



## Paging Support

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## Feature Summary and Revision History

### Summary Data

*Table 1: Summary Data*

|  |                     |
|--|---------------------|
| Applicable Product(s) or Functional Area | AMF                 |
| Applicable Platform(s)                   | SMI                 |
| Feature Default Setting                  | Enabled - Always-on |
| Related Documentation                    | Not Applicable      |

## Revision History

Table 2: Revision History

| Revision Details   | Release   |
|--|-----------|
| The following enhancements were introduced: <ul style="list-style-type: none"> <li>• New paging actions</li> <li>• New paging trigger types</li> <li>• Handling of incoming N1N2 messages from SMF when paging is already in progress for previous N1N2Msg.</li> <li>• Additional failure handling scenarios</li> <li>• Paging Priority Mapping</li> </ul> | 2021.04.0 |
| First introduced.  | 2021.04.0 |

## Feature Description

AMF uses the paging procedure when the network requires to signal the UE which is in CM-IDLE state. For example, N1 signaling to UE, or User Plane connection activation for PDU sessions (to deliver mobile terminated user data). AMF supports paging strategies to minimize the paging load.

Paging Request triggers the UE-initiated Service Request procedure and the paging procedure has the following three essential functionalities:

- Paging Initiation
- Selecting a paging profile
- Paging procedure

## Paging Initiation

Paging is done in response to the network needing to communicate with a UE that is in CM-IDLE state. The first step in the process is to analyze the messages from a peer node and decide whether paging is needed or not. The operator policy can decide that paging isn't required under certain circumstances.

When AMF receives the N1N2MsgTransfer from SMF for a UE in CM-IDLE mode, it decides whether to trigger paging or not based on the following checks:

- PPF flag set to true, which indicates mobile reachability timer isn't expired.
- Incoming request doesn't have *skipind* attribute set in *N1N2MsgTransferReqData* IE.
- Incoming request doesn't indicate to transfer a N2 PDU Session Resource Release Command.
- Asynchronous type communication isn't activated at AMF.

- ARP-based paging priority comparisons for the newly received N1N2Msg from SMF with the previous N1N2Msg for which paging is already in progress.

AMF updates the SMF with the appropriate cause. When AMF is satisfied with the preceding checks, it selects paging profile based on the incoming triggers.

AMF doesn't perform any check, when the paging is triggered to Deregister a UE.

## Selecting a Paging Profile

AMF supports multiple paging profiles. Paging usually happens in stages, with each stage having its own algorithm configured.

AMF selects the operator policy based on SUPI-prefix. If the SUPI-prefix match isn't found, it selects the operator-policy associated with the AMF-service.

The paging-map can be associated with the operator-policy. Each paging-map has a list of trigger-to-paging profile mapping to support unique precedence for each trigger. The available trigger types are:

- 5QI
- PPI
- DEREK
- DNN
- ARP

Paging profile selection is based on the configured precedence with matching trigger and value pair. When multiple trigger-value pair matches, AMF selects based on the higher precedence. Lower the value, higher the precedence.

Each paging profile has a list of stages with each stage defining a paging-algorithm to use.

## Paging Procedure

Paging in AMF minimizes the load on the network and locates the UE with minimal area of paging and attempts.

The first response message from the UE terminates the paging.



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**Note** AMF considers only service request from UE as response to paging.

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AMF initiates the paging procedure in the following three scenarios:

- **Clear Subscriber at AMF:** AMF triggers paging, when a subscriber in CM-IDLE state gets cleared through AMF CLI. Paging is followed by the AMF-initiated UE deregistration procedure.
- **UDM-initiated UE Deregistration:** AMF initiates paging when UDM sends Deregistration notification (UDM-initiated UE Deregistration) to AMF for a subscriber which is in CM-IDLE state. If UE doesn't respond, AMF Deregisters the UE and clears the UE in SMF and in PCF. If there's no paging response, no response is sent back to UDM.

- **N1N2MsgTransfer received from SMF:** AMF initiates paging when it receives N1N2MsgTransfer from SMF for a subscriber that is in CM-IDLE state. If UE doesn't respond, AMF sends N1N2MsgTxfrFailNotification back to SMF over the callback URI.

