Recommendation

ITU-T Q.5025 (09/2022)

SERIES Q: Switching and signalling, and associated measurements and tests

Signalling requirements and protocols for IMT-2020 – Protocols for IMT-2020

Protocol for managing the user plane function in IMT-2020 networks

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Recommendation ITU-T Q.5025

Protocol for managing the user plane function in IMT-2020 networks

Summary

Recommendation ITU-T Q.5025 specifies the protocol for managing user plane function (UPF) in the IMT-2020 network. It describes the communication mechanism inside the UPF. It also describes the application programming interface (API) management, procedure, signalling flow and message format between the UPF and other core network functions or third-party applications.

Keywords

API management, IMT-2020, user plane function.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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Protocol for managing the user plane function in IMT-2020 networks

1   Scope

This Recommendation specifies the protocol for managing user plane function (UPF) in the International mobile telecommunications (IMT)-2020 network. It describes the communication mechanisms inside UPF. It also describes the application programming interface (API) management, procedure, signalling flow and message format between UPF and other core network functions or third-party applications.

2   References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

None.

3   Definitions

3.1   Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1   data analysis function [b-ITU-T Q.5023]: A network function that can collect, analyse, and provide data from/to International Mobile Telecommunications 2020 (IMT-2020) core network functions, network management and third-party applications.

3.1.2   IMT-2020 [b-ITU-T Y.3100]: (Based on [b-ITU-R M.2083-0]) Systems, system components, and related technologies that provide far more enhanced capabilities than those described in [b-ITU-R M.1645].

3.1.3   management [b-ITU-T Y.3100]: In the context of IMT-2020, the processes aiming at fulfilment, assurance, and billing of services, network functions, and resources in both physical and virtual infrastructure including compute, storage, and network resources.

3.1.4   network function [b-ITU-T Y.3100]: In the context of IMT-2020, a processing function in a network.

3.1.5   user plane [b-ITU-T Y.2011]: A synonym for the data plane.

3.2   Terms defined in this Recommendation

None.

4   Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API   Application Programming Interface

CEF   Capability Exposure Function

DAF   Data Analysis Function

DN   Data Network

DNN   Data Network Name

FQDN   Fully Qualified Domain Name

IMT   International Mobile Telecommunications

IP   Internet Protocol

LAN   Local Area Network

NF   Network Function

NFR   Network Function Registry function

OAM   Operation Administration and Maintenance

PCF   Policy Control Function

PDU   Protocol Data Unit

QoS   Quality of Service

RAN   Radio Access Network

SMF   Session Management Function

SUPI   Subscription Permanent Identifier

UE   User Equipment

UPF   User Plane Function

5   Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

The keywords "M" indicate the element is mandatory. The keywords "O" indicate the element is optional. The keywords "C" indicate the element is conditional.

6   Overview

With the increasing requirement for an IMT-2020 network in edge environments from vertical industries, the demand for user plane function (UPF) is diverse and urgent. Service-based UPF is proposed to meet the needs of verticals.

Based on the internal function modularization of UPF, clear and independent services lead to easy deployment and reorganization. In addition, open application programming interface (API) offers 3rd party applications to develop functions independently, such as secondary authentication in the industry and autonomous internet protocol (IP) address allocation. The customized function

management service will manage and orchestrate customized functions from 3rd party applications in the UPF. Based on the internal and external modularization, UPF is easy to be customized and reorganized.

7 Modularized UPF architecture

Figure 7-1 shows the architecture reference model of service based UPF and open API in the IMT-2020 network. It includes the UPF native function services and customized services from 3rd party applications. It also shows the relationship between UPF and other core network functions (NF) of IMT-2020 and 3rd party applications. UPF interacts with the network function registry function (NFR) by invoking service based interfaces.

Native function / services of UPF includes traffic routing and forwarding, protocol data unit (PDU) session tunnel management, policy control, anchor point, event exposure, security management and other customized functions, like packet inspection and collection of UPF traffic for lawful intercept and interworking functionalities among different network domains, e.g., interworking between IP-based core network and non-IP based access network. These UPF services can be invoked by other network functions to achieve related functionalities, and these UPF services can be created, updated, or removed.

Traffic routing and forwarding: UPF supports

– traffic forwarding, dropping and buffering, including IPv4, IPv6 and Ethernet type;

– forwarding traffic to the session management function (SMF), radio access network (RAN), data network (DN) and 3rd party applications;

– classifier for traffic based on traffic forwarding rules.

PDU session tunnel management: UPF supports

– encapsulation and decapsulation of the packet for tunnel;

– enforcement of tunnel establishment and release based on the rules received from SMF.

Policy control: UPF supports

– predefined rules configured by network management;

– dynamic policies configured for traffic flows by the policy control function (PCF) via SMF, e.g., Quality of service (QoS) enforcement rule, traffic forwarding rule with SMF invoking UPF policy control services;

– traffic usage report based on traffic volume, usage time and event.

Anchor point: UPF supports

– act as a PDU session anchor point providing access to the DN;

– multiple session anchors in a single PDU session;

– construct end marker when RAN handover.

Event exposure: UPF supports

– Expose PDU session related information;

– Expose UPF load information.

Security management: UPF supports

– Clear user personal information, such as a subscription permanent identifier (SUPI), etc., after the session ends;

– Access device security monitoring and access address security verification;

– Interface filtering and security protection.

Customized services are developed independently by 3rd party based on an open API offered by UPF, which are managed and orchestrated by a customized service management.

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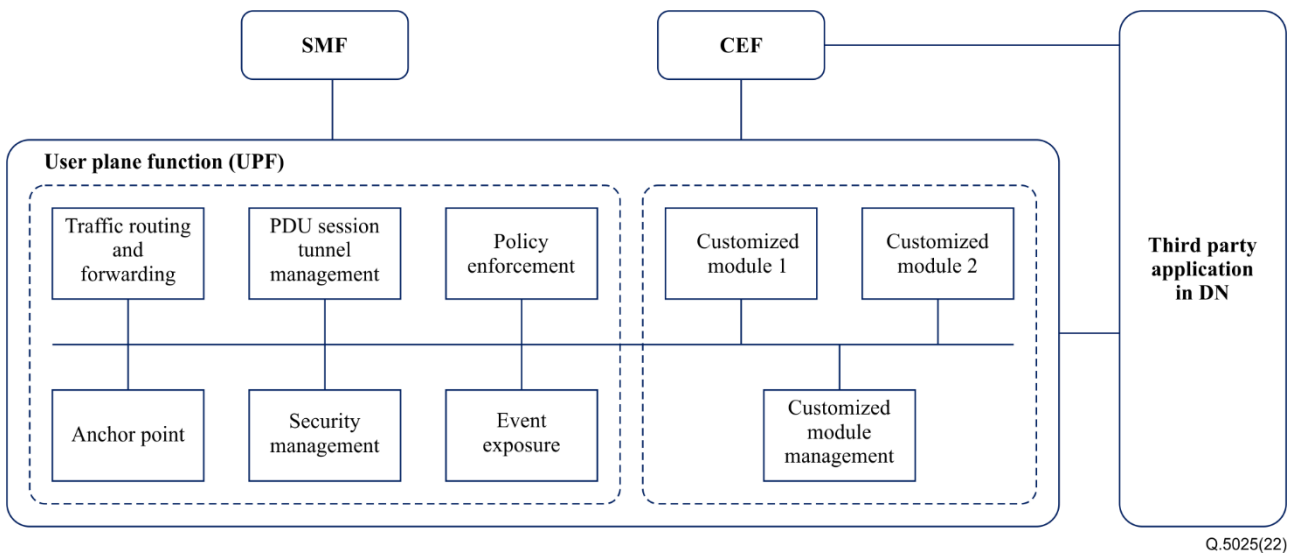
Figure 7-1 – Architecture reference model for user plane function in IMT-2020 network

8 Signalling flow

8.1 UPF service registration

UPF service registers in the NFR by invoking the service based interface Nfr_NFService_Registration which is shown in Figure 8-1.

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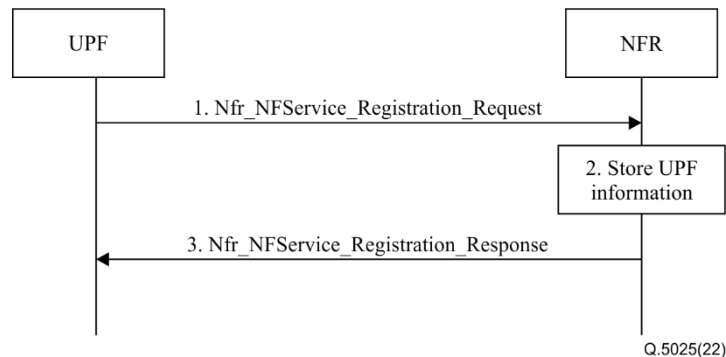
Figure 8-1 – UPF services registration procedure

1   UPF sends Nfr_NFService_Registration_Request message to NFR to inform of the available UPF services. The message includes information on the available UPF services (e.g., traffic routing and forwarding, PDU session tunnel management, policy enforcement, anchor point, and other customized functions), UPF serving area, network slice type indicator, data network name (DNN), interface, UPF ID and UPF address.

2   NFR stores information about the UPF services and marks the UPF services available.

3   The NFR sends Nfr_NFService_Registration_Response message to the UPF to inform of the accomplishment of UPF services registration.

8.2 UPF service update

UPF updates its service information in the NFR by invoking the service based interface Nfr_NFService_Update which is shown in Figure 8-2.
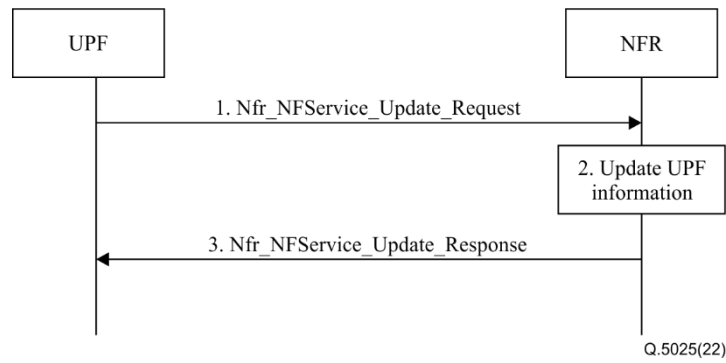
Figure 8-2 – UPF service update procedure

1   UPF sends Nfr_NFService_Update_Request message to the NFR when the UPF service updating is needed, e.g., UPF scaling. The message includes updated information of the UPF services (e.g., traffic routing and forwarding, PDU session tunnel management, policy enforcement, anchor point, and other customized functions), UPF serving area, network slice type indicator, DNN, interface, UPF ID and UPF address.

2   NFR updates the information on the UPF services and sends a UPF services update notification to the UPF services consumers.

3   The NFR sends Nfr_NFService_Update_Response message to the UPF to inform of the accomplishment of the update.

8.3   UPF service deregistration

UPF service deregisters in the NFR by invoking a service based interface Nfr_NFService_Deregistration which is shown in Figure 8-3.
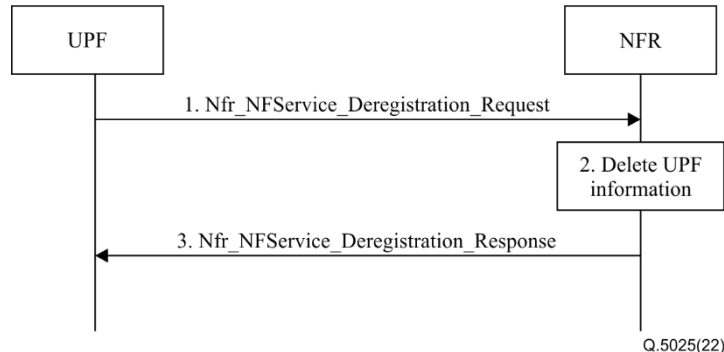

Figure 8-3 – UPF service deregistration procedure

1   UPF sends Nfr_NFService_Deregistration_Request message to the NFR to inform of the unavailable UPF services. The message includes the list of unavailable services of the UPF.

2   NFR deletes the information of the unavailable UPF services and sends an unavailable notification to the UPF services consumers.

3   The NFR sends Nfr_NFService_Deregistration_Response message to the UPF to inform of the accomplishment of the deregistration.

8.4   UPF service discovery

Consumer NF discovers the target UPF service by NFR as shown in Figure 8-4.
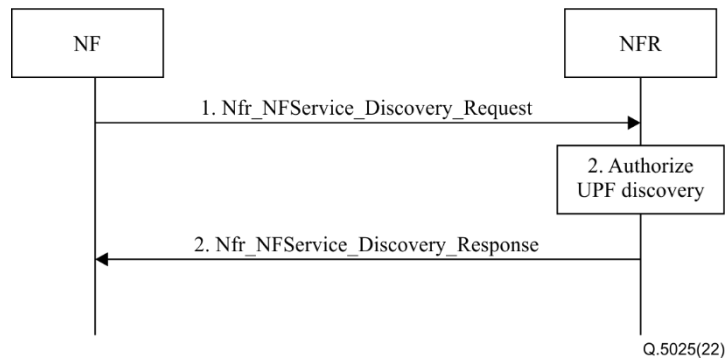
Figure 8-4 – UPF service discovery procedure

1   Consumer NF invokes Nfr_NFService_Discovery_Request to the NFR to the discovery UPF services, UPF serving area, network slice type indicator, DNN, interface, UPF ID, UPF IP address or a fully qualified domain name (FQDN), UE IP address, NF type, UPF instance ID, PLMN ID and application ID.

2   NFR authorizes the UPF discovery request based on the UPF registration information or local information of the operator.

3   NFR returns the UPF lists to the consumer NF, which match the discovery request.

8.5   UPF node transmission path set-up

The UPF node transmission path set-up procedure shall be used to set-up an invocation path between the SMF and the UPF which is shown in Figure 8-5, to enable the SMF to use the resources of the UPF subsequently, e.g., establish a session for a user equipment (UE), or based on this path to support the invocation of the UPF policy control service.
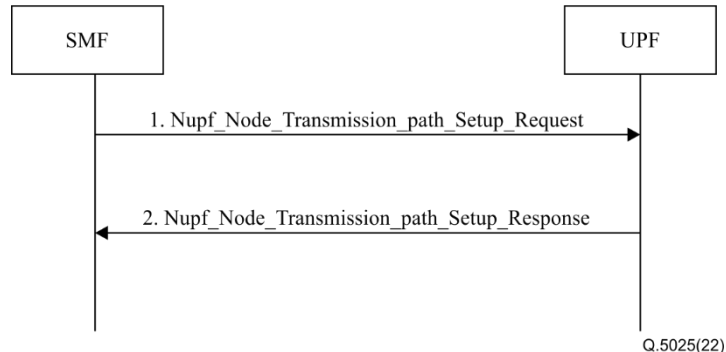
Figure 8-5 – UPF node transmission path set-up procedure

1   SMF sends Nupf_Node_Transmission_path_Setup_Request message to the UPF with the Node ID of the SMF and the list of optional features supported by the SMF which may affect the UPF behaviour.

2   When the UPF receives the Nupf_Node_Transmission_path_Setup_Request message and determines to accept the request, the UPF shall store the Node ID of the SMF as the identifier of the node transmission path, and send a Nupf_Node_Transmission_path_Setup_Response with a successful cause, including all the supported optional features in the UPF and optionally including the available user plane resources, e.g., IP address(es). If the UPF determines not to accept the request, then the UPF shall send a Nupf_Node_Transmission_path_Setup_Response with an appropriate error cause to indicate why to reject the node transmission path set-up.

8.6 UPF node transmission path update

The UPF node transmission path update procedure shall be used to modify an existing node level path between the SMF and the UPF which is shown in Figure 8-6.

Figure 8-6 – UPF node transmission path update procedure

1 SMF sends Nupf_Node_Transmission_path_Update_Request message to the UPF with the Node ID of the SMF and the list of optional features supported by the SMF which need to be updated that may affect the UPF behaviour.

2 When the UPF receives the Nupf_Node_Transmission_path_Update_Request message and determines to accept the request, the UPF shall update the parameters of the node transmission path and send a Nupf_Node_Transmission_path_Update_Response with a successful cause. If the UPF determines not to accept the request such as if the Node ID is not known by the UPF, then the UPF shall send a Nupf_Node_Transmission_path_Update_Response with an appropriate error cause to indicate why to reject the node transmission path update.

