules, a UE may store a UE Local Configuration about the association of an application to e.g., a PDU session (e.g., an operator provided S-NSSAI and DNN or application-specific parameters to set up a PDU Session). A UE compliant to GSMA PRD NG.114 [4] can use UE Local Configuration to establish PDU sessions to, for example, the IMS DNN, the Internet DNN and/or the HOS DNN. The format and contents of UE Local Configuration is not specified and left for UE implementation.

NOTE: MNO may provide information to Original Equipment Manufacturer (OEM) for UE Local Configuration.

Upon receiving an application request, the UE evaluates the URSP rules in order of priority and proceeds as follows (see also clause 6.1.2.2.1 of 3GPP TS 23.503 [7]):

1. If a non-default URSP rule matches the application request, the UE selects this URSP rule to associate the application to a PDU Session (the UE may establish a new PDU session or use an existing PDU Session, see clause 4.2.2 of 3GPP TS 24.526 [8]).

2. If no matching non-default URSP rule is found or the UE does not have any non-default URSP rules, the UE checks if a UE Local Configuration is available for the requesting application.

    i. If a suitable UE Local Configuration exists, the UE selects this UE Local Configuration to associate the application to a PDU Session (see clause 4.2.2 of 3GPP TS 24.526 [8]).

    ii. If a suitable UE Local Configuration does not exist and the default URSP rule is defined, the UE selects the default URSP rule to associate the application to a PDU Session (see clause 4.2.2 of 3GPP TS 24.526 [8]).

    iii. If a suitable UE Local Configuration does not exist and the default URSP rule is not defined, the way the UE associates the application to a PDU Session is implementation dependent.

For more details on additional checks necessary before an existing PDU session can be used, see clause 6.6.2.3 of 3GPP TS 23.503 [7].

3.3 URSP and registration procedure

As per 3GPP TS 23.501 [5], a UE may use a Requested NSSAI that includes up to eight S-NSSAIs. A UE provides a Requested NSSAI in the Registration procedure amongst others based on available URSP rules or UE Local Configuration. The UE uses applicable URSP rules or the UE Local Configuration to ensure that the S-NSSAIs included in the Requested NSSAI are not in conflict with the URSP rules or with the UE Local Configuration.

The S-NSSAI included in the URSP rules is related to the Allowed NSSAI provided by the network to the UE during the registration procedure. If the Allowed NSSAI contains an S-NSSAI for which a matching URSP rule exists, then this rule can be applied (following the details specified in 3GPP TS 23.503 [7]). If the UE is roaming, then the S-NSSAI in the URSP rule is the HPMN S-NSSAI (see also Section 6.1 of GSMA PRD NG.113 [1]).

3.4 URSP and PDU Session Establishment

A matching URSP rule instructs the UE to establish a PDU Session if the PDU Session is not already established. The UE procedure for associating applications to PDU Sessions based on URSP is described in clause 6.6.2.3 of TS 23.503 [7].

A UE uses the Route Selection Descriptor in the matching URSP rule to determine PDU Session connectivity parameters such as S-NSSAI(s), SSC mode, DNN(s), and PDU Session Type. These parameters enable the UE to determine if the user traffic data can be routed through an already established PDU Session or if there is a need to trigger the establishment of a new PDU Session.

If the UE selects a S-NSSAI to serve certain application traffic based on URSP rules or UE Local Configuration, and the selected S-NSSAI is in the Allowed NSSAI list, then the UE includes the selected S-NSSAI in the PDU Session Establishment Request and the AMF uses the received S-NSSAI (and DNN) to select the SMF. If the selected S-NSSAI is neither in the

Allowed NSSAI nor in the Rejected NSSAI, but it is in the Configured NSSAI, then the UE can attempt to request the selected S-NSSAI by including it in Requested NSSAI in next Mobility Registration Update. Only if the selected S-NSSAI is included in the Allowed NSSAI in the Registration Accept, then the UE can proceed with the establishment of the PDU Session with this S-NSSAI.

If there is no matching URSP rule and no matching UE Local Configuration, then the UE does not include an S-NSSAI when establishing a PDU Session, even if there are one or more S-NSSAIs in the Allowed NSSAI. In such a case, when establishing a PDU Session, the AMF selects an S-NSSAI from the Allowed NSSAIs as specified in clause 4.3.2.2.1 of 3GPP TS 23.502 [6].

