



URSP Support in PCF

Table 1: Feature History

Feature Name	Release Information	Description
URSP Support in PCF	2023.04	PCF offers UE Route Selection Policy or URSP support for the UE to determine the routing of outgoing traffic. Default Setting: Enable – Always on

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Feature Summary and Revision History

Summary Data

Table 2: Summary Data

Applicable Products or Functional Area	PCF
Applicable Platform(s)	SMI
Feature Default Setting	Enabled - Always-on
Related Documentation	Not Applicable

Revision History

Table 3: Revision History

Revision Details	Release
First Introduced.	2023.04.0

Feature Description

PCF offers URSP support which is the UE Route Selection Policy. It is used by the UE to determine how to route outgoing traffic. Traffic can be routed to an established PDU Session, can be offloaded to non-3GPP access outside a PDU Session.

PCF provides the UE policy procedures and controls via AMF interface (N15) using NAS Signalling. The NAS messages are transparent to AMF which cannot be decoded by the AMF or gNB on its way between UE to PCF and vice versa.

Based on the UE policy, UE initiates the separate PDU sessions. The operator defines these policies on PCF which are pushed to the UE via AMF based on the various parameters and their values of the UE like current PLMN, Location Area, Service Area, Network Slice allowed in the network and DNN configuration.

How it Works

This section describes on how this feature works.

The URSP rule includes one traffic descriptor and route selection descriptors.

If the URSP rule includes one or more traffic descriptor that specifies the matching criteria:

Traffic Descriptors

- OSId and OSAppId(s) - The OSId identifier identifying the operating system. OSAppId(s) identifier is associated with a given application and uniquely identifying the application within the UE for a given operating system.
- DNN - This is matched against the DNN information provided by the application.
- Match all

Route Selection Components

- SSC Mode Selection Policy (SSCMSP) - This is used by the UE to associate the matching application with SSC modes. The modes take the following types:
 - SSC 1
 - SSC 2
 - SSC 3

- Network Slice Selection Policy (NSSP) - This is used by the UE to associate the matching application with SNSSAI.
- DNN Selection Policy - This is used by the UE to associate the matching application with DNN.
- PDU Session Type Policy - This is used by the UE to associate the matching application with a PDU Session Type. It takes the following session types:
 - IPv4
 - IPv6
 - IPv4 and IPv6
- Non-Seamless Offload Policy - This is used by the UE to determine that the matching application should be non-seamlessly offloaded to non-3GPP access (i.e., outside of a PDU Session).
- Access Type preference - If the UE needs to establish a PDU Session for the matching application, this indicates the any of the preferred Access Type from the following:
 - 3GPP
 - Non 3GPP

Discover AMF Interface

The following sample configurations helps to discover the AMF interface:

```
profile nf-pair nf-type AMF
nrf-discovery-group nrf-discovery-group
subscription-enabled true
subscription-extension 5
locality client loc1
locality preferred-server loc1
locality geo-server geoLocality
Exit
```

Use the below show command to display the list of profiles:

```
show rest-endpoint discovered-profiles
```

UE Registration Scenario

When UE registers on the network, AMF initiates the UE Policy Create Request to PCF. PCF must respond with a set of policy rules based on the policy logic which takes in to account the status of the UE (SPLMN, Location area) in the network.

UE De-Registration Scenario

If the UE de-register from the network, AMF triggers UE Policy Delete Request of the UE policy to PCF. PCF will delete any Policy Association stored in the database or in the UDR for the subscriber

UE Policy Procedures

URSP is pre-configured in the UE or provisioned to UE from PCF. The pre-configured policy is applied by the UE only when it has not received the same type of policy from the PCF.

- PCF selects the UE policy information applicable for each UE based on local configuration, and operator policies.
- PCF provides the UE policy information to the AMF through N15 or Namf interface and then from AMF to the UE through the N1 interface and AMF will not change the UE policy information provided by the PCF.
- PCF adds policy control trigger through Npcf_UEPolicyControl Create Response to AMF.
- The PCF is responsible for delivery of UE policy. If the PCF is notified about UE policy information delivery failure, then PCF will retry based on the configuration.
- If the UE has an URSP rule (except the URSP rule with the `match all` traffic descriptor) that matches the application as the UE shall perform the association of the application to the corresponding PDU session.
- If no URSP rule is applicable for the application, the UE shall perform the association of the application to a PDU session according to the applicable UE local configurations.