8.7 UPF node transmission path release

The UPF node transmission path release procedure shall be used to release a node level path between the SMF and the UPF due to for example, operation administration and maintenance (OAM) reasons, and the procedure is shown in Figure 8-7.
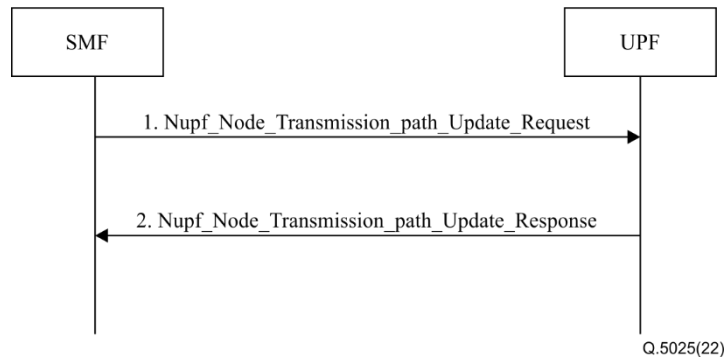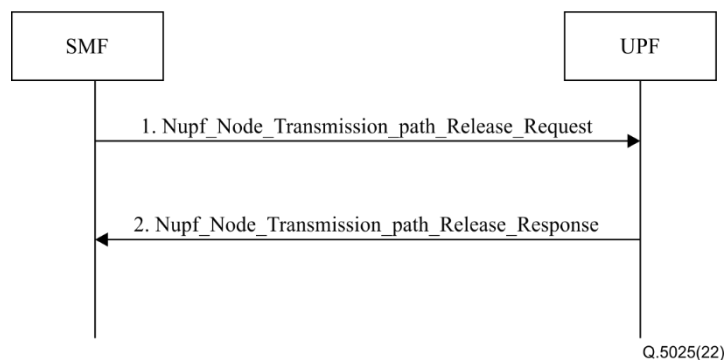

Figure 8-7 – UPF node transmission path release procedure

1 SMF sends Nupf_Node_Transmission_path_Release_Request message to the UPF with the Node ID of the SMF to release a node level path between the SMF and the UPF.

2 When the UPF receives the Nupf_Node_Transmission_path_Release_Request message, the UPF shall delete all the UE sessions related to that node transmission path and delete the node transmission path and any related information (e.g., Node ID of the SMF). Then the UPF shall send a Nupf_Node_Transmission_path_Release_Response with a successful cause.

8.8 Session establishment

The session establishment procedure shall be used to set up a session between the SMF and the UPF and configure the rules in the UPF so that the UPF can handle the incoming packets. This procedure can also be used to establish a core network tunnel between UPFs in the same group for the local area networks between two UPFs. The detail of the procedure is shown in Figure 8-8.
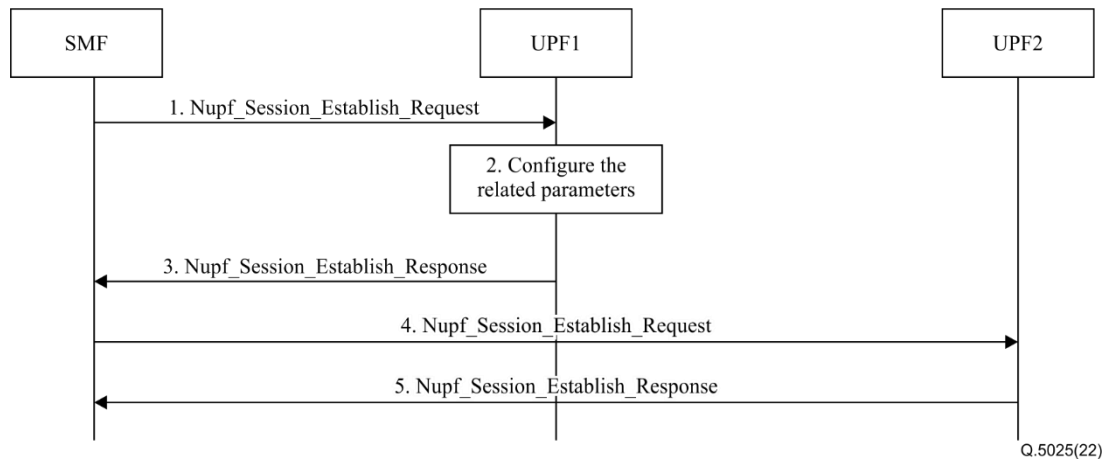
Figure 8-8 – Session establishment procedure

1   SMF sends Nupf_Session_Establish_Request message to the UPF to set up a session between the SMF and the UPF. The SMF assigns a new session ID and the related parameters such as QoS and provides them to the UPF in this message. The session ID is stored by both the entities and is used to identify the session context during their interaction. The SMF also stores the relation between the session ID and the PDU session for a UE.

2   Once received the Nupf_Session_Establish_Request message, the UPF will save the related parameters received from the SMF, and set up a context for the new PDU session.

3   The UPF sends a Nupf_Session_Establishment_Response message containing any information that the UPF has to provide to the SMF, such as the UE IP address if it is allocated by the UPF.

4   (Optional) If a core network tunnel for the local area networks between two UPFs is needed to be established and the tunnel parameters are allocated by the UPF, then the parameters will not be included in the Nupf_Session_Establish_Request message to the UPF1, and the UPF1 will allocate the parameters and send them to the SMF in the response message, then the SMF will forward them to the UPF2 in the Nupf_Session_Establish_Request message.

5   The UPF2 will also allocate the parameters and send them to the SMF in the Nupf_Session_Establish_Response message and the SMF will forward them to the UPF1.

8.9 Session update

The session update procedure shall be used to update a session between the SMF and the UPF and update the related rules in the UPF so that the UPF can handle the incoming packets using new rules.

Figure 8-9 – Session update procedure

1   SMF sends Nupf_Session_Update_Request message to the UPF to set up a session between the SMF and the UPF. The SMF assigns new parameters such as a new QoS and provides them to the UPF.

2   Once received the Nupf_Session_Update_Request message, the UPF will save the related new parameters received from the SMF and update the context for the PDU session.

3   The UPF sends a Nupf_Session_Establishment_Response message containing any information that the UPF shall provide to the SMF, such as the UE IP address if it is allocated by the UPF.

8.10   Session release

The session release procedure shall be used to release the session between the SMF and the UPF and release the related context in the SMF and the UPF. The detail of the procedure is shown in Figure 8-10.

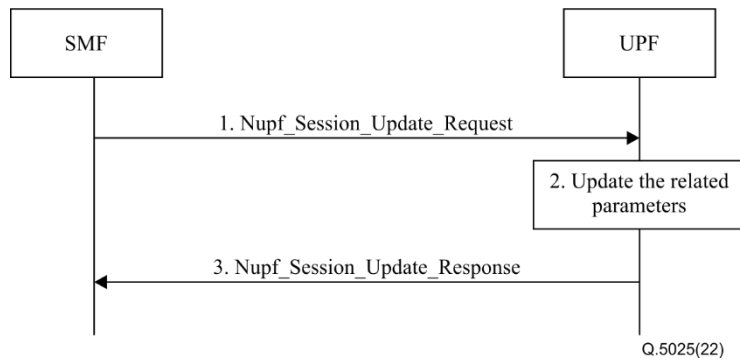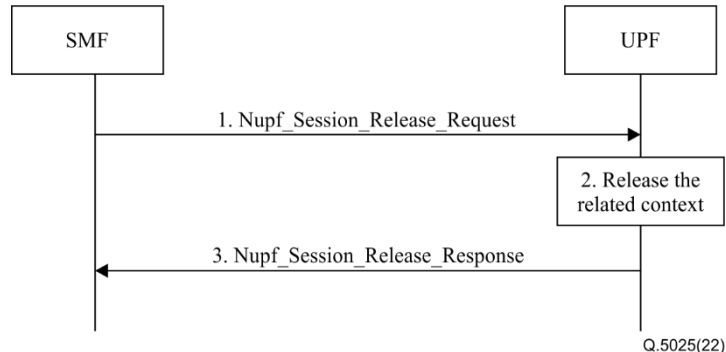**Figure 8-10 – Session release procedure**

1   SMF sends Nupf_Session_Release_Request message to the UPF to release the session between the SMF and the UPF and release the related context in the SMF and the UPF.

2   The UPF deletes any context related to the PDU session. Optionally, the core network tunnel for local area networks can also be released when the release message is received.