If the UE does not provide a DNN in the PDU Session Establishment Request for a given S-NSSAI, the serving AMF determines the DNN for the requested PDU Session by selecting the default DNN for this S-NSSAI if a default DNN is present in the UE's Subscription Information; otherwise, the serving AMF selects a locally configured DNN for this S-NSSAI (clause 4.3.2.2.1 of 3GPP TS 23.502 [6]).

In the case of network rejection of the PDU Session Establishment Request, the UE shall follow clause 6.4.1.4 of 3GPP TS 24.501 [9] and clause 4.2.2.2 of 3GPP TS 24.526 [8] to determine whether to trigger the establishment of a new PDU Session.

3.5 URSP and PDN Connection Establishment in EPS

If a UE does not have preconfigured rules for associating an application to a PDN connection (i.e., the UE does not have rules in UE local configuration), the UE can use a matching URSP rule to derive DNN/APN for PDN Connection establishment as specified in Section 5.17.1.2 of 3GPP Release 16 23.501 [5].

3.6 Receiving new URSP rules

For those cases when a PDU Session is already established, and the UE receives new URSP rules, then the new URSP rules are to be applied timely, but the UE behavior is not specified and implementation specific. There is no mechanism to force a UE to release established PDU Sessions in such situations.

Applying new URSP rules by a UE may imply that the association of an application to a PDU Session needs to be updated, and hence connectivity may be broken as traffic needs to be routed to another PDU Session with another IP address. It is UE-specific how quickly this migration is achieved and whether/how the application shall be informed about this.

3.7 Receiving updated Allowed NSSAI and/or Configured NSSAI

AMF updates the UE with the Allowed NSSAI and/or Configured NSSAI for the Serving PLMN as specified in section 5.15.4 of 3GPP TS 23.501 [5], e.g., when the Subscribed S-NSSAI(s) are updated (i.e., some existing S-NSSAIs are removed and/or some new S-NSSAIs are added) and one or more Subscribed S-NSSAI(s) are applicable to the Serving PLMN the UE is registered in.

The UE may re-evaluate the URSP rules when the allowed NSSAI is changed as specified in section 4.2.2.2 of 3GPP Release 16 TS 24.526 [8]. There is no mechanism to force a UE to release an established PDU Session if the S-NSSAI used in the PDU session has been removed from the Allowed NSSAI.

If an S-NSSAI is no longer available for a UE, the AMF indicates to the SMF(s) the PDU Session ID(s) corresponding to the S-NSSAI and to release these PDU session(s) as specified in 5.15.5.2.2 of 3GPP TS 23.501 [5].

3.8 Traffic categories

Traffic categories, listed in Table 1, are defined to accommodate connectivity requirements that are shared among different applications traffic.

Traffic Category	Description
IMS	IMS Voice + Video comprising voice, video telephony and multimedia communications over IP networks. Voice, Video and SMS over IMS DNN, as well as RCS (Rich Communication Services) are included in this traffic category.
Internet	Internet data traffic with wide availability but no critical requirements on latency or data rates.
IoT delay-tolerant	Delay-tolerant, low sustained data rate IoT traffic.
IoT non-delay-tolerant	Non-delay-tolerant, low sustained data rate IoT traffic
Downlink streaming	Downlink streaming, characterized as downlink high data rates content and low latency.
Uplink streaming	Uplink streaming, characterized as uplink high data rates content and low latency.
Vehicular Communications/	Vehicle-to-Everything (V2X) traffic comprising V2X messages, characterized by low latency, high reliability, and high availability.
Real time interactive	Real time interactive traffic, for example, for gaming or AR/VR.
Unified Communications	Unified communications traffic, which comprise communications through a single user interface at the UE, for instance instant messaging, VoIP, and video collaboration through the same application.
Background	Any traffic that is not time-sensitive, e.g., firmware/ software updates over the air. This traffic has no critical requirements from latency or data rates perspective. This traffic should/can be subject of scheduling (e.g. at specific time of day) by the applications/networks.
Mission Critical Communications	Mission-critical communications, may include MC-PTT, MC video and MC data
Time Critical Communications	Time Critical Communications, with bounded, low to very low latency requirements, and high availability.
Low latency loss tolerant Communications in Unacknowledged Mode	Traffic which has low latency requirements and is tolerant to some loss, hence using un-acknowledged mode at the RLC layer. E.g., for certain real time voice or video traffic.