UE Policy Delivery

- PCF provides the UE policy information during UE Policy Association Establishment and UE Policy Association Modification procedures.
- The PCF includes the UE policy information delivered to the UE into a Policy Section identified by a Policy Section Identifier (PSI).
- The PCF may divide the UE policy information into different Policy Sections, each one identified by a PSI. Each policy section provides a list of self-contained UE policy information to the UE, through AMF. The PCF ensures that a policy section is under a predefined size limit, known by the PCF.
- The size limit is configured in the PCF. The PLMN ID is provided to the UE together with UE policy information and it is used to indicate which PLMN a policy section list belongs to.
- If the UE has no policy sections with the same PSI, the UE stores the policy section.
- If the UE has an existing policy section with the same PSI, the UE replaces the stored policy section with the received information.
- The UE removes the stored policy section if the received information contains only the PSI.
- The UE keeps the received UE policies stored even when registering in another PLMN.
- The UE provides the list of stored PSIs (Policy Section Identifier) which identify the policy sections associated to the home PLMN that are currently stored in the UE.
- The UE may trigger an initial registration with the list of stored PSIs to request a synchronization for example if the UE powers up without USIM being changed.
- If USIM is changed, the UE does not provide any PSI. If no policies are stored in the UE for the home PLMN, the UE does not provide any PSI associated to the home PLMN.
- PCF subscribes to the AMF to be notified about the UE response to an update of UE policy information.
- PCF invokes `Namf_Communication_N1N2MessageTransfer` service operation then AMF shall transfer transparently the UE Policy to UE.

- After the successful N1Message Notification from AMF, UE Policy gets installed in the UE. So PCF will send the UDR update message with the installed UE Policy details.
- When UE is not reachable AMF reports to the PCF that the UE Policy could not be delivered to the UE using `Namf_Communication_N1N2TransferFailureNotification`.

Principles of PTI Handling For UE Policy Delivery Service Procedures

Procedure Transaction Identity (PTI)

When the PCF or the UE initiates a procedure, it shall include a valid PTI value in the message header of the command message or the request message.

When the PCF initiates a transaction related procedure, it shall include a valid PTI value in the message header of the command message.

If a response message is sent as a result of a received command or request message, the UE or the PCF shall include in the response message the PTI value received within the received command or request message.

If a command message is sent as a result of a received request message, the PCF shall include in the command message the PTI value received with the request message.

Network Requested UE Policy Management Procedure Initiation

To initiate the network-requested UE policy management procedure, the PCF shall:

- Allocate a PTI value currently not used and set the PTI IE to the allocated PTI value.
- Encode the information about the UE policy sections to be added, modified, or deleted in a UE policy section management list IE as specified in subclause D.6.2 and include it in a MANAGE UE POLICY COMMAND message.
- Send the MANAGE UE POLICY COMMAND message to the UE via the AMF .
- Start the timer T3501.



Note The PCF starts a different timer T3501 for each allocated PTI value.

UE Policy Delivery Service Message Type

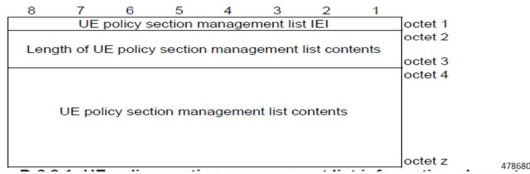
UE Policy Section Management List

The purpose of the UE policy section management list information element is to transfer from the PCF to the UE a list of instructions to be performed at the UE for management of UE policy section stored at the UE.

The UE policy section management list information element has a minimum length of 12 octets and a maximum length of 65534 octets.

The value part of the UE policy section management list information element consists of one or several UE policy section management sub lists.

Figure 1: UE Policy Section Management List

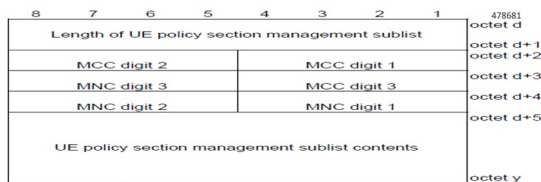


UE Policy Section Management Sublist

Following are the details of UE policy section management sub list:

- Length of UE policy section management sub list (octets d to d+1). This field contains the binary encoding of the length of the UE policy section management sub list in units of octets.
- Mobile country code (MCC) from octet d+2, and bits 4 to 1 of octet d+3.
- Mobile network code (MNC) from bits 8 to 5 of octet d+3, and octet d+4 .
- The coding of this field is the responsibility of each administration, but BCD coding shall be used. The MNC shall consist of 2 or 3 digits. If a network operator decides to use only two digits in the MNC, MNC digit 3 shall be coded as 1111.

Figure 2: UE Policy Section Management Sublist



The UE policy section management sub list contents consist of one or several instructions.

Instructions:

- Instruction contents length (octets d+5 to d+6) This field contains the binary encoding of the instruction contents length in units of octets.

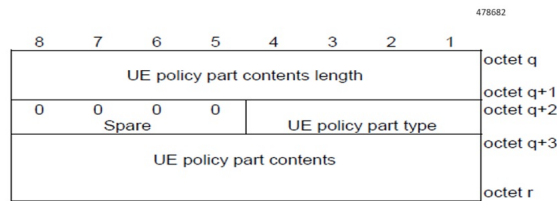
- UPSC (octets d+7 to d+8) This field contains the binary encoding of the UPSC. The value of the UPSC is set by the PCF.
- UE policy section contents (octets d+9 to k)

The UE policy section contents consist of one or several UE policy parts.

UE Policy Part

UE policy part contents length (octets q to q+1) . This field contains the binary encoding of the UE policy part contents length in units of octets.

Figure 3: UE Policy Part



UE policy part type (bits 4 to 1 of octet q+2)

Bits

0 0 0 1 URSP

Bits 8 to 5 of octet q+2 are spare and shall be coded as zero.

UE policy part contents

This field contains a UE policy part encoded as specified in 3GPP TS 24.526 [19] for the UE policy part type field set to URSP or ANDSP and encoded as specified in 3GPP TS 24.588 [19C] for the UE policy part type field set to V2XP (V2X Policy).

UE Policy Association

UE Policy Association Management Service

- Npcf_UEPolicyControl Create Request - This message is for UE Policy Establishment.
- Npcf_UEPolicyControl Delete Request - Provides means to delete UE Policy Association.

UE Policy Delivery to UE via AMF using NAS Procedures

- Namf_Communication_N1N2MessageTransfer (UE Specific) - This service operation is used by PCF to transfer N1 and/or N2 information to the UE and/or 5G-AN through the AMF.

- `Namf_Communication_N1N2MessageN1N2MessageSubscribe` (UE Specific) - This message is used by PCF to subscribe to the AMF for notifying N1 messages of a specific type or N2 information of a specific type.
- `Namf_Communication_N1MessageNotify` - This `N1MessageNotify` service operation is invoked by the AMF, towards the PCF which subscribed to be notified with UPDP messages received from the UE.
- `Namf_Communication_N1N2MessageUnSubscribe` - This service operation is used by PCF to unsubscribe to the AMF to stop notifying N1 messages of a specific type .
- `Namf_Communication_N1N2MessageN1N2TransferFailureNotification` (UE Specific) - This notification to inform PCF that an earlier `Namf_Communication_N1N2Message` Transfer failed, since AMF failed to deliver the N1 message to the UE as the UE failed to respond to paging.

UDR Query APIs

Following are the APIs for UDR query `UEPolicySet`:

- GET - Retriever the policy data set for a subscriber.
- PATCH - Modify the policy data set for a subscriber.

UE Policy Association Creation

UE Policy Association create request will be triggered by AMF in following scenarios:

- UE initial registration with the network.
- UE registration with 5GS when the UE moves from EPS to 5GS and there is no existing UE Policy Association between AMF and PCF for this UE.

The AMF creates the UE policy association with the PCF when a UE policy is received from the UE.

The AMF sends a `Npcf_UEPolicyControl` Create Request with SUPI, may include Access Type and RAT, PEI (Permanent Equipment Identifier), ULI, UE time zone, Serving Network (PLMN ID, or PLMN ID and NID), the Internal-Group-ID-list and UE Policy Container (the list of stored PSIs, operating system identifier).

PCF gets policy subscription related information and the latest list of PSIs from the UDR using `Nudr_DM_Query` service operation (SUPI, Policy Data, UE context policy control data, Policy Set Entry)

Then PCF sends a `Npcf_UEPolicyControl` Create Response to the AMF. The PCF relays the Policy Control Request Trigger parameters in the `Npcf_UEPolicyControl` Create Response.