3   The UPF sends a Nupf_Session_Release_Response message to the SMF.

8.11   Local area network tunnel set-up between UPFs

This procedure will be used to establish an IMT-2020 local area network (LAN) tunnel between UPFs. An IMT-2020 local area can provide a group of users with a local area network through an IMT-2020 network. When users within the group communicate with each other, they can directly exchange data packets within the network. When this group of users is under two different PDU session anchor UPFs which provide IMT-2020 local area network type services, a core network tunnel

for the IMT-2020 local area network needs to be established between them to forward data for the group of users. The detail of the procedure is shown in Figure 8-11.
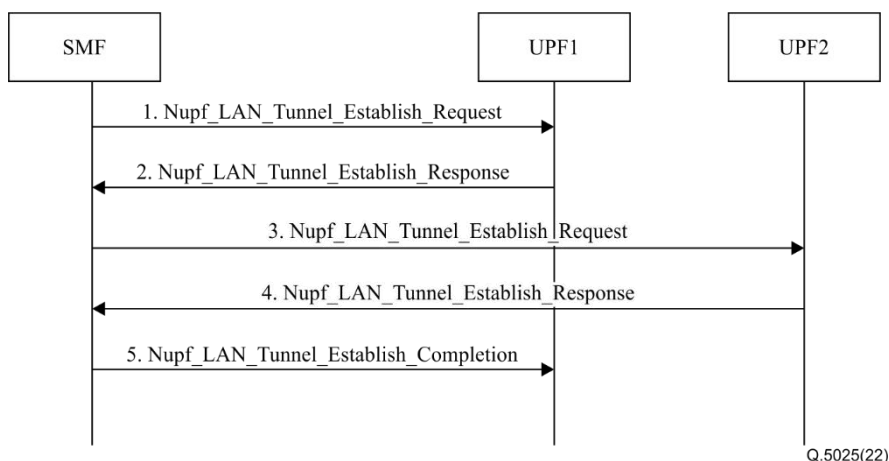
Figure 8-11 – Local area network tunnel set-up between UPFs procedure

1   In order to set up a core network tunnel between two UPFs for the IMT-2020 local area network, SMF firstly sends a Nupf_LAN_Tunnel_Establish_Request message to UPF1. Since the tunnel parameters can be allocated by the UPF, then the parameters will not be included in the Nupf_LAN_Tunnel_Establish_Request message to UPF1.

2   UPF1 receives the request message and allocates the tunnel parameters and sends them back to the SMF in the response message.

3   Then the SMF sends the Nupf_LAN_Tunnel_Establish_Request message including the tunnel parameters to UPF2.

4   UPF2 receives the request message and saves the parameters allocated by UPF1, from which the UPF2 knows the destination when forwarding data packets. Then UPF2 allocates the tunnel parameters and sends them back to the SMF in the response message.

5   SMF forwards the tunnel parameters allocated by UPF2 to UPF1.

8.12   UPF event exposure

UPF can expose real-time network information to a 3rd party via the capability exposure function (CEF), e.g., PDU session information (QoS profile) or end-to-end latency. CEF may establish a session with the UPF based on the UPF ID / FQDN and communicate directly with the UPF to get the corresponding PDU session information in order to achieve low latency information exposure. The procedure is shown in Figure 8-12.
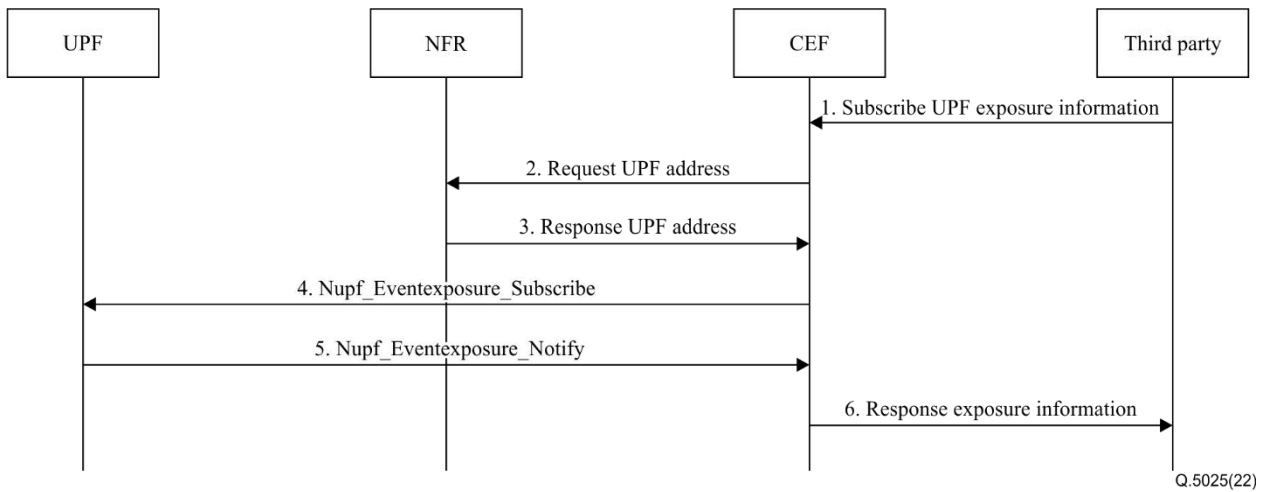
Figure 8-12 – UPF information exposure procedure

1   3rd party applications request / subscribe to the CEF for PDU information exposure of specific UE and a specific PDU session. It may include the UE IP address, network exposure information indication which indicates information 3rd party request, e.g., QoS profile, end-to-end latency for specific QoS flow, or air-interface latency for specific QoS flow.

2   When the CEF receives the UPF ID, the CEF may request the NFR to get the UPF address.

3   NFR responds to the UPF address to CEF.

4   CEF may initiate a session establishment (an interface) with the UPF based on the UPF address. The CEF may request the PDU session information e.g., user plane latency or QoS profile, directly to the UPF for specific a UE PDU session by invoking Nupf_Eventexposure_Subscribe.

5   The UPF responds to the related required information to the CEF.

6   CEF responds to the related required information to the 3rd party applications.

8.13   Customized UPF service registration

Customized UPF service registration is implemented by the NFR as shown in Figure 8-13. NFR will notify the 3rd party via CEF.
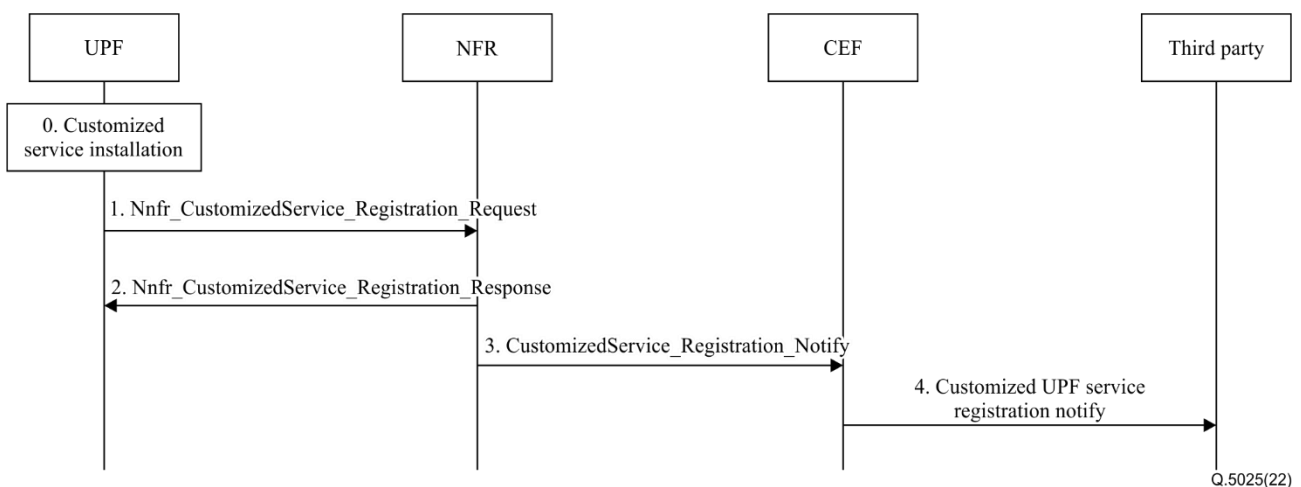
Figure 8-13 – Customized UPF service registration procedure

0   Customized services from a 3rd party are installed in the UPF.

1   UPF invokes Nnfr_CustomizedService_Registration_Request to send services information to the NFR. The message includes information of the available customized UPF services

(e.g., UPF time-sensitive network translator service), UPF serving area, network slice type indicator, DNN, interface, UPF ID and the UPF address.

2   NFR invokes Nfr_CustomizedService_Registration_Response to inform the UPF of the success or failure of the customized services registration.

3   NFR invokes CustomizedService_Registration_Notify to notify the CEF of the complement of customized service registration.

