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| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Study on generic group management, exposure and communication enhancements (GMEC)  (Release 18) | |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, certain modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

NOTE 1: The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

NOTE 2: The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

NOTE 3: The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

NOTE 4: The constructions "can" and "cannot" shall not to be used as substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

NOTE 5: The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The scope of this Technical Report is to study potential enhancements on generic group management, exposure and communication. Specifically, the following aspects are in the scope of the study:

- Enhance group attribute management and group status event reporting:

- set/modify the group attributes: provisioning of service area or QoS applicable to each UE of a given group;

- subscribe to group status event reporting for the event "newly registered or (de)-registered group member".

- Study whether and how to enhance NEF exposure framework to enable capability exposure for provisioning of traffic characteristics and monitoring of performance characteristics applicable to each UE of a given group.

- Support group communication for a 5G VN, which supports multiple SMFs, including support of SMF redundancy for reliability of the 5G VN group communication.

- Whether additional mechanism or enhancement is needed and how to support group communication allowing UE to simultaneously send data to different groups, where each group has a different QoS policy (requirement regarding 5SEI as indicated in clause 6.13.2 of TS 22.261 [6]).

# 2 References

The following documents contain provisions, which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[3] 3GPP TS 23.502: "Procedures for the 5G system, Stage 2".

[4] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System".

[5] 3GPP TS 22.104: "Service requirements for cyber-physical control applications in vertical domains".

[6] 3GPP TS 22.261: "Service requirements for next generation new services and markets".

# 3 Definitions of terms and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1], in TS 23.501 [2] and in TS 23.502 [3] apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

The following definitions of terms are copied from TS 23.501 [2]:

**5G LAN-type Service:** A service over the 5G system offering private communication using IP and/or non-IP type communications.

**5G LAN-Virtual Network:** A virtual network over the 5G system capable of supporting 5G LAN-type service.

**5G VN Group:** A set of UEs using private communication for 5G LAN-type service.

**Private communication:** A communication between two or more UEs belonging to a restricted set of UEs.

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], in TS 23.501 [2] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

<ABBREVIATION> <Expansion>

5G LAN 5G Local Area Network

5G VN 5G LAN-Virtual Network

# 4 Architectural Assumptions and Requirements

## 4.1 Architectural Assumptions

The NEF exposure framework as in TS 23.501 [2] is the baseline for study of 5G capabilities exposure for industrial and automation applications.

The QoS and policy framework as in TS 23.501 [2] is used for enforcement of QoS applicable to each UE of a given group.

Existing QoS mechanism and service area mechanism are re-used for enforcement of service area or QoS applicable to each UE of a given group, thus neither new QoS nor service area enforcement mechanism will be specified.

Architecture and functions defined for 5G LAN-type service in clauses 4.4.6, 5.8.2.13 and 5.29 of TS 23.501 [2] are used as the baseline for 5G VN group communication enhancements.

Unstructured PDU Session type is out of scope for this study.

## 4.2 Architectural Requirements

The solutions for this study will describe what kind of group the solution is targeting (e.g. 5G VN group, or a group UE identified by External Group ID, or a group UE identified Internal Group ID, or a group UE identified by address (multicast/broadcast address) or any other form of group).

# 5 Key Issues

## 5.1 Key Issue #1: Enhance group attribute management

### 5.1.1 Description

Based on the scope of this study, a group can be set with service area or QoS that is applicable to each UE within the group.

NOTE: UE can belong to multiple groups concurrently.

Release-17 specifications including TS 23.501 [2] and TS 23.502 [3] already provides enforcement mechanisms of "Service Area" attribute and these depends on the particular service. For example:

- Service area restrictions: service area restrictions mechanism is per UE and enforced in AMF and UE. The UE that is in non-allowed area is not allowed to initiate Service Request, or have user plane connectivity etc. as described in clause 5.3.4.1 of TS 23.501 [2].

- LADN: LADN service area applies to any PDU Session to the given DNN. LADN service area is enforced in SMF. The UE that is out of LADN service area cannot access any services of the given DNN.

- Spatial validity in Traffic Influence for Edge services: Spatial validity is enforced in SMF. The UE that is out of spatial validity area can access the service via C-PSA. "Service Area" for a group of UEs using an Edge service is already supported by the existing spatial validity mechanism. A mechanism for the AF to create and modify Edge user groups on temporary basis is out of scope of this key issue.

This key issue aims at addressing the following points:

- How to provision (i.e. set, modify and delete) the service area or QoS applicable to each UE of the group via exposure interface, i.e.:

- What is the information that constitutes the service area applicable to each UE of the group via the exposure interface, and how to enforce the service area applicable to each UE of the group by reusing the existing mechanisms;

- What is the information that constitutes the QoS applicable to each UE of the group, and how to enforce the QoS applicable to each UE of the group using existing mechanisms.

## 5.2 Key Issue #2: Enhance group status event reporting

### 5.2.1 Description

The study item includes objectives to enhance group status event reporting in order to allow subscription to group status event reporting for the event "newly registered or (de)-registered group member". To enable this, this key issue aims at addressing the following points:

- How to enable the group status event reporting via exposure interface, i.e.:

- What is the subscription information for the event "newly registered or (de)-registered group member";

- What is the trigger to detect such event;

- What is the information within the event reporting to reflect the changes of group status.

## 5.3 Key Issue #3: NEF exposure framework for provisioning of traffic characteristics and monitoring of performance characteristics

### 5.3.1 Description

The objective of this Key Issue is to study the potential enhancement needs for the NEF exposure framework to enable capability exposure for provisioning of traffic characteristics and monitoring of performance characteristics applicable to each UE of a given group. NEF framework shall allow the external applications to subscribe to events of UEs forming the group.

For monitoring of performance characteristics applicable to each UE of a given group the exposure framework shall support on-demand, periodic and event-triggered monitoring for each UE that is part of a group of UEs. For event-triggered monitoring, there shall be possible to define the triggering event(s) or parameter threshold(s) valid for all monitored UEs (that are part of a group).

The key issue will study:

- What enhancements are needed for the defined Network Exposure procedures and NEF Services;

- How to use the NEF exposure framework to configure traffic characteristics applicable to each UE of a given group;

- How to use the NEF exposure framework to monitor performance characteristics applicable to each UE of a given group;

- Which traffic characteristics (e.g. transfer interval, data volume per cycle time, average and peak date rates, silence time interval, and PDU Session Type) are relevant for 5GS;

- Which performance characteristics (e.g. communication service availability, communication service reliability, end-to-end latency, service bit rate and packet error rate) are relevant to be monitored;

NOTE 1: See 5G-ACIA White Paper (Exposure of 5G Capabilities for Connected Industries and Automation Applications, February 2021), clause 5 and Annex C of TS 22.104 [5] for more examples of traffic characteristics and performance characteristics.

NOTE 2: This key issue focuses on exposure enhancements. No new enforcement mechanisms will be specified as part of this key issue.

## 5.4 Key Issue #4: Multiple SMFs for VN group communication

### 5.4.1 Description

There is a restriction on the Rel-16 5G VN group communication session management, "A dedicated SMF is responsible for all the PDU Sessions for communication of a certain 5G VN group".. R18 work aims at supporting reliability of the 5G VN group communication as well as the case where a 5G VN spans over a large area and different UE group member accesses to the 5G VN at different locations, . When multiple SMFs are involved to serve a 5G VN group, multiple UPFs controlled by these SMFs might be involved to enable 5G VN group communication of the 5G VN group.

For this Key Issue, it will be studied how to support multiple SMFs to serve PDU Sessions of a 5G VN group, including:

- Support of SMF redundancy for reliability of the 5G VN group communication;

- Which architectural enhancements, if any, are needed to enable the support of multiple SMFs to serve a 5G VN group; this may include:

- How to manage session management when multiple SMFs are involved to serve a 5G VN group where the UE group members are connected to multiple UPFs controlled by these SMFs;

- How to manage communication among the UE group members when they are served by different UPFs and different SMFs including the case of UE(s) mobility, this needs to take the signaling scalability issues for large VN groups with lots of devices into account.

It is assumed that each solution will describe assumptions on UPF deployment topology, if any.

## 5.5 Key Issue #5: Allowing UE to simultaneously send data to different groups with different QoS policy

### 5.5.1 Description

This key issue will study whether additional mechanisms or enhancement are needed to support group communication allowing a UE to simultaneously send data to different groups where each group has a different QoS policy and if yes how to.

# 6 Solutions

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Key Issues | | | | |
| Solutions | #1 | #2 | #3 | #4 | #5 |
| #1 | X |  |  |  |  |
| #2 |  |  | X |  |  |
| #3 |  |  |  | X |  |
| #4 |  |  |  | X |  |
| #5 |  |  |  | X |  |
| #6 |  |  |  |  | X |
| #7 |  |  |  |  | X |
| #8 | X |  |  |  |  |
| #9 | X |  |  |  |  |
| #10 | X |  |  |  |  |
| #11 |  | X |  |  |  |
| #12 | X |  |  |  |  |
| #13 | X |  |  |  |  |
| #14 |  | X |  |  |  |
| #15 |  | X |  |  |  |
| #16 |  |  |  | X |  |
| #17 |  |  |  |  | X |

## 6.1 Solution #1: Support for service area group attribute

### 6.1.1 Introduction

This solution aims to address the key issues #1: enhance group attribute management, it addresses particularly how to set or modify the service area group attribute for a 5G VN group.

### 6.1.2 Functional Description

To address how to set or modify the service area group attribute for a 5G VN group, this solution follows the principles below:

- The parameter provisioning service can be re-used to configure or update the group membership information of a 5G VN group as defined in clause 4.15.6.3c of TS 23.502 [3] to UDM, and UDM manages the group membership information as part of the group subscription data.

- Enhance the parameter provisioning service by introducing the service area information as a new input parameter, and this service area information is stored as part of the group data in group subscription data.

- AMF can retrieve from UDM the group subscription data as "Subscription Data, Group Data" data type using Nudm\_SDM\_Get, or the AMF can be notified by UDM the group subscription data as "Subscription Data, Group Data" data type using Nudm\_SDM\_Notification. With the group subscription data, the AMF can transform the service area group attribute to service area per UE group member (Group Service Area) using the registration area of the registered UE group member.

Editor’s note: It is FFS whether there are impacts to the way AMF, SMF, PCF receives the content of the group subscription data from UDM.

- AMF can configure UE with the Group Service Area, and further inform SMF of whether UE is IN or OUT of the Group Service Area during PDU Session establishment or in UE mobility event notification, the UE and SMF then take actions same as Local Area Data Network (LADN) mechanism as specified in clause 5.6.5 of TS 23.501 [2].

- AMF can determine UE presence in Group Service Area and provide the UE mobility related event reporting to SMF using UE mobility event notification as defined in clause 5.3.4.4 of TS 23.501 [2].

Figure 6.1.2-1 depicts the architecture to support service area group attribute:



Figure 6.1.2-1: Architecture to support service area group attribute

**AF:** Application Function that interacts with NEF to dynamically create, update or release a group with service area group attribute and group membership.

**NEF:** 5G capabilities exposure function that supports interacting with AF for management of a group with service area group attribute and group membership, and interacting with UDM to update the group subscription data including service area information and group membership. It can also transform the geographical area received from AF into a list of TAI or cell ID.

**UDM:** Based on NEF request, it manages the group subscription data including service area information and group membership via interacting with UDR. It can also provide AMF or SMF with the group subscription data including service area information and group membership as "Subscription Data, Group Data" data type via Nudm\_SDM\_Get or Nudm\_SDM\_Notification.

**UDR:** Storage of the group subscription data including service area information and group membership. It can also provide AMF or SMF with the group subscription data as "Subscription Data, Group Data" data type using Nudr\_DM\_Query or Nudr\_DM\_Notify.

**AMF:** It is responsible to transform the service area information received in group subscription data to service area per UE group member (Group Service Area) using the registration area of the registered UE group member, and optionally configure UE with the Group Service Area. It is also responsible to detect that the UE is "IN" or "OUT" of the Group Service Area and inform SMF about this during PDU Session establishment or in UE mobility event notification.

**UE:** It can be provisioned with the Group Service Area and determines whether it is in or out of the Group Service Area. Then it takes actions as defined for LADN, i.e. UE behaviour is based on LADN as defined in Rel-17 specifications without any changes.

**SMF:** SMF can be informed by AMF that the UE is "IN" or "OUT" of the Group Service Area via subscribing to UE mobility event notification for the corresponding group and takes actions as defined for LADN.

### 6.1.3 Procedures

Figure 6.1.3-1 outlines the procedure for support of service area group attribute.



Figure 6.1.3-1: Procedures for support of service area group attribute

1. The AF provides information (Group ID, Group Data, and Group Membership) of a group to be created or updated in Nnef\_ParameterProvision\_Create or Nnef\_ParameterProvision\_Update to create.

Group ID identifies the 5G VN Group.

Group Data contains the DNN, S-NSSAI and Service Area Information for the group.

Group Membership contains a list of UE identities that uniquely identify the group member.

2. The NEF requests to create or update group subscription data (External Group ID, Group Data, and Group Membership) via Nudm\_ParameterProvision\_Create or Nudm\_ParameterProvision\_Update.

The NEF can transform the Service Area Information expressed in geographical area into Service Area Information expressed in a list of TAI or cell ID.

3. The UDM may read from UDR, by means of Nudr\_DM\_Query, corresponding group subscription data in order to validate required data updates and authorize these changes for group for the corresponding AF.

4. The UDM updates the UE subscription data and/or group subscription data, and requests to create or update UE subscription data and/or group subscription data via Nudr\_DM\_Create/Update.

