

Power Saving Mode (PSM) in UEs

This feature describes the Power Saving Mode (PSM) support on the MME in the following sections:

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Feature Summary and Revision History

Summary Data

Applicable Product(s) or Functional Area	• C-SGN • MME
Applicable Platform(s)	• UGP • VPC-DI • VPC-SI
Feature Default	Disabled
Related Changes in This Release	Not applicable
Related Documentation	• *Command Line Interface Reference* • *Statistics and Counters Reference*

Revision History

Revision Details	Release
The feature is tested and qualified on the ASR 5500 platform.	21.3

Revision Details	Release
• If the **packet-count value** is not configured locally, the subscription value for packet-count is used. The subscription value can be "0", in this case the packet count IE will not be sent for that subscriber even if it is configured locally. If the T3324 active and T3412 extended timers are locally configured these values are always used. If the UE does not request T3412 extended timer, then the value available in subscription data is used for Extended Periodic timer. If the values are not available in the subscription data then the values configured under the MME service are used. • If a session recovery occurs then the T3324 Active Timer restarts only for the remaining time of the total time configured before session recovery. Once the remaining time of the active timer elapses the UE moves to the power saving mode. • The DL-Buffering-Suggested-Packet-Count AVP is supported.	N5.1 (21.1.V0)
First introduced.	21.0

Feature Description

Internet of Things (IoT) is a computing concept where everyday objects have internet connectivity and they can collect and exchange data. IoT is a network which can comprise of a wide variety of physical devices, vehicles, buildings, and any other device/object used in our daily lives. They are embedded with sensors, software and network connectivity which help them communicate with other devices in the network and can be controlled remotely thus increasing efficiency, accuracy and economic benefit. Any device/object which has to be a part of the IoT network must have:

- Long battery life
- Low device cost
- Low deployment cost
- Full network coverage
- Support to connect to large number of devices



Important This feature is license controlled. Please consult your Cisco Account Representative for information about the specific license.

Power Saving Mode (PSM) was introduced in 3GPP Release 12, to improve device battery life of IoT devices. The most significant benefit of this feature is the UE has more control in terms of power management required for its application. There are a wide range of IoT applications where flexibility of the UE to manage its power is very important and also implementation of PSM can prevent network congestion. The timers of all the devices can be managed using PSM, and the wake-up periods can be adjusted to be offset as much as possible. This way all of the devices will not wake at the same time and attempt to access the network. The PSM mode is similar to power-off but the UE remains registered on the network.

The UE activates PSM by including two timer values in the Attach or Tracking Area Update (TAU). The first timer is the T3324, which defines the time the UE stays active after idle mode following the Attach or TAU procedure. The second timer is an extended T3412 which defines the extended time for an UE to send periodic TAU.

Power Saving Mode Timers

T3324 Active Timer

The UE requests for a T3324 Active Timer value during Attach and TAU procedures. The MME allocates the T3324 value to the UE. The T3324 active timer determines the duration during which the device remains reachable for mobile terminated transaction on transition from connected to idle mode. The device starts the active timer when it moves from connected to idle mode and when the active timer expires, the device moves to Power Saving Mode. The MME takes the UE requested value and MME local configuration into account for determining the Active Timer value. The MME includes the T3324 value IE in the ATTACH ACCEPT/TAU ACCEPT message only if the T3324 value IE was included in the ATTACH REQUEST/TAU REQUEST message. A UE using PSM is available for mobile terminating services only for the period of an Active Time after a mobile originated event like data transfer or signaling for example after a periodic TAU/RAU procedure.

The MME allows a value of '0' for the T3324 timer. In this case the UE enters the Power Saving Mode immediately.

The Mobile reachability timer is set equal to the T3324 timer (Active Time). The MME allows a value of '0' for the T3324 timer. In this case the UE enters the Power Saving Mode immediately.

If a session recovery occurs then the active timer re-starts only for the remaining time of the total time configured before session recovery. Once the remaining time of the active timer elapses the UE moves to the power saving mode.