4   CEF informs the 3rd party of the success of the customized services registration.

8.14   Customized UPF service deregistration

Customized UPF service deregistration is implemented by the NFR as shown in Figure 8-14. NFR will notify the 3rd party via CEF.
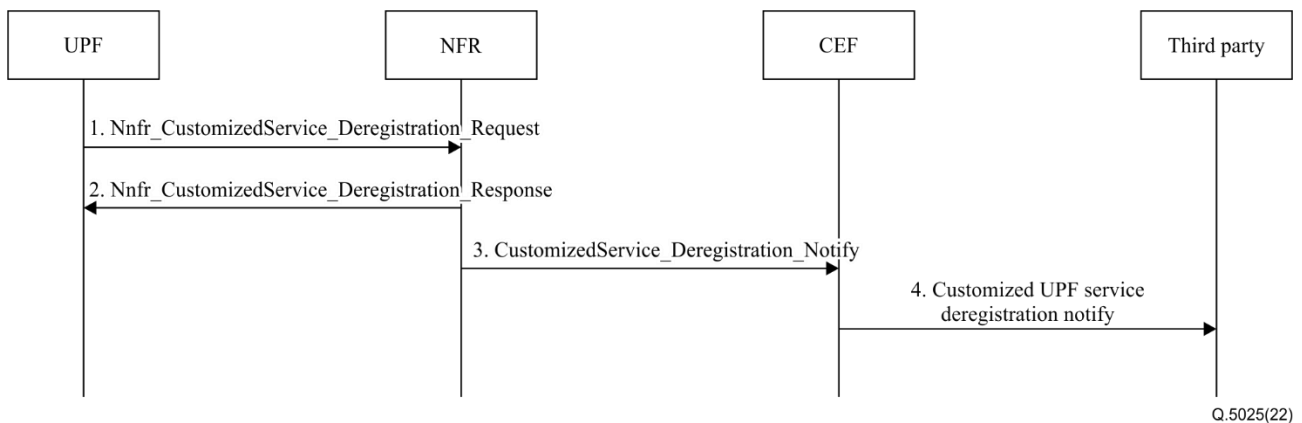
Figure 8-14 – Customized UPF service deregistration procedure

1   UPF invokes Nnfr_CustomizedService_Deregistration_Request to send services information to NFR. The message includes a list of unavailable customized services of the UPF.

2   NFR deregisters customized services and sends a response to the UPF to inform of the success or failure of the customized services deregistration by invoking Nnfr_CustomizedService_Deregistration_Response.

3   NFR invokes CustomizedService_Deregistration_notify to notify CEF of the customized service deregistration.

4   CEF informs the 3rd party of the result of customized services deregistration.

8.15   DAF subscription to periodic UPF information

Data analysis function (DAF) subscribes to the UPF information for data analysis and resource dispatch as shown in Figure 8-15.
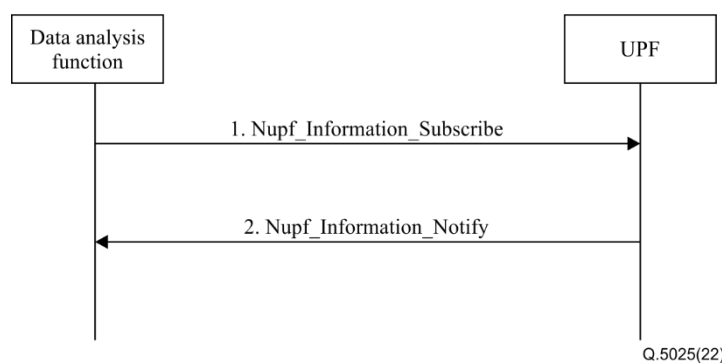
Figure 8-15 – DAF subscription to periodic UPF information procedure

1   Data analysis function subscribes to the UPF information by invoking Nupf_Information_Subscribe to create a new subscription. It includes the UPF node information, e.g., UPF throughout, node computing resource, node storage, session number, latency, access UPF or UPF service number of the UE, periodicity of subscription, UPF instance ID, UE location and other information DAF subscribes.

2   UPF notifies the data analysis function by invoking Nupf_Information_Notify service operation.

8.16   DAF unsubscription to UPF information

DAF unsubscribes to the UPF information as shown in Figure 8-16.
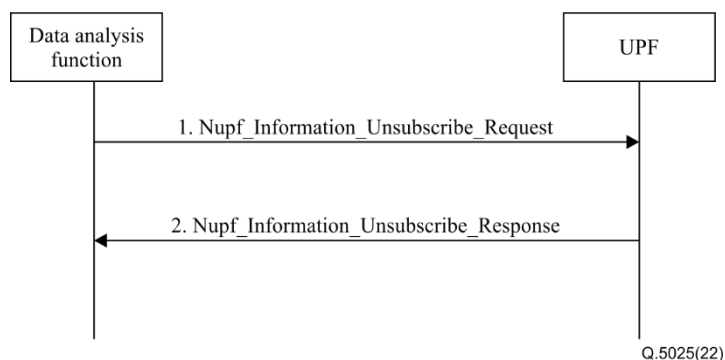
Figure 8-16 – DAF unsubscription to the UPF information procedure

1   Data analysis function unsubscribes to the UPF information by invoking Nupf_Information_Unsubscribe_Request.

2   UPF informs the data analysis function of the result of the unsubscription by invoking Nupf_Information_Unsubscribe_Response.

8.17   DAF request for the UPF information

DAF requests for the UPF information as needed as shown in Figure 8-17.
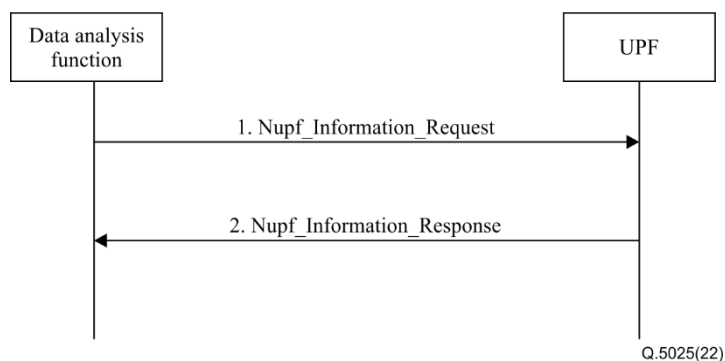
Figure 8-17 – DAF request for the UPF information procedure

1   Data analysis function requests for the UPF information by invoking Nupf_Information_Request. It may include the UPF node information or the UPF service information.

2   UPF sends a response to the DAF by invoking Nupf_Information_Response.

8.18   UPF information notification

UPF reports the KPI information to the network management by invoking UPF_Information_Notification.
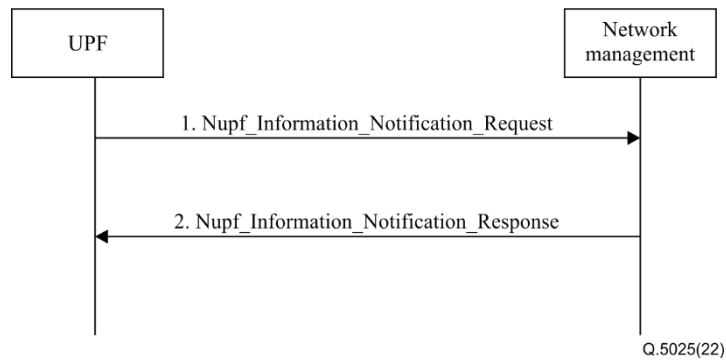
Figure 8-18 – UPF reports the KPI to the network management procedure

1   UPF invokes Nupf_Information_Notification_Request to send the KPI to the network management. It includes the UPF key performance information, e.g., UPF throughout, node computing resource, node storage, session number, latency, and access UPF/UPF service number of the UE.

2   Network management sends Nupf_Information_Notification_Response to the UPF to inform the result of the KPI report.

8.19   Network management triggered UPF energy saving

Network management monitors the resource usage of the UPFs and would trigger the UPF energy saving service when the resource usage is low (e.g., resource usage is less than a certain threshold).
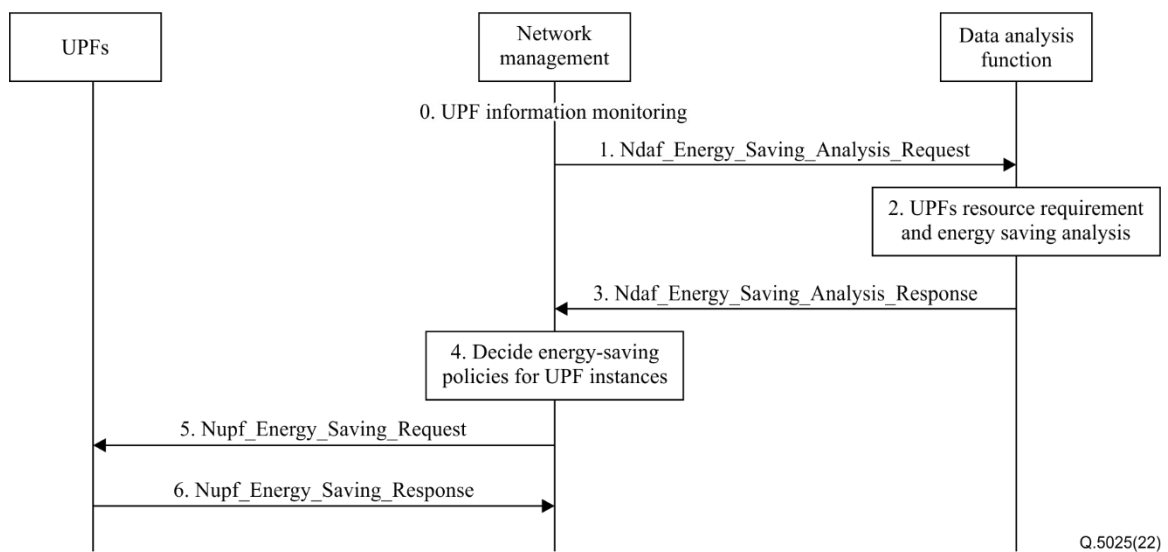
Figure 8-19 – Network management triggered UPF energy saving procedure

0   Network management monitors the UPF KPI information and justifies the energy-saving requirements of the UPF instances.

1   Network management invokes Ndaf_Energy_Saving_Analysis_Request to trigger the energy-saving analysis for those UPF instances with low resource usage.

2   DAF analyses and predicts resource requirements and the consumed energy for the UPF instances based on the UPF information (e.g., UPF throughout, session number and resource usage) provided by the UPF, and energy consumption provided by the network management.

3   DAF sends Ndaf_Energy_Saving_Analysis_Response to the network management to inform the analysis result of the resource and energy for the UPF instances.

4   Network management decides the energy saving policies for the UPF instances, which may include decreasing at least one type of the resources configuration, load migration and redirection, deactivating the idle UPF instances, or other energy-saving mechanisms.

5   Network management sends Nupf_Energy_Saving_Request to the UPF to trigger energy saving operations.

6   UPF gives the energy saving policies execution feedback by invoking Nupf_Energy_Saving_Response.

9   Message format

9.1   UPF service registration

This message is sent to the network function registry function (NFR) to register the UPF services in the core network. Core network function can be discovered and interact with the UPF.

Table 9-1 describes the detailed information of Nfr_NFService_Registration_Request:

Table 9-1 – Nfr_NFService_Registration_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates a list of UPF service instances which register in the NFR
Network slice type indicator	M	string	1… N	Indicates the network slices to which the UPF services are serving for
DNN	M	string	1… N	Indicates the data network names to which the UPF services are serving for
UPF ID	M	string	1	Indicates the UPF identifier to which the UPF services belong to
UPF address	M	string	1	Indicates the UPF address to which services belong to
Service serving area	M	string	1… N	Indicates the serving area of each UPF services instance

Table 9-2 describes the detailed information of Nfr_NFService_Registration_Response:

Table 9-2 – Nfr_NFService_Registration_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the registration of the UPF services. 201 Created 400 Input parameter error 500 Server internal error

9.2   UPF service update

This message is sent to the NFR to update the UPF services in the core network. Table 9-3 describes the detailed information of Nfr_NFService_Update_Request:

Table 9-3 – Nfr_NFService_Update_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of UPF service instances which are updated
Network slice type indicator	O	string	1… N	Indicates the network slices to which the updated UPF services are serving for
DNN	O	string	1… N	Indicates the data network names to which the updated UPF services are serving for
UPF ID	O	string	1	Indicates the UPF identifier to which the updated UPF services belong to
UPF address	O	string	1	Indicates the UPF address to which the updated UPF services belong to
Service serving area	O	string	1… N	Indicates the serving area of each updated UPF services instance

Table 9-4 describes the detailed information of Nfr_NFService_Update_Response:

Table 9-4 – Nfr_NFService_Update_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the update of the UPF service. 201 Created 400 Input parameter error 500 Server internal error

9.3   UPF service deregistration

This message is sent to the NFR to the deregistered UPF services in the core network. Table 9-5 describes the detailed information of Nfr_NFService_Deregistration_Request:

Table 9-5 – Nfr_NFService_Deregistration_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of the UPF service instances which is deregistered
Network slice type indicator	O	string	1… N	Indicates the network slices to which the deregistered UPF services are serving for
DNN	O	string	1… N	Indicates the data network names to which the deregistered UPF services are serving for

Table 9-6 describes the detailed information of Nfr_NFService_Deregistration_Response:

Table 9-6 – Nfr_NFService_Deregistration_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	200 400 500	Indicates the success or failure of the deregistration of the UPF service. 200 OK 400 Input parameter error 500 Server internal error

9.4　UPF service discovery

This message is sent to the NFR to discover the UPF services. Table 9-7 describes the detailed information of Nfr_NFService_Discovery_Request:

Table 9-7 – Nfr_NFService_Discovery_Request

Information element	Status	Data type	Cardinality	Description
NF type	M	string	1… N	Indicates the NF type of the NF discovery which is the UPF in this procedure
UPF ID	O	string	1… N	Indicates the UPF identifier of the target UPF
UPF service instance	O	string	1… N	Indicates the instance of the UPF service which is the NF consumer discovery
UPF serving area	O	string	1… N	Indicates the serving area of the target UPF
Network slice type indicator	O	string	1… N	Indicates the network slices to which the target UPF services belong to
DNN	O	string	1… N	Indicates the data network names to which the target UPF services belong to

Table 9-7 – Nfr_NFService_Discovery_Request

Information element	Status	Data type	Cardinality	Description
UPF address	O	string	1… N	Indicates the UPF address which can be either the IP address or the FQDN
UE IP address	O	string	1… N	Indicates the IP address of the UE which established the PDU session in the target UPF
PLMN ID	O	string	1… N	Indicates the PLMN identifier of the UPF
Application ID	O	string	1… N	Indicates the application identifier to which the target UPF has the PDU session to serve for

Table 9-8 describes the detailed information of Nfr_NFService_Discovery_Response:

Table 9-8 – Nfr_NFService_Discovery_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	200 400 500	Indicates the success or failure of the UPF service discovery. 200 OK 400 Input parameter error 500 Server internal error
UPF lists	M	string	1… N	N/A	Indicates the discovery results of the UPF discovery.

9.5 UPF node transmission path set-up

These messages are used to set up a node level path between the SMF and the UPF, then the SMF can use the resources of the UPF subsequently.

Table 9-9 describes the detailed information of Nupf_Node_Transmission_path_Setup_Request:

Table 9-9 – Nupf_Node_Transmission_path_Setup_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of the UPF service instances which register in NFR
Transmission path ID	M	num	1	Indicates the number of this node association.
Network slice type indicator	M	string	1… N	Indicates the network slices to which the UPF services are serving for
SMF ID	M	string	1… N	Indicates the SMF identifier

Table 9-9 – Nupf_Node_Transmission_path_Setup_Request

Information element	Status	Data type	Cardinality	Description
UPF ID	M	string	1	Indicates the UPF identifier to which the UPF services belong to
UPF address	M	string	1	Indicates the UPF address to which services belong to
SMF features	M	string	1… N	Indicates the list of optional features that the SMF supports

Table 9-10 describes the detailed information of Nupf_Node_Transmission_path_Setup_Response:

Table 9-10 – Nupf_Node_Transmission_path_Setup_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the registration of the UPF service. 201 Created 400 Input parameter error 500 Server internal error
Transmission path ID	M	num	1	N/A	Indicates the number of this node transmission path.
UPF features	M	string	1… N	N/A	Indicates the list of optional features that the UPF supports

9.6 UPF node transmission path update

These messages are used to update a node level path between the SMF and the UPF. Table 9-11 describes the detailed information of Nupf_Node_Transmission_path_Update_Request:

Table 9-11 – Nupf_Node_Transmission_path_Update_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of the UPF service instance which register in the NFR
Transmission path ID	M	num	1	Indicates the number of this node transmission path.
Network slice type indicator	M	string	1… N	Indicates the network slices to which the UPF services are serving for
SMF ID	M	string	1… N	Indicates the SMF identifier

Table 9-11 – Nupf_Node_Transmission_path_Update_Request

Information element	Status	Data type	Cardinality	Description
UPF ID	M	string	1	Indicates the UPF identifier to which the UPF services belong to
UPF address	M	string	1	Indicates the UPF address to which services belong to
SMF features	M	string	1… N	Indicates the list of optional features that the SMF supports

Table 9-12 describes the detailed information of Nupf_Node_Transmission_path_Update_Response:

Table 9-12 – Nupf_Node_Transmission_path_Update_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the registration of the UPF service. 201 Created 400 Input parameter error 500 Server internal error
Transmission path ID	M	num	1	N/A	Indicates the number of this node transmission path.
UPF features	M	string	1… N	N/A	Indicates the list of optional features that the UPF supports

9.7 UPF node transmission path release

These messages are used to release a node level path between the SMF and the UPF due to e.g., OAM reasons.