5. The UDM responds the NEF with Nudm\_ParameterProvision\_Create/Update Response.

6. The NEF responds the AF with Nnef\_ParameterProvision\_Create/Update Response.

7. The UDM provides group subscription data to AMF or SMF as "Subscription Data, Group Data" data type via Nudm\_SDM\_Notification or Nudm\_SDM\_Get.

The UDM can provide the AMF with the group subscription data via Nudm\_SDM\_Notification when there are UE group member(s) already registered via the AMF or via Nudm\_SDM\_Get Response when the first UE group member is registering via the AMF.

The UDM can provide the SMF with the group subscription data via Nudm\_SDM\_Notification when there are ongoing PDU Session(s) accessing the group established via the SMF or via Nudm\_SDM\_Get Response when the first PDU Session accessing the group is going to be established via the SMF.

8. The UDR provides group subscription data to PCF as "Subscription Data, Group Data" data type via Nudr\_DM\_Query or Nudr\_DM\_Notify. The PCF updates URSP rules to the registered UE group member, if needed.

9. The AMF transforms the service area information received in group subscription data to service area per UE group member (Group Service Area, i.e. DNN, S-NSSAI, a list of TAIs) using the registration area of the registered UE group member, and configure UE with the Group Service Area via Registration or UE Configuration Update procedure.

10. The UE behaves similar with mechanism defined for LADN as defined in clause 5.6.5 of TS 23.501 [2]. When the UE is in a Group Service Area, the UE can send NAS SM request to the network.

a) When the UE is out of a Group Service Area, the UE:

- shall not request to activate UP connection of a PDU Session for the corresponding DNN, S-NSSAI;

- shall not establish/modify a PDU Session for the corresponding DNN, S-NSSAI (except for PS Data Off status change reporting for an established PDU Session);

- need not release any existing PDU Session for the corresponding DNN, S-NSSAI unless UE receives explicit SM PDU Session Release Request message from the network.

b) When the UE is in a Group Service Area, the UE:

- may request a PDU Session Establishment/Modification for the corresponding DNN, S-NSSAI;

- may request to activate UP connection of the existing PDU Session for the corresponding DNN, S-NSSAI.

11. When receiving NAS SM request with the DNN, S-NSSAI associated with the group, the AMF determines UE presence in Group Service Area and forwards it to the SMF.

12. When receiving NAS SM request with the DNN, S-NSSAI associated with the group, the SMF determines UE presence in Group Service Area based on the indication received from the AMF. The SMF shall also subscribe to "UE mobility event notification" for reporting UE presence in Area of Interest by providing DNN, S-NSSAI associated with the group to the AMF as described in clauses 5.6.11 and 5.3.4.4 of TS 23.501 [2]. The UE behaves similar with mechanism defined for LADN as defined in clause 5.6.5 of TS 23.501 [2].

a) When SMF is informed that the UE presence in a Group Service Area is OUT, the SMF shall:

- release the PDU Session immediately; or

- deactivate the user plane connection for the PDU Session with maintaining the PDU Session and ensure the Data Notification is disabled and the SMF may release the PDU Session if the SMF is not informed that the UE moves into the LADN service area after a period.

b) When SMF is informed that the UE presence a Group Service Area is IN, the SMF shall:

- ensure that Data Notification is enabled.

- trigger the Network triggered Service Request procedure for a PDU Session accessing the group to active the UP connection when the SMF receives downlink data or Data Notification from UPF.

c) When the SMF is informed that the UE presence in a Group Service Area is UNKNOWN, the SMF may:

- ensure that Data Notification is enabled.

- trigger the Network triggered Service Request procedure for a PDU Session accessing the group to active the UP connection when the SMF receives downlink data or Data Notification from UPF.

13. Finish rest of the Session Management procedures as defined in clause 4.3 of TS 23.502 [3].

### 6.1.4 Impacts on existing entities and interfaces

NEF/UDM: The parameter provisioning service can support service area information as a new input parameter for management of a 5G VN group.

UDM/UDR: The group subscription data can contain 5G VN group membership information and 5G VN group data including the service area information.

AMF: The AMF can transform the service area information received in the group subscription data to service area per UE group member (Group Service Area) using the registration area of the registered UE group member, and configure UE with the Group Service Area along with the associated DNN and S-NSSAI. The AMF can detect that the UE is "IN" or "OUT" of the Group Service Area and inform SMF about this during PDU Session establishment or in UE mobility event notification.

UE: With the Group Service Area along with the associated DNN and S-NSSAI, the UE behaves as same as Rel-17 LADN.

SMF: With the information received from AMF that the UE is "IN" or "OUT" of the Group Service Area, the SMF takes actions as same as Rel-17 LADN.

## 6.2 Solution #2: New NEF service for connection management for a group

### 6.2.1 Introduction

Editor's note: This clause briefly lists the key issue(s) addressed by this solution, and the main principles of the solution.

This solution aims to address the key issue #3: NEF exposure framework for provisioning of traffic characteristics and monitoring of performance characteristics, particularly it introduces a new NEF service to address how to use the NEF exposure framework to configure traffic characteristics applicable to each UE of a given group, and how to use the NEF exposure framework to monitor performance characteristics applicable to each UE of a given group.

The solution assumes that the group membership information (e.g., list of UE ID) of a group is already stored in the UDM/UDR via OAM configuration or NEF Parameter Provisioning service request, and will investigate the following traffic characteristics for this group:

- Transfer interval: Time difference between two consecutive transfers of application data from an application via the service interface to 3GPP system. It indicates the time elapsed between any two consecutive messages delivered by the automation application to the ingress of the 3GPP system. Applicable only to periodic communication.

- Data volume per cycle time: Largest data volume within a cycle i.e. one transmission occurred every transfer interval.

- Average and peak data rates: Indicate the expected target data rate and maximum data rate of a connection during a given time window.

- Silence time interval: Indicate the time period when an established connection will not carry any user payload (e.g. at night or on weekends).

- PDU Session Type: Indicate the target PDU Session Type (e.g. Ethernet or IP) for an established connection.

The solution will investigate the following performance characteristics:

- End-to-end latency: The time that it takes to transfer a given piece of information from a source to a destination, measured at the communication interface, from the moment it is transmitted by the source to the moment it is successfully received at the destination. This parameter indicates the time allotted to the communication system for transmitting a message and the permitted timeliness. Maximum and average End-to-end latency are investigated in this solution.

- Service bit rate: In the context of deterministic communication, this indicates committed data rate sought from the communication service. This is the minimum data rate the communication system guarantees to provide at any time.

- Packet error rate: The Packet Error Rate (PER) defines an upper bound for the rate of PDUs (e.g. IP packets) that have been processed by the sender of a link layer protocol (e.g. RLC in RAN of a 3GPP access) but that are not successfully delivered by the corresponding receiver to the upper layer (e.g. PDCP in RAN of a 3GPP access). Thus, the PER defines an upper bound for a rate of non-congestion related packet losses.

### 6.2.2 Functional Description

Editor's note: This clause further details the solution principles and any assumptions made.

This solution introduces a new NEF service, this new service supports provisioning of traffic characteristics applicable to each UE of a given group, and monitoring of performance characteristics applicable to each UE of a given group.

The following are the main principles of the solution:

- Via this new NEF service, the AF can provide NEF with the information targeting to a group in order to influence the user plane connection for packet transmission within 5GC.

Editor's note: Whether a new NEF service is justified, or existing NEF services e.g. for parameter provisioning and monitoring can be enhanced is FFS.

Editor's note: The user plane connection is mapping from "device connectivity" used in 5G-ACIA White Paper (Exposure of 5G Capabilities for Connected Industries and Automation Applications, February 2021). Whether other 3GPP terms instead of "user plane connection" can reflect "device connectivity" more appropriately is FFS.

- NEF can query UDR with the group ID to retrieve the group subscription data, and then transforms the information targeting to a group (e.g. traffic characteristics to be configured or performance characteristics to be measured) to information for each UE group member.

Editor's note: Further details on the data stored in UDR, e.g. whether it is treated as subscription data or other data type is FFS.

- For traffic characteristics to be configured for each UE group member, NEF initiates the Policy Authorization request towards PCF directly or via TSCTSF, the PCF or TSCTSF performs mapping between the traffic characteristics to be configured and 5GS QoS parameters, and triggers PCF initiated SM Policy Association Modification/ Termination.

- If transfer interval is one parameter within the traffic characteristics to be configured, the AF can map the transfer interval to periodicity and provide mapped periodicity to TSCTSF via NEF using existing mechanism as defined in clause 6.1.3.22 of TS 23.503 [4]. Alternatively, the AF can directly provide transfer interval to TSCTSF via NEF and then TSCTSF can map the transfer interval to periodicity, the TSCTSF can deliver the mapped periodicity in TSCAC using existing mechanism as defined in clause 5.27.2.3 of TS 23.501 [2].

- If data volume per cycle time is one parameter within the traffic characteristics to be configured, the AF can map the data volume per cycle time to Maximum Burst Size and provide mapped Maximum Burst Size to TSCTSF via NEF using existing mechanism as defined in clause 6.1.3.22 of TS 23.503 [4]. Alternatively, the AF can directly provide data volume per cycle time to TSCTSF via NEF and then TSCTSF can map the data volume per cycle time to Maximum Burst Size, the TSCTSF can deliver the mapped Maximum Burst Size to PCF as defined in clause 6.1.3.22 of TS 23.503 [4].

- If average and peak data rates are parameters within the traffic characteristics to be configured, the AF can map the average and peak data rates to Requested Guaranteed Bitrate and Requested Maximum Bitrate respectively, and provide the Requested Guaranteed Bitrate and Requested Maximum Bitrate via NEF using existing mechanism as defined in clause 6.1.3.22 of TS 23.503 [4]. Alternatively, the AF can directly provide average and peak data rates to TSCTSF via NEF and then TSCTSF can map the average and peak data rates to Requested Guaranteed Bitrate and Requested Maximum Bitrate, the TSCTSF can deliver the Requested Guaranteed Bitrate and Requested Maximum Bitrate to PCF as defined in clause 6.1.3.22 of TS 23.503 [4].

- If silence time interval is one parameter within the traffic characteristics to be configured, the AF can map the silence time interval to temporal invalidity condition and provide temporal invalidity condition to TSCTSF via NEF. Alternatively, the AF can directly provide silence time interval to TSCTSF via NEF and then TSCTSF can map the silence time interval to temporal invalidity condition. The TSCTSF manages the temporal invalidity condition (start-time, end-time), for example when the start-time is reached, the TSCTSF initiates SM Policy Association Modification so to remove the QoS Flow or de-activate the UP connection of a PDU Session as defined in clause 4.16.5.2 of TS 23.502 [3]; when the end-time is reached, the TSCTSF initiates SM Policy Association Modification so to add a new QoS Flow or activate the UP connection of a PDU Session as defined in clause 4.16.5.2 of TS 23.502 [3].

- If PDU Session Type is one parameter within the traffic characteristics to be configured, the AF should ensure that the requested PDU Session Type is configured as part of the 5G VN group data e.g. via Nnef\_ParameterProvision\_Create/Nnef\_ParameterProvision\_Update, so the UE group members within the target group have subscription for the requested PDU Session Type and have URSP rules configured for the requested PDU Session Type. If the PCF/SMF receives the requests to update the PDU Session type for an ongoing PDU Session and the requested PDU Session type is the only authorized PDU Session type subscribed for the UE or 5G VN group, then SMF sends PDU Session Release COMMAND to UE indicating that re-establishment of the PDU Session is required, so the UE will re-establish the PDU Session using URSP rules for the requested PDU Session Type.

NOTE: There is only one subscribed PDU Session Type for a 5G VN group at a time.

- For performance characteristics to be measured for each UE group member, NEF initiates the Event Exposure request towards PCF or NWDAF directly or via TSCTSF, e.g. for QoS Notification Control (QNC) or QoS Monitoring for URLLC.

- If maximum end-to-end latency is one parameter within performance characteristics to be measured, the AF can map the maximum end-to-end latency to Requested 5GS Delay and provide Requested 5GS Delay to TSCTSF via NEF using existing mechanism as defined in clause 6.1.3.22 of TS 23.503 [4]. Alternatively, the AF can directly provide maximum end-to-end latency to TSCTSF via NEF and then TSCTSF can map the maximum end-to-end latency to Requested 5GS Delay, the TSCTSF can calculate the Requested PDB using Requested 5GS Delay and deliver the Requested PDB using existing mechanism as defined in clause 4.15.6.6 and 4.15.6.6a of TS 23.502 [3]. The PCF knows that Requested PDB is to be monitored, then the PCF triggers QoS Notification Control for Requested 5GS PDB. When the Requested 5GS PDB is no longer fulfilled , the RAN reports that the " PDB can no longer be guaranteed", additionally along with the measured PDB.

- If average end-to-end latency is one parameter within performance characteristics to be measured, QoS Monitoring for URLLC as defined in clause 6.1.3.21 of TS 23.503 [4] can be re-used.

- If service bit rate is one parameter within performance characteristics to be measured, the AF can map the service bit rate to Requested Guaranteed Bitrate, and provide the Requested Guaranteed Bitrate using existing mechanism as defined in clause 6.1.3.22 of TS 23.503 [4]. Alternatively, the AF can directly provide service bit rate to TSCTSF via NEF and then TSCTSF can map the service bit rate to Requested Guaranteed Bitrate, the TSCTSF can deliver the Requested Guaranteed Bitrate to PCF as defined in clause 6.1.3.22 of TS 23.503 [4]. The PCF knows that Requested Guaranteed Bitrate is to be monitored, then the PCF triggers QoS Notification Control for Requested Guaranteed Bitrate. When the Requested Guaranteed Bitrate is no longer fulfilled , the RAN reports that the "GFBR can no longer be guaranteed", additionally along with the measured flow bit rate.