Table 1: Traffic Categories

Traffic categories have been specified as Connection Capabilities in 3GPP Release 18 TS 23.503 [7] and 3GPP Release 18 TS 24.526 [8].

NOTE: Use cases implemented based on pre-Release 18 capabilities in Traffic Descriptors continue to exist while new use cases can emerge relying upon Traffic Categories based on Release 18.

Table 2 provides example mappings of traffic categories to GSMA-defined NESTs in NG.116 [10]. This table is not meant to recommend or preclude mappings for MNOs' deployments. Particularly, MNOs may choose different mappings than those shown in Table 2, including mappings to MNO-defined NESTs.

Traffic Category	NG.116 NEST
IMS traffic	eMBB (4.1)
Unified communications traffic	eMBB (4.1)
Internet traffic	eMBB (4.1)
IoT delay-tolerant	MioT (4.3)
IoT non-delay-tolerant	MioT (4.3)
Downlink streaming	eMBB (4.1)
Uplink streaming	FFS
Vehicular communications	V2X (4.7)
Real time interactive	XR (4.8)
Background	MioT (4.3)
Mission critical communications	Public Safety (4.5)
Low latency loss tolerant communications in un-acknowledged mode	No GSMA-defined NEST
Time critical communications	URLLC (4.2)

Table 2: Example mappings of traffic categories to GSMA-defined NESTs

Editor's Note: Entries tagged with FFS will be updated or be removed from the table.

4 Example URSP rule configuration and usage

This section includes several examples for URSP, covering one more PDU sessions established by the UE on one or more network slices.

4.1 Single network slice, single PDU session

4.1.1 Application Descriptor as Traffic Descriptor

In this use case, the UE has been configured with the following URSP rule, using Application Descriptor as Traffic Descriptor. The URSP rule includes DNN selection, Network Slice Selection and Access Type preference.

Rule Precedence		1
Traffic Descriptor	Application descriptors	“String”
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	DNN_1
	Network Slice Selection	S-NSSAI_X
	Access Type preference	3GPP access

Table 3: URSP rule using Application Descriptor

If the rule is matched, the UE will establish a PDU session using DNN_1 and S-NSSAI-X on 3GPP access, as shown on the following figure.

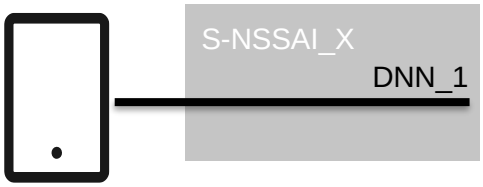

Figure 1: Single PDU session on a network slice

4.1.2 DNN as Traffic Descriptor

In this use case, the UE has been configured with the following URSP rule, using DNN as Traffic Descriptor. The URSP rule includes Network Slice Selection and Access Type preference.

Rule Precedence		1
Traffic Descriptor	DNN	DNN_1
Route Selection Descriptor Precedence		0
Route Selection Descriptor	Network Slice Selection	S-NSSAI_X
	Access Type preference	3GPP access

Table 4: URSP rule using Application Descriptor

If the rule is matched, the UE will establish a PDU session using DNN_1 and S-NSSAI-X on 3GPP access, as shown on the following figure.

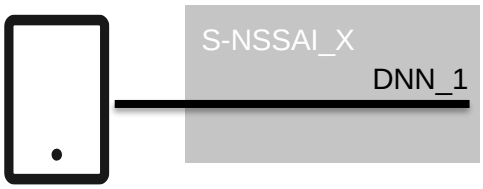

Figure 2: Single PDU session on a network slice

4.2 Two PDU sessions

4.2.1 Two PDU sessions on the same network slice

In this use case, the UE has been configured with the following URSP rules, one using Application Descriptor as Traffic Descriptor and one using DNN as Traffic Descriptor. Both URSP rules have the same S-NSSAI value in Network Slice Selection.

