

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.

History

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* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

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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.

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Recommendation ITU-T Q.5025

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.

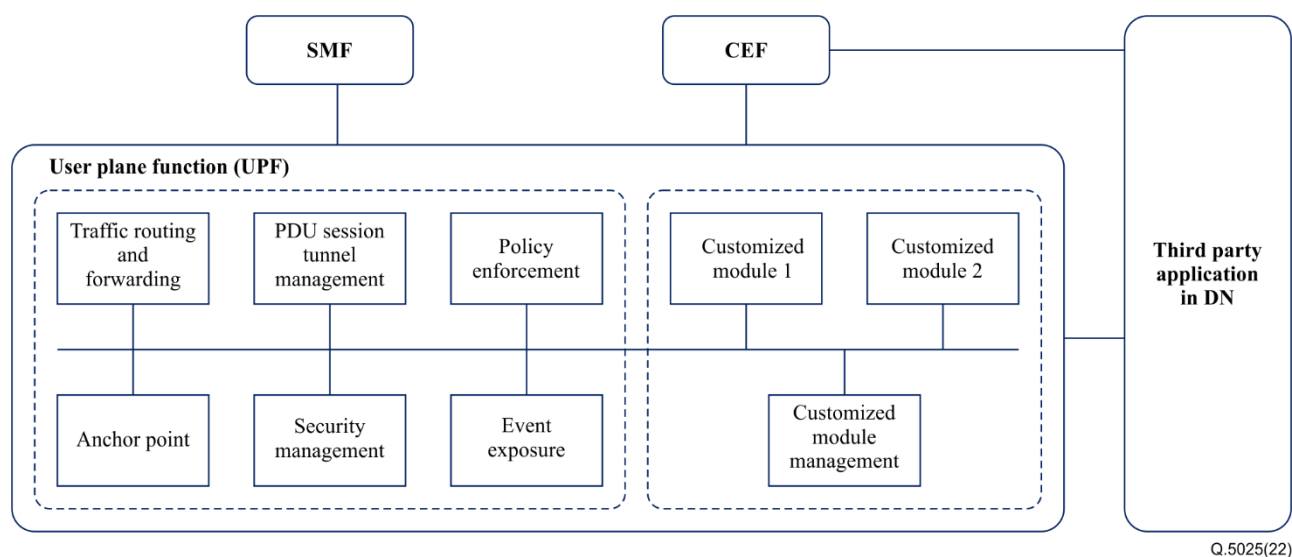


Figure 7-1 – Architecture reference model for user plane function in IMT-2020 network

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.

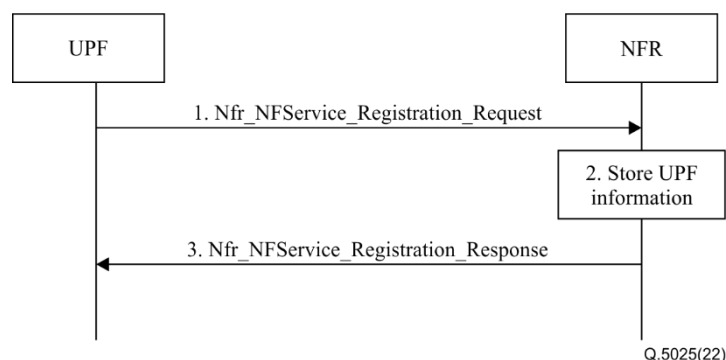


Figure 8-1 – UPF services registration procedure

- 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.

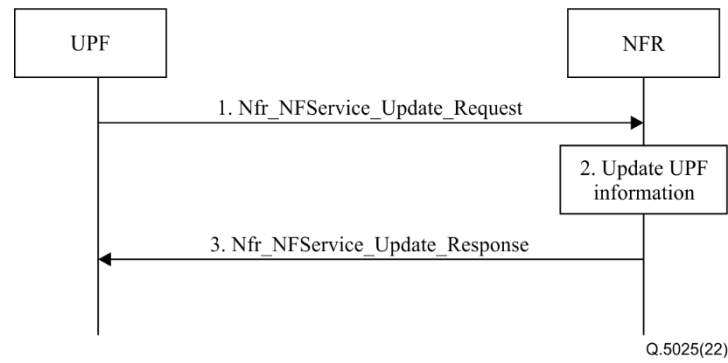


Figure 8-2 – UPF service update procedure

- 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.