- If packet error rate is one parameter within performance characteristics to be measured, the AF can provide the Requested packet error rate as one parameter in Individual QoS parameters as defined in clause 6.1.3.22 of TS 23.503 [4]. The PCF knows that Requested packet error rate is to be monitored, then the PCF triggers QoS Notification Control for Requested packet error rate. When the Requested packet error rate is no longer fulfilled , the RAN reports that the "PER can no longer be guaranteed", additionally along with the measured packet error rate.

- NEF performs the aggregation of the event reporting about performance characteristics to be measured for each UE group member, and sends this aggregated reporting is sent to AF as achieved performance for performance characteristics to be measured.

Editor's note: Whether aggregated reporting is needed, what is the trigger and when to provide aggregated reporting are FFS.

Editor's note: It is FFS what is information that can be provisioned as part of the traffic characteristics and what is the information that can be monitored as part of the performance characteristics.

Editor's note: It is FFS whether there is a need and how to perform for event reporting aggregation for each monitored performance characteristic.

Editor's note: It is FFS how to handle provisioning and monitoring for traffic between two UEs.

Editor's note: It is FFS how to handle transfer interval with statistical deviation (aperiodic traffic).

Editor's note: It is FFS whether NWDAF is involved and how NWDAF functions in this solution.

Figure 6.2.2-1 depicts the architecture to support connection management for a group:



Figure 6.2.2-1: Architecture to support connection management for a group

**AF:** Application Function that interacts with NEF to control (establish, modify, terminate, monitor) the user plane connection for packet transmission within 5GC.

**NEF:** 5G capabilities exposure function that supports interacting with AF in order for AF to influence the user plane connection for packet transmission within 5GC. It can also query UDR with the group ID to retrieve the group subscription data, and then transform the information target to a group to information for each UE group member, as well as interact with PCF (via TSCTSF) to request network resources for the user plane connection. It also performs the aggregation of the monitoring reports for each UE group member.

**UDR:** Storage of the group subscription data including group membership.

**NWDAF:** Performsnetwork data analytics and exposes the analytics to AF via NEF as requested.

**PCF:** Perform mapping between traffic characteristics to be configured and 5GS QoS parameters, and provides policy rules to Control Plane function(s) to enforce them, e.g. TSCAI, QoS Notification Control (QNC) or QoS Monitoring for URLLC.

**TSCTSF:** Provide Ntsctsf\_QoSand TSCAssistance to allow handling for AF requests with individual QoS parameters as described in clause 6.1.3.22 of TS 23.503 [4].

### 6.2.3 Procedures

Editor's note: This clause describes high-level procedures and information flows for the solution.

### 6.2.4 Impacts on existing entities and interfaces

Editor's note: This clause lists impacts to existing entities and interfaces.

AF: provide the transfer interval, data volume per cycle time, the average and peak data rates, the maximum end-to-end latency, the service bit rate, Requested packet error rate, temporal invalidity condition (start-time, end-time), target PDU Type in AF request.

NEF: query UDR with the group ID to retrieve the group subscription data, and then transform the information target to a group to information for each UE group member.

TSCTSF: map the transfer interval to periodicity, map the data volume per cycle time to Maximum Burst Size, map the average and peak data rates to Requested Guaranteed Bitrate and Requested Maximum Bitrate, map the maximum end-to-end latency to Requested 5GS Delay, map the service bit rate to Requested Guaranteed Bitrate, and manage the temporal invalidity condition (start-time, end-time).

SMF: authorizes the AF request to change PDU Type for the PDU Sessions of UE group member for a group. The SMF sends PDU Session Release COMMAND to UE indicating that re-establishment of the PDU Session is required.

PCF: triggers QoS Notification Control for Requested 5GS PDB or Requested Guaranteed Bitrate or Requested packet error rate respectively.

RAN: When the Requested 5GS PDB or Requested Guaranteed Bitrate or Requested packet error rate is no longer fulfilled , the RAN reports that the "PDB can no longer be guaranteed" along with the measured PDB, or "GBR can no longer be guaranteed" along with the measured bit rate, or "PER can no longer be guaranteed" along with the measured packet error rate.

## 6.3 Solution #3: use of SMF sets for 5G VN group communications.

### 6.3.1 Introduction

### 6.3.2 Functional Description

The Support of group communication for a 5G VN needs to ensure SMF redundancy for the reliability of the 5G VN group communications.

Such redundancy can be provided by the SMF set feature that has been supported by 5GC since Rel-16.

Any inter SMF interactions related with intra SMF set co-ordination about a 5G VN group ( e.g. on the control of the N19 tunnel between the UPF(s) involved in a 5G VN group communication) is left outside the scope of 3GPP specifications.

NOTE: This solution does not assume that 5G VN group communication only happens in a local area, e.g. involving the same unique data center as a SMF Set may be deployed across multiple sites/data centres. Furthermore, to handle 5G VN groups with UE spread over a large country, I-SMF may be used to connect remote UE(s) to the (unique) SMF set serving the 5G VN group.

### 6.3.3 Procedures

Following note of clause 5.29.3 of 23.501 [2] "PDU Session management" needs to be reworded to no more refer to a "SMF" but to a "SMF set":

NOTE 1: The network is configured so that the same SMF is always selected for a certain 5G VN group, e.g. only one SMF registers on the NRF with the DNN/S-NSSAI used for a given 5G VN group.

Thus, the NOTE would read as follows:

NOTE 1: The network is configured so that the same SMF \*set\* is always selected for a certain 5G VN group, e.g. only one SMF registers on the NRF with the DNN/S-NSSAI used for a given 5G VN group.

When the UE is not located in the service area of the SMF set associated with the DNN/S-NSSAI used for a 5G VN group, per 3GPP R16 procedures, the AMF involves an I-SMF for the PDU Session.

NOTE 1: The SMF(s) that are part of a SMF set can collaborate via one of or a combination of following implementation dependant means:

* The SMF(s) can share contextual information associated with the 5G VN group (DNN + S-NSSAI) in the UDSF. The contextual information may e.g. relate to the N19 configuration, to the list of PDU Sessions established by 5G VN group members, etc….
* Implementation dependant signaling can be used between SMF(s) that are part of a SMF set e.g. based on an implementation choice SMF(s) within the set can elect one SMF to control the N19 configuration

The solution supports 5G VN groups with UE spread over a wide area (e.g. a whole country like China). In this case, the SMF(s) that control the PDU Session (SMF(s) that have the PCF and CHF interactions, etc…) are part of the same SMF set while I-SMF(s) handling the local connectivity to the UE do not need to be part of this SMF set. A SMF can control local traffic switching between group members via proper FAR(s) and PDR(s) rules sent over N16a. When a UE moves out of the service area of the SMF set that controls the communications within a 5G VN group an I-SMF is used as specified in 3GPP R17 specifications

NOTE 2: Each 5G VN group can be associated with a specific slice, using e.g. the Slice Differentiator (SD), parameter of the S-NSSAI, to ensure that PDU Sessions of 5G VN users in the I-SMF serving areas are handled by I-UPF(s) supporting the necessary features.

NOTE 3: Even though signaling between SMF(s) that are part of a SMF set is based on an implementation choice, but the SMF set or SMF instances in SMF set need to support functionality for 5G VN group communications across SMFs.

Editor's note: It is FFS how to support local switching at I-UPFs or N19-based forwarding across I-UPFs, e.g. within one data center, so to avoid routing traffic always to A-UPFs.

### 6.3.4 Impacts on existing entities and interfaces

The solution impacts are on:

- Registering a SMF set (and not a SMF instance) as associated with the DNN + S-NSSAI representing a certain 5G VN group.

- possibly associate a 5G VN group with a dedicated Slice Differentiator.

## 6.4 Solution #4: Multiple SMFs for VN group communication

### 6.4.1 Introduction

This solution is for Key Issue #4 on Multiple SMFs for VN group communication.

Figure 6.4.1-1 depicts the architecture for the solution.



Figure 6.4.1-1: Architecture for multiple SMFs involved 5G VN group communication

### 6.4.2 Functional Description

The main idea of this solution is as below:

- If the SMF has established at least one PDU session for a VN, the SMF can be treated as SMF serving the VN.

- Each SMF serving the same 5G VN group registers/update its profile in the NRF with the serving 5G VN group identifier. The serving VN group identifier is the DNN/S-NSSAI used by the PDU session.

- Each SMF can obtain the other SMF(s) serving the same VN by querying the NRF with VN group identifier.

- Each SMF can subscribe the VN group status change event (e.g. new SMF serving the VN, or a SMF stop serving the VN) with NRF. When the event occurs, the NRF sends notification to subscribed SMF with SMF information of the VN.

- After SMF obtains the other SMF(s) serving the same 5G VN, it initiates the VN session requests with each of other SMFs to establish the VN session and N19 tunnels between UPFs controlled by two SMFs.

- When the SMF determines VN status has changed (e.g. a new PDU session for the VN established, a PDU session for the VN released, etc.), it sends update/release requests to the all other SMFs to update the VN session (e.g. update the PDR/FAR in the UPF).

- There is a full mesh of N19 tunnels between UPFs serving the 5G VN group controlled by different SMFs.

### 6.4.3 Procedures

Editor's note: This clause describes high-level procedures and information flows for the solution.

The procedure in Figure 6.4.3-1 shows a signalling flow in which the N19 tunnel between UPFs controlled by two SMFs is created/updated.



Figure 6.4.3-1: Procedure to establish the N19 between UPFs controlled by two SMFs

Editor’s Note: it is FFS whether the SMF triggers a new procedure (and what the procedure is) :

* At every additional PDU Session (contact all other SMFs to inform about the new UE address)? Is Ethernet and IP based PDU Sessions handled in the same way or differently?
* At every new MAC address detected on an Ethernet PDU Session (contact all other SMFs to inform about the new UE address)?
* At PDU Session release and when a MAC address has not been seen for a while (contact all other SMFs to inform about the removed UE address)? Same FFS about usage of Prefix Delegation or IPV6 multi Homing.
* When An UPF is removed from the list of UPF serving a 5G VN group
* When a SMF no more serves any member of the 5G VN group

1. The SMF-1 receives the PDU session establishment request. According to the information in the request, i.e. DNN/S-NSSAI, it knows this PDU session is for the VN group.

2. The SMF-1 update or register its profile to NRF with serving 5G VN group identifier.

3. The SMF-1 perform the SMF discovery to the NRF using the serving 5G VN group identifier. The NRF only return the SMF-1 in the response.

4. The SMF-1 configure the PDR/FAR for this PDU session.

5. The SMF-2 receives the PDU session establishment request. According to the information in the request, i.e. DNN/S-NSSAI, it knows this PDU session is for the VN group.

6. The SMF-2 update or register its profile to NRF with serving 5G VN group identifier.

7. The SMF-2 perform the SMF discovery to the NRF using the serving 5G VN group identifier. The NRF only return the SMF-1 and SMF-2 in the response.

Editor’s Note: it is FFS whether SMF-1 is also triggered that SMF-2 is added as a SMF supporting the group and also contacts also SMF-2 for N19 establishment

8. The SMF-2 configure the PDR/FAR for this PDU session and request the UPF-2 to allocate the N19 tunnel resource information (e.g. TEID).

Editor's note: It is FFS how the SMF-2UPF2 is aware of the number of tunnel end point information it needs to provide to the SMF2. Or whether the procedure needs to be run for each pair of UPF(s) served by the 2 different SMF(s)

9. The SMF-2 sends the VN session request to SMF-1, in the request, the N19 tunnel resource is included.

10. The SMF-1 sends the received N19 tunnel resource information to UPF-1 and request UPF-1 to allocate the N19 tunnel resource information in UPF-1 (e.g. TEID)

11. The SMF-1 sends the VN session response to SMF-2, in the response, the N19 tunnel resource of UPF-1 is included.

12. The SMF-2 sends the N4 request to UPF-2, to inform the N19 tunnel resource information in the UPF-1.

After step 12, the N19 tunnel between UPF-1 and UPF-2 is established.

### 6.4.4 Impacts on existing entities and interfaces

- NRF: adding a new IE, i.e. serving VN ID in the SMF profiles. It supports SMF discovery using serving VN ID.

- SMF: Update/Register serving VN ID to NRF. Establishes the VN session with other SMF serving the same VN group (there is a full protocol to establish the N19 (adding, removing N19 tunnels) and exchange information about UE members and their address, including addition and removal of such addresses)

Editor's note: Additional impact is FFS.

## 6.5 Solution #5: Multiple SMFs involved 5G VN group communication

### 6.5.1 Introduction

This solution is for Key Issue #4 on enhancements of 5G VN group communication.

### 6.5.2 Functional Description

The main idea of this solution is as below:

- Each SMF serving the same 5G VN group reports/registers its identifier and the 5G VN group identifier to the Group Session Management Function. Thus, the Group Session Management Function has the knowledge of all the SMF serving the 5G VN group.

- Each SMF can be aware of other SMFs via the Group Session Management Function as following:

- A SMF subscribes to the Group Session Management Function for the 5G VN group change events (e.g. when another new SMF starts to serve the same 5G VN group or another SMF stops to serve the 5G VN group). When the 5G VN group change events occurs, the Group Session Management Function sends a notification including the changed SMF's identifier information to the subscribed SMF; or

- A SMF can query the SMF information of other group member from the Group Session Management Function.

- The SMF requests a session with another SMF and these two SMFs can establish the N19 tunnels between UPFs and configure the UPFs via the session. When the SMF detects, allocates or releases an address of the UE within the 5G VN group, the SMF sends update/release requests to the other SMF via the session to update the configuration on the UPF.

Editor's note: it is FFS how the SMF(s) collaborate to manage the topology of N19 links (star, ring, tree, etc.).

Figure 6.5.2-1 depicts the architecture for the solution.



Figure 6.5.2-1: Architecture for multiple SMFs involved 5G VN group communication

The Group Session Management Function is defined as a new NF.