Rule Precedence		0
Traffic Descriptor	Application descriptors	“String”
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	DNN_1
	Network Slice Selection	S-NSSAI_X
	Access Type preference	3GPP access
Rule Precedence		1
Traffic Descriptor	DNN	DNN_2
Route Selection Descriptor Precedence		0
Route Selection Descriptor	Network Slice Selection	S-NSSAI_X
	Access Type preference	3GPP access

Table 5: URSP rule using Application Descriptor

If the first rule is matched, the UE will establish a PDU session using DNN_1 and S-NSSAI-X on 3GPP access. If the second rule is matched the UE will establish a PDU session using DNN_2 and S-NSSAI-X on 3GPP access. Please see the following figure.

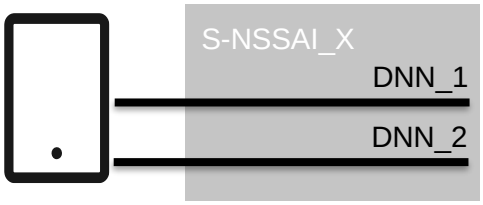

Figure 3: Two PDU sessions on the same network slice

4.2.2 Two PDU sessions on two network slices

In this use case, the UE has been configured with the following URSP rules, one using Application Descriptor as Traffic Descriptor and one using DNN as Traffic Descriptor. The URSP rules have different S-NSSAI in Network Slice Selection.

Rule Precedence		0
Traffic Descriptor	Application descriptors	“String”
Route Selection Descriptor Precedence		1
Route Selection Descriptor	DNN Selection	DNN_1
	Network Slice Selection	S-NSSAI_X
	Access Type preference	3GPP access
Rule Precedence		1
Traffic Descriptor	DNN	DNN_2
Route Selection Descriptor Precedence		1
Route Selection Descriptor	Network Slice Selection	S-NSSAI_Y
	Access Type preference	3GPP access

Table 6: URSP rule using Application Descriptor

If the first rule is matched, the UE will establish a PDU session using DNN_1 and S-NSSAI_X on 3GPP access. If the second rule is matched, the UE will establish a PDU session using DNN_2 and S-NSSAI_Y on 3GPP access. Please see the following figure.

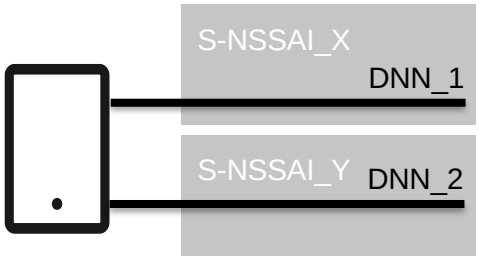

Figure 4: Two PDU sessions on two network slices

4.3 Three PDU sessions / two network slices for a NG.114 compliant UE

A UE compliant to GSMA NG.114 [4] uses at least a PDU session to the IMS well-known DNN and a PDU session to the Home Operator Services (HOS) DNN. The HOS DNN can be the Internet DNN.

In the following we exemplify the use of both IMS DNN and Internet DNN on the MBB network slice and a third DNN on a different network slice. There are different alternatives on how to address this use case, using

- local configuration and a URSP rule, or
- only URSP rules.

4.3.1 Using Local configuration and URSP

The UE has local configuration on how to establish the PDU sessions to the IMS DNN and to the Internet DNN. This local configuration includes the DNN and can include the MBB S-NSSAI to be used for PDU Session establishment (see also section 0 on how the AMF selects the S-NSSAI if not provided by the UE). In addition, the UE has been configured with the following URSP rule (see also Section 3.2), but the UE neither has a URSP rule for the IMS DNN nor for the Internet DNN.

Rule Precedence		1
Traffic Descriptor	Application descriptors	"String"
Route Selection Descriptor Precedence		1
Route Selection Descriptor	DNN Selection	DNN_1
	Network Slice Selection	S-NSSAI_X
	Access Type preference	3GPP access

Table 7: URSP rule using Application Descriptor

If the rule is matched, the UE will establish a PDU session using DNN_1 and S-NSSAI_X on 3GPP access. The UE uses the local configuration to establish the PDU sessions to the IMS DNN and to the Internet DNN. Please see the following figure.

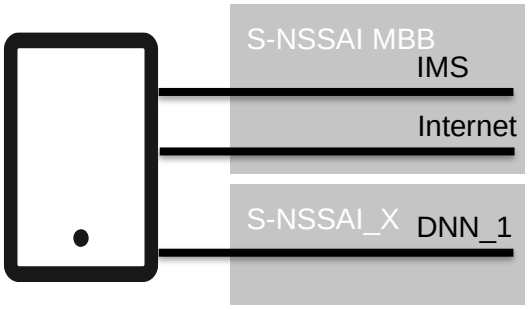

Figure 5: Three PDU sessions on two network slices

4.3.2 Using only URSP rules

The UE has been configured with the following URSP rules:

- one using Connection Capabilities with value 8 (Internet) as Traffic Descriptor,
- one using Connection Capabilities with value 1 (IMS) as Traffic Descriptor, and
- one using Application Descriptor with value "string" as Traffic Descriptor.

Rule Precedence		0
Traffic Descriptor	Connection Capabilities	8 (Internet)

Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		1
Traffic Descriptor	Connection Capabilities	1 (IMS)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	IMS
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		2
Traffic Descriptor	Application descriptors	“String”
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	DNN_1
	Network Slice Selection	S-NSSAI_X
	Access Type preference	3GPP access

Table 8: URSP rules using Connection Capabilities and Application Descriptors

If the first rule is matched, the UE will establish a PDU session using Internet DNN and S-NSSAI MBB on 3GPP access. If the second rule is matched, the UE will establish a PDU session using IMS as DNN and S-NSSAI MBB on 3GPP access. If the third rule is matched, the UE will establish a PDU session using DNN_1 and S-NSSAI_X on 3GPP access. Please see also Figure 5.

4.4 Match-all rule (Using only URSP rules)

The UE may be configured with URSP rules containing “match all” Traffic Descriptor.

A URSP rule containing “match all” Traffic Descriptor is regarded as the default URSP rule. If a default URSP rule and one or more non-default URSP rules are included in the URSP, the default URSP rule has the lowest priority (i.e., highest precedence value).

Table 9 shows an example of URSP rules to be added a URSP rule containing “match all” Traffic Descriptor to Table 8. It is noted that the rule precedence value of the rule containing “match all” Traffic Descriptor in this example can be configured as more than 3, which shall be higher than ones of the other rules and be 255 at maximum.

Rule Precedence		0
Traffic Descriptor	Connection Capabilities	8 (Internet)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		1
Traffic Descriptor	Connection Capabilities	1 (IMS)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	IMS
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		2
Traffic Descriptor	Application descriptors	“String”
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	DNN_1
	Network Slice Selection	S-NSSAI_X
	Access Type preference	3GPP access
Rule Precedence		3
Traffic Descriptor	Match all	
Route election Descriptor Precedence		0

Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access

Table 9: URSP rules using Connection Capabilities and Application Descriptors

If there are no traffic descriptor values corresponding to URSP rules with its precedence 0 through 2 in the values requested by applications, UE tries to use UE Local Configuration for the applications. And then, if neither UE Local Configuration nor the URSP rules are applicable for the applications, the URSP rule containing “match all” Traffic Descriptor is applied (see clause 6.1.2.2.1 of 3GPP TS 23.503 [7] and clause 4.2.2.2 of 3GPP TS 24.526 [8]).

For more details on additional checks necessary before an existing PDU session can be used, see clause 6.6.2.3 of 3GPP TS 23.503 [7].

The UE may be configured with only URSP rules containing “match all” Traffic Descriptor as described in Table 9. It is noted that the rule precedence value of the rule using match-all in this example can be configured to be 255 at maximum.

Rule Precedence		255
Traffic Descriptor	Match all	
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access

Table 10: Only URSP rule using “match all” Traffic Descriptor

4.5 Adding a network slice for a NG.114 compliant UE

A UE compliant to GSMA NG.114 [4] uses at least a PDU session to the IMS well-known DNN and a PDU session to the Internet DNN on the MBB network slice.

In the following we exemplify the cases that the UE has a gaming application, and the UE is either using a match all URSP rule to also route the gaming traffic on the Internet PDU session or the UE is using a URSP rule by which the gaming traffic is routed to a new PDU session via a network slice other than MBB.

4.5.1 Using only URSP rules – gaming traffic on the Internet DNN

The UE has been configured with the following URSP rules:

- one using Connection Capabilities with value 8 (Internet) as Traffic Descriptor,
- one using Connection Capabilities with value 1 (IMS) as Traffic Descriptor, and

- one match-all rule.

Rule Precedence		0
Traffic Descriptor	Connection Capabilities	8 (Internet)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		1
Traffic Descriptor	Connection Capabilities	1 (IMS)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	IMS
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		2
Traffic Descriptor	“match all”	
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access

Table 11: Two URSP rules using Connection Capabilities and “match all” rule

If the first rule is matched, the UE will establish a PDU session using Internet DNN and S-NSSAI MBB on 3GPP access. If the second rule is matched, the UE will establish a PDU session using IMS as DNN and S-NSSAI MBB on 3GPP access. If the gaming application is requesting the connection capability “real time interactive”, then no rule is matched and instead the “match all” rule is used, and the UE will route all traffic of the gaming application via the already established P DU session using Internet DNN and S-NSSAI MBB on 3GPP access. Hence the UE uses only two PDU Sessions. See also Figure 6.

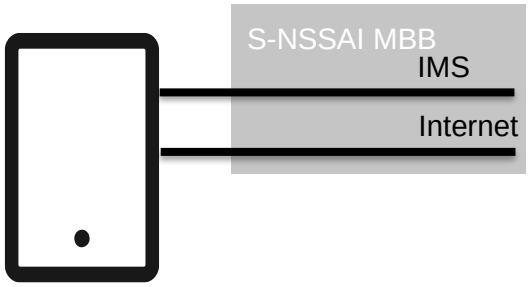

Figure 6: Two PDU sessions on one network slice

4.5.2 Using only URSP rules – gaming traffic on the Gaming DNN

If the subscription is changed to include a Gaming DNN and an S-NSSAI to be used for gaming, e.g., if the subscriber has bought a corresponding upgrade from the MNO, then the UE receives an additional URSP rule as shown in the following table. Details on how to buy such an upgrade are out of scope of this document.

After receiving new URSP rules, the UE has been configured with the following URSP rules:

- one using Connection Capabilities with value 8 (Internet) as Traffic Descriptor,
- one using Connection Capabilities with value 1 (IMS) as Traffic Descriptor, and
- one using Connection Capabilities with value 166 (real time interactive) as Traffic Descriptor,
- one match-all rule.

Rule Precedence		0
Traffic Descriptor	Connection Capabilities	8 (Internet)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		1
Traffic Descriptor	Connection Capabilities	1 (IMS)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	IMS
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access

Rule Precedence		2
Traffic Descriptor	Connection Capabilities	166 (Real-time interactive)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Gaming
	Network Slice Selection	S-NSSAI Gaming
	Access Type preference	3GPP access
Rule Precedence		3
Traffic Descriptor	“match all”	
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access

Table 12 : Three URSP rules using Connection Capabilities and “match all” rule

The UE behaviour is not specified in case of receiving new URSP rules, leaving it implementation specific. See also section 3.6. However, once the UE has applied the new URSP rules, and the gaming application is requesting the connection capability “real time interactive”, then the UE has in addition to the two PDU session on the MBB network slice also a PDU session on the gaming network slice as shown in Figure 5

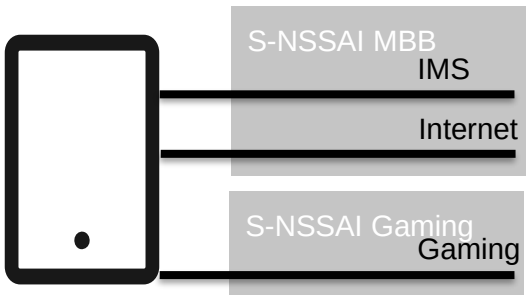

Figure 7: Three PDU sessions on two network slices, one for MBB and one for gaming

4.6 Removing a network slice for a UE

In the following we exemplify the case that the UE has a gaming application, and the UE is using a URSP rule by which the gaming traffic is routed to a new PDU session via a network slice other than MBB, see also section 4.5. At a certain point in time, the network slice and the DNN used for the gaming traffic are removed from the subscription. The trigger for removing the network slice and the DNN from the subscription is out of scope of this document.

If the subscription is changed to remove both the Gaming DNN and the Gaming S-NSSAI, then the URSP rules are updated to exclude the URSP rule using Gaming S-NSSAI and Gaming DNN. The UE also receives updated Configured NSSAI and/or updated Allowed NSSAI, see section 3.7.

After receiving new URSP rules, the UE is configured with the following URSP rules:

- one using Connection Capabilities with value 8 (Internet) as Traffic Descriptor,
- one using Connection Capabilities with value 1 (IMS) as Traffic Descriptor, and
- one match-all rule.

Rule Precedence		0
Traffic Descriptor	Connection Capabilities	8 (Internet)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		1
Traffic Descriptor	Connection Capabilities	1 (IMS)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	IMS
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access
Rule Precedence		2
Traffic Descriptor	“match all”	

Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	Internet DNN
	Network Slice Selection	S-NSSAI MBB
	Access Type preference	3GPP access

Table 13: Two URSP rules using Connection Capabilities and "match all" rule

As described in section 3.6, when a PDU Session is already established, and the UE receives new URSP rules, then the new URSP rules are to be applied timely, but the UE behaviour is not specified and implementation specific. There is no mechanism to force a UE to release established PDU Sessions in such situations; actually, the UE behaviour is not specified, leaving it implementation specific.

As described in section 3.7, when a PDU Session is already established, and the UE receives updated Allowed NSSAI, then the UE may re-evaluate the URSP rules, but the UE behaviour is not specified and implementation specific. There is no mechanism to force a UE to release an established PDU Session in such situations.

During the subsequent registration procedure or during the subsequent UE Configuration Update procedure, the UE will also receive Allowed NSSAI which does not include the Gaming S-NSSAI. If the Gaming S-NSSAI is no longer available for a UE, the AMF indicates to the SMF to release the corresponding PDU Session. Thereafter the UE has only two PDU sessions left, see also Figure 6. If there is further traffic from the gaming application, then the "match all" rule is matched, and the traffic is routed via the already established PDU session to the Internet DNN.

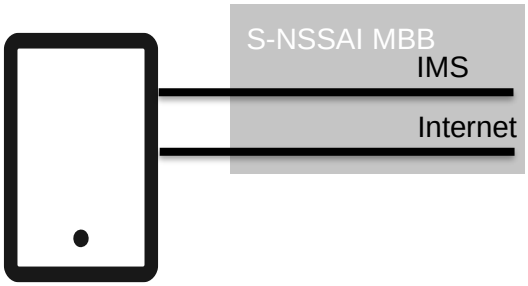

Figure 8: Two PDU sessions on one network slice

4.7 Operator specific connection capability

The UE may be configured with URSP rules using operator specific values as Connection Capabiilties in Traffic Descriptor.

While the format and values of Connection Capabilities in Traffic Descriptors to match against standardized traffic categories are defined in TS 24.526 [8] according to the requirements in Section 3.7, the reserved values of Connection Capabilities to match operator-specific traffic categories are specified in TS 24.526 [8]. However, operator specific traffic category values

are out of the scope of 3GPP specifications and are used by each operator to classify traffic based on their own criteria.

Therefore, a typical use case would involve an operator determining the values and making an agreement to use the values with an enterprise customer who provides a service and an application in a B2B scenario. Subsequently, the enterprise customer would develop an application that requests the relevant value. The operating system (OS) in the UE implements specific capability constants to utilize operator specific connection capabilities as an OS-specific API. The application can then make a connection request to the OS, including the corresponding specific capability constant.
Table 14 shows an example of a URSP rule using operator specific connection capability.

Rule Precedence		0
Traffic Descriptor	Connection Capabilities	32 (Operator specific connection capability)
Route Selection Descriptor Precedence		0
Route Selection Descriptor	DNN Selection	DNN_1
	Network Slice Selection	S-NSSAI_Y
	Access Type preference	3GPP access

Table 14: URSP rules using operator specific connection capabilities

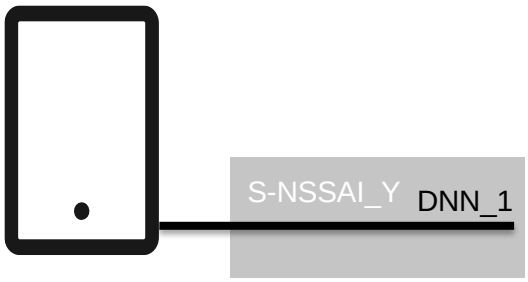

Figure 9: Single PDU session on a network slice

Annex A An Example of application class mapping to traffic categories

Table 14 provides an example of mapping of typical application classes to one or more traffic categories. Table 14 is informative.