T3412 Extended Timer

The T3412 timer is also referred to as the periodic Tracking Area Update (TAU) timer. Periodic tracking area updating is used to periodically notify the availability of the UE to the network. The procedure is controlled in the UE by the periodic tracking area update timer (timer T3412). The value of timer T3412 is sent by the network to the UE in the ATTACH ACCEPT message and can be sent in the TRACKING AREA UPDATE ACCEPT message. The UE shall apply this value in all tracking areas of the list of tracking areas assigned to the UE, until a new value is received. A longer periodic TAU timer is possible using T3412 extended timer. When the UE includes the T3324 value IE and the UE indicates support for extended periodic timer value in the MS network feature support IE, it may also include the T3412 extended value IE. Apart from the value requested by the UE, the MME verifies the local configuration into account while selecting a value for the T3412 extended timer. When the MME includes the T3412 extended value IE in the ATTACH ACCEPT message or TRACKING AREA UPDATE ACCEPT message , the MME uses timer T3412 extended value IE as the value of timer T3412. The Implicit Detach Timer (IDT) is set to 4 minutes greater than the T3412 extended timer.

Other Feature Enhancements

The MME allows a value of "0" for timer T3324 (Which implies the UE enters Power Saving Mode immediately).

MME may also include Downlink buffer duration and "Downlink suggested packet count" in DDN ACK if it is configured.

The following new flags are introduced as part of this feature; these flags are supported in GTPCv2 Indication IE:

- Pending Network Initiated PDN Connection Signaling Indication (PNSI): The source MME supports sending of PNSI flag in GTPCv2 Indication IE of Context response.
- UE Available for Signaling Indication (UASI): The MME supports sending of the UASI flag in GTPCv2 Indication IE of Create Session Request and Modify Bearer Request to indicate to the PGW that the UE is available for end to end signaling.
- Delay Tolerant Connection Indication (DTCI): The MME supports receiving the DTCI flag in Create Session Response from the SGW. The MME supports receiving of the DTCI flag in Context Response and Forward Relocation Request from peer MME or S4-SGSN.
- Availability after DDN Failure: If there is an Availability after DDN Failure monitoring event configured for the UE in the MME/SGSN, the MME/SGSN does not invoke extended buffering. Instead, the MME/SGSN sets the Notify-on-available-after-DDN-failure flag to remember to send an Availability after DDN Failure notification when the UE becomes available. If there is a UE Reachability monitoring event configured for the UE in the MME/SGSN, the MME/SGSN does not invoke extended buffering.

The MME rejects CBR/UBR when PPF is False. The cause "UE is temporarily not reachable due to power saving" is sent in the response by the MME if the corresponding PDN was marked "Delay tolerant" by PGW.

How It Works

A subscriber is PSM enabled only when:

- The Power Saving Mode timers T3324 active and T3412 extended timers are configured.
- The MME supports Power Saving Mode for that subscriber.

A CLI based configuration is provided to configure the T3324 active and T3412 extended timers. The CLI provides an option to either accept UE requested values or MME configured values for these timers. When the PSM CLI configuration is enabled, the MME accepts the use of PSM and a UE requested value of T3324 is received in Attach/TAU request. If the CLI is configured to accept UE requested values of timers and if T3412 extended timer is not received from the UE along with T3324 in Attach/TAU request, then MME uses the same value of T3412 timer available in HSS subscription and if not, then MME service configuration. The values of T3324 and T3412 timers are determined based on the configuration. If the MME has allocated an Active Time (T3324) to the UE, then the MME starts the Active timer with the value of T3324 whenever the UE enters IDLE mode. If this timer expires, then MME clears the PPF (Paging Proceed Flag) and sets the IDT timer as "4" minutes greater than T3412 extended. When the PPF is clear, the MME does not page the UE on receiving a Downlink Data Notification message and sends a Downlink Data Notification Ack message with cause "Unable to page UE" to the Serving GW with DL buffering duration and DL suggested packet count IEs as per the operator configuration. The CLI option **dl-buf-duration [packet-count** *packet_value* **]** is used to optionally configure either to send or not send the downlink buffer duration in DDN Ack, the DDN Ack Optional IE "Downlink Suggested Packet Count" can also be configured. If this option is not configured and not sent in subscription, MME does not send IE in DDN reject. If the **packet-count** value is not configured locally, the subscription value for **packet-count** is used. The subscription value can be "0", in this case the packet count IE will not be sent for that subscriber even if it is configured locally. If the T3324 active and T3412 extended timers are locally configured these values are always used. If the **psm** command is configured to use the UE requested values for Active and Extended Periodic timers the UE requested values are accepted, but in case if the UE does not request T3412 extended timer, then the value available in subscription data are used for Extended Periodic timer. If the values are not available in the subscription data then the values configured under the MME service are used .

The MME rejects network initiated PDN connections during power saving mode. The MME sends the cause "UE is temporarily not reachable due to power saving" if the corresponding PDN was marked Delay Tolerant (DTCI flag set) by PGW. The source MME sets the PNSI flag in Context Response if there are any pending network initiated PDN connections (for example, Create Bearer Request/Update Bearer Request). The MME sets the UASI flag in the Create Session Request or Modify Bearer Request message when UE is available for end-to-end signaling. The UE is in PSM until a mobile originated event (for example periodic RAU/TAU, mobile originated data or detach) requires the UE to begin any procedure towards the MME.

Limitations

UE Power Saving Mode is not supported in the CS domain on the network side. A UE that uses mobile terminated IMS or CS services other than SMS should not use PSM as neither IMS nor the CS domain provide support for mobile terminated CS voice or IMS services to UEs that are in PSM.

As per latest version of 3GPP TS 24.008, the maximum value of T3412 extended timer can be "320*31" hours that is "35712000" seconds. Due to MME constraints on timer implementation the T3412 extended timer is restricted to 1050 hours that is "3780000" seconds. However, the nearest usable value of this timer as 3GPP TS 24.008 GPRS Timer 3 is 960 hours (320 * 3) that is 3456000 seconds.

Standards Compliance

The Power Saving Mode feature complies with the following standards:

- 3GPP TS 24.301 Release 13.5.0
- 3GPP TS 23.401 Release 13.5.0
- 3GPP TS 29.274 Release 13.5.0
- 3GPP TS 24.008 Release 13.5.0
- 3GPP TS 36.413 Release 13.5.0

Configuring UE Power Saving Mode

Use the following configuration in the Call Control Profile Configuration mode to configure the UE Power Saving Mode parameters.

```
configure
  call-control-profile profile_name
    [ remove ] psm { ue-requested [ dl-buf-duration [ packet-count
packet_value ] ] | t3324-timeout t3324_value t3412-extended-timeout t3412_ext_value
 [ dl-buf-duration [ packet-count packet_value  ] ] }
    exit
```

Notes:

- The operator can use the **ue-requested** keyword when UE requested values for Active and Extended Periodic timers are to be accepted.

- The **dl-buf-duration** keyword is used to send the Downlink Buffer Duration in DDN ACK when unable to page UE. If this keyword is not configured, buffer duration will not be sent in DDN-ACK. By default, the buffer duration is not sent in DDN ACK.
- The **packet-count** keyword is used to send "DL Buffering Suggested Packet Count" in DDN ACK when unable to page UE. The packet count value is an integer ranging from 0 to 65535.
- The **t3324-timeout** keyword is used to configure the T3324 active timer value. The T3324 active timer is an integer ranging from 0 to 11160 seconds.
- The **t3412-timeout** keyword is used to configure the T3412 Extended timer value. The T3412 extended timer is an integer ranging from 0 to 35712000 seconds.
- The **remove** keyword is used to disable the UE power saving mode.
- This command is disabled by default.

Monitoring and Troubleshooting

This section provides information on how to monitor the UE Power Saving Mode feature and to determine that it is working correctly.

Show Command(s) and/or Outputs

This section provides information regarding show commands and/or their outputs updated in support of the UE Power Saving Mode feature.

The show commands in this section are available in support of this feature.

show call-control-profile full name

The PSM parameters are added to this command:

- UE Power Saving Mode - This section displays all the PSM related parameters.
- T3324 Timeout - Displays the T3324 timer value in seconds.
- T3412 Extended Timeout - Displays the T3412 extended timer value in seconds.
- Downlink Buffer Duration in DDN ACK - Displays if Downlink Buffer Duration in DDN ACK is either enabled or disabled.
- DL Buffering Suggested Packet Count in DDN ACK - Displays the DL buffering suggested packet count in DDN ACK.

show mme-service session all

The following new parameters are added to this command:

- UE Reachability Timer (PSM UE)
- T3412 Extended Timer
- UE Active Timer

- Remaining Time

Note These timers are calculated based on the **psm** command configuration in the Call Control Profile Configuration mode.

show mme-service statistics

The following new parameters are added to this command:

- PSM Subscribers: Displays information related to PSM subscribers.
- Attached Calls: Displays the number of attached subscribers for whom PSM is enabled.
- DDN Rejects: Displays the number of DDN rejects that have occurred for PSM enabled subscribers. A Downlink Data Notification (DDN) is rejected when an UE is in power saving mode.

show egtpc statistics verbose

The following new parameters are added to this command:

- UE not reachable due to PSM
- Create Bearer Denied
- Create Bearer Denied TX
- Update Bearer Denied
- Update Bearer Denied TX

The Create Bearer Request and Update Bearer Request are rejected when the UE is in Power Saving Mode. The MME sends the cause "EGTP_CAUSE_UE_TEMP_NOT_REACHABLE_DUE_TO_POWER_SAVING" in the reject message if that PDN is marked "Delay Tolerant" by P-GW (DTCI flag enabled in PDN Connection Indication IE of Create Session Response). Otherwise the MME sends the cause "EGTP_CAUSE_UNABLE_TO_PAGE_UE" to S-GW in CBR/UBR Reject.

UE Power Saving Mode Bulk Statistics

The following statistics are added in the MME Schema in support of the UE Power Saving Mode feature:

- attached-psm-subscriber - The current number of attached subscribers in PSM mode.
- ddn-rejects-psm - The total number of DDN rejects due to PSM ever since the chassis was up.

Diameter Attributes

Diameter Attribute Value Pairs (AVPs) carry specific authentication, accounting, authorization, routing and security information as well as configuration details for the request and reply.

The following Diameter attributes are added in support of this feature:

DL-Buffering-Suggested-Packet-Count

This AVP indicates the DL buffering suggested packet count.

Vendor ID 10415

VSA Type 1674

AVP Type Integer32

AVP Flag V-bit is set to true, M-bit is set to false.

Troubleshooting

The troubleshooting steps for operator configured and UE requested timers are described in this section.

Operator Configured Timers

The operator can configure the T3324 active and T3412 extended timer using the **psm** CLI command. The procedure below is a step-by-step procedure for troubleshooting.

1. The **psm** command in the Call Control Profile Configuration mode is used to configure the active and extended timers:

   psm t3324-timeout *5* **t3412-extended-timeout** *1000*

Note If the value of T3324 is set as 5 seconds, it will try to set the nearby value that is 4 seconds and if the value of T3412 extended timer is set as 1000 seconds, it will set as 960 seconds. See the *3GPP TS 24.008* for more information.

2. A subscriber with T3324 and T3412 extended timers sends the Attach Request.
3. The Attach request is completed and followed by the S1 release. The UE moves to an IDLE state.
4. On execution of the **show mme-service session** command, the following parameters are displayed:

```
UE Active Timer  : 4 secs          Remaining Time : 2 secs
T3412 Extended Timer     : 960 secs
```

5. The Paging Proceed Flag (PPF) changes to “FALSE” after the configured T3324 timer expires and the UE enters power saving mode.
6. Downlink Data Notification (DDN) is sent and it gets rejected as the UE is in power saving mode.
7. On execution of the **show mme-service statistics** command, the following parameters are displayed:

```
PSM Subscribers:

Attached Calls: 1       DDN Rejects: 1
```

8. The UE continues to be in power saving mode until the IDT timer expires or the UE initiates any other procedure.

UE Requested Timers

The user can enable the usage of UE requested values for Active and Extended Periodic timers by using the **ue-requested** keyword in the **psm** command. The procedure below is a step-by-step procedure for troubleshooting.

1. The **psm ue-requested** command in the Call Control Profile Configuration mode is used to configure the usage of UE requested active and extended timers.
2. A subscriber with T3324 and T3412 extended timers sends the Attach Request.
3. The Attach Request is completed and followed by the S1 release. The UE moves to an IDLE state.
4. The Paging Proceed Flag (PPF) changes to “False” after the T3324 expires (UE requested value) and the UE enters power saving mode.
5. The Create Bearer Request (CBR) is rejected when the PPF is “False”. The cause “UE is temporarily not reachable due to power saving” is sent in the response by the MME if the corresponding PDN was marked “Delay tolerant” by P-GW.
6. On execution of the **show egtpc statistics verbose** command, the following parameters are displayed:

```
Create Bearer Denied:

 Create Bearer Denied TX:
 UE not reachable due to PSM: 1
```