Editor’s note: It is FFS whether the GSMF functionality is better handled as part of an existing NF (e.g. UDM which already has information on SMF ID and DNN/S-NSSAI for each PDU Session). This may be further analysed when the functionality of the GSMF is clearer.

### 6.5.3 Procedures

#### 6.5.3.1 Retrieval of peer SMF

Pre-condition/assumption:

1. UE1 and UE2 belongs to the same 5G VN group.



Figure 6.5.3.1-1: multiple SMFs involved 5G VN group communication

1. The UE1 establishes a PDU session (clause 4.3.2.2.1 of TS 23.502 [3]) for getting access to a 5G VN group. In this figure, the UE1 is served by SMF1 and UPF1.

2. SMF1 reports/registers the 5G VN group identifier (which can be identified by DNN and S-NSSAI) of UE1 and SMF1 identifier to the GSMF (Group Session Management Function). If the address of UE1 is further registered to the GSMF in this step, then this step is performed for every new PDU Session to 5G VN in SMF1.

3. In order to enable communication among the group members served by different SMFs, the SMF1 may subscribe to the GSMF for the 5G VN group change events (e.g., when another SMF serves the same 5GVN group or another SMF stops to serve the 5GVN group).

4. Similar as step 1. In this figure, the UE2 is served by SMF2 and UPF2.

5. Similar as step 2.

6. Similar as step 3.

7. The SMF1 retrieves other SMF(s) information via the following two alternatives:

7a. Corresponding to step 3, the GSMF sends a notification including the SMF2 identifier information to the subscribed SMF1 that a new SMF (i.e., the SMF2) starts to serve the 5GVN group.

7b. The SMF1 queries other SMF(s) information of the 5G VN group from the GSMF with the group identifier in the request. If the UE address is also registered to the GSMF, then the SMF1 can query the serving SMF information of a certain target UE from the GSMF with the group identifier and UE identifier in the request (e.g., this may be triggered by a data notification from the UPF).

#### 6.5.3.2 N19 tunnel management



Figure 6.5.3.2-1: N19 tunnel management

1. The SMF1 retrieves the SMF2 information as described in clause 6.5.3.1.

2. Upon the received SMF2 information, the SMF1 determines to establish N19 tunnel between UPF1 controlled by SMF1 and UPF(s) controlled by SMF2. The SMF1 initiates a N4 Session Modification to the UPF1 and the UPF1 provides tunnel information to the SMF1.

Editor's note: It is FFS whether step 2 and beyond take place during the establishment of a PDU Session for a UE, and in that case whether they need to complete for the PDU Session establishment to with the UE to complete .

Editor's note: It is FFS whether and how SMF1 and SMF2 need to know the list of UE and UE IP address served by another SMF serving the group. E.g. When the N19 tunnel is established or modified, the SMF can know the UE addresses served by other SMFs/UPFs by interaction with other SMFs directly (option 1) or querying from/notified by GSMF.

The SMF1 may establish N19 tunnel between UPF1 and UPF(s) controlled by SMF2 via either option #1 or option #2:

Option #1:

3. The SMF1 sends PDUSession\_Create Request (5G VN group identifier, SM Context ID at SMF1, UPF1 tunnel information, list of UE1 IP address served by UPF1) towards the SMF2 to establish a session with SMF2. The SMF2 would reject the PDUSession\_Create Request from the SMF1 if the session already exists.

4. The SMF2 initiates a N4 Session Modification to the UPF2. During this step:

* The SMF2 installs N4 rules(e.g. PDRs and FARs related to UE1) on the UPF2.
* The UPF2 provides tunnel information to the SMF2.

Editor's note: It is FFS how the UPF2 is aware of the number of tunnel end point information it needs to provide to the SMF2. Or whether the procedure needs to be run for each pair of UPF(s) served by the 2 different SMF(s)

5. The SMF2 responds to the SMF1 (SM Context ID at SMF2, UPF2 tunnel information, UE2 IP address). Based on the received SMF Context ID, the SMF1 can update the session towards SMF2 if a UE member has been added or removed to/from the group at SMF1 later.

6. The SMF1 initiates a N4 Session Modification to the UPF1 and installs N4 rules (e.g. PDRs and FARs related to UE2) on the UPF1.

7a. If another UE (e.g. UE3) belongs to the same 5G VN group as UE1 is also served by the SMF1 and UPF3 (it can be the same as or different with UPF1). The SMF1 installs N4 rules related to UE1 and UE2 on the UPF3 and receives UPF3 tunnel information from the UPF3. The SMF1 sends PDUSession\_Update Request (SM Context ID at SMF2, UPF3 tunnel information, UE3 IP address) towards the SMF2.

7b. The SMF2 initiates a N4 Session Modification to install N4 rules related to UE3 on the UPF2.

7c. The SMF2 sends PDUSession\_Update Respond to the SMF1.

Editor's note: It is FFS whether Nsmf\_PDUSession\_Create/Update fits with inter SMF information exchange about each UE served by peer SMF(s) .

Option #2:

8. The SMF1 sends N19 tunnel establishment request (5G VN group identifier, UPF1 tunnel information, UE1 IP address) to the SMF2 via the GSMF. The GSMF stores this information when receive the request from the SMF1 and forward the request to the SMF2.

9. The SMF2 initiates a N4 Session Modification to each UPF controlled by SMF2 for the same 5G VN group. During this step, taking UPF2 in the figure as an example:

* The SMF2 installs N4 rules(e.g. PDRs and FARs related to UE1) on the UPF2.
* The UPF2 provides tunnel information to the SMF2.

10. The SMF2 sends respond to the SMF1 via the GSMF, the response message includes (list of) UPF tunnel information and corresponding UE IP address(es) served by the UPF.

11. The SMF1 initiates a N4 Session Modification to the each UPF controlled by SMF1 for the same 5G VN group and installs N4 rules (e.g. PDRs and FARs related to UE2) on the UPF.

12a. If another UE (e.g. UE3) belongs to the same 5G VN group as UE1 is also served by the SMF1 and UPF3 (it can be the same as or different with UPF1). The SMF1 installs N4 rules related to UE1 and UE2 on the UPF3 and receives UPF3 tunnel information from the UPF3. The SMF1 sends N19 tunnel modification request (5G VN group identifier, UPF3 tunnel information, UE3 IP address) towards the SMF2 via the GSMF. If a UE3 is served by SMF3 (i.e., a SMF different with SMF1), the SMF3 can retrieve the UPF1 and UPF2 tunnel information from the GSMF.

12b. The SMF2 initiates a N4 Session Modification to install N4 rules related to UE3 on the UPF2.

12c. The SMF2 sends respond to the SMF1.

Editor's note: Call flows to remove N19 tunnels between UPF(s) controlled by different SMF(s) are FFS.

Editor's note: it is FFS whether a Call flow is needed to show how each SMF serving a 5G VN group knows that that the list of MAC addresses of a UE member has changed (e.g. based on MAC address learning at UPF)

### 6.5.4 Impacts on existing entities and interfaces

Editor's note: This clause lists impacts to existing entities and interfaces.

## 6.6 Solution #6: Reuse of R17 QoS framework

### 6.6.1 Introduction

The solution targets Key Issue #5: Allowing UE to simultaneously send data to different groups with different QoS policy

### 6.6.2 Functional Description

It is assumed that application logic in the UE determines which data the UE needs to send towards which groups. This may mean sending the same data to different destinations (IP addresses).

To support support group communication allowing UE to simultaneously send data to different groups, where each group has a different QoS policy, following R17 mechanisms may be used:

- usage of a single PDU Session where PCC rules from the PCF can associate different Qos flows to the traffic of the UE within different groups (e.g. traffic to or from different sets of addresses for IP PDU session types, or using different VLAN(s) for Ethernet PDU session types). This alternative does not assume groups associated with 5G VN communications.

A UE member of multiple groups may per R17 establish one or multiple PDU Sessions.

When for example each group is represented by an IP multicast address or a set of IP singlecast addresses, QoS policies represented by PCC rules, QER policies sent over N4 and by QoS rules sent over NAS may associate this IP multicast address or set of IP single cast addresses with dedicated QoS parameters.

If the UE has the same data to send to different groups (thus to different destinations) it creates multiple UL packet to send (one per destination) and applies the QoS rules received from the network to each of the UL packet

NOTE 1: as an example, a UE can send data to different IP multicast addresses where the different IP multicast addresses are reachable over the same PDU Session. Traffic filters (received from the SMF as part of R17 QoS rules within NAS signalling) allow per R17 mechanisms the UE to perform the classification and marking of UL User plane traffic, i.e. the association of UL traffic to QoS Flows.

- usage of 5G VN group communications: where each group maps to a DNN (and slice) that may be associated with its own QoS policies.

When for example each 5G VN group is associated with an IP multicast address or a set of IP singlecast addresses, QoS policies represented by PCC rules, QER policies sent over N4 and by QoS rules sent over NAS may associate this IP multicast address or set of IP single cast addresses with dedicated QoS parameters.

If the UE has the same data to send to different groups (thus to different destinations) it creates multiple UL packet to send (one per destination). In case of 5G VN usage, each UL packet corresponding to a different group maps to a different PDU Session and the UE and applies the QoS rules received from the network on this PDU Session.

For Ethernet PDU Sessions different PDU sessions, hence different groups correspond to different values of the couple (UE MAC address, VLAN tag)

NOTE 2: As defined in Rel-17, for UL traffic, the application in the UE determines the target group(s) thus the target IP (multicast) address(es) or MAC address(es) or VLAN tag(s) that UL data are to be associated with. Then, Rel-17 URSP mechanisms associate the UL data to the relevant PDU Session and Rel-17 Traffic filters allow the UE to associate this UL traffic to QoS Flows. For DL traffic, PCC rules can associate DL traffic to a relevant QoS flow (using e.g. target IP (multicast) address(es) or VLAN tag(s)), noting that Ethernet PDU Sessions support traffic filtering based on IP addresses.

NOTE: Broadcast -multicast requirements in clause 6.13.2 of TS 22.261 [6] need to be studied in a 5MBS related study.

### 6.6.3 Procedures

No changes to existing procedures are needed.

### 6.6.4 Impacts on existing entities and interfaces

None

## 6.7 Solution #7: A PDU Session with multiple groups

### 6.7.1 Introduction

This solution is Key Issue #5 on 5G Smart Energy and Infrastructure.

Figure 6.7.1-1 depicts the concept of the solution.

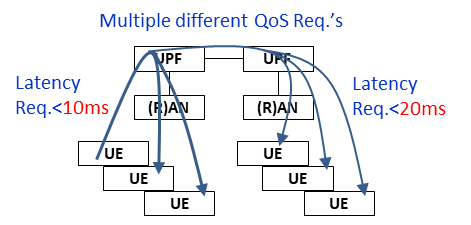


Figure 6.7.1-1: Group communication enhancements for SEI (Smart Energy and Infrastructure)

Target scenario of this solution is a smart grid scenario. For example, a UE shares its phase info with the UEs in Regsion.1 for synchronization and with the UEs in Area.1 for monitoring. Region.1 is located in Aera.1. For that, a UE belongs to Region.1 group and to Area.A group. When the UE sends data to Region.1 group in higher QoS and to Area.A group in lower QoS. The other UEs which belong to Region.1 group and to Area.A group receive data in higher QoS. The UEs which belong to only Region.1 group receive the data in higher QoS. The UEs which belong to Area.A group receive the data in lower QoS. A UE which belongs to Region.1 only, sends data to UEs which belong to Region.1 group and to Area.1 group and to UEs which belong to Region.1 group. A UE which belongs to Area.A group olny sends data to UEs which belong to Region.1 group and to Area.1 group and to UEs which belong to Area.A group.

### 6.7.2 Functional Description

Figure 6.7.2-1 depicts the concept of the solution.

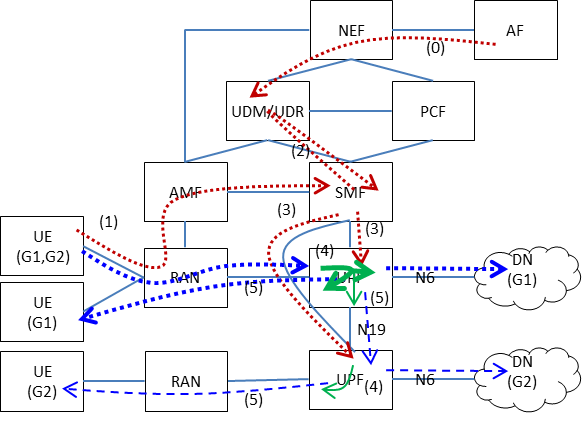


Figure 6.7.2-1: A PDU session with multiple groups

The principles of this solution are like the following. The numbers of each bullet refer to those in Figure 6.7.2-1.

- A UE or an AF requests 5GS to configure new groups with different QoS's (0). UDM/UDR stores the group QoS information. SMF retrieves the information during PDU Session setup. AF can pre-configure the group and the QoS per group.  
A UE belongs to Group1 and Group2 sends data to the UEs which belong to at least one of Group1 and Group2. A UE belongs to Group1 only sends data to UEs which belong to Group1. A UE belongs to Group2 only sends data to UEs which belong to Group2.

- A UE establish a PDU Session for the groups with explicit priorities or implicit priorities (e.g. the former of the list means the higher priority) (1). The UE provides list of group IDs with explicit priorities. For this, the UE provides an indication when it send PDU Session request to 5GC. It is assumed that the UE knows the group id via pre-configuration or via any other means.

For each group the PDU Session is accessing, there should have one QoS flow. For that, priorities among QoSs among groups are needed. It is also possible with implicit priorities when the QoS information includes priorities. Explicit priorities (e.g. using Priority Levels) are provided when the AF pre-configure the group and the QoS per group. If explicit priorities are not provided more strict requirements can be considered to have higher priorities if the same types of requirements like max-latency or min-rate. If the same types of requirements are not used, the groups specified in the earlier order of the PDU Session Request from the UE can be considered to have higher priorities.

The SMF sets up the UPF forwarding table based on the groups and the SMF sets up the QoS flows based on the QoS requirements (2, 3, 4). For example, an UPF can be configured to forward the highest group traffic first, and then to forward the next-higher group traffic not overlapped with the previous traffic. Each UE is verified if it is allowed to communicate with a group when the PDU Session is established.

- The UE sends the traffic to the PSA UPF with the highest QoS of the groups. The UPF forwards the traffic to the UEs of a group with the QoS requirements of the group and to the other UEs of another group with the dedicated QoS for the group. (5) For the UL packet, the UE just needs to send one copy to the PDU session on the QoS flow with most strict QoS requirements, and UPF is responsible for distribution of packet to different groups with different QoS. The usage of QoS rules may also need to know priorities among QoS's among groups. The traffic from the UE belongs to multiple groups with in the PDU Session of multiple DNNs/S-NSSAIs mapped to 5G VN groups is identified as group traffic, and is forwarded as the SMF configured the UPF for the group communication. The UE sends the traffic to the PSA UPF. Each PSA UPF of a UE with a single group forwards the traffic to the UE with the QoS of the group. Each PSA UPF of a UE with multiple groups forwards the traffic to the UE with the highest priority QoS of the groups.

Editor’s NOTE: As different 5G VN groups are mapped to different (DNN, S-NSSAI)(s), the solution means that inter UPF communication needs to be set by SMF(s) controlling different DNN/S-NSSAI(s)between UPF(s) serving different DNN/S-NSSAI(s). it is FFs how this is realized.

### 6.7.3 Procedures

Figure 6.7.3.1-1 outlines the procedure for support of a PDU Session with multiple groups when there can be one UPF.



Figure 6.7.3-1: Procedure for a PDU session with multiple groups

0. The AF configures Group1 and Group2. It also configures QoS requirements1 for Group1 and QoS requirements2 for Group2. Then, the PCF maps QoS1 and QoS2 based on the QoS requirements1 and QoS requirements2.

1. UE1, which belongs to Group1 and Group2, sends PDU Session Request with Group1 and Group2 to the SMF. In this step, the AMF needs to select the SMF based on the information including Group1 and Group2. UE should include multiple DNNs/S-NSSAIs for a PDU Session.

Editor’s note: How DNN/S\_NSSAI specific configuration and subscription data can be accommodated for PDU Sessions that have multiple DNBNs/SNSSAIs is FFS. E.g. how to address inconsistencies, conflicts and overlaps between the respective subscription data.

NOTE: Configuration shall ensure that a SMF / UPF can support all DNNs/S-NSSAIs of the group of groups

2. The SMF checks subscription of the UE1 with the UDM and retrieves group information for Group1 and Group2 from UDM.

2a. The SMF associates with PCF and retrieves QoS information like QoS1 for Group1 and QoS2 for Group2.

3. The SMF exchanges N4 controls with the UPF for Group1 and Group2.

4. The UPF setup the forwarding rules for Group1 and Group2.

Editor’s NOTE: It is FFS how to set the forwarding rules, e.g. PDR/FAR to achieve the replication of one UL packet and distribution the copies to respective group.

5. The SMF sends PDU Session Establish Response for Group1 and Group2 to UE1. The SMF sets QoS for the traffic for Group1 and Group2 to QoS1 if QoS1 has higher priority than QoS2.

5a. UE2, which belongs to Group1, establishes PDU Session for Group1 with QoS1. This includes similar steps similar to steps 1 through 5.

5b. UE3, which belongs to Group2, establishes PDU Session for Group2 with QoS2. This includes similar steps similar to steps 1 through 5.

6. UE1 sends traffic for Group1 and Group2 with QoS1 to the UPF.

Editor’s NOTE: it is FFS whether any data sent to such a group (e.g. group 1) shall always be sent to the other group (e.g. group 2). if this is the case, it is questionable to create different groups for this purpose.

7. The UPF forwards the traffic from UE1 for Group1 and Group2 to UEs belongs to (Group1 and Group2) or to Group1.

8. The UPF sends traffic from UE1 for Group1 and Group2 to UE2 for Group1 with QoS1.

9. The UPF forwards the traffic from UE1 for Group1 and Group2 to UEs belongs to Group2 but not belongs to Group1.

10. The UPF sends traffic from UE1 for Group1 and Group2 to UE3 for Group2 with QoS2.

### 6.7.4 Impacts on existing entities and interfaces

The impacts on the existing entities are like the following.

- UE shall include multiple DNNs/S-NSSAIs for a PDU Session.

- AMF shall select the SMF based on the multiple DNNs/S-NSSAIs.

- SMF shall control the UPF(s) based on the multiple DNNs/S-NSSAIs and QoS setup considering priorities among multiple groups.

- UPF shall forwards traffic for multiple groups.

- AMF (including NAS) PCF/CHF/RAN shall support PDU Sessions with multiple DNNs/S-NSSAIs.

## 6.8 Solution #8: Support for service/LADN area and QoS provided by AF for a group

### 6.8.1 Introduction

This solution aims to address the KI#1.

This solution assumes that the LADN feature is used to enforce the “Service Area”, and therefore uses the term “LADN Area” to distinguish it from the unrelated Service Area Restriction feature.

This solution re-uses the 5G VN group management API to allow an AF to create a group with an associated DNN/S-NSSAI. There is no assumption that the 5G VN group communication features (eg. N19) are used for the group.

### 6.8.2 Functional Description

To address how to set or modify the LADN area and QoS for a group, this solution follows the principles below:

- The 5G VN group data is extended to include LADN Area and QoS information

- The existing NEF parameter provisioning service for 5G VN group data provisioning is re-used, with the difference that the 5G VN group data may contain a “AF LADN Area” and QoS information as a new input parameters.

- The existing UDM parameter provisioning service for 5G VN group data provisioning is re-used, with the difference that the 5G VN group data may contain a LADN Area and QoS information as a new input parameter. The LADN Area and QoS information is also stored as part of the 5G VN group data in UDR.

- The KI#1 is not limited to 5G VN groups and thus applicable to general subscribed groups. It should however be noted that the 5G VN API assumes that the AF has created the group and provided the list of subscribers to the DNN/S-NSSAI for the group. The 5G VN API is not applicable for regularly subscribed DNN/S-NSSAIs, i.e. DNN/S-NSSAIs configured in regular MM/SM UE subscription data by the operator.

It should also be noted that 5G VN solution defined in TS 23.501/502 consists of two main parts:

- Group management solution where an AF can create a group of UEs and associated with a DNN/S-NSSAI representing the 5G VN group.

- Group communication enhancements that can optionally be used for 5G VN, e.g, using local switch and N19 based forwarding in UPF.

In principle these two aspects are independent. I.e. a group can be created using the 5G VN NEF API without using the 5G VN communication related features. Therefore, the NEF and UDM services for 5G VN group data provisioning could apply also for groups not using the specific 5G VN group communication mechanisms. This makes it possible for an AF to create and manage groups and group data that are not specifically 5G VN groups.

NOTE: The name of the APIs used with 5G VN groups unfortunately contain the terms 5G VN or 5G LAN. For example, the NEF API for provisioning group data is named “3gpp-5glan-pp”. The NEF APIs to provision other parameters (even for groups of UEs) are named e.g. “3gpp-cp-parameter-provisioning” and “3gpp-network-parameter-configuration”. Similar applies for UDM services: The UDM resource used with Nudm\_ParameterProvision is named “/5g-vn-groups” and is different from the resource used for provisioning other parameters (named “/pp-data”). The resource “/pp-data” can be used to provision parameters for individual UEs as well as groups of UEs.

Editor’s note: It is FFS whether group management API without specific “5G VN” names should be defined instead, to enable a solution separate from the 5G VN specific group management

- The provisioning of LADN Area and QoS takes place as follows:

- The NEF allows an AF to invoke the NEF Parameter Provisioning API to provide a 5G VN group data including a AF LADN Area and QoS information. The AF may provide additional information as part of the 5G VN group data based on existing specifications, e.g. AAA server address. The External Group ID refers to a group that the AF has created.

- The AF LADN Area provided by the AF refers to a geographical area. The NEF maps this information to a list of TAIs.

- The NEF invokes the Nudm Parameter Provision Services to provide the 5G VN group data to UDM.

- The UDM stores the 5G VN group data in UDR, and updates each group member’s AM and SM subscription data to refer to the 5G VN group data. If Shared Data is not supported by AMF or UDM, the UDM includes the LADN Area in the regular AM subscription data.

- The AMF receives the UE’s subscription data (and related 5G VN group data). The AMF applies the LADN Area as described for LADN in 23.501, with the difference that the LADN Area is received from UDM instead of being configured in AMF.

- The UDR notifies subscribed PCFs about the updated 5G VN group data. The PCFs take the received QoS information into account. The QoS information provided by the AF contains a QoS Reference and it is used by PCF in determining QoS parameters for application traffic.

Editor’s note: It is FFS the purpose to create a 5G VN group without the need to use 5G VN group communication or a group other than 5G VN group.

Editor’s note: It is FFS whether there is need to differentiate the Parameter Provisioning API in stage 2 even though stage 3 uses different APIs to implement Parameter Provisioning service for managing a 5G VN group and Parameter Provisioning service for provisioning UE related information.

Editor’s note: Support for Local Area Data Network is per DNN basis as described in clause 5.6.5 of TS 23.501 [2]. It is FFS how to map AF LADN Area for a 5G VN group associated with DNN/S-NSSAI to LADN Area per DNN.

### 6.8.3 Procedures

Figure 6.8.3-1 outlines the procedure for support of LADN area and QoS group attributes.



Figure 6.8.3-1: Procedures for support of LADN area and QoS group attributes

It is assumed that the AF has previously created the group and provided the group member information using the same API.

1. The AF invokes Nnef\_ParameterProvision service for 5G VN group management is used to provide the AF LADN Area and QoS information for a DNN/S-NSSAI for a group of UEs. The External Group ID identifies the group of UEs.

2. The NEF maps the AF LADN Area (geographical area) to a LADN Area (list of TAIs). The NEF invokes the Nudm\_ParameterProvision for 5G VN group management to provide the 5G VN group data (including LADN Area and QoS information) to UDM.

3. The UDM stores the 5G VN group data for the DNN/S-NSSAI (including LADN Area and QoS information) in UDR.

4. The UDM replies to NEF.

5. The NEF replies to the AF.

6. In case there are AMFs that have subscribed to AM subscription data updates for the UEs that are part of the group, the UDM notifies those AMFs. The AMF receives the LADN Area as part of the 5G VN group data type, or as part of the AM subscription data (if Shared Data is not supported). The AMF enforces the LADN Area using the LADN mechanism as described in TS 23.501, clause 5.6.5.

7. In case there are PCFs that have subscribed to UDR notifications for 5G VN group data, the UDR notifies the PCFs. The PCF take the QoS information into account and may trigger PCC rule updates and PDU Session Modification. The PCF may also take the LADN Area into account when generating URSP rules, e.g. to define the validity area in the URSP rules.

### 6.8.4 Impacts on existing entities and interfaces

**General:** The 5G VN group data provisioning procedure is enhanced to apply to general groups not using 5G VN specific communication mechanisms.

**AF:** Support update of 5G VN group data information containing AF LADN Area and QoS information attributes.

**NEF:** Transform the geographical area received from AF into a list of TAI. Provides the 5G VN group data (including LADN Area and QoS information) to UDM in existing Nudm\_ParameterProvision service.

**UDM:** Based on NEF request, it manages the 5G VN group data including LADN area and QoS information via interacting with UDR. It can also provide AMF with the LADN Area information based on existing UDM services.

**UDR:** Storage of the 5G VN group subscription data including LADN Area and QoS information.

**AMF:** Receive LADN Area from UDM and enforce it per UE group member.

**PCF:** Receive 5G VN group data (including LADN Area and QoS information) and apply it when making policy decisions.

## 6.9 Solution #9: Support for service/LADN area and QoS group attributes

### 6.9.1 Introduction

This solution aims to address the KI#1, it addresses particularly how to set or modify the service area and QoS group attributes for a group of UEs.

This solution assumes that the LADN feature is used to enforce the “Service Area”, and therefore uses the term “LADN Area” to distinguish it from the unrelated Service Area Restriction feature.

### 6.9.2 Functional Description

To address how to set or modify the LADN area group attribute for a group, this solution follows the principles below:

#### For Service Area group attribute

- Enhance the NEF and UDM Parameter Provision services by introducing LADN Area information associated to a group of UEs as a new input parameter. This LADN Area information may be stored as part of each group members’ subscription data.

Alternatively, the UDM may store the LADN Area information as Group Subscription data related to the group. For this, the Shared Data feature defined in TS 29.503 [4] could be extended to allow the UDM to create/update and store (in UDR) corresponding resources related to the Group Subscription data provided by the AF.

NOTE: This can be applied not only for the newly introduced LADN Area information but also to other parameters currently supported over the Nudm\_ParameterProvision service (e.g. expected UE behaviour or network configuration parameters).

- The NEF allows an AF to invoke the NEF Parameter Provisioning API to provide a “AF LADN Area” parameter for a group of UEs identified by an External Group ID. The AF also provides the DNN and S-NSSAI for which the LADN Area applies.

- The NEF translates the “AF LADN Area” (geographical area) into a LADN Area (TAI list)

- The NEF invokes the Nudm Parameter Provision Services to provide the LADN Area together with the External Group ID, DNN and S-NSSAI.