AMF performs the following procedures during paging:

- Filling of the following IEs in NGAP messages other than mandatory IEs:
    - Paging Discontinuous Reception (DRX)
      - It's filled based on the requested DRX parameters received from the UE during registration.
    - Assistance Data for Paging
      - Assistance Data for Recommended Cells is derived from the *Information on Recommended Cells and RAN Nodes for Paging* IE. AMF receives this IE as part of the UE Context Release Complete message from gNB.
      - AMF fills the *Paging Attempt Information* IE based on the paging algorithm used for the respective paging stage. Whenever there's a change in the paging stage, AMF marks *Next Paging Area Scope* as changed. AMF doesn't fill *Next Paging Area Scope* for the last attempt of the last paging stage.
    - Paging priority
      - It's applicable if paging trigger is from SMF and priority mapping is configured.
  - Handling of the new incoming N1N2Msg when paging is in progress for previous N1N2Msg:
    - **Precedence Calculation:** AMF calculates the precedence (lower values considered as higher precedence) as per the incoming parameters along with the paging map configuration. It computes this precedence for the incoming N1N2Msg and performs the following:
      - If new precedence value is lower than ongoing precedence, AMF selects the new paging profile as per the new precedence.
      - If new precedence value is same or greater than ongoing precedence, no new profile is selected and AMF continues with the ongoing paging profile.
    - **Priority Comparision:** Paging priority comparison is based on incoming ARP value and its mapped NGAP paging priority under AMF configuration. AMF compares the paging priority (lower values considered as higher priority) of ongoing paging with the new incoming paging, and performs the following:
      - AMF rejects the incoming N1N2 with the cause HIGHER\_PRIORITY\_REQUEST\_ONGOING as part of N1N2MsgTransferError when:
        - The ongoing paging has high or same priority as incoming paging.
        - The incoming paging doesn't have any paging priority mapped to it.
- In this scenario, AMF doesn't select any new paging profile. AMF fills N1N2MsgTxfrErrDetail as part of the N1N2MsgTransferError. AMF fills the *retryAfter* attribute, based on the ongoing and pending paging stages.

- If incoming N1N2Msg has high priority, AMF triggers a new paging message with a new paging priority value. AMF triggers new paging as part of the ongoing paging attempt of the ongoing paging stage.

**Note**

- Paging profile selection and triggering of new paging with new priority are independent of each other.
- AMF supports handling of new N1N2 messages when UE is in IDLE mode and paging is already triggered due to a previous N1N2 message. AMF doesn't support handling of simultaneously received multiple N1N2 messages when UE is in IDLE mode and paging is not yet triggered.

- Sending a PAGING message to each gNB (belonging to the UE tracking areas) based on the actions configured under paging algorithm for respective paging stages
- Paging in stages, where each stage defines the scope of paging. Each paging stage is associated with a paging algorithm that consists of paging action.

AMF supports the following paging actions:

- PAGING\_LAST\_GNB\_LAST\_TAI
- PAGING\_LAST\_N\_GNB\_LAST\_TAI
- PAGING\_ALL\_GNB\_LAST\_TAI
- PAGING\_ALL\_GNB\_ALL\_TAI
- PAGING\_ALL\_GNB\_REM\_TAI\_ALL
- PAGING\_ALL\_GNB\_REM\_TAI\_SEQ

PAGING\_LAST\_GNB\_LAST\_TAI - As part of this action, AMF pages the last gNB in the last Tracking Area Identifier (TAI) from which UE contacted AMF.

PAGING\_LAST\_N\_GNB\_LAST\_TAI - As part of this action, AMF pages the last n gNB in the last TAI from which UE contacted AMF.

PAGING\_ALL\_GNB\_LAST\_TAI - As part of this action, AMF pages all the gNBs in the last TAI from which UE contacted AMF.

PAGING\_ALL\_GNB\_ALL\_TAI - As part of this action, AMF pages all the gNBs in all the TAIs as part of UE restricted area.

PAGING\_ALL\_GNB\_REM\_TAI\_ALL - As part of this action, AMF pages the remaining TAIs (Except the last known TAI) all together.

Example: If UE's registration area contains TAI A, B, C, and the last known TAI is A, AMF pages gNBs in TAI B, C together at the same time.

PAGING\_ALL\_GNB\_REM\_TAI\_SEQ - As part of this action, AMF pages the remaining TAIs (Except the last known TAI) in a sequential manner. There's no specific order in which AMF selects the TAI when paging is sequential.

Example: If UE's registration area contains TAI A, B, C, and the last known TAI is A, AMF first pages gNBs in TAI B. When no response is received for paging after reaching the maximum attempts, AMF proceeds to page gNBs in TAI C.




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**Note** AMF doesn't support PAGING\_ALL\_GNB\_REM\_TAI\_ALL and PAGING\_ALL\_GNB\_REM\_TAI\_SEQ as first stage of paging profile.

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The t3513 timeout value and number of retries at a given stage is configurable as part of paging-algo. The maximum number of gNB to page is also configurable and it is applicable only to paging action PAGING\_LAST\_N\_GNB\_LAST\_TAI.

AMF uses default paging-algo, when no paging map or profile or algo or matching triggers are configured for the incoming paging trigger.

Default paging-algo has only one stage and has the following parameters:

- action is all\_gnb\_last\_tai, which is configured automatically.
- max-paging-attempts and timeout value is fetched from the configured t3513 timer under Call Control Profile.

The default value of the t3513 timer is set to five seconds and the default paging retry count is set to two.

## How it Works

This section describes how this feature works.

## Standards Compliance

This feature complies with the following standards specifications:

- *3GPP TS 23.501 "System Architecture for the 5G System"*
- *3GPP TS 23.502 "Procedures for the 5G System"*
- *3GPP TS 38.413 "NG Application Protocol"*
- *3GPP TS 24.501 "Non-Access-Stratum (NAS) protocol for 5G System"*
- *3GPP TS 29.518 "Access and Mobility Management Services; Stage 3"*

## Feature Configuration

Configuring this feature involves the following steps:

1. **Operator Policy**—AMF allows you to configure the Operator defined policies. This configuration provides the commands to configure the operator defined policies for UE. For more information, refer to [Configuring the Operator Policy, on page 7](#).

2. **Paging Map**—AMF allows you to map the precedence, trigger (traffic-type), trigger-value, and its profile name to the paging. This configuration provides the commands to configure the paging map for UE. For more information, refer to [Configuring the Paging Map, on page 8](#).
3. **Paging Profile**—AMF allows you to configure paging stage and paging algorithm in paging profile. This configuration provides the commands to configure the paging profile for UE. For more information, refer to [Configuring the Paging Profile, on page 9](#).
4. **Paging Algorithm**—AMF allows you to configure paging algorithm with its name, action and with other associated parameters. This configuration provides the commands to configure the paging algorithm for UE. For more information, refer to [Configuring the Paging Algorithm, on page 10](#).
5. **Paging Priority**—AMF allows you to configure a map of ARP values to NGAP paging priority. This configuration provides the commands to configure the priority for the paging. For more information, refer to [Configuring the Paging Priority, on page 11](#).

## Configuring the Operator Policy

To configure the Operator Policy, use the following configuration:

```
config
  amf-global
    operator-policy operator_policy_name
    paging-map-name paging_map_name
  end
```

### NOTES:

- **operator-policy** *operator\_policy\_name*—Specify the operator policy name.
- **paging-map-name** *paging\_map\_name*—Specify the name of paging map. Must be a string in the size of 1–64 characters.

## Configuration Example

The following is an example configuration.

```
config
  amf-global
    operator-policy local
    paging-map-name pml
  end
```

## Configuration Verification

To verify the configuration:

```
show full-configuration amf-global operator-policy local
amf-global
operator-policy local
cp-name local
paging-map-name pml
```

## Configuring the Paging Map

To configure the Paging Map, use the following configuration:

```

config
  amf-global
    paging-map paging_map_name
      precedence precedence_count
      trigger-type
        5qi { fiveqi-value fiveqi_value | paging-profile-name
profile_name }
        arp { arp-value arp_value | paging-profile-name profile_name
}
        dereg { dereg-value { amf_init paging-profile-name
profile_name | udm_init paging-profile-name profile_name } | paging-profile-name
profile_name }
        dnn { dnn-value dnn_value | paging-profile-name profile_name
}
        ppi { ppi-value ppi_value | paging-profile-name profile_name
}
      end

```

### NOTES:

- **paging-map** *paging\_map\_name*—Specify the paging map.  
Based on the fetched paging map from the operator policy, a matching paging map is selected from paging-map list configured in amf-global.  
Each paging-map is a list of triggers having unique precedence associated with them. Based on the high precedence value matched trigger (with trigger value), the associated paging-profile is selected.
- **precedence** *precedence\_count* —Specify the map precedence level. Must be an integer in the range of 1–255. 1: High and 255: Low.
- **paging-profile-name** *profile\_name*—Specify the paging profile name. Must be a string of 1–64 characters.
- **trigger-type**—Specify the trigger type. Trigger can be the traffic type. Must be one of the following:
  - 5qi - 5G QoS Identifier, received as part of N1N2 message from SMF.
  - dereg - Paging Policy Indicator, received as part of N1N2 message from SMF.
  - ppi - Paging triggered due to Deregistration by UDM or AMF.
  - dnn - DNN for which paging is triggered.
  - arp - Allocation and Retention Priority, received as part of N1N2 message from SMF.
- **fiveqi-value** *fiveqi\_value* —Specify QoS Indicator value. Must be an integer in the range of 1–85.
- **arp-value** *arp\_value*—Specify the allocation and retention priority value. Must be an integer in the range of 1–15.
- **dereg-value**—Specify the deregistration trigger value which is either amf\_init or udm\_init.
- **dnn-value** *dnn\_value*—Specify the Data Network Name value. Must be a string of 1–64 characters.



- **ppi-value** *ppi\_value*—Specify the Paging Policy Indicator value. Must be an integer in the range of 1–7.

## Configuration Example

The following is an example configuration.

```
config
  amf-global
    paging-map pml
      precedence 1
        trigger-type 5qi
        fiveqi-value 5
    paging-profile-name ppml
  end
```

## Configuration Verification

To verify the configuration:

```
show full-configuration amf-global paging-map pml
amf-global
  paging-map pml
  precedence 1
  triggertype 5qi
  fiveqi-value 5
  paging-profile-name ppml
```

## Configuring the Paging Profile

To configure the Paging profile, use the following configuration:

```
config
  amf-global
    paging-profile paging_profile_name
    paging-stage paging_stage_count
  end
```

NOTES:

- **paging-profile** *paging\_profile\_name*—Specify the paging profile name. Each paging profile is a list of paging stages wherein stages are selected in increasing order of their number. Once paging stage is selected, paging algorithm associated with paging stage is selected.
- **paging-stage** *paging\_stage\_count*—Specify the paging stage precedence value in the range of 1-5. 1: High, 5: Low. Paging profile can have multiple stages. Stage defines the scope of paging.

## Configuration Example

The following is an example configuration.

```
config
  amf-global
    paging-profile pp1
      paging-stage 1
        paging-algo pal
      end
```

## Configuration Verification

To verify the configuration:

```
show full-configuration amf-global paging-profile pp1
amf-global
  paging-profile pp1
  paging-stage 1
  paging-algo pal
```

## Configuring the Paging Algorithm

To configure Paging algorithm, use the following configuration:

```
config
  amf-global
    paging-algo paging_algorithm_name
      action { all_gnb_all_tai | all_gnb_last_tai |
all_gnb_remaining_tai_all | all_gnb_remaining_tai_seq | last_gnb_last_tai
| last_n_gnb_last_tai }
      max-n-gnb max_n_gnb_count
      max-paging-attempts attempts_count
      t3513-timeout timeout_value
    end
```

### NOTES:

- **paging-algo** *paging\_algorithm\_name*—Specify the paging algorithm.
- **action** { **all\_gnb\_all\_tai** | **all\_gnb\_last\_tai** | **all\_gnb\_remaining\_tai\_all** | **all\_gnb\_remaining\_tai\_seq** | **last\_gnb\_last\_tai** | **last\_n\_gnb\_last\_tai** }—Specify the paging action.
- **max-n-gnb** *max\_n\_gnb\_count*—Specify the number of gNBs to page. It's the number of last gNBs from which UE contacted AMF. Must be an integer in the range of 1–5.  
AMF uses **max-n-gnb** when paging action is **last\_n\_gnb\_last\_tai**.
- **max-paging-attempts** *attempts\_count*—Specify the maximum number of paging attempts. It's an integer in the range of 1–5.
- **t3513-timeout** *timeout\_value*—Specify the paging timeout in seconds. Stops paging if all retries are done otherwise it performs retry. Must be an integer in the range of 1–10.