To establish a UE policy association with the PCF, AMF request with `{apiRoot}/npcf-ue-policy-control/v1/policies` as Resource URI and the `PolicyAssociationRequest` data structure as request body shall include the following attributes:

- Notification URI as `notificationUri` attribute
- SUPI as `supi` attribute
- Features supported by the NF service consumer as `suppFeat` attribute

Following are the optional attributes:

- GPSI as `gpsi` attribute.
- Access type as `accessType` attribute

- Permanent Equipment Identifier (PEI) as `pei` attribute
- User Location Information as `userLoc` attribute
- UE Time Zone as `timeZone` attribute
- Identifier of the serving network (the PLMN Identifier or the SNPN Identifier), as `servingPlmn` attribute
- RAT type as `ratType` attribute

```
{
  "notificationUri": "string",
  "altNotifIpv4Addrs": [
    "string"
  ],
  "altNotifIpv6Addrs": [
    "string"
  ],
  "altNotifFqdns": [
    "string"
  ],
  "supi": "string",
  "gpsi": "string",
  "accessType": "string",
  "pei": "string",
  "userLoc": "string",
  "timeZone": "string",
  "servingPlmn": "string",
  "ratType": "string" [
    "string"
  ],
  "suppFeat": "string"
}
```

Following is the response body:

- The negotiated supported features are encoded as a `suppFeat` attribute.
- The information provided by the NF service consumer when requesting the creation of this policy association encoded as a `request` attribute.
- Following Policy Control Request Trigger are encoded as the `triggers` attribute:
 - Location change (tracking area)
 - Change of UE presence in PRA
 - Change of PLMN, if the `PlmnChange` feature is supported.
 - Change of UE connectivity state, if the `ConnectivityStateChange` feature is supported.



Note Supports only the `PlmnChange` and `Connectivity Change` two feature numbers.

UDR GET QUERY

As a part of UE policy association creation and modification request, PCF makes UDR GET request to get UDR profile for the subscriber on `ue-policy-set` URI.

The response for UDR Get request on UE Policy set has upsi list and urPolicySections, pei, osIds.

As a part of UE Policy Association create request, PCF subscribes to the UDR on any changes of UE Policy Set for the subscriber.

PCF requests notifications from the UDR on changes in the policy data subscription information, and in this case, the PCF shall invoke the `Nudr_DataRepository_Subscribe` service operation by sending an HTTP POST request to the `PolicyDataSubscriptions` resource (`/policy-data/subs-to-notify/{subsId}`).

N1 N2 Message Subscribe and Unsubscribe

To subscribe to notifications of N1 message for UE Policy Delivery Result, or subsequent UE policy requests, the PCF invokes `Namf_Communication_N1N2MessageSubscribe` service operation to the AMF by sending the HTTP POST method with the URI of the `N1N2 Subscriptions Collection for Individual UE Contexts` resource.

This subscribe request has `ueContextId`, `n2NotifyCallbackUri` and `n1MessageClass` (UPDP) attributes provided by the PCF.

UE Policy Association Termination

The following cases are considered for UE Policy Association Termination:

- UE Deregistration from the network.
- The mobility with change of AMF .
- 5GS to EPS mobility with N26 if the UE is not connected to the 5GC over a non-3GPP access in the same PLMN.

Configuration

Figure 4: PB Image for Service Configuration

The screenshot displays the configuration page for a 'Use Case Template' named 'UE_Policy'. The main area is titled 'Service Configurations' and contains a table of 'URSPConfiguration Parameters'. The table has four columns: 'Name', 'Value', 'Bind Field', and 'Allow Override'. The parameters listed include:

Name	Value	Bind Field	Allow Override
Priority	0		<input checked="" type="checkbox"/>
PLMN	310310		<input checked="" type="checkbox"/>
UE Policy Sections (List)			<input checked="" type="checkbox"/>
UEPolicySection			<input checked="" type="checkbox"/>
UE Policy Section Code	100		<input checked="" type="checkbox"/>
URSP Rules (List)			<input checked="" type="checkbox"/>
URSPRule			<input checked="" type="checkbox"/>
Precedence	100		<input checked="" type="checkbox"/>
Traffic Descriptor Components (List)			<input checked="" type="checkbox"/>
Traffic Descriptor Component			<input checked="" type="checkbox"/>
Traffic Descriptor Type	MATCH_ALL		<input checked="" type="checkbox"/>
Dnn	test		<input checked="" type="checkbox"/>
OS Id			<input checked="" type="checkbox"/>
OS App Id			<input checked="" type="checkbox"/>
Route Selection Descriptors (List)			<input checked="" type="checkbox"/>
RouteSelectionDescriptor			<input checked="" type="checkbox"/>
Precedence	100		<input checked="" type="checkbox"/>
Dnn	test		<input checked="" type="checkbox"/>
Ssc Mode	SSC_1		<input checked="" type="checkbox"/>
Access Type Preference	_3GPP		<input checked="" type="checkbox"/>
Pdu Session Type	IPv4		<input checked="" type="checkbox"/>
Slice Info (List)			<input checked="" type="checkbox"/>
SliceInfo			<input checked="" type="checkbox"/>
Sst	1		<input checked="" type="checkbox"/>
Sd	100		<input checked="" type="checkbox"/>
Non Seamless Off Load			<input checked="" type="checkbox"/>

Ops Center Configuration

Following are the configuration details:

```
nln2message.transfer.retry.interval.in.secs
```

After the N1 message failure notification, PCF will retry after the configured interval using the following configuration:

```
nln2message.transfer.retry.times
```

The following configuration is to know the number of retry of the N1N2 message transfer after the failure or Un-acknowledged status from the AMF.

```
nln2message.transfer.ack.timer.in.secs
```

Call Flows

Following are the call flows for UE registration and UE de-registration:

Figure 5: UE Registration Call Flow

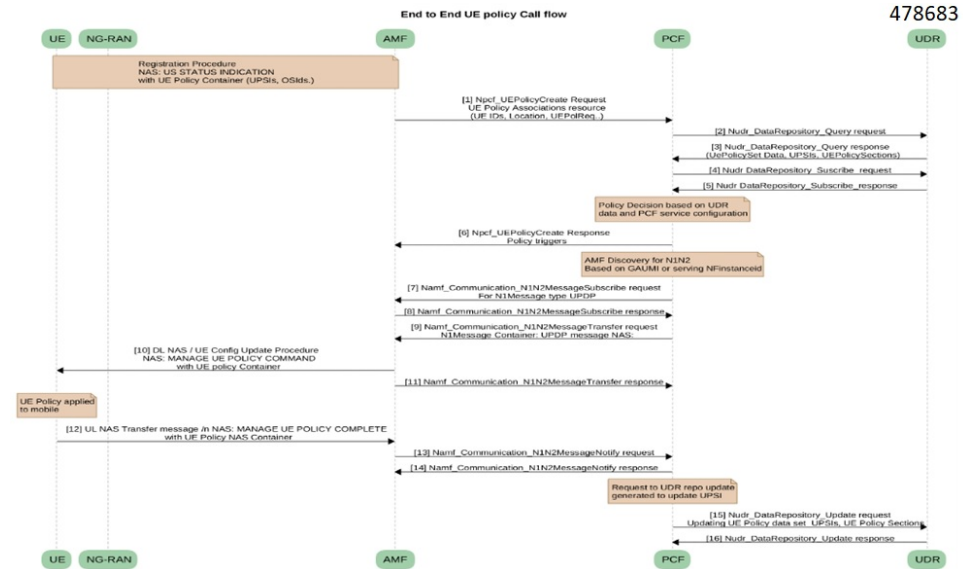
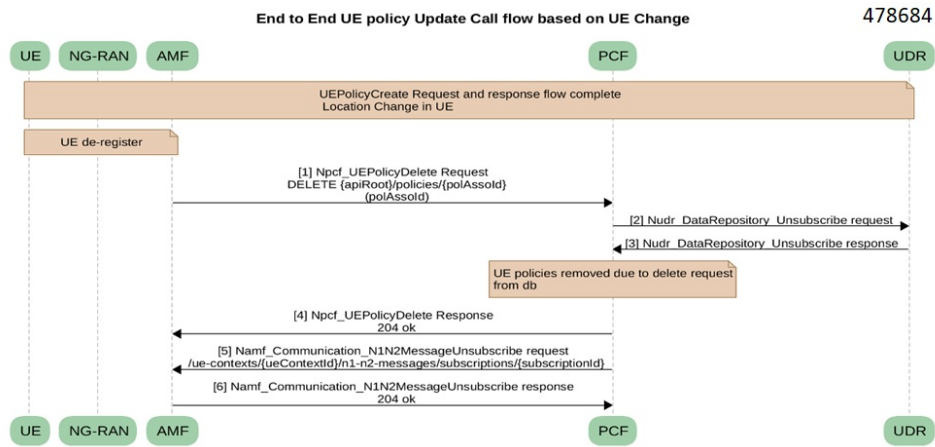
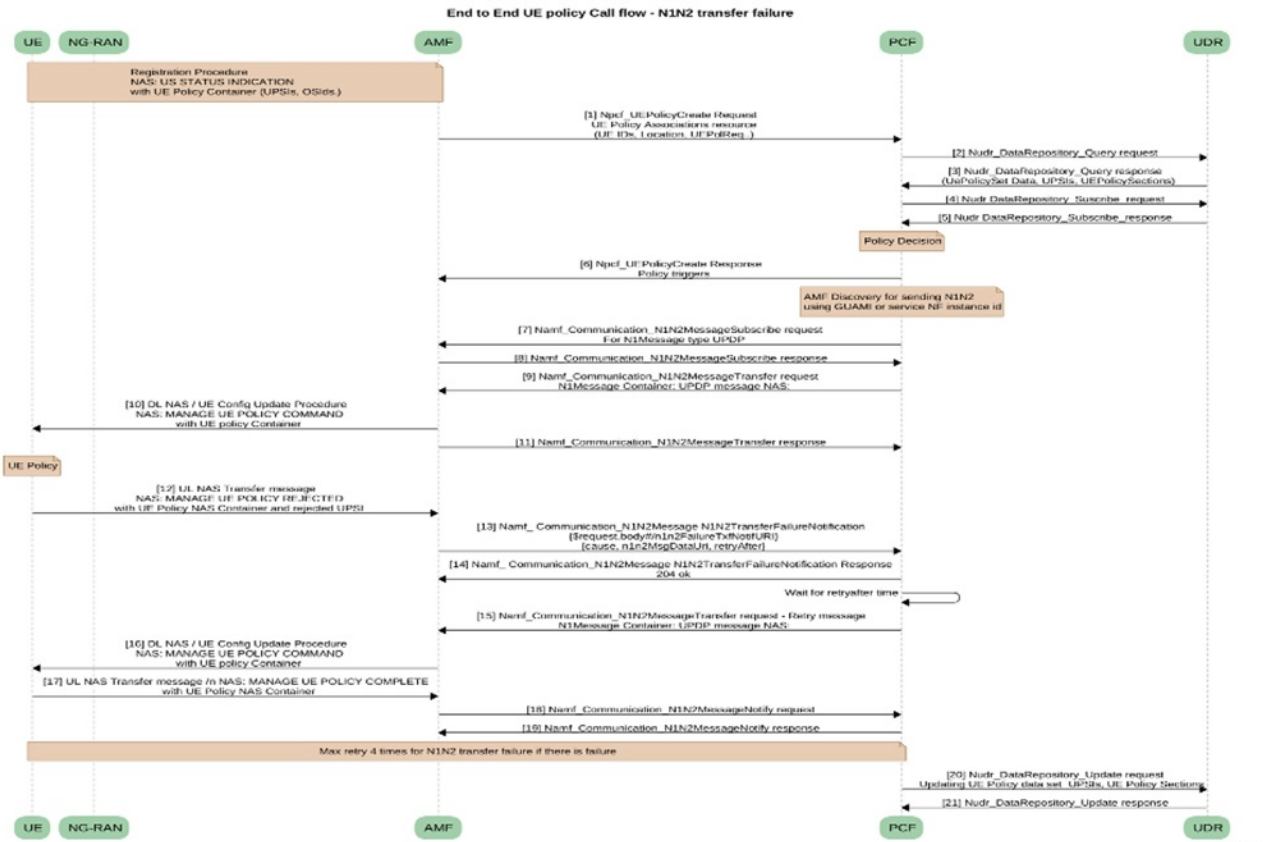


Figure 6: UE De-registration Call Flow



Following is the call flow for N1N2 transfer failure:



Bulk Statistics Support

Following are the KPIs details:

- Message type KPIs for Success, Error Code, response times, event triggers and message prioritization (engine queue level)
- UE policy for create and delete
- N1MessageNotify
- N1N2MessageSubscribe
- N1N2MessageUnSubscribe
- N1N2MessageTransfer
- N1N2TransferFailureNotification (along with failure cause)
- KPIs for UDR (UE policy Query, subscribe, unsubscribe)