- The KI#1 is applicable to general groups and is not specific to 5G VN groups. Therefore, this solution proposes to enhance the existing general NEF APIs (3gpp-cp-parameter-provisioning) to provision LADN Area, rather than enhancing the 5G VN specific NEF API (3gpp-5glan-pp). The general NEF APIs allows the AF to provision parameters for individual UEs as well as groups of UEs and allows the solution to be applied to regular subscribed DNN/S-NSSAIs.

- The UDM stores the LADN Area per DNN and S-NSSAI in each group member’s Access and Mobility Subscription Data or as shared data related to the group based on local configuration.

- The AMF receives the LADN Area(s) as part of the UE’s Access and Mobility Subscription Data if UDM stores the LADN Area per DNN and S-NSSAI in each group member’s AM Subscription Data or if AMF does not support retrieval of Group Subscription data from the UDM.

- The Shared Data feature defined by CT4 can be used to handle the data in UDM/UDR and signalling towards AMF/SMF, in order to optimize the provisioning of subscription data that is common to many UEs (e.g. a group of UEs). In this case, if the UDM stores the LADN Area per DNN and S-NSSAAI as shared subscription data and the AMF also supports the retrieval of shared data from the UDM, the AMF receives a reference to the shared data associated to the corresponding group the UE belongs to (e.g. a sharedDataIdentifier). Then the AMF retrieves the shared data associated to the group from the UDM using the received sharedDataIdentifier.

- The AMF enforces the LADN area as described for the LADN feature in 23.501 [Y], clause 5.6.5, with the difference that the LADN Area is received form UDM rather than configured on the AMF.

Editor’s note: It is FFS the purpose to create a 5G VN group without the need to use 5G VN group communication or a group other than 5G VN group.

Editor’s note: It is FFS whether there is need to differentiate the Parameter Provisioning API in stage 2 even though stage 3 uses different APIs to implement Parameter Provisioning service for managing a 5G VN group and Parameter Provisioning service for provisioning UE related information.

Editor’s note: Support for Local Area Data Network is per DNN basis as described in clause 5.6.5 of TS 23.501 [2]. It is FFS how to map AF LADN Area for a 5G VN group associated with DNN/S-NSSAI to LADN Area per DNN.

#### For QoS group attribute

To address how to set or modify the QoS for a group, this solution follows the principles below:

- Enhance the NEF Service Parameter service by introducing QoS information as a new input parameter. This allows the AF to provide QoS information for a group of UEs identified by an External Group Id.

- The QoS information contains a QoS Reference.

Editor’s note: It is FFS whether the QoS information can contain additional QoS parameters, e.g. individual QoS parameters

- The NEF stores the QoS information in UDR as Application Data.

- The UDR provides the QoS information to the PCFs that have subscribed to notifications.

- The PCF takes QoS information into account in its policy decisions. In particular, the PCF uses the QoS Reference to determine the QoS parameters for application traffic in the PDU Session. This is done in a similar way as when QoS References is provided in the Nnef\_AFsessionWithQoS service. The PCF may provide updated PCC rules to the SMF based on the policy decision.

- The KI#1 is applicable to general groups and is not specific to 5G VN groups. The NEF Service Parameter service allows the AF to provision parameters for individual UEs as well as groups of UEs and allows the solution to be applied to regular subscribed DNN/S-NSSAIs.

Editor’s note: It is FFS the purpose to create a group other than 5G VN group.

### 6.9.3 Procedures

#### 6.9.3.1 Procedure for exposure of Service Area group attribute



Figure 6.9.3.1-1. Procedure to support provision of LADN Area per DNN/S-NSSAI for a group of UEs

1. The AF invokes Nnef\_ParameterProvision service to provide the “AF LADN Area” for a DNN/S-NSSAI for a group of UEs. The External Group ID identifies the group of UEs.

2. The NEF translates the “AF LADN Area” (geographical area) to a LADN Area (TAI List) and invokes the Nudm\_ParameterProvision to provide the LADN Area to UDM.

3. The UDM stores the LADN Area as part of each group member’s subscription data or as shared data related to the group based on local configuration.

4. The UDM replies to NEF

5. The NEF replies to the AF

6. In case there are AMFs supporting members of the group that have subscribed for AM subscription data updates for the UEs that are part of the group, the UDM notifies those AMFs either:

a. including the LADN Area within the AM subscription Data set of individual UE subscriptions (i.e. one notification per UE belonging to the group registered in each AMF subscribed in UDM); or

b. including the created shared data identifier within the AM subscription Data set of individual UE subscriptions (i.e. one notification per UE belonging to the group registered in each AMF subscribed in UDM). The AMF then retrieves the shared data associated to the group which includes the LADN Area (i.e. only one request based on sharedDataIdentifier). The AMF may also subscribe to changes in the shared data related to the group to receive further updates. The AMF applies the received shared data associated to the group for any UE belonging to the group currently registered or registered subsequently via the AMF.

#### 6.9.3.2 Procedure for exposure of QoS group attribute

Figure 6.9.3.2-1: Provisioning of QoS for a group

0. A PDU Session is established, and the PCF subscribes to notifications for Application Data from UDR.

1. The AF decides to update the QoS requested for a group of UEs identified by an External Group ID. The AF invokes the Nnef\_ServiceParameter service to provide the QoS for the group.

2. If the QoS info is provided in relation to a DNN/S-NSSAI, the NEF checks with UDM that the members of the group are subscribed already to that DNN/S-NSSAI, as described in TS 23.502, clause 4.15.6.10, steps 2-4. If UDM authorization is successful, the UDM provides the mapping of the External Group ID to Internal Group ID in its response to the NEF.

Editor’s note: It is FFS whether there is a need to provide DNN/S-NSSAI in addition to Group ID in step 1 and whether there is a need to execute step 2.

3. The NEF invokes the Nudr\_DM Create/Update/Remove to store the QoS information related to the Internal Group ID in UDR.

4. The NEF replies to the AF.

5. The UDR notifies the PCFs that have subscribed with the QoS information for a group.

6. The PCF may take a policy decision and may provide updated PCC rules towards SMF. This may trigger a PDU Session Modification procedure.

### 6.9.4 Impacts on existing entities and interfaces

**AF:** Able to provide AF LADN Area for a DNN/S-NSSAI in the NEF Parameter Provision service. Able to provide QoS for a group of UEs in the NEF Service Parameter service.

**NEF:** Able to map AF LADN Area to LADN Area, and provide LADN Area for a DNN/S-NSSAI in the UDM Parameter Provision service. Able to store the QoS information in UDR as Application Data.

**UDM:** Based on NEF request, it manages the UE’s subscription data including LADN area information via interacting with UDR. Shared Data functionality as defined in CT4 specifications can be extended dynamically to create/update shared data related to the group and used to optimize the handling of subscription data common to many UEs. Potential updates to authorization of service specific parameter provisioning for a DNN/S-NSSAI.

**UDR:** Storage of the UE’s subscription data including LADN Area information. Creation/Update of shared data associated to a group. Storage of the QoS information for a group of UEs.

**AMF:** Be able to apply the LADN Area in the UE’s subscription data for a DNN/S-NSSAI.

**PCF:** Be able to receive the QoS information for a group of UEs from UDR and take it into account in policy decisions.

## 6.10 Solution #10: Support 5G VN service area with LADN mechanism

### 6.10.1 Key Issue mapping

This solution is for Key Issue #1, which addresses following aspects:

- How to provision (i.e. set, modify and delete) the service area or QoS applicable to each UE of the group via exposure interface, i.e.:

- What is the information that constitutes the service area applicable to each UE of the group via the exposure interface, and how to enforce the service area applicable to each UE of the group by reusing the existing mechanisms;

### 6.10.2 Description

5G LAN type service may only support the UEs, which are belong to 5G VN group, when the they are located in specific service area.

In this solution, it is proposed to use LADN mechanism to support the 5G VN group restriction service area. AF/NEF may provide the External Group ID, 5G VN group membership information and 5G VN group data to the UDM. In the 5G VN group data, the 5G VN group service can be added to show the service area restriction for the 5G LAN type services.

In this solution the LADN DNN is the same as 5G VN group DNN.

For LADN mechanism, the AMF is configured with the LADN service area by OAM as defined in TS 23.501.

When a UE from 5G VN group registers to the 5G network, the AMF retrieve the subscription information from UDM with the 5G VN group data. After the AMF get the 5G VN group service area from UDM, the AMF should compare the LADN service area and the 5G VN group service area information, to check whether these two areas are the same or not. If there is some overlapping between these two areas, i.e. the same TAs existing in both two areas, the overlapping part area can be decided as the LADN service area and sent to UE. If there is no overlapping between these two areas, the AMF may send the LADN information to UE with indication that the 5G LAN type service cannot be used even the 5G VN group DNN related PDU session has been establishment.

Editor’s Note: whether there are other results if there is no overlapping between LADN service area and 5G VN group service area if the DNN are the same, is FFS

After the UE registration procedure, the UE can get the 5G LADN DNN and related LADN service area.

When a UE request a LADN DNN PDU session establishment, the AMF and SMF can treat the PDU session as a general LADN PDU session.

### 6.10.3 Procedures for support of LADN service area

UE

RAN

AMF

SMF

UPF

UDM

NEF/AF

2. LADN service area and LADN DNN configured in AMF

1. AF provides 5G VN group service area to UDM

3. TS23.502 clause 4.2.2.2.2-1: Registration procedure.

In step 14b, AMF retrieves UE subscription data from UDM, and AMF decides LADN service area

4. TS23.502 clause 4.3.2.2.1-1: UE requested PDU Session Establishment for non-roaming and roaming with local breakout. LADN PDU session establishment.

**Figure 6.10.3-1: Procedures for support of** **LADN service area**

Note: In the following procedures, 5G VN Group DNN is the same of 5G LADN DNN.

1. The AF provides 5G VN group data information through NEF to UDM (GPSI, DNN, S-NSSAI and 5G VN Group service area).

2. AMF is configured with LADN information (LADN service area, LADN DNN).

3. During the registration procedure, AMF can retrieve the group subscription data from UDM, which contains the 5G VN group data (5G VN group service area, DNN,S-NSSAI). Then AMF should compare the LADN service area and the 5G VN group service area information, to check whether these two areas are the same or not, and generates the overlapped service area. The overlapped service area can be considered as the LADN service area for this UE. The overlapped service area will be sent to UE in registration accept message.

4. UE has the information of LADN DNN and LADN service area (the one which the AMF send to the UE in step3). UE can request the LADN DNN PDU session establishment, and AMF and SMF handle the PDU session establishment request as the LADN DNN PDU session.

### 6.10.4 Impacts on services, entities and interfaces

AMF:

* Capability enhancement to compare the LADN service area and 5G VN group service area, and then generate the overlapped service area as the new LADN service area.

## 6.11 Solution #11: Support for group status event reporting

### 6.11.1 Introduction

This solution aims to address the key issue #2: enhance group status event reporting, it addresses particularly how to enable the 5G VN group status event reporting.

### 6.11.2 Functional Description

To enable the 5G VN group status event reporting, this solution follows the principles or assumptions below:

- Enhance the event exposure service by introducing the new "group status event" monitoring event for a group.

- NEF can retrieve from UDR the group subscription data including the group membership, which can be used by NEF to transform the subscription to the "group status event" to subscription to monitoring event (s) e.g. "PDU Session Status ", "Registration state changes", "Area Of Interest", monitoring event for each UE group member.

- NEF can subscribe to the notification for the corresponding mentoring event (s) for each UE group member within the 5GC using existing mechanism as defined in clause 4.15.3 of TS 23.502 [3].

- When subscription to the "group status event" indicates continuous reporting (e.g. periodic reporting or event based reporting) along with certain parameters (periodic time interval, Group Reporting Guard time, threshold value, Maximum number of reports, or Maximum duration of reporting), NEF can perform the aggregation of the event reports for each UE group member, namely NEF buffers or stores the event reports related with the UEs in a group before the certain condition is met (e.g. expiry of periodic timer or Group Reporting Guard timer, threshold is reached, event subscription becomes invalid when Maximum number of reports is reached or Maximum duration of reporting is expired). Once the certain condition is met, the NEF sends the aggregated report to AF in the notification to "group status event" monitoring event. The notification can include the Group ID, list of UE IDs and Event Reporting information for the affected group members.

Figure 6.11.2-1 depicts the architecture to support group status event reporting:



Figure 6.11.2-1: Architecture to support group status event reporting

**AF:** Application Function that interacts with NEF to subscribe to the notification of "group status event" so as to be informed of the group status event reporting.

**NEF:** 5G capabilities exposure function that supports transforming the subscription for "group status event" to subscription to monitoring events (e.g. "PDU Session Status ", "Registration state changes", "Area Of Interest") for each UE group member within the group according to group subscription data received from UDR, additionally supports aggregating the event reporting collected for the UE group members in the group as the group status event reporting (e.g. notification is periodical).

**UDR:** Store the group subscription data including group membership. It can provide the group subscription data to NEF as the response to query request or as the notification to "group subscription data" change.

### 6.11.3 Procedures

Figure 6.11.3-1 outlines the procedure for support of group status event reporting.



Figure 6.11.3-1: Procedures for support of group status event reporting

1. The AF subscribes to "group status event" by sending Nnef\_EventExposure\_Subscribe Request (Group ID, Event ID: group status event, Event Filter: Status Information, Event Reporting Information).

Group ID identifies the target Group.

Event ID indicates the "group status event" the AF wants to subscribe to.

Event Filter indicates the exact status information (e.g. PDU Session status, Registration state, UE Presence in Group Service Area) the AF is interested in.

Event Reporting Information can include the parameters defined in clause 4.15.1 of TS 23.502 [3].

The event reporting subscription is authorized by the NEF, the NEF records the association of the event trigger and the requester identity.

2. The NEF reads from UDR, by means of Nudr\_DM\_Query, corresponding group subscription data in order to transform the subscription for "group status event" to subscription to monitoring events (e.g. "PDU Session Status", "Registration state changes", "Area Of Interest") for each UE group member within the group according to group subscription data received from UDR.