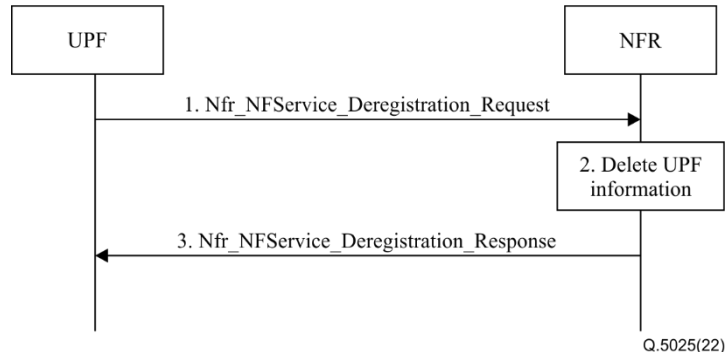


Figure 8-3 – UPF service deregistration procedure

- 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.

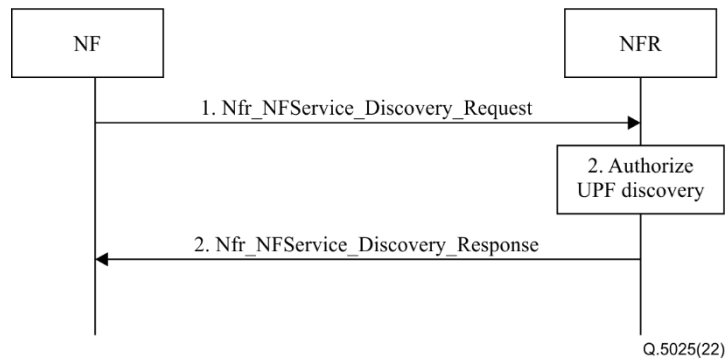


Figure 8-4 – UPF service discovery procedure

- 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.

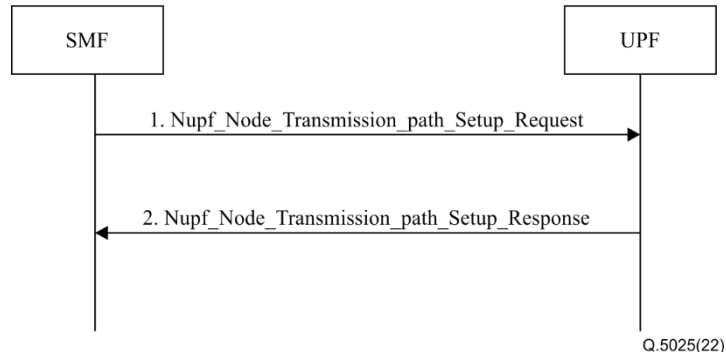


Figure 8-5 – UPF node transmission path set-up procedure

- 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.

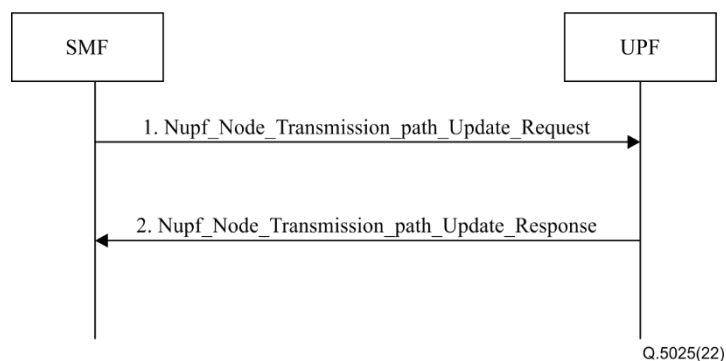


Figure 8-6 – UPF node transmission path update procedure

- 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.

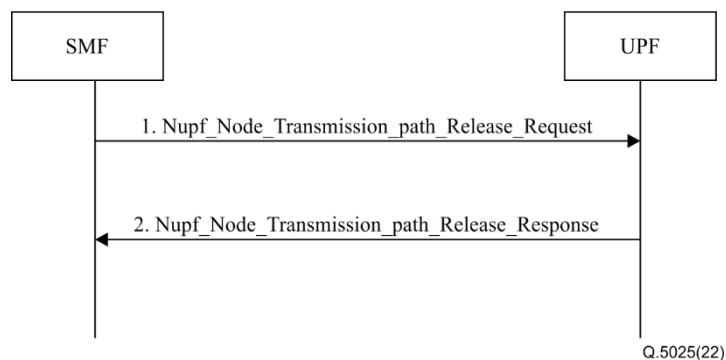


Figure 8-7 – UPF node transmission path release procedure

- 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.