

eDRX Support on the MME

This feature describes the Extended Discontinuous Reception (eDRX) 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)	• ASR 5500 • UGP • VPC-DI • VPC-SI
Feature Default	Disabled - Configuration Required (eDRX feature) Enabled - Configuration Required (eDRX GPS time support in 21.4)
Related Changes in This Release	Not applicable
Related Documentation	• *Command Line Interface Reference* • *Statistics and Counters Reference* • *Ultra IoT C-SGN Administration Guide*

Revision History

Revision Details	Release
Paging eDRX H-SFN changed to 10 bits counter.	21.11.3
The eDRX feature is enhanced to support H-SFN Start time configuration in GPS format and H-SFN Reference time in GPS and UTC format. The **edrx** command in the MME Service Configuration mode is enhanced in this release. Refer to Configuring Hyper SFN Synchronization, on page 6 section for more information. The feature default for this enhancement is "Enabled - Configuration Required".	21.4
The feature is tested and qualified on the ASR 5500 platform.	21.3
The enhancements in the N5.1 release include: • MME supports configuration of the T3415 paging timeout value. MME uses the T3415 timer for eDRX UEs. • The **edrx** CLI command is enhanced to support DL Buffering Suggested Packet Count in DDN ACK when unable to page UE. • Support of the DL-Buffering-Suggested-Packet-Count AVP.	N5.1 (21.1.V0)
First introduced.	21.0

Feature Description

The Extended Discontinuous Reception (eDRX) feature allows IoT devices to remain inactive for longer periods. This feature allows the device to connect to a network on a need basis – the device can remain inactive or in sleep mode for minutes, hours, or even days, thus increasing the battery life of the device.

Extended DRX cycles provide UEs longer inactive periods between reading, paging, or controlling channels.

Important The Extended DRX feature is license controlled. Contact your Cisco Account or Support representative for information on how to obtain a license.

Important With release 21.11.3 Paging eDRX H-SFN changed to 10 bits counter to allow values between 0 to 1023 as per 3GPP TS 36.331 V13.13.0.

The primary advantage is that without eDRX support, the MME will page the UE unconditionally. When eDRX is enabled, the MME pages the UE only at valid paging occasions and the MME sends the eDRX paging parameters to eNodeB during paging.

How eDRX Works

In order to use the eDRX feature, the UE requests the eDRX parameters during ATTACH and TAU procedures. Based on the configuration, the MME may accept or reject the UE's request to enable the eDRX feature. If the MME accepts the eDRX request, different values of the eDRX parameters are provided based on operator policies, apart from the parameters requested by the UE.

The operator can configure the eDRX parameters Paging Time Window (PTW) and eDRX cycle length duration in the Call Control Profile Configuration mode. The UE requested values of PTW and eDRX cycle is received in the Attach or TAU request. The H-SFN start time and H-SFN reference time for leap second adjustment can also be configured. MME calculates the paging occasion for the UE using the values of H-SFN start time, H-SFN reference time, PTW, and eDRX cycle length. The UE is paged only at the paging occasion until the PTW expires. The MME rejects all other paging requirements which occur in between the paging occasion.

The downlink buffer duration in DDN ACK can be configured when the MME cannot page the UE. This is an optional configuration. For Downlink Data Notifications (DDN), if the UE is not in a paging occasion, the MME does not page the UE. The MME sends a Downlink Data Notification Reject message to the S-GW along with the DL buffering duration and DL suggested packet count IEs as per the operator configuration. The packet count in DDN ACK can be configured to configure the packet count value. The MME starts a timer to page at the next paging occasion. If downlink buffer duration is not configured, the MME rejects the DDN without these IEs. If the packet count value is not configured locally, the subscription provided value is used. The subscription value can be "0" in which case the packet count IE will not be sent for that subscriber even if it is configured locally.

If the UE is not in a paging occasion, the MME rejects the paging request for dedicated bearer creation request and sends bearer reject to the S-GW with the cause "UE is temporarily not reachable due to power saving". The MME starts a timer to page at the next paging occasion. If the UE is not in a paging occasion during MME-initiated detach where the MME needs to page the UE to send a detach request, the MME does not page the UE and performs an implicit detach.

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 P-GW 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 S-GW. The MME supports receiving of the DTCI flag in Context Response and Forward Relocation Request from peer MME or S4-SGSN.

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 P-GW.

eDRX Parameters

A Hyper-SFN (H-SFN) frame structure is defined for regular idle mode DRX. Each H-SFN value corresponds to a legacy SFN cycle comprised of 1024 radio frames (10.24 seconds). The eDRX consists of values that are

a power of 2, ranging from 5.12 seconds (that is, 5.12, 10.24, 20.48 seconds and so on) up to a maximum of 2621.44 seconds (43.69 minutes). When eDRX is enabled for a UE, the UE is reachable for paging in specific Paging Hyperframes (PH), which is a specific set of H-SFN values. The PH computation is a formula that is function of the eDRX cycle, and a UE specific identifier. This value can be computed at all UEs and MMEs without need for signalling. The MME includes the extended idle mode DRX cycle length in paging message to assist the eNodeB in paging the UE.

The MME also assigns a Paging Time Window length, and provides this value to the UE during attach/TAU procedures together with the extended idle mode DRX cycle length. The UE first paging occasion is within the Paging Hyperframe. The UE is assumed reachable for paging for an additional Paging Time Window length after first paging occasion. After the Paging Time Window length, the MME considers the UE unreachable for paging until the next Paging Hyperframe.

Loose Hyper SFN Synchronization

In order for the UE to be paged at the same time, the H-SFN of all eNodeBs and MMEs must be loosely synchronized. Each eNodeB and MME synchronizes the H-SFN counter so that the start of H-SFN=0 coincides with a pre-configured time. It is assumed that eNodeBs and MMEs are able to use the same H-SFN value with accuracy in the order of legacy DRX cycle lengths, for example 1 to 2 seconds. Synchronization is not required at SFN level and signaling between network nodes is not required to achieve loose H-SFN synchronization.

Paging and Paging Retransmission Strategy

When the MME receives trigger for paging and the UE is reachable for paging, the MME sends the paging request. If the UE is not reachable for paging, then the MME pages the UE just before the next paging occasion. The MME determines the Paging Time Window length based on paging retransmission strategy, and uses it to execute the retransmission scheme.

The MME uses the T3413 timer for non-eDRX UEs to re-transmit paging. For eDRX UEs the MME uses the T3415 timer and on expiry of T3415 timer, the network aborts the paging procedure.

If a session recovery occurs then the eDