**3GPP TSG-CT WG3 Meeting #116e C3-213201**

**E-Meeting, 19th – 28th May 2021 (Revision of C3-21xxxx)**

|  |
| --- |
| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
|  |
|  | **29.561** | **CR** | **0114** | **rev** |  | **Current version:** | **17.1.0** |  |
|  |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
|  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network | **X** |

|  |
| --- |
|  |
| ***Title:***  | Reporting UPF ID to RADIUS DN-AAA server |
|  |  |
| ***Source to WG:*** | Ericsson |
| ***Source to TSG:*** | CT3 |
|  |  |
| ***Work item code:*** | TEI17, 5GS\_Ph1-CT |  | ***Date:*** | 2021-05-04 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** |  Rel-17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
|  |  |
| ***Reason for change:*** | 1. UPF ID can be used by DN-AAA server to decide the DNS server address close to the UPF, to be sent in the Access-Accept message.
2. UPF ID is already included in N40 i/f and CHF CDR, which can be used for UPF based charging, hence can also be sent in Accounting Request messages to indicate the reported usage volume serving by the UPF e.g. with multiple UPF scenario, the local offloaded traffic flow volume served by the local UPF for charging and/or accounting statistics.
 |
|  |  |
| ***Summary of change:*** | Adding 3GPP VSA for the UPF ID may be reported to the trusted external DN in RADIUS messages. |
|  |  |
| ***Consequences if not approved:*** | Can not support DN-AAA server for UPF based DNS server address provisioning. Can not support UPF based charging and/or accounting statistics. |
|  |  |
| ***Clauses affected:*** | 11.2.1, 11.2.2, 11.3.1 |
|  |  |
|  | **Y** | **N** |  |   |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

**Additional discussion(if needed):**

**Proposed changes:**

\*\*\* 1st Change \*\*\*

### 11.2.1 Authentication, Authorization and Accounting procedures

The SMF also represents the H-SMF in the home routed scenario in this subclause unless specified otherwise.

When an SMF receives an initial access request (i.e. the SMF receives the Nsmf\_PDUSession\_CreateSMContext request with type "Initial request" for non-roaming case or local breakout case, or the H-SMF receives the Nsmf\_PDUSession\_Create Request with type "Initial request" for home routed case) message for a given DNN, the SMF may (depending on the configuration for this DNN) send a RADIUS Access-Request message with EAP extension to a DN-AAA server. The SMF may also (depending on the configuration for this DNN) send the S-NSSAI and the PDU Session ID that are associated with the PDU Session, respectively in the 3GPP-Session-S-NSSAI VSA and the 3GPP-Session-Id VSA, and/or the UPF ID that is selected by SMF for the PDU Session interworking with the trusted external DN in the 3GPP-UPF-Id VSA, to a DN-AAA server. Upon receipt of the Access-Request message, the DN-AAA server shall respond with an Access-Challenge message. Multi-round authentication using the Access-Challenge (sent by DN-AAA) and Access-Request messages may be used. The DN-AAA server finally authenticates and authorizes the user by replying with an Access Accept message. If the DN-AAA server is also responsible for IPv4 address and/or IPv6 prefix allocation, the DN-AAA server shall return the allocated IPv4 address and/or IPv6 prefix in the Access-Accept message.

For re-authentication and re-authorization, the SMF shall send a RADIUS Access-Request message with EAP extension and the DN-AAA shall respond with an Access-Challenge message. Multi-round authentication using the Access-Challenge (sent by DN-AAA) and Access-Request messages may be used. The DN-AAA server finally authenticates and authorizes the user by replying with an Access Accept message.

The SMF may initiate RADIUS re-authorization procedures for the purpose of IPv4 address and/or IPv6 prefix allocation (or renew the lease). In this case, the SMF shall set the Service-Type attribute to "Authorize Only" and the 3GPP-Allocate-IP-Type subattribute to the type of IP address to be allocated in the Access-Request message sent to the DN-AAA server. If the SMF is using DHCP signalling towards the UE and the DN-AAA server includes the Session-Timeout attribute in the Access-Accept, the SMF may use the Session-Timeout value as the DHCP lease time. The SMF shall not set the DHCP lease time value higher than the Session-Timeout value. The SMF may renew the DHCP lease to the UE without re-authorization towards the DN-AAA server providing that the new lease expiry is no later than the Session-Timeout timer expiry. If the SMF wishes to extend the lease time beyond the current Session-Timeout expiry, it shall initiate a new AAA re-authorization.

Even if the SMF was not involved in user authentication, it may send a RADIUS Accounting-Request (START) message to a DN-AAA server. This message may contain parameters, e.g. the tuple which includes the user ID and IPv4 address and/or IPv6 prefix, to be used by application servers (e.g. WAP gateway) in order to identify the user. This message may also (depending on the configuration for the DNN) contains the S-NSSAI and the PDU Session ID that are associated with the PDU Session, respectively in the 3GPP-Session-S-NSSAI VSA and the 3GPP-Session-Id VSA, and/or the used UPF ID interworking with the trusted external DN in the 3GPP-UPF-Id VSA, to a DN-AAA server. This message also indicates to the AAA server that the user session has started. The user session is uniquely identified by the Acct-Session-Id that is composed of the Charging ID and the SMF IP address.

NOTE: If the accounting session is required by the DN-AAA server to be created per QoS flow, how to identify the different accounting sessions is implementation specific. The SMF can include the Acct-Session-Id which is extended to include the QFI of the QoS flow or the Acct-Session-Id without QFI extension and with 3GPP-NSAPI combination in the RADIUS Accounting-Request (START).

If some external applications require RADIUS Accounting-Request (START) information before they can process user packets, then the selected DNN (SMF) may be configured in such a way that the UPF is instructed to drop user data until the Accounting-Response (START) is received from the AAA server. The SMF may wait for the Accounting-Response (START) before sending the final authentication response message in Namf\_Communication\_N1N2MessageTransfer service operation. The SMF may reject the initial access request if the Accounting-Response (START) is not received. The authentication and accounting servers may be separately configured for each DNN.

For IPv4 PDU type, if IPv4 address is allocated via DHCPv4 signalling between the UE and the DN-AAA after PDU session establishment, the SMF may wait to send the Accounting-Request (START) message until the UE receives its IPv4 address in a DHCPACK.

When the SMF receives a message indicating a QoS flow or PDU session release request and providing a RADIUS Accounting-Request (START) message was sent previously, the SMF shall send a RADIUS Accounting-Request (STOP) message to the DN-AAA server, which indicates the termination of this particular QoS flow or PDU session. The SMF shall immediately send the corresponding response (e.g. Nsmf\_PDUSession\_UpdateSMContext response) to the AMF, without waiting for an Accounting-Response (STOP) message from the DN-AAA server.

The DN-AAA server shall deallocate the IPv4 address and/or IPv6 prefix initially allocated to the subscriber, if there is no session for the subscriber.

Accounting-Request (ON) and Accounting-Request (OFF) messages may be sent from the SMF to the DN-AAA server to ensure the correct synchronization of the session information in the SMF and the DN-AAA server.

The SMF may send an Accounting-Request (ON) message to the DN-AAA server to indicate that a restart has occurred. The DN-AAA server may then release the associated resources.

Prior to a scheduled restart, the SMF may send Accounting-Request (OFF) message to the DN-AAA server. The DN-AAA server may then release the associated resources.

The following figure 11.2.1-1 is an example message flow to show the procedure of RADIUS Authentication and Accounting between an SMF and a DN-AAA server:

1. UE initiates the PDU Session Establishment procedure, including authentication/authorization information.

2. The AMF sends Nsmf\_PDUSession\_CreateSMContext Request including the authentication/authorization information to the SMF and the SMF responds to the service operation.

 According to the configuration in the SMF, step 6 to step 9 are executed before step 3 if the SMF needs to send an EAP-Request message to the UE.

 In the case of home routed, the AMF sends Nsmf\_PDUSession\_CreateSMContext Request including the authentication/authorization information to the V-SMF and the V-SMF sends Nsmf\_PDUSession\_Create Request including the authentication/authorization information to the H-SMF.

3. If the N4 session has not been established before, the SMF triggers the N4 Session Establishment procedure to the UPF.

In the case of home routed, the V-SMF triggers the N4 Session Establishment procedure to the V-UPF and the H-SMF triggers the N4 Session Establishment procedure to the H-UPF.

4. The SMF sends the Access-Request message to the DN-AAA via the UPF, the message is forwarded from the SMF to the DN-AAA by the UPF in N4 user plane message.

In the case of home routed, the H-SMF sends the Access-Request message to the DN-AAA via the H-UPF, the message is forwarded from the H-SMF to the DN-AAA by the H-UPF in N4 user plane message.

5-10. The DN-AAA responds with the Access-Challenge message to the SMF via the UPF, the message is forwarded from the DN-AAA to the SMF by the UPF in N4 user plane message. The authentication/authorization information is further transferred to UE via Namf\_Communication\_N1N2MessageTransfer service and NAS SM Transport message. UE responds to the received authentication/authorization data and such information is transferred in NAS SM Transport message and Nsmf\_PDUSession\_UpdateSMContext service, then finally sent to the DN-AAA by the SMF, via the UPF, in the Access-Request message.

In the case of home routed, the DN-AAA responds with the Access-Challenge message to the H-SMF via the H-UPF, the message is forwarded from the DN-AAA to the H-SMF by the H-UPF in N4 user plane message. The authentication/authorization information is transferred to V-SMF via Nsmf\_PDUSession\_Update service and is further transferred to UE via Namf\_Communication\_N1N2MessageTransfer service and NAS SM Transport message. UE responds to the received authentication/authorization data and such information is transferred in NAS SM Transport message, Nsmf\_PDUSession\_UpdateSMContext service and Nsmf\_PDUSession\_Update servic, then finally sent to the DN-AAA by the H-SMF, via the H-UPF, in the Access-Request message.

NOTE: Step 5 to step 10 can be repeated depending on the authentication/authorization mechanism used (e.g. EAP-TLS).

11. The SMF receives the final result of authentication/authorization from the DN-AAA in the Access-Accept message, via the UPF.

12. The SMF requests to start accounting by sending the Accounting-Request (START) message to the DN-AAA via the UPF.

13. The SMF proceeds with the PDU session establishment procedure and includes the authentication/authorization information in Namf\_Communication\_N1N2MessageTransfer service.

In the case of home routed, the H-SMF proceeds with the PDU session establishment procedure and includes the authentication/authorization information is transferred to V-SMF via Nsmf\_PDUSession\_Update service and is further transferred to the AMF via Namf\_Communication\_N1N2MessageTransfer service.

14. The DN-AAA responds with the Accounting-Response (START) message. The SMF may wait for the Accounting-Response (START) before sending the Namf\_Communication\_N1N2MessageTransfer request in step 13.

In the case of home routed, the H-SMF may wait for the Accounting-Response (START) before sending the Nsmf\_PDUSession\_Update service in step 13.

15. The AMF sends the NAS PDU Session Establishment Request with the authentication/authorization information to the UE.

16. The UE sends a NAS message Deregistration Request to the AMF.

17. The AMF sends Nsmf\_PDUSession\_ReleaseSMContext Request to the SMF and the SMF responds to the service operation.

 In the case of home routed, the AMF sends Nsmf\_PDUSession\_ReleaseSMContext Request to the V-SMF and the V-SMF sends the Nsmf\_PDUSession\_Release Request to the H-SMF.

18-19. The SMF requests to stop accounting by sending the Accounting-Request (STOP) message to the DN-AAA via the UPF and the DN-AAA responds with the Accounting-Response (STOP) message.



Figure 11.2.1-1: RADIUS Authentication and Accounting example (successful case)

When PAP/CHAP is used as the authentication protocol with the external DN-AAA server which does not support EAP for the 5GS or for the 5GC and EPC interworking scenarios, the RADIUS Authentication procedures refer to the non transparent access procedures in subclause 11.2.1 and the related RADIUS Authentication description in subclause 16.3a.1 in 3GPP TS 29.061 [5] are reused with the following differences:

- the SMF or SMF+PGW-C performs the actions specified for the P-GW;

- the external DN-AAA server performs the actions specified for AAA;

- PDU Session Establishment request is sent from the UE to the SMF or SMF+PGW-C instead of the Activate PDN connection request being sent from the UE to the S-GW and the Create Session request being sent from S-GW to P-GW;

- PDU Session Establishment accept is sent from the SMF or SMF+PGW-C to the UE instead of the Create Session Response message being sent from the P-GW to S-GW and the Activate PDN Connection Accept being sent from S-GW to the UE; and

- PDU Session Establishment reject is sent from the SMF or SMF+PGW-C to the UE instead of the Create Session Response message being sent from the P-GW to the S-GW and the Activate PDN Connection Reject being sent from S-GW to the UE.

\*\*\* 2nd Change \*\*\*

### 11.2.2 Accounting Update

During the life of a QoS flow some information related to this QoS flow may change. The SMF may send RADIUS Accounting Request Interim-Update to the DN-AAA server upon occurrence of a chargeable event, e.g. RAT change, UPF change or QoS change. Interim updates are also used when the IPv4 address and/or IPv6 prefix is allocated/released/re-allocated.

When the SMF receives a signalling request (i.e. Nsmf\_PDUSession\_UpdateSMContext) that indicates the occurrence of one of these chargeable events, the SMF may send an Accounting Request Interim-Update to the DN-AAA server to update the necessary information related to this QoS flow. It is not necessary for the SMF to wait for the RADIUS AccountingResponse message from the DN-AAA server before sending the response for the triggering signalling message (i.e. Namf\_Communication\_N1N2MessageTransfer). The SMF may delete the QoS flow if the AccountingResponse is not received from the DN-AAA server.

The SMF may also send interim updates at the expiry of an operator configured time limit.

Figure 11.2.2-1 is an example message flow to show the procedure of RADIUS accounting update, messages between the SMF and DN-AAA are forwarded by the UPF in N4 user plane message.



Figure 11.2.2-1: RADIUS accounting update

For the 5GC and EPC interworking scenario without authentication, authorization, re-authentication and/or re-authorization impacts, if the UE establishes the PDU session through the 5GC and initiates the accounting session, when the SMF+PGW-C determines that the UE has moved to the EPS (i.e. the SMF+PGW-C receives the modify bearer request or create session request from the S-GW), the SMF+PGW-C may perform the accounting session update with the following modifications:

- for the case that the accounting session is initiated per PDU session, the SMF+PGW-C may update the accounting session by including the identifier of the accounting session within the Acct-Session-Id, the "EUTRA" within the 3GPP-RAT-Type, the IPv4 address of S-GW within the 3GPP-SGSN-Address, the default EPS bearer id within the 3GPP-NSAPI, the user location in the EPC within the 3GPP-User-Location-Info if available and the new QoS profile within the 3GPP-GPRS-Negotiated-QoS-Profile if changed.

- for the case that the accounting session is initiated per QoS flow:

- if the SMF+PGW-C mapped a QoS flow to an EPS bearer, the SMF may update the accounting session corresponding to the QoS flow with the information of the EPS bearer by including the identifier of the accounting session within the Acct-Session-Id, the "EUTRA" within the 3GPP-RAT-Type, the IPv4 address of S-GW within the 3GPP-SGSN-Address, the EPS bearer id within the 3GPP-NSAPI, the user location in the EPC within the 3GPP-User-Location-Info if available, the new QoS profile within the 3GPP-GPRS-Negotiated-QoS-Profile if changed, the new charging id within the 3GPP-Charging-Id if allocated and the new packet filters within the 3GPP-Packet-Filter if changed;

- if the SMF+PGW-C mapped multiple QoS flows to one EPS bearer, the SMF shall select one of the accouting sessions corresponding to these QoS flows to update it as above and terminate the accounting session(s) corresponding to the other QoS flow(s).

- if the SMF+PGW-C did not map a QoS flow to any EPS bearer, the SMF may decide to associate the corresponding account session to the default EPS bearer or terminate the corresponding accounting session.

\*\*\* 3rd Change \*\*\*

### 11.3.1 General

RADIUS attributes as defined in subclause 16.4 of 3GPP TS 29.061 [5] are re-used in 5G with the following differences:

- SMF replaces P-GW. GGSN and PPP PDP type related description are not applicable for 5G.

- 5G QoS flow replaces IP-CAN bearer and PDU session replaces IP-CAN session.

- N6 replaces Gi/Sgi and UE replaces MS.

- DNN replaces APN.

- Detailed information needed for 5G compared to 3GPP TS 29.061 [5] is described below.