3. [Conditional] If the NEF determines to subscribe to "Registration state changes" monitoring event for each UE group member in the group, the NEF retrieves the serving AMF for each group member from UDM via Nudm\_UECM\_Get and sends for each UE group member to AMF the Namf\_EventExposure\_Subscribe Request with "Area Of Interest" Event ID, UE ID, Group Data (DNN, S-NSSAI or Group Service Area).

4. [Conditional] The AMF responds the NEF with Namf\_EventExposure\_Subscribe Response.

5. [Conditional] If the NEF determines to subscribe to "PDU Session status" and/or "Registration state" monitoring event for each UE group member in the group, the NEF sends to UDM the Numf\_EventExposure\_Subscribe Request with "PDU Session status" and/or "Registration state" Event ID, UE ID, DNN, S-NSSAI).

6. [Conditional] If the UDM receives the subscription to "Registration state changes" monitoring event, the UDM sends to AMF the Namf\_EventExposure\_Subscribe Request with "Registration state changes" Event ID, UE ID.

7. [Conditional] The AMF responds the UDM with Namf\_EventExposure\_Subscribe Response.

8. [Conditional] If the UDM receives the subscription to "PDU Session Status" monitoring event, the UDM sends to SMF the Nsmf\_EventExposure\_Subscribe Request with "PDU Session Status" Event ID, UE ID, DNN, S-NSSAI.

9. [Conditional] The SMF responds the UDM with Nsmf\_EventExposure\_Subscribe Response.

10. [Conditional] The UDM responds the NEF with Nudm\_EventExposure\_Subscribe Response.

11. The NEF responds the AF with Nnef\_EventExposure\_Subscribe Response.

12. [Conditional] When AMF detects the subscribed event occurs, it sends the event reporting to NEF via Namf\_EventExposure\_Notify or via UDM.

13. [Conditional] When SMF detects the subscribed event occurs, it sends the event reporting to NEF via Nsmf\_EventExposure\_Notify or via UDM.

14. [Conditional] Upon reception of the event reporting from AMF or SMF or UDM, the NEF can immediately send the received event reporting to AF. When Event Reporting Information indicates continuous reporting (e.g. periodic reporting or event based reporting) along with certain parameters (periodic time interval, Group Reporting Guard time, threshold value, Maximum number of reports, or Maximum duration of reporting), the NEF performs the aggregation of the event reports received for each UE group member before the certain condition is met (e.g. expiry of periodic timer or Group Reporting Guard timer, threshold is reached, event subscription becomes invalid when Maximum number of reports is reached or Maximum duration of reporting is expired). And once the certain condition is met, the NEF sends aggregated report to AF via Nnef\_EventExposure\_Notify (Group ID, list of UE IDs and Event Reporting information for the affected group members).

### 6.11.4 Impacts on existing entities and interfaces

NEF: The event exposure service supports new "group status event" monitoring event for a group. The NEF can retrieve from UDR the group subscription data including the group membership, which can be used by NEF to transform the subscription to the "group status event" to subscription to monitoring event (s) for each UE group member.

UDR: The group subscription data can contain 5G VN group membership information. The UDM can provide the group subscription data to NEF.

## 6.12 Solution #12: Support 5G VN service area restriction with SMF service area

### 6.12.1 Key Issue mapping

This solution is for Key Issue #1, which addresses following aspects:

- How to provision (i.e. set, modify and delete) the service area or QoS applicable to each UE of the group via exposure interface, i.e.:

- What is the information that constitutes the service area applicable to each UE of the group via the exposure interface, and how to enforce the service area applicable to each UE of the group by reusing the existing mechanisms;

### 6.12.2 Description

5G LAN type service may only support the UEs, which are belong to 5G VN group, when the they are located in specific service area.

In this solution, it is proposed to introduce 5G VN group service area in UDM subscription data, and SMF judge whether the UE is located within the 5G VN group service area. If the UE is located in it, the PDU session for 5G VN group can be established, otherwise the PDU session establishment request will be rejected by SMF.

SMF get the UE location from AMF.

### 6.12.3 Procedures for support of SMF service area

UE

RAN

AMF

SMF

UPF

UDM

NEF/AF

8. UE change location

1. AF provides 5G VN group service area in UDM

2. PDU session establishment request

9.AMF notify SMF UE location when UE move out of service area

3. Nsmf\_PDUSession\_CreateSMContext request

4. Subscription retrieval

7. SMF subscribe UE location to AMF

5. SMF determines whether UE is within 5G VN service area

10. SMF determine to release the PDU session

6. TS23.502 4.3.2.2.1-1: UE-requested PDU Session Establishment for non-roaming and roaming with local breakout. Step 5-16

**Figure 6.12.3-1: Procedures for support of** **SMF service area**

1. The AF provides 5G VN group information (GPSI, DNN, S-NSSAI and 5G VN group service area) through NEF by invoking Nnef\_ParameterProvision\_Create (as described in TS 23.502 clause 4.15.6.2) and to UDM by invoking Nudm\_ParameterProvision\_Create (as described in TS 23.502 clause 5.2.3.6.3).

2. UE initiates 5G VN group DNN PDU session establishment request.

3. AMF sends PDU session establishment request to SMF with carrying UE location information.

4. SMF retrieves SM subscription data from UDM with Nudm\_SubscriberDataManagement request include 5G VN DNN, S-NSSAI, and 5G VN group service area.

5. SMF determines whether the UE is within the 5G VN group service area. If not, the SMF may reject the PDU session establishment.

6. PDU session establishment procedure.

7. SMF subscribe the UE location with AMF by invoke Namf\_EventExposure\_Subscribe request. In This step, the SMF may send the 5G VN group service area to AMF as the location subscription requirement.

8-9. During UE mobility, when UE moves out of the 5G VN group service area, the AMF can notify the SMF.

10. SMF will verify if the UE is within the service area of 5G VN group, if UE move out of the service area, 5G VN PDU session will be released.

### 6.12.4 Impacts on services, entities and interfaces

Editor's Note: This clause captures impacts on existing 3GPP nodes and functional elements.

## 6.13 Solution #13: Support for group attribute management

### 6.13.1 Introduction

This solution addresses the KI#1

A group can be set with the service area that are applicable to each UE within the group.

### 6.13.2 Functional Description

When an AF creates a group, it provides an explicit list of group members (each identified by the UE ID or UE address)

AF creates and configures group, with group members, and subsequently group profiles are stored in the UDR. Consumer NFs can then retrieve such group details from UDM/UDR, as required.

Editor's note: It is FFS what is the UE address, static IP address or MAC address of device behind UE or IP addresses assigned from 5GC for the PDU Session?

### 6.13.3 Group Provisioning Procedure

Figure 6.13.3-1 provides the details of the procedures:



Figure 6.13.3-1: AF Creating and Provisioning Group ID profiles to 5GC

Step 1: AF assigns an (external) Group ID and includes a list of UEs to the group. AF then sends Nnef\_ParameterProvision\_Create/Update/Delete request

Editor's note: It is FFS whether there is a need to group type, and what the values can be set.

Step 2: NEF after authorizing the AF request, translates the external information to 5GC internal information e.g. external group ID into an internal group ID. The NEF creates or updates this information in UDM by sending Nudm\_ParameterProvision\_Create/Update/Delete request (Group ID, Service area definition or Area of Interest or TAI(s))

Step 3-4: UDM stores the Information in UDR using Nudr\_DM\_Query/Update messages.

Step 5-6: AF receives the Response message to its request in step 1.

Step 7: Consumer Network Function e.g. AMF and SMF may subscribe and get notified on these information. In case of NF enforced functionality (e.g. Service area related restriction) the subscribing to the notification is mandatory. If the group information is to be provided to AMF and/or to SMF following mechanism is envisaged:

* NFs (e.g. AMF, SMF) subscribe to UDM for the subscription data changes (creation / modification / deletion) of the group member UEs. When such groups are subject to a creation / modification / deletion, the UDM notifies the subscribed NF for the respective group member UEs. UDM may also indicate shared data identifier, as mentioned in TS 23.501 [2] clause 4.15.6.2 and explained in TS 29.503 [X] clause 5.2.2.

In case PCF has subscribed to receive notification on the shared data, UDR notifies using Nudr\_DM\_Notify procedure.

Editor's note: It is FFS whether the same purpose can be achieved via spatial validity in AF request, e.g. clause 5.6.7 in TS 23.501 [2].

### 6.13.4 Impacts on existing entities and interfaces

The identified enhancements concern Information elements contained in AF:

* Enhancements to externally indicated service area definition into TAI or Area of Interest or to existing IE Potential Locations of Applications and IE Spatial Validity Condition)

NFs (AMF, SMF, PCF) provisioning to the group membership definition and NF subscription to the group event notifications and taking the required actions.

PCF performing mapping between the UDR stored QoS attributes and 5GS QoS parameters, manages the potential conflicts of the QoS definitions, and triggers PCF initiated SM Policy Association Modification/ Termination for each UE belonging to the group.

## 6.14 Solution #14: Group status event reporting based on existing NEF Event Exposure service

### 6.14.1 Introduction

This solution addresses KI#2 to enable an AF to subscribe to group status event reporting for the event "newly registered or (de)-registered group member".

### 6.14.2 Functional Description

The existing Monitoring services exposed by NEF (described under Nnef\_EventExposure service in TS 23.502 [X]) can be used to subscribe to monitoring events. The supported monitoring events are listed in TS 23.502 clause 4.15.3. Several of the current available monitoring events such as UE Reachability, PDU Session Status and Number of UEs in an area, are related to the Key Issue event "newly registered or (de)-registered group member".

Editor’s note: It is FFS whether a new monitoring event (Event ID) is needed specifically for "newly registered or (de)-registered group member" or the existing monitoring events are sufficient.

An AF can subscribe to monitoring events for a single UE (based on GPSI) or a group of UEs (based on External Group ID).

If the monitoring event subscription refers to a group of UEs the AF can provide a Group Reporting Guard Time. Group Reporting Guard Time is an optional parameter for group-based monitoring configuration to indicate the time for which the Monitoring Event Reporting related with the UEs in a group can be aggregated before sending them to the AF. If no Group Reporting Guard Time is provided, the NEF provides a notification for each UE for which it received an event notification e.g. from AMF or UDM. If the AF provided a Group Reporting Guard Time, the NEF accumulates all of the monitoring event reports received from the UDM for the group members until the Group Reporting Guard Time expires. When the timer expires, the NEF sends the accumulated Monitoring Event Reports to the AF.

### 6.14.3 Procedures

The call flow below is based on existing pre-rel-18 standards, as e.g. described in TS 23.502 [3], clause 4.15.3.2.3.



Figure 6.14-1. Procedure to support event monitoring of group status related events

1. The AF subscribes to event monitoring for the group. The AF provides e.g. the External Group ID and the requested monitoring events.

2. For event subscriptions for a group of UEs, the NEF subscribes to UDM by invoking the Nudm Event Exposure services. For certain events the UDM needs to subscribe to the AMF or the SMF for the event.

The UDM knows what UEs are registered and have PDU Sessions (since each AMF and SMF registers with UDM). UDM also knows the group membership since the Internal Group ID(s) are part of each UE’s subscription data. So UDM can subscribe to the AMFs that have UEs that are Registered and are members of the group, and to SMFs that have UEs that are members of the group with PDU Sessions.

AMF/SMF knows the group membership since the Internal Group ID(s) are part of the UE’s subscription data.

3. For events subscriptions for Number of UEs in an area, the NEF subscribes directly to the AMF.

4. The NEF acknowledges the event subscription to the AF.

5. When the UDM detects that an event occurs the UDM sends an event report, by means of Nudm\_EventExposure\_Notify message, to the NEF.

6. When the AMF/SMF detects that an event occurs the AMF/SMF sends an event report, by means of Namf\_EventExposure\_Notify/Nsmf\_EventExposure\_Notify message, to the NEF.

7. The NEF forwards the event notifications to the AF. In case the subscription was for a group of UEs and the Group Reporting Guard Time was provided, the NEF accumulates the reports and provides the accumulated monitoring report to the AF when the Group Reporting Guard Time expires.

### 6.14.4 Impacts on existing entities and interfaces

No impacts.

Editor’s note: It is FFS whether a new monitoring event (Event ID) is needed specifically for "newly registered or (de)-registered group member" or the existing monitoring events are sufficient.

## 6.15 Solution #15: Group status event reporting

### 6.15.1 Introduction

This solution aims to address the KI#2, i.e. to enhance group status event reporting in order to allow subscription to group status event reporting for the event "newly registered or (de)-registered group member". Newly registered or de-registered group member should be notified to the AF that has subscribed for changes on the members of the group, i.e. when a new member is added or old member is removed from the group as identified by External Group ID. This may occur e.g. when the corresponding Internal Group ID is removed from the user subscription data by OAM.

### 6.15.2 Functional Description

The solution is based on the following principles:

- The AF can subscribe for changes in the 5G VN group data. This is done by including a Notification Target Address into the Nnef\_ParameterProvision\_Create request when the 5G VN group is created. The NEF then notifies the AF by invoking Nnef\_ParameterProvision\_UpdateNotify service operation, and includes the current content of the 5G VN group data to the notification.

- If NEF receives 5G VN group creation (Nnef\_ParameterProvision\_Create) request with a Notification Target Address, the NEF includes its own Notification Target Address to the Nudm\_ParameterProvision\_Create request when the NEF creates the 5G VN group into UDM. Whenever the UDM determines the 5G VN group data has changed, e.g. because the Internal Group ID is removed from a member's user subscription data by OAM, the UDM invokes Nudm\_ParameterProvision\_UpdateNotify to the given Notification Target Address, and includes the current 5G VN group data to the notification. The NEF may further notify the AF via Nnef\_ParameterProvision\_UpdateNotify.