An application may use one or many traffic categories depending on the target connectivity requirements for the application data exchange via a network. An application may use more than one traffic category when requesting connectivity for data exchange. The application may also issue more than one request for connectivity, each request associated with a different traffic category.

Application classes	*IMS traffic*	*Internet traffic*	*IoT delay-tolerant*	*IoT non-delay-tolerant*	*Downlink streaming*	*Uplink streaming*	*Vehicular communications*	*Real time interactive*	*Unified communications traffic*	*Mission critical communications*	*Low latency loss tolerant communications in un-acknowledged mode*	*Time critical communications*
Email clients	-	Y	-	-	-	-	-	-	-	-	-	-
Browsers	-	Y	-	-	Y	Y	-	-	-	-	Y	-
IMS voice/video call	Y	-	-	-	-	-	-	-	-	-	-	-
Utility meters, e.g., water meter, electric meter	-	-	Y	-	-	-	-	-	-	-	-	-
Safety alarms, e.g., fire alarm, gas leak alarm	-	-	-	Y	-	Y	-	-	-	-	Y	Y
General health monitors, e.g., smart wearables	-	-	Y	-	-	-	-	-	-	-	-	-
Medical grade health monitors, e.g., heart rate monitor or blood pressure monitor	-	-	-	Y	-	Y	-	-	-	-	Y	Y
Environmental sensors, e.g., pollution monitors, anemometers, or temperature gauge	-	-	Y	-	-	-	-	-	-	-	-	-
V2X safety applications	-	-	-	-	-	-	Y	-	-	-	Y	Y
V2X telematics	-	-	-	Y[1]	-	-	-	-	-	-	-	-
In-vehicle infotainment,		Y	-	-	Y	Y	-	-	-	-	-	-
Audio/video streaming	-	Y	-	-	Y	-	-	-	-	-	-	-
Live event sharing e.g., sports matches, weddings	-	Y	-	-	-	Y	-	-	-	-	Y	-
IP voice/video calls without need for seamless handover, e.g., using over-the-top applications.	-	-	-	-	-	-	-	-	Y	-	-	-
Instant information exchange requiring real-time response	-	-	-	-	-	-	-	Y	-	-	-	-
Messaging without need for real-time response	-	Y	-	-	-	-	-	-	Y	-	Y	-
First Responder applications (police, ambulance, fire, etc.)	Y	Y	-	-	-	-	-	-	-	Y	-	Y
Internet radio applications	-	Y	-	-	Y	-	-	-	-	-	-	-
Cloud-linked productivity applications (e.g., document editors, audio editors, or video editors)	-	Y	-	-	-	-	-	-	-	-	-	-
Real-time gaming	-	-	-	-	-	-	-	Y	-	-	-	Y
Extended reality/augmented reality/virtual reality	Y	-	-	-	-	-	-	Y	-	-	-	Y

Table 14: Example of Traffic category mapping to typical application classes

[1] For services such as diagnostic reporting, i.e., not directly related to immediate safety or vehicle driveability.

Annex B Guidance for ecosystem with use of network slicing

This Annex provides guidance information for application developers and application publishers to share information that can be useful for an MNO for configuring network slices. While application developers might indicate via OS APIs what traffic categories are suitable for the application traffic (see section 3.8), it is the MNO that decides which traffic categories (see 3GPP Release 18 TS 23.503 [7]) are actually supported in its network.

B.1 Information to support application developers

OS vendors define APIs to enable applications to request network connections, where a request may contain information relevant for selection of a specific traffic category (see also section 3.2). For further details, see GSMA PRD TS.62 [19].

Information about the traffic categories that an application would like to use may be found in the application itself (e.g., as part of the meta information bundled with application code) and/or listed in repositories/portals from where users can download and install application(s).

B.2 Information to support MNO

Whilst application developers may determine the traffic categories that are best suited for an application based on a specific use case, e.g., browsing, streaming, or voice calls, the MNO determines the network slice characteristics. To assist MNOs to configure the network slices that benefit actual applications, it is useful for MNOs to have information on the traffic categories used in the connection requests from the OS.

Annex C Document Management

C.1 Document History

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C.2 Other Information

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