Table 9-13 describes the detailed information of Nupf_Node_Transmission_path_Release_Request:

Table 9-13 – Nupf_Node_Transmission_path_Release_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of UPF service instance which register in the NFR
SMF ID	M	string	1… N	Indicates the SMF identifier
UPF ID	M	string	1	Indicates the UPF identifier to which the UPF services belong to
UPF address	M	string	1	Indicates the UPF address to which services belong to

Table 9-14 describes the detailed information of Nupf_Node_Transmission_path_Release_Response:

Table 9-14 – Nupf_Node_Transmission_path_Release_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	200 400 500	Indicates the success or failure of the registration of the UPF service. 200 OK 400 Input parameter error 500 Server internal error

9.8 Session establishment

These messages are used to set up a session between the SMF and the UPF and configured the rules in the UPF so that the UPF can handle the incoming packets. This message can also be used to establish a core network tunnel for local area networks between two UPFs.

Table 9-15 describes the detailed information of Nupf_Session_Establish_Request:

Table 9-15 – Nupf_Session_Establish_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of UPF service instances which register in the NFR
Network slice type indicator	M	string	1… N	Indicates the network slices to which the UPF services are serving for
DNN	M	string	1… N	Indicates the data network names to which the UPF services are serving for
UPF ID	M	string	1	Indicates the UPF identifier to which the UPF services belong to
UPF address	M	string	1	Indicates the UPF address to which services belong to
PDU session ID	M	string	1… N	Indicates the identifier of the PDU session
Rules	M	string	1… N	Indicates the rules such as QoS, charging rules
Tunnel parameters	O	string	1	Indicates the tunnel parameters that the UPF allocated

Table 9-16 describes the detailed information of Nupf_Session_Establish_Response:

Table 9-16 – Nupf_Session_Establish_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the registration of the UPF service. 201 Created 400 Input parameter error

Table 9-16 – Nupf_Session_Establish_Response

Information element	Status	Data type	Cardinality	Code value	Description
					500 Server internal error
UE IP address	O	string	1	N/A	Indicates the UE IP address that the UPF allocated
Tunnel parameters	O	string	1	N/A	Indicates the tunnel parameters that the UPF allocated

9.9 Session update

These messages are used to update a session between the SMF and the UPF and update the related rules in the UPF so that the UPF can handle the incoming packets using new rules.

Table 9-17 describes the detailed information of Nupf_Session_Update_Request:

Table 9-17 – Nupf_Session_Update_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of UPF service instances which register in the NFR
Network slice type indicator	M	string	1… N	Indicates the network slices to which the UPF services are serving for
DNN	M	string	1… N	Indicates the data network names to which the UPF services are serving for
UPF ID	M	string	1	Indicates the UPF identifier to which the UPF services belong to
UPF address	M	string	1	Indicates the UPF address to which services belong to
PDU session ID	M	string	1… N	Indicates the identifier of the PDU session
Rules	M	string	1… N	Indicates the rules such as QoS, charging rules
Tunnel parameters	O	string	1	Indicates the tunnel parameters that UPF allocated

Table 9-18 describes the detailed information of Nupf_Session_Update_Response:

Table 9-18 – Nupf_Session_Update_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the registration of the UPF service. 201 Created 400 Input parameter error 500 Server internal error
UE IP address	O	string	1	N/A	Indicates the UE IP address that the UPF allocated
Tunnel parameters	O	string	1	N/A	Indicates the tunnel parameters that the UPF allocated

9.10 Session release

These messages are used to release the session between the SMF and the UPF and release the related context in the SMF and the UPF.

Table 9-19 describes the detailed information of Nupf_Session_Release_Request:

Table 9-19 – Nupf_Session_Release_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1... N	Indicates the list of UPF service instances which register in the NFR
UPF ID	M	string	1	Indicates the UPF identifier to which the UPF services belong to
UPF address	M	string	1	Indicates the UPF address to which services belong to
PDU session ID	M	string	1… N	Indicates the identifier of the PDU session

Table 9-20 describes the detailed information of Nupf_Session_Release_Response:

Table 9-20 – Nupf_Session_Release_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	200 400 500	Indicates the success or failure of the registration of the UPF service. 200 OK 400 Input parameter error 500 Server internal error

9.11 Local area network tunnel set-up between UPFs

These messages are used to establish a core network tunnel for the IMT-2020 local area network, then users can directly exchange data packets within the network.

Table 9-21 describes the detailed information of Nupf_LAN_Tunnel_Establish_Request:

Table 9-21 – Nupf_LAN_Tunnel_Establish_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of UPF service instances which register in the NFR
Network slice type indicator	M	string	1… N	Indicates the network slices to which the UPF services are serving for
DNN	M	string	1… N	Indicates the data network names to which the UPF services are serving for
UPF ID	M	string	1	Indicates the UPF identifier to which the UPF services belong to
UPF address	M	string	1	Indicates the UPF address to which services belong to
PDU session ID	M	string	1… N	Indicates the identifier of the PDU session
Rules	M	string	1… N	Indicates the rules such as QoS, charging rules
Tunnel parameters	O	string	1	Indicates the parameters that the UPF allocated of the core network tunnel between the UPFs in the same group

Table 9-22 describes the detailed information of Nupf_LAN_Tunnel_Establish_Response:

Table 9-22 – Nupf_LAN_Tunnel_Establish_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the registration of the UPF service. 201 Created 400 Input parameter error 500 Server internal error
Tunnel parameters	O	string	1	N/A	Indicates the parameters of the core network tunnel between the UPFs in the same group that the UPF allocated

Table 9-23 describes the detailed information of Nupf_LAN_Tunnel_Establish_Completion:

Table 9-23 – Nupf_LAN_Tunnel_Establish_Completion

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the registration of the UPF service. 201 Created 400 Input parameter error 500 Server internal error
Tunnel parameters	O	string	1	N/A	Indicates the parameters of the core network tunnel between the UPFs in the same group that the UPF allocated

9.12 UPF event exposure

This message is for CEF, 3rd party applications or other network functions to get the UPF information based on some events. Table 9-24 and Table 9-25 describes the detailed information of Nupf_Eventexposure_Subscribe and Nupf_Eventexposure_Notify:

Table 9-24 – Nupf_Eventexposure_Subscribe

Information element	Status	Data type	Cardinality	Description
Request information indication	M	string	1… N	Indicates the list of information which the UPF can expose.
IP address	M	string	1… N	Indicates which PDU session is the target for such information exposure.
DNN	M	string	1… N	Indicates the data network names to which the UPF services are serving for
Network slice type indicator	M	string	1	Indicates which network slice is related to such exposure request.

Table 9-25 – Nupf_Eventexposure_Notify

Information element	Status	Data type	Cardinality	Description
The requested network information	M	string	1	The information that the consumer NF requested for the UPF exposure.
Correlation ID	M	num	1… N	The correlation ID for such interaction between the UPF and the requested NFs.

9.13 Customized UPF service registration

This message is sent to the NFR to register the customized UPF services. Core network functions can be discovered and interact with the customized services.

Table 9-26 describes the detailed information of Nnfr_CustomizedService_Registration_Request.

Table 9-26 – Nnfr_CustomizedService_Registration_Request

Information element	Status	Data type	Cardinality	Description
Customized UPF service	M	string	1… N	Indicates the list of customized service instances which register in the NFR
Network slice type indicator	M	string	1… N	Indicates the network slices which the customized UPF services are serving for
DNN	M	string	1… N	Indicates the data network names which the customized UPF services are serving for
Service serving area	M	string	1… N	Indicates the serving area of each customized UPF services instances
3rd party	M	string	1	Indicates the 3rd party name to which the customized services belong to

Table 9-27 describes the detailed information of Nnfr_CustomizedService_Registration_Response:

Table 9-27 – Nnfr_CustomizedService_Registration_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the registration of the customized UPF service. 201 Created 400 Input parameter error 500 Server internal error

Table 9-28 describes the detailed information of CustomizedService_Registration_Notify.

Table 9-28 – CustomizedService_Registration_Notify

Information element	Status	Data type	Cardinality	Description
Customized UPF service	M	string	1… N	Indicates the list of customized service instances which register in the NFR
Network slice type indicator	M	string	1… N	Indicates the network slices which the customized UPF services are serving for
DNN	M	string	1… N	Indicates the data network names which the customized UPF services are serving for
Service serving area	M	string	1… N	Indicates the serving area of each customized UPF services instances
UPF ID	M	string	1	Indicates the UPF identifier to which the customized UPF services belong to
3rd party	M	string	1	Indicates the 3rd party name to which the customized services belong to

9.14 Customized UPF service deregistration

This message is sent to the NFR to deregister the customized UPF services. Table 9-29 describes the detailed information of Nnfr_CustomizedService_Deregistration_Request:

Table 9-29 – Nnfr_CustomizedService_Deregistration_Request

Information element	Status	Data type	Cardinality	Description
Customized UPF service	M	string	1… N	Indicates the list of customized UPF service instances which are deregistered
Network slice type indicator	O	string	1… N	Indicates the network slices which the deregistered customized UPF services are serving for
DNN	O	string	1… N	Indicates the data network names which the deregistered customized UPF services are serving for
3rd party	M	string	1	Indicates the 3rd party name to which the deregistered customized services belong to

Table 9-30 describes the detailed information of Nnfr_CustomizedService_Deregistration_Response:

Table 9-30 – Nnfr_CustomizedService_Deregistration_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	200 400 500	Indicates the success or failure of the deregistration of the customized UPF service. 200 OK 400 Input parameter error 500 Server internal error

Table 9-31 describes the detailed information of CustomizedService_Deregistration_Notify.

Table 9-31 – CustomizedService_Deregistration_Notify

Information element	Status	Data type	Cardinality	Description
Customized UPF service	M	string	1… N	Indicates the list of customized UPF service instances which are deregistered
Network slice type indicator	O	string	1… N	Indicates the network slices which the deregistered customized UPF services are serving for
DNN	O	string	1… N	Indicates the data network names which the deregistered customized UPF services are serving for

Table 9-31 – CustomizedService_Deregistration_Notify

Information element	Status	Data type	Cardinality	Description
3rd party	M	string	1	Indicates the 3rd party name which the deregistered customized services belong to

9.15 DAF subscription to periodic UPF information

This message is sent to the UPF to subscribe for information. Table 9-32 describes the details information of Nupf_Information_Subscribe:

Table 9-32 – Nupf_Information_Subscribe

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the UPF services instance which the DAF requests for
UPF information	M	string	1… N	Indicates the UPF information report to the DAF. It may be UPF throughout, node computing resource, node storage, session number, latency, access UPF/UPF service number of the UE, UPF instance ID, UE location and other information of the UPF or UPF services
Periodicity	M	string	1	Periodicity of the UPF information report

Table 9-33 describes the detailed information of Nupf_Information_Notify:

Table 9-33 – Nupf_Information_Notify

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the UPF information subscription. 201 Created 400 Input parameter error 500 Server internal error
Time information	M	string	1… N	N/A	Time information of the UPF information.

9.16 DAF unsubscription to UPF information

This message is sent to the UPF to unsubscribe from the UPF information.

Table 9-34 describes the detailed information of Nupf_Information_Unsubscribe_Request:

Table 9-34 – Nupf_Information_Unsubscribe_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the UPF services instance which the DAF requests for
UPF information	M	string	1… N	Indicates the UPF information which the DAF request for unsubscription

Table 9-35 describes the detailed information of Nupf_Information_Unsubscribe_Response:

Table 9-35 – Nupf_Information_Unsubscribe_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	200 400 500	Indicates the success or failure of the UPF information unsubscription 200 OK 400 Input parameter error 500 Server internal error

9.17 DAF request for UPF information

This message is sent to the UPF to request for the UPF information as needed.

Table 9-36 describes the detailed information of Nupf_Information_Request:

Table 9-36 – Nupf_Information_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the UPF services instance which the DAF requests for
UPF information	M	string	1… N	Indicates the UPF information which the DAF requests for. It may be UPF throughout, node computing resource, node storage, session number, latency, access UPF/UPF service number of the UE and other information of the UPF or UPF services

Table 9-37 describes the detailed information of Nupf_Information_Response:

Table 9-37 – Nupf_Information_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the UPF information request. 201 Created 400 Input parameter error 500 Server internal error
UPF information	M	string	1… N	N/A	Indicates the data and report sent by the UPF to the DAF. It may be UPF throughout, node computing resource, node storage, session number, latency, access UPF/UPF service number of the UE, UPF instance ID, UE location and other information of the UPF or UPF services
Time information	M	string	1… N	N/A	Time information of the UPF information

9.18 UPF information notification

This message is sent to the network management to report the KPI of the UPF through Nupf_Information_Notification. Table 9-38 describes the detailed information of Nupf_Information_Notification_Request:

Table 9-38 – Nupf_Information_Notification_Request

Information element	Status	Data type	Cardinality	Description
UPF service instance	M	string	1… N	Indicates the list of UPF service instances which report KPI information
UPF KPI	M	string	1… N	Indicates the KPI information UPF services report to the network management. KPI information may be UPF throughout, node computing resource, node storage, session number, latency, access UPF/UPF service number of the UE and other information of the UPF or UPF services

Table 9-39 describes the detailed information of Nupf_Information_Notification_Response:

Table 9-39 – Nupf_Information_Notification_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the core network data collection subscribe 201 Created 400 Input parameter error 500 Server internal error

9.19 Network management triggered UPF energy saving

This message of Ndaf_Energy_Saving_Analysis_Request is sent to the DAF to request energy-saving analysis for the UPF instances.

Table 9-40 describes the detailed information of Ndaf_Energy_Saving_Analysis_Request.

Table 9-40 – Ndaf_Energy_Saving_Analysis_Request

Information element	Status	Data type	Cardinality	Description
UPF instance ID	M	string	1… N	Indicates the UPF instance identifiers that triggered the UPF energy saving analysis
UPF EnSaReq	M	string	1… N	Indicates the UPF energy saving analysis requirements. It may include the requirements of the predicted load and the corresponding resource and energy.

Table 9-41 describes the detailed information of Ndaf_Energy_Saving_Analysis_Response.

Table 9-41 – Ndaf_Energy_Saving_Analysis_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the UPF energy saving analysis. 201 Created 400 Input parameter Error 500 Server internal error
UPF instance ID	M	string	1… N	N/A	Indicate sthe UPF instance identifiers that have energy saving analysis in the response.
Analysis result	M	string	1… N	N/A	Indicates the analysis result of the resource and energy for the energy-saving UPF.
Time information	M	string	1… N	N/A	The time information of the UPF energy saving analysis.

This message of Nupf_Energy_Saving_Request is sent to the UPF to issue the energy-saving policies.

Table 9-42 describes the detailed information of Nupf_Energy_Saving_Request.

Table 9-42 – Nupf_Energy_Saving_Request

Information element	Status	Data type	Cardinality	Description
UPF instance ID	M	string	1… N	Indicates the UPF instance identifiers that need to execute energy saving operations.
SMF instance ID	O	string	1… N	Indicates the SMF instance identifiers that need to execute energy saving operations.
UPF PolExeReq	M	string	1… N	Indicates the UPF energy saving policy execution requirements. It may include the UPF deactivating command.
SMF PolExeReq	O	string	1… N	Indicates the UPF energy saving policy execution requirements in the SMF. It may include the load migration to increase resource usage.

Table 9-43 describes the detailed information of Nupf_Energy_Saving_Response.

Table 9-43 – Nupf_Energy_Saving_Response

Information element	Status	Data type	Cardinality	Code value	Description
Result	M	num	1	201 400 500	Indicates the success or failure of the energy saving policies execution for the UPF. 201 Created 400 Input parameter error 500 Server internal error

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