- If the AF wants to subscribe for any of the monitoring event(s) as described in Table 4.15.3.1-1 in TS 23.502 [3] (e.g. UE reachability or PDU Session status) for the members of the group, the AF can use the existing Nnef\_EventExposure service and include the External Group ID as a target to the subscription. In this case the NEF subscribes to the notification for the corresponding monitoring event(s) for each UE group member within the 5GC using existing mechanism as defined in clause 4.15.3 of TS 23.502 [3].

- The AF may include a Group Reporting Guard Time (as in Table 4.15.1-1 in TS 23.502 [3]) into the Nnef\_EventExposure\_Subscribe request that is targeted to an External Group ID. In this case the NEF shall accumulate all of the received Monitoring Event reports for the group of UEs until the Group Reporting Guard Time expires or the monitoring duration is reached. No impacts to the existing procedures are foreseen.

Editor's note: Other services other than Parameter Provision service to support subscription/notify for membership changes of a group may also be available and can be evaluated or investigated later.

### 6.15.3 Procedures

### 6.15.4 Impacts on existing entities and interfaces

- UDM: new service operation Nudm\_ParameterProvision\_UpdateNotify allows the UDM to notify the NF consumer (NEF) on changes for the 5G VN group data.

- NEF: new service operation Nnef\_ParameterProvision\_UpdateNotify allows the NEF to notify the NF consumer (AF) on changes for the 5G VN group data.

## 6.16 Solution #16: Use of N6 interconnect for 5G VN with multiple SMFs

### 6.16.1 Introduction

This solution addresses KI#4 on multiple SMFs for VN group communication.

Currently the 5G VN is assumed to be served by a single SMF. The reason for that is to allow the user plane for 5G VN to be controlled by a single controller (SMF) to enable N19 tunnel management. Since the SMF manages all PDU Sessions and controls all UPFs, that SMF can ensure that relevant N19 tunnels are established and forwarding rules are provided to the involved UPFs. Other 5G VN features than N19 are not dependent on the use of a single SMF.

This solution generalizes the support of 5G VN to multiple SMFs by enabling transport for traffic that goes between UE served by different SMFs. This allows a 5G VN to be deployed by multiple SMFs (or multiple SMF Sets).

### 6.16.2 Functional Description

#### General

One of the main ideas with 5G VN is to allow an operator to create a virtual network where UEs can communicate with each other as well as with a DN.

As described in e.g. TS 23.501, clause 5.8.2.13 and 5.29.3, a 5G VN supports connectivity via N6. In 5GS in general, the N6 interface has two purposes that applies also to 5G VN: allow the UEs (5G VN group members) to access entities (e.g. servers) on the DN and enable UE-to-UE communication between UEs served by different SMFs/UPFs.

In this solution two deployment scenarios are considered:

1) A 5G VN deployment scenarios with a “native” N6 access from UPF to a DN. The UPF thus have access to a “native” DN that supports Ethernet in case of Ethernet PDU Sessions and IP payload in case of IP PDU Session types.

2) Another 5G VN deployment scenario where there may not be a “native” N6 or DN. Instead, the N6 interface may be running over an underlying transport network. The N6 interface and the DN is thus a virtual network on top of this underlay transport network.

#### Native N6

In this deployment a native N6 exists, i.e. with either an Ethernet connection towards Ethernet bridge(s) on the DN in case of Ethernet PDU Session, or an IP connection towards IP router(s) for IP based PDU Sessions. Any up-link traffic that is sent onto N6 will be forwarded/routed towards the destination based on the destination MAC address or IP address, respectively.

Forwarding between UEs served by different SMFs is done via the bridged/routed N6 network (DN). This is further illustrated in Figure 1. Forwarding between UEs served by the same SMF may (optionally) utilize N19 tunnels, as per rel-17. The figure shows a single router/bridge for simplicity, but there may be multiple routers/bridges in the DN. The solution also supports communication with hosts/servers on the DN, if needed.



Figure 6.16-1. Traffic forwarding between UEs served by different SMFs via native N6

#### N6 overlay

In this deployment the N6 interface is running over an underlying transport network, similar to how N3, N9 and N19 GTP-U tunnels are running over an underlying transport network. The N6 network (DN) is in this case a virtual (overlay) network created on top of a (underlay) transport network. This is a common deployment today and there are multiple well-established technologies for handling packet transport and routing/bridging in such deployments, including IP VPNs (or L3VPNs) and E-VPNs. Both IPVPN and EVPN are standardized by IETF in a number of RFCs. There are several other VPN technologies available, and different technologies may fit different operator deployments. The intention is not to standardize a specific VPN solution in 3GPP (examples of VPN solutions could however be made).

Forwarding between UEs served by different SMFs is done via the VPN. Forwarding between UEs served by the same SMF may (optionally) utilize N19 tunnels, as per rel-17. This is further illustrated in Figure 2 where the Provider Edge (PE) router functionality is shown. The solution also supports communication with hosts/servers on the DN, if needed. To enable connectivity with networks on the DN, “standalone” PE routers can also be included in the VPN (as shown in the figure 2). This is however optional and if only UE-to-UE communication is desired, separate PE routers are not needed. The figure shows a single separate PE, but there may be multiple PEs in the VPN.

Since the IP/E-VPN is a virtual network running over an underlay IP network, the routers in the underlay transport network have no visibility into VPN tunnels, they simply provide connectivity from one PE router to another, similar to how it works for GTP-U.



Figure 6.16-2. Traffic forwarding between UEs served by different SMFs via IP/E-VPN

#### Traffic routing/forwarding

The traffic routing/forwarding in both solutions above are based on existing technologies.

For native N6 deployments with IP PDU Sessions, regular IP routing by IP routers in the DN ensures that UE-to-UE traffic reaches the UPF that serves the target UE IP address. For Ethernet PDU Sessions, Ethernet bridges in the DN performs forwarding of Ethernet frames based on IEEE mechanisms.

For VPN deployments, it is the PE router functionality that performs IP routing or Ethernet forwarding towards target destination based on either IP routing protocols or Ethernet/IEEE based forwarding. These are old and proven technologies that have worked in the field in carrier-grade environments for many years. There seems to be no need to re-invent the wheel in 3GPP.

The routing information on N6 (VPN) is updated via IETF based mechanisms that do not require further 3GPP standardization

Editor's note: It is FFS whether this solution is in the study scope considering that a related objective is not agreed as part of the study scope: S2-2108574, **Work Task 2.3:** Support VxLAN/EVPN-type communication among UPFs interconnected via N6 across different sites.

Editor's note: It is FFS whether and how to control IP/E-VPN in a dynamic manner considering that a 5G VN is managed per 5G VN group, which can be defined/removed on AF request basis.

Editor's note: It is FFS how to link a 5G VN with the correct IP/E-VPN on N6, e.g. the route and forwarding.

Editor's note: If this solution doesn’t require further 3GPP standardization, it is FFS whether this is an implementation choice for UPF supporting IP/E-VPN.

### 6.16.3 Procedures

3GPP procedures are not impacted by this solution.

### 6.16.4 Impacts on existing entities and interfaces

UPF: Support of VPN solution towards N6, e.g. to act as Provider Edge router in IP/E VPN solution based on IETF RFCs.

The solution assumes that the PSA UPFs of the 5G VN group are either

- connected via N6 to a “native” DN where the UE’s Ethernet (PDU Session type Ethernet) or IP traffic (IP based PDU Session types) can be forwarded

or

* connected via N6 to an IP based transport network which allows IP connectivity between the PSA UPFs.

Several VPN solutions exist based on IETF standards and in deployments. Examples of VPN solutions could be documented in a 3GPP annex to show the IETF protocols that are already available.

## 6.17 Solution #17: Allowing 5G VN group member UE simultaneously send data to different multicast groups with different QoS policy

### 6.17.1 Introduction

This solution aims to address the key issue #5: Allowing UE to simultaneously send data to different groups with different QoS policy. In particular, it addresses the following requirements from clause 6.13.2 of TS 22.261 [6]:

- The 5G system shall allow a UE to request a communication service to simultaneously send data to different groups of UEs at the same time.

- The 5G system shall allow different QoS policy for each group the UE communicates with.

This solution assumes that a UE with one dedicated application is a group member of a 5G VN group, and the dedicated application can join multiple Ethernet multicast groups. This application on the UE can generate the data and replicates multiple copies of the data, and then each copy is sent to a different Ethernet multicast destination that corresponds to a different Ethernet multicast group. The transmission of the copy within the different Ethernet multicast group needs different QoS treatment because of the different purpose of data usage for the Ethernet multicast group.

### 6.17.2 Functional Description

The following are the main principles of the solution:

- UE is a group member within a 5G VN group, and the UE/App can join multiple Ethernet multicast groups.

- 5G VN group subscription data contains different instances of Application descriptor, each for a multicast address for distinct multicast group. The UE is provisioned/signalled with the multiple URSP rules, all the URSP rules has the same Route Selection [including 5G VN group DNN, 5G VN group S-NSSAI, Ethernet PDU Type], but different Traffic descriptors that is distinguished by the multicast address for multicast group.

- The UE application traffic targeting to different multicast groups will trigger the UE to find the same PDU Session with 5G VN group DNN/S-NSSAI/PDU Type by using the matched URSP rules.

- 5G VN group subscription data contains different instances of group QoS Policy, where each instance is distinguished by the multicast address for multicast group. During establishment of the PDU Session targeting to the 5G VN group, the SMF retrieves the group QoS Policy as part of the 5G VN group subscription data. Then the SMF will setup multiple QoS Flows in the PDU Session, the QoS Profile (e.g. QoS Rule or N4 Rule) for each QoS flow contains different QoS parameters and multicast addresses that are derived from the group QoS Policy.

- UE simultaneously sends data to different multicast groups via different QoS Flows within the PDU Session targeting to the 5G VN group.

Figure 6.17.2-1 depicts the architecture to support the solution: Allowing 5G VN group member UE simultaneously send data to different multicast groups with different QoS policy.



Figure 6.17.2-1: Architecture to support 5G VN group member UE simultaneously sending data to different multicast groups with different QoS policy

### 6.17.3 Procedures

1. The AF manages the 5G VN group as in clause 4.15.6.2 of TS 23.502 [3]. The group members in the 5G VN group can join more than one multicast groups: then the 5G VN group subscription data contains multiple instances of Application descriptor, each corresponds to a target multicast group. The instance of the Application descriptor contains the multicast address of the multicast group.

- The 5G VN group subscription data contains multiple instances of Application descriptor, each corresponds to a target multicast group. The instance of the Application descriptor contains the multicast address of the multicast group. This can be achieved using existing mechanism.

- The 5G VN group subscription data contains multiple instances of group QoS Policy, each corresponds to a target multicast group. The instance of the group QoS Policy contains the multicast address of the multicast group and distinct QoS requirements. The exact QoS requirements and provisioning procedures depend on the solutions to key issue #1, specifically for provisioning of QoS applicable to each UE of the group.

2. The UE is provisioned with the URSP rules used for the 5G VN group as in clause 5.29.2 of TS 23.501 [2], clause 4.16.11 and 4.16.12.2 of TS 23.502 [3]. Each URSP rule contains a different Traffic Descriptor and the same Route Selection component. The Traffic Descriptor is differentiated by the multicast address of the multicast group.

3. With the URSP rules for the 5G VN group, the UE group member can match the application data targeting to different multicast groups to the same PDU Session associated with the DNN, S-NSSAI and PDU Session type of the 5G VN group. This step can be achieved using mechanism in clause 6.6.2 of TS 23.503 [4], i.e. URSP as defined in R17 specifications is reused without any enhancements.

4. During PDU Session establishment procedure, the SMF obtains group QoS Policy as part of 5G VN group subscription data or obtains group QoS Policy as part of the PCC rules. The SMF can set up multiple QoS Flows within the PDU Session, the QoS profile for each QoS Flow is derived from the instance of the group QoS Policy corresponding to a target multicast group. The exact execution procedures depend on the solutions to key issue #1, specifically for provisioning of QoS applicable to each UE of the group.

NOTE : The group QoS Policy as part of the PCC rules describe the Ethernet multicast group and QoS parameters, e.g., IP/Ethernet multicast addresses, VLAN headers that are specific to individual multicast group. The SMF obtains group QoS Policy as part of PCC rules for a group member per R17 procedures and interfaces during the lifetime of the PDU Session.

### 6.17.4 Impacts on existing entities and interfaces

Editor's Note: it is FFS whether the solution requires changes to 3GPP R17 specification.

# 7 Overall Evaluation

## 7.X Key Issue #<X>: <Key Issue Title>

Editor's note: This clause will provide a general evaluation and comparison of the solutions per Key Issue #<X>.

# 8 Conclusions

Editor's note: This clause will capture conclusions for the study.

Annex A (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2022-02 | SA2#149E | S2-2200646 | - | - | - | Proposed skeleton approved at S2#149E | 0.0.0 |
| 2022-02 | SA2#149E |  | - | - | - | Updated with approved pCRs at S2#149E. S2-2200646 (skeleton), S2-2200647, S2-2201555, S2-2201556, S2-2201557, S2-2201558, S2-2201559, S2-2201560, S2-2201561, S2-2201562, S2-2201563, S2-2201564, S2-2201565, S2-2201566, S2-2201567 | 0.1.0 |
| 2022-04 | SA2#150E |  |  |  |  | Updated with approved pCRs at S2#150E. S2-2203255, S2-2203256, S2-2203257, S2-2203258, S2-2203259, S2-2203260, S2-2203261, S2-2203262, S2-2203263, S2-2203264, S2-2203265, S2-2203266, S2-2203267, S2-2203268, S2-2203269, S2-2203270, S2-2202175, S2-2203271, S2-2203272 | 0.2.0 |