Table 11.3-1: Additional information needed for 5G compared to the RADIUS attributes defined in 3GPP TS 29.061 [5]

| Attr # | Attribute Name | Description | Content | Presence Requirement | Applicable message |
| --- | --- | --- | --- | --- | --- |
| 79 | EAP-Message | This attribute encapsulates EAP message (as defined in IETF RFC 3748 [6]) exchanged between the SMF and DN-AAA, see IETF RFC 3579 [7] for details. | String | ConditionalNOTE | Access-Request,Access-Accept,Access-Reject,CoA-Request,CoA-ACK,Disconnect-Request,Disconnect-ACK |
| Mandatory | Access-Challenge |
| 80 | Message-Authenticator | This attribute includes the message authenticator, see IETF RFC 3579 [7] for details. | String | ConditionalNOTE | Access-Request,Access-Accept,Access-Reject,CoA-Request,CoA-ACK,CoA-NAKDisconnect-Request,Disconnect-ACK,Disconnect-NAK |
| Mandatory | Access-Challenge |
| NOTE: Shall be present if EAP is used. |

Table 11.3-2: Different information needed for 5G compared to the RADIUS VSA defined in subclause 16.4.7 of 3GPP TS 29.061 [5]

| Sub-attr # | Sub-attribute Name | Differences |
| --- | --- | --- |
| 1 | 3GPP-IMSI | Re-used. |
| 2 | 3GPP-Charging-Id | Charging ID for this PDU Session. |
| 3 | 3GPP-PDP-Type | Re-used. For SMF, this sub-attribute represents PDU session type and only the values "0", "2", "3", "5" and "6" are applicable. |
| 4 | 3GPP-CG-Address | Re-used. Ipv4 address of CHF. |
| 5 | 3GPP-GPRS-Negotiated-QoS-Profile | Re-used. For SMF, it uses the format for Release indicator value "15" as defined in 3GPP TS 29.061 [5]. |
| 6 | 3GPP-SGSN-Address | Re-used. It includes AMF, I-SMF or V-SMF control plane Ipv4 address. |
| 7 | 3GPP-GGSN-Address | Re-used. It includes (home) SMF control plane Ipv4 address providing the Nsmf\_PDUSession service. |
| 8 | 3GPP-IMSI-MCC-MNC | Re-used. |
| 9 | 3GPP-GGSN-MCC-MNC | Re-used. MCC and MNC of the network the (home) SMF belongs to. |
| 10 | 3GPP-NSAPI | Re-used. It identifies QFI with value range 0-255. |
| 11 | 3GPP-Session-Stop-Indicator | Re-used. |
| 12 | 3GPP-Selection-Mode | Re-used. SMF maps the selection mode value from the enumeration value of DnnSelectionMode in 3GPP TS 29.502 [40]. |
| 13 | 3GPP-Charging-Characteristics | Re-used. |
| 14 | 3GPP-CG-Ipv6-Address | Re-used. Ipv6 address of CHF. |
| 15 | 3GPP-SGSN-Ipv6-Address | Re-used. It includes AMF, I-SMF or V-SMF control plane Ipv6 address. |
| 16 | 3GPP-GGSN-Ipv6-Address | Re-used. It includes (home) SMF control plane Ipv6 address providing the Nsmf\_PDUSession service. |
| 17 | 3GPP-Ipv6-DNS-Servers | Re-used. |
| 18 | 3GPP-SGSN-MCC-MNC | Re-used. MCC and MNC of the network the AMF belongs to |
| 19 | 3GPP-Teardown-Indicator | Re-used. |
| 20 | 3GPP-IMEISV | Re-used. |
| 21 | 3GPP-RAT-Type | Re-used. For SMF, it uses the sub-attribute definition for P-GW and only the values "3", "6" - "9", and "51" - "57" are applicable. |
| 22 | 3GPP-User-Location-Info | Re-used. For SMF, only the values "128", "129", "130", "135" and "136" of Geographic Location Type are applicable. |
| 23 | 3GPP-MS-TimeZone | Re-used. |
| 24 | 3GPP-CAMEL-Charging-Info | Not applicable. |
| 25 | 3GPP-Packet-Filter | Re-used. |
| 26 | 3GPP-Negotiated-DSCP | Re-used. |
| 27 | 3GPP-Allocate-IP-Type | Re-used. |
| 28 | External-Identifier | Re-used. |
| 29 | TWAN-Identifier | Re-used by TWAP Identifier field, supporting ssid, bssid and/or civicAddress. |
| 30 | 3GPP-User-Location-Info-Time | Re-used. |
| 31 | 3GPP-Secondary-RAT-Usage | Re-used. For SMF, the RAT values "0", "1", "2" and "3" are applicable, and the SESS field is used to indicate secondary RAT usage of the PDU session. |
| 110 | 3GPP-Notification | Added. |
| 111 | 3GPP-UE-MAC-Address | Added. |
| 112 | 3GPP-Authorization-Reference | Added. |
| 113 | 3GPP-Policy-Reference | Added. It is not used in this release. |
| 114 | 3GPP-Session-AMBR | Added. |
| 115 | 3GPP-NAI | Added. |
| 116 | 3GPP-Session-AMBR-v2 | Added. |
| 117 | 3GPP-Supported-Features | Added. |
| 118 | 3GPP-IP-Address-Pool-Info | Added. |
| 119 | 3GPP-VLAN-Id | Added. |
| 120 | 3GPP-TNAP-Identifier | Added. |
| 121 | 3GPP-HFC-NodeId | Added. |
| 122 | 3GPP-GLI | Added. |
| 123 | 3GPP-Line-Type | Added. |
| 124 | 3GPP-NID | Added. |
| 125 | 3GPP-Session-S-NSSAI | Added. |
| 126 | 3GPP-CHF-FQDN | Added. FQDN of CHF. |
| 127 | 3GPP-Serving-NF-FQDN | Added. It includes AMF, I-SMF or V-SMF FQDN address. |
| 128 | 3GPP-Session-Id | Added. |
| 129 | 3GPP-GCI | Added. |
| 130 | 3GPP-UPF-Id | Added. |
| NOTE: 5G specific RADIUS VSAs are numbered from 110. |

***110 – 3GPP***-***Notification***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 |  | 2 | 1 |
| 1 |  | 3GPP type = 110 |
| 2 |  | 3GPP Length= 3 |
| 3 |  | Spare | ACC | AUTH |

3GPP Type: 110

Length: 3

Octet 3 is Octet String type.

For bit 1 AUTH,

- if the value of AUTH is set to "1", and there is IPv4 address and/or IPv6 prefix change (not allocated/de-allocated by the DN-AAA itself) and the PDU session is not terminated, the SMF shall send Access-Request message to the DN-AAA with GPSI in Calling-Station-Id or External-Identifier attribute and IP address in:

1) Framed-IP-Address and Framed-IPv6-Prefix, if both IPv4 address and IPv6 prefix(es) exist for the PDU session; or

2) Framed-IP-Address, if only IPv4 address exists for the PDU session; or

3) Framed-IPv6-Prefix, if only IPv6 prefix(es) exists for the PDU session.

For Ethernet PDU session, if there is UE MAC address change, the SMF shall send Access-Request message to the DN-AAA with GPSI in Calling-Station-Id or External-Identifier attribute and the complete list of used UE MAC addresses in the 3GPP-UE-MAC-Address attribute.

- if the value is set to "0", the SMF may notify authentication DN-AAA with the UE address and GPSI based on local configuration.

For bit 2 ACC,

- if the value is set to "1", and there is IPv4 address and/or IPv6 prefix change (not allocated/de-allocated by the DN-AAA itself) and the PDU session is not terminated, the SMF shall send Accounting-Request Interim-Update message to the DN-AAA with GPSI in Calling-Station-Id or External-Identifier attribute and IP address in:

1) Framed-IP-Address and Framed-IPv6-Prefix, if both IPv4 address and IPv6 prefix(es) exist for the PDU session; or

2) Framed-IP-Address, if only IPv4 address exists for the PDU session; or

3) Framed-IPv6-Prefix, if only IPv6 prefix(es) exists for the PDU session.

For Ethernet PDU session, if there is UE MAC address change, the SMF shall send Accounting-Request Interim-Update message to the DN-AAA with GPSI in Calling-Station-Id or External-Identifier attribute and the complete list of used UE MAC addresses in the 3GPP-UE-MAC-Address attribute.

- if the value is set to "0", the SMF may notify accounting DN-AAA with the UE address and GPSI based on local configuration.

***111 – 3GPP-UE-MAC-Address***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 111 |
| 2 |  | 3GPP Length= 8 |
| 3-8 |  | MAC Address (octet string) |

3GPP Type: 111

Length: 8

It is sent from the DN-AAA to authorize UE MAC addresses. Multiple 3GPP-UE-MAC-Address sub-attributes (maximum 16) may be sent in one RADIUS CoA or Access-Accept message. The DN-AAA shall always provide the full list of allowed MAC addresses, and SMF shall replace the existing list with the newly received one. When omitted, there is no restriction and all UE MAC addresses are permitted for the Ethernet PDU session.

When sending from the SMF to the DN-AAA, it indicates UE MAC addresses in use. Multiple 3GPP-UE-MAC-Address sub-attributes may be sent in one RADIUS Access-Request or Accounting-Request Interim-Update message.

MAC address is Octet String type. The encoding is defined as MacAddr48 in 3GPP TS 29.571 [39] without dashes as delimiter, encoded as 12-digit hexadecimal numbers.

***112 – 3GPP-Authorization-Reference***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 112 |
| 2 |  | 3GPP Length= m |
| 3-m |  | Authorization Data Reference (octet string) |

3GPP Type: 112

Length: m

Authorization Data Reference: Octet String. It is sent from the DN-AAA to refer to the local authorization data in the SMF or PCF.

***113 – 3GPP-Policy-Reference***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 113 |
| 2 |  | 3GPP Length= m |
| 3-m |  | Policy Data Reference (octet string) |

3GPP Type: 113

Length: m

Policy Data Reference: Octet String. It is sent from the DN-AAA and used by the SMF to retrieve the SM or QoS policy data from the PCF. It is not used in this release.

***114 – 3GPP-Session-AMBR***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 114 |
| 2 |  | 3GPP Length= m |
| 3-m |  | Session AMBR (octet string) |

3GPP Type: 114

Length: m

Session AMBR: Octet String. It is sent from the DN-AAA to authorize the PDU Session AMBR in the downlink and uplink direction. The encoding is defined as BitRate in 3GPP TS 29.571 [39]. Same value is applied to downlink and uplink via this VSA.

***115 – 3GPP-NAI***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 115 |
| 2 |  | 3GPP Length= m |
| 3-m |  | NAI (octet string) |

3GPP Type: 115

Length: m

NAI: Octet String. It shall be formatted according to subclause 14.3 of 3GPP TS 23.003 [28] that describes an NAI.

***116 – 3GPP-Session-AMBR-v2***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 |  | 2 | 1 |
| 1 |  | 3GPP type = 116 |
| 2 |  | 3GPP Length= m |
| 3 |  | Spare | DL | UL |
| 4-5 |  | UL Session-AMBR length (octet string) |
| 6-m |  | UL Session-AMBR (octet string) |
| (m+1)-(m+2) |  | DL Session-AMBR length (octet string) |
| (m+3)-n |  | DL Session-AMBR (octet string) |

3GPP Type: 116

Length: m

Octet 3 is Octet String type.

Bit 1 UL and bit 2 DL indicate if the corresponding UL and DL Session-AMBR shall be present in a respective field or not. If one of these bits is set to "0", the corresponding field shall not be present at all.

UL/DL Session AMBR: Octet String. It is sent from the DN-AAA to authorize the PDU Session AMBR. The encoding is defined as BitRate in 3GPP TS 29.571 [39].

If the feature eSessionAMBR is supported and if applicable, the DN-AAA shall send this VSA; otherwise, the DN-AAA shall send the VSA 3GPP-Session-AMBR.

***117 – 3GPP-Supported-Features***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 |  | 2 | 1 |
| 1 |  | 3GPP type = 117 |
| 2 |  | 3GPP Length= m |
| 3-6 |  | Vendor ID (octet string) |
| 7-10 |  | Feature List ID (octet string) |
| 11-14 |  | Feature List (octet string) |

3GPP Type: 117

Length: m

This VSA may be present in the Access-Request (initial one) message and either the Access-Challenge (initial one) or the Access-Accept message. If present, this VSA informs the destination entity about the features that the origin entity requires to successfully complete the message exchange. The Vendor ID, Feature List ID and Feature List are encoded according to 3GPP TS 29.229 [41]. See clause 12.4.1 for more detailed information regarding the general principle of the feature negotiation with the difference that RADIUS terms replace Diameter terms. The table 12.4.1-1 defines the features applicable to the RADIUS N6 interfaces for the feature lists with a Feature-List-ID of 1.

***118 – 3GPP-IP-Address-Pool-Info***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 |  | 2 | 1 |
| 1 |  | 3GPP type = 118 |
| 2 |  | 3GPP Length= m |
| 3 |  | Spare | IP version |
| 4-5 |  | IP address pool id length (octet string) |
| 6-m |  | IP address pool id (octet string) |

3GPP Type: 118

Length: m

Octet 3 is Octet String type.

For bit 1 and bit 2 IP version:- if the value is set to "0", it indicates the IP address pool id is applicable for both IPv4 and IPv6;

- if the value is set to "1", it indicates the IP address pool id is applicable for IPv4;

- if the value is set to "2", it indicates the IP address pool id is applicable for IPv6; and

- value "3" is reserved.

The SMF may determine an IP address pool ID based on UPF ID, S-NSSAI, DNN, and IP version as described in subclause 5.8.2.2.1 in 3GPP TS 23.501 [2] and includes the IP address pool ID within 3GPP-IP-Address-Pool-Info and send it to the DN-AAA. The DN-AAA assigns IPv6 prefix or IPv4 address from the requested IP address pool. Multiple 3GPP-IP-Address-Pool-Info sub-attributes may be sent in the RADIUS Access-Request message. The DN-AAA shall include the selected IP address pool in the 3GPP-IP-Address-Pool-Info sub-attribute of the RADIUS Access-Accept message. For accounting, if Framed-IP-Address or Framed-IPv6-Prefix attribute is included in RADIUS Accounting-Request (START/Interim-Update/STOP), the SMF shall also include the 3GPP-IP-Address-Pool-Info sub-attribute.

***119 – 3GPP-VLAN-Id***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 |  | 2 | 1 |
| 1 |  | 3GPP type = 119 |
| 2 |  | 3GPP Length= 4 |
| 3 |  | VID value | Spare |
| 4 |  | VID value |

3GPP Type: 119

Length: 4

VLAN Id: Octet String. Octet 3/ Bit 1 to Bit 4 shall be zero, Octet 3 / Bit 8 shall be the most significant bit of the VLAN Id and Octet 4 / Bit 1 shall be the least significant bit.

It is sent from the DN-AAA to authorize the allowed VLAN Ids for the Ethernet PDU session. Multiple 3GPP-VLAN-Id sub-attributes (maximum 16) may be sent in one RADIUS CoA or Access-Accept message. The DN-AAA shall always provide the full list of allowed VLAN Ids, and SMF shall replace the existing list with the newly received one. When omitted, there is no restriction and all VLAN Ids are permitted for the Ethernet PDU session.

***120 – 3GPP-TNAP-Identifier***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| **Octets** |  | **8** | **7** | **6** | **5** | **4** | **3** | **2** | **1** |
| 1 |  | 3GPP type = 120 |
| 2 |  | 3GPP Length= m |
| 3-m |  | TNAP Identifier (octet string) |

3GPP Type: 120

Length=m, where m depends on the type of location that is present as described in 3GPP TS 29.274 [50].

TNAP Identifier field is used to convey the location information in a Trusted Non-3GPP Access Network. The coding of this field shall be the same as for the GTP TWAN Identifier starting with Octet 5, till Octet (q+r) +2 as per clause 8.100 in 3GPP TS 29.274 [50], with LAII flag, OPNAI flag and PLMNI flag in Octet 5 shall be set as zero.

TNAP Identifier field is Octet String type.

The SMF may indicate the UE location in a Trusted Non-3GPP Access Network, in Access-Request, Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages.

***121 – 3GPP-HFC-NodeId***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| **Octets** |  | **8** | **7** | **6** | **5** | **4** | **3** | **2** | **1** |
| 1 |  | 3GPP type = 121 |
| 2 |  | 3GPP Length= n |
| 3-n |  | HFCNodeId (octet string) |

3GPP Type: 121

Length: n≤6+2

HFCNodeId field is the identifier of the HFC node Id as specified in CableLabs WR-TR-5WWC-ARCH [51]. It is provisioned by the wireline operator as part of wireline operations and may contain up to six characters.

HFCNodeId field is Octet String type.

The SMF may indicate the HFC Node Identifier received over NGAP. Present for a 5G-CRG accessing the 5GC via wireline access network, in Access-Request, Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages. Present for a FN-CRG accessing the 5GC via wireline access network, in Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages.

***122 – 3GPP-GLI***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| **Octets** |  | **8** | **7** | **6** | **5** | **4** | **3** | **2** | **1** |
| 1 |  | 3GPP type = 122 |
| 2 |  | 3GPP Length= n |
| 3-n |  | GLI (octet string) |

3GPP Type: 122

Length: n≤150+2

GLI field is the Global Line Identifier uniquely identifying the line connecting the 5G-BRG or FN-BRG to the 5GS. See clause 28.16.3 of 3GPP TS 23.003 [28]. Shall be encoded as a string with format "byte", i.e. base64-encoded characters, representing the GLI value (up to 150 bytes) encoded as specified in BBF WT-470 [52].

GLI field is Octet String type.

The SMF may indicate the Global Line Identifier. Present for a 5G-BRG accessing the 5GC via wireline access network, in Access-Request, Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages. Present for a 5G-BRG accessing the 5GC via wireline access network, in Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages.

***123 – 3GPP-Line-Type***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| **Octets** |  | **8** | **7** | **6** | **5** | **4** | **3** | **2** | **1** |
| 1 |  | 3GPP type = 123 |
| 2 |  | 3GPP Length= 3 |
| 3 |  | Line-Type (octet string) |

3GPP Type: 123

The Line-Type sub-attribute may be present for a 5G-BRG/FN-BRG accessing the 5GC via wireline access network.

When present, it shall indicate the type of the wireline (DSL or PON).

Line-Type field is Octet String type. It shall be coded as follows:

0 (DSL):

 This value shall be used to indicate DSL line.

1 (PON):

 This value shall be used to indicate PON line.

The SMF may indicate the type of the wireline (DLS or PON). Present for a 5G-BRG accessing the 5GC via wireline access network, in Access-Request, Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages. Present for a FN-BRG accessing the 5GC via wireline access network, in Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages.

***124 – 3GPP-NID***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| **Octets** |  | **8** | **7** | **6** | **5** | **4** | **3** | **2** | **1** |
| 1 |  | 3GPP type = 124 |
| 2 |  | 3GPP Length= 13 |
| 3-13 |  | Network ID (octet string) |

3GPP Type: 124

Length: 13

The Network ID field is Octet String type. The encoding is defined as Nid in 3GPP TS 29.571 [39].

Table 11.3-3 describes the sub-attributes of the 3GPP Vendor-Specific attribute described above in different RADIUS messages.

***125 – 3GPP-Session-S-NSSAI***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 125 |
| 2 |  | 3GPP Length= m |
| 3 |  | SST |
| 4-6 |  | SD (octet string) |

3GPP Type: 125

Length: 3 or 6

SST: the Slice/Service Type with value range 0 to 255.

SD: 3-octet string, representing the Slice Differentiator, the encoding follows sd attribute specified in subclause 5.4.4.2 of 3GPP TS 29.571 [46]. Its presence depends on the Length field.

It is sent from the SMF to the DN-AAA server to indicate the S-NSSAI that is associated with the PDU Session.

***126 – 3GPP-CHF-FQDN***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 126 |
| 2 |  | 3GPP Length= m |
| 3-m |  | CHF FQDN |

3GPP Type: 126

Length: m

CHF FQDN: string, indicates the FQDN of the CHF.

It is sent from the SMF to the DN-AAA server to indicate the FQDN of the CHF.

***127 – 3GPP-Serving-NF-FQDN***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 127 |
| 2 |  | 3GPP Length= m |
| 3-m |  | Serving NF FQDN |

3GPP Type: 127

Length: m

Serving NF FQDN: string, indicates the FQDN of the Serving NF (including AMF, I-SMF or V-SMF).

It is sent from the SMF to the DN-AAA server to indicate the Serving NF FQDN address.

***128 – 3GPP-Session-Id***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 125 |
| 2 |  | 3GPP Length= m |
| 3 |  | PduSessionId |

3GPP Type: 128

Length: 3

PduSessionId: 1-octet integer, Unsigned integer identifying a PDU session, within the range 0 to 255, as specified in subclause 5.4.2 of 3GPP TS 29.571 [46].

It is sent from the SMF to the DN-AAA server to indicate the PDU Session Identifier.

***129 – 3GPP-GCI***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 129 |
| 2 |  | 3GPP Length= m |
| 3-m |  | GCI (octet string) |

3GPP Type: 129

Length: m

GCI field is Octet String type.

The GCI is the Global Cable Identifier uniquely identifies the line connecting the 5G-CRG or FN-CRG to the 5GS. See clause 28.15.4 of 3GPP TS 23.003 [28].

The GCI is a variable length opaque identifier, shall be encoded as specified in CableLabs WR‑TR‑5WWC‑ARCH [51] and CableLabs DOCSIS MULPI [55]. It shall comply with the syntax specified in clause 2.2 of IETF RFC 7542 [56] for the username part of a NAI.

The SMF may indicate the Global Cable Identifier. Present for a 5G-CRG accessing the 5GC via wireline access network, in Access-Request, Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages. Present for a FN-CRG accessing the 5GC via wireline access network, in Accounting-Request START, Accounting-Request STOP, or Accounting-Request Interim-Update messages.

***130 – 3GPP-UPF-Id***

|  |  |  |
| --- | --- | --- |
|  |  | Bits |
| Octets |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 |  | 3GPP type = 130 |
| 2 |  | 3GPP Length= m |
| 3-m |  | UPF ID (string) |

3GPP Type: 130

Length: m

UPF ID: string, indicates the UPF Identifier.

It is sent from SMF to DN-AAA server to indicate the SMF selected or used UPF interworking with the trusted external DN. Shall not be reported to the untrusted DN-AAA server.