## Configuration Example

The following is an example configuration.

```
config
  amf-global
    paging-algo pal
      action last_gnb_last_tai
      max-n-gnb 5
      max-paging-attempts 2
      t3513-timeout 5
    end
```

## Configuration Verification

To verify the configuration:

```
show full-configuration amf-global paging-algo pal
amf-global
paging-algo pal
action last_gnb_last_tai
max-n-gnb 5
t3513 5
max-paging-attempts 2
```

## Configuring the Paging Priority

To configure the Paging priority, use the following configuration:

```
config
  amf-global
    call-control-policy call_control_policy_name
      paging-priority map arp arp_value ngap-paging-priority priority_value
    end
```

### NOTES:

- **call-control-policy** *call\_control\_policy\_name*—Specify the operator policy name.
- **paging-priority map arp** *arp\_value* **ngap-paging-priority** *priority\_value*—Specify the paging priority mapping value for ARP and NGAP. The NGAP paging priority value must be an integer in the range of 0-7.

AMF allows you to map incoming ARP value from SMF to NGAP paging priority.

When configured, AMF does the following:

- Populates the paging priority IE in PAGING message and sends to gNB.
- Handles new incoming N1N2 message as per the configuration, when paging is already in progress.

## Configuration Example

The following is an example configuration.

```
config
  amf-global
    call-control-policy local
      paging-priority map arp 5 ngap-paging-priority 1
      paging-priority map arp 8 ngap-paging-priority 2
    end
```

## Configuration Verification

To verify the configuration:

```
show full-configuration amf-global call-control-policy local paging-priority
amf-global
call-control-policy local
paging-priority map arp 5 ngap-paging-priority 1
paging-priority map arp 8 ngap-paging-priority 2
```

## AMF Paging Configuration Example

The following is an example configuration.

```

config
amf-global
operator-policy local
  ccp-name      local
  paging-map-name pm1
  ..
exit
paging-map pm1
  precedence 1
    trigger-type      arp
    arp-value         5
    paging-profile-name pp3
  exit
  precedence 2
    trigger-type      dereg
    dereg-value       udm_init
    paging-profile-name pp4
  exit
  precedence 3
    trigger-type      ppi
    ppi-value         7
    paging-profile-name pp1
  exit
  precedence 4
    trigger-type      5qi
    fiveqi-value      5
    paging-profile-name pp4
  exit
  precedence 5
    trigger-type      dereg
    dereg-value       amf_init
    paging-profile-name pp4
  exit
  precedence 6
    trigger-type      ppi
    ppi-value         6
    paging-profile-name pp5
  exit
precedence 9
  trigger-type      dnn
  dnn-value         starent1.com
  paging-profile-name pp4
  exit
exit
paging-profile pm1
exit
paging-profile pp1
  paging-stage 1
    paging-algo pa1
  exit
exit
paging-profile pp2
  paging-stage 1
    paging-algo pa2
  exit
exit
paging-profile pp3
  paging-stage 2
    paging-algo pa4
  exit

```

```
paging-stage 3
  paging-algo pa1
exit
paging-stage 4
  paging-algo pa2
exit
paging-stage 5
  paging-algo pa3
exit
exit
paging-profile pp4
  paging-stage 1
    paging-algo pa1
  exit
  paging-stage 2
    paging-algo pa2
  exit
  paging-stage 3
    paging-algo pa3
  exit
  paging-stage 4
    paging-algo pa6
  exit
  paging-stage 5
    paging-algo pa4
  exit
exit
paging-profile pp5
  paging-stage 5
    paging-algo pa5
  exit
exit
paging-algo pa1
  action                last_gnb_last_tai
  max-n-gnb             3
  t3513-timeout        2
  max-paging-attempts  1
exit
paging-algo pa2
  action                last_n_gnb_last_tai
  max-n-gnb             3
  t3513-timeout        3
  max-paging-attempts  2
exit
paging-algo pa3
  action                all_gnb_last_tai
  max-n-gnb             5
  t3513-timeout        4
  max-paging-attempts  3
exit
paging-algo pa4
  action                all_gnb_all_tai
  max-n-gnb             5
  t3513-timeout        5
  max-paging-attempts  5
exit
paging-algo pa5
  action                all_gnb_all_tai
  max-n-gnb             5
  t3513-timeout        10
  max-paging-attempts  5
exit
paging-algo pa6
  action                all_gnb_remaining_tai_all
```

```
max-n-gnb          5
t3513-timeout     5
max-paging-attempts 1
end
```