Table 11.3-3: List of the 3GPP Vendor-Specific sub-attributes for N6

| Sub-attr # | Sub-attribute Name | Description | Presence Requirement | Associated attribute(Location of Sub-attr) | Applicability |
| --- | --- | --- | --- | --- | --- |
| 110 | 3GPP-Notification | It includes all notifications that the DN-AAA wants to receive from the SMF. | Optional | Access-Accept |  |
| 111 | 3GPP-UE-MAC-Address | It is sent from the DN-AAA to authorize UE MAC addresses, or it indicates UE MAC addresses in use when sending from the SMF to the DN-AAA. | Optional | Access-Request,Access-Accept,Accounting-Request Interim-Update,Change-of-Authorization |  |
| 112 | 3GPP-Authorization-Reference | It is sent from the DN-AAA to refer to the local authorization data in the SMF. | Optional | Access-Accept,Change-of-Authorization |  |
| 113 | 3GPP-Policy-Reference | It is sent from the DN-AAA and used by the SMF to retrieve the SM or QoS policy data from the PCF. It is not used in this release. | Optional | Access-Accept,Change-of-Authorization |  |
| 114 | 3GPP-Session-AMBR | It is sent from the DN-AAA to authorize the PDU Session AMBR in the downlink and uplink. | Optional | Access-Accept,Change-of-Authorization |  |
| 115 | 3GPP-NAI | The Network Access Identifier identifying the UE. | Optional | Access-Request,Accounting-Request START,Accounting-Request STOP,Accounting-Request Interim-Update |  |
| 116 | 3GPP-Session-AMBR-v2 | It is sent from the DN-AAA to authorize the PDU Session AMBR, it includes separate session AMBR for UL and DL. | Optional | Access-Accept,Change-of-Authorization | eSessionAMBR |
| 117 | 3GPP-Supported-Features | It indicates the supported features as specified in clause 12.4.1. | Optional | Access-Request,Access-Accept,Access-Challenge,Accounting-Request START,Accounting-Response START |  |
| 118 | 3GPP-IP-Address-Pool-Info | It indicates the IP address pool identifier. | Optional | Access-Request,Access-Accept,Accounting-Request START,Accounting-Request STOP,Accounting-Request Interim-Update |  |
| 119 | 3GPP-VLAN-Id | It is sent from the DN-AAA to authorize the allowed VLAN Id for the Ethernet PDU session. | Optional | Access-Accept,Change-of-Authorization |  |
| 120 | 3GPP-TNAP-Identifier | Indicates the UE location in a Trusted Non-3GPP Access Network. | Optional | Access-Request,Accounting-Request START, Accounting-Request STOP, Accounting-Request Interim-Update |  |
| 121 | 3GPP-HFC-NodeId | Indicates the HFC Node Identifier received over NGAP. Present for a 5G-CRG/FN-CRG accessing the 5GC via wireline access network | Optional | Access-Request (NOTE 1), Accounting-Request START, Accounting-Request STOP, Accounting-Request Interim-Update |  |
| 122 | 3GPP-GLI | Indicates the Global Line Identifier. Present for a 5G-BRG/FN-BRG accessing the 5GC via wireline access network. | Optional | Access-Request (NOTE 1), Accounting-Request START, Accounting-Request STOP, Accounting-Request Interim-Update |  |
| 123 | 3GPP-Line-Type | Indicates the type of the wireline (DLS or PON). Present for a 5G-BRG/FN-BRG accessing the 5GC via wireline access network. | Optional | Access-Request (NOTE 1), Accounting-Request START, Accounting-Request STOP, Accounting-Request Interim-Update |  |
| 124 | 3GPP-NID | Indicates the network identifier. It shall only be present together with 3GPP-SGSN-MCC-MNC to identify an SNPN. | Optional | Access-Request, Accounting-Request START, Accounting-Request STOP, Accounting-Request Interim-Update |  |
| 125 | 3GPP-Session-S-NSSAI | Indicates the S-NSSAI that is associated with the PDU Session. | Optional  | Access-RequestAccounting-Request START,Accounting-Request STOP,Accounting-Request Interim-Update (NOTE 2) |  |
| 126 | 3GPP-CHF-FQDN | Indicates the FQDN of the CHF. | Optional | Access-RequestAccounting-Request START,Accounting-Request STOP,Accounting-Request Interim-Update |  |
| 127 | 3GPP-Serving NF-FQDN | Indicates the FQDN of the Serving NF (includes AMF, I-SMF or V-SMF). | Optional | Access-RequestAccounting-Request START,Accounting-Request STOP,Accounting-Request Interim-Update |  |
| 128 | 3GPP-Session-Id | Indicates the PDU Session Identifier. | Optional | Access-RequestAccounting-Request START,Accounting-Request STOP,Accounting-Request Interim-Update (NOTE 2) |  |
| 129 | 3GPP-GCI | Indicates the line connecting the 5G-CRG or FN-CRG to the 5GS | Optional | Access-Request (NOTE 1),Accounting-Request START,Accounting-Request STOP,Accounting-Request Interim-Update |  |
| 130 | 3GPP-UPF-Id | Indicates the SMF selected or used UPF Identifier interworking with the trusted external DN. | Optional | Access-Request,Accounting-Request START,Accounting-Request STOP,Accounting-Request Interim-Update |  |
| NOTE 1: Access-Request is not applicable for FN-CRG or FN-BRG.NOTE 2: This VSA is optional in the Accounting-Request Interim-Update message. |

RADIUS attributes related to the DN-AAA initiated re-authorization and authentication challenge are described in the following subclauses.

\*\*\* End of Changes \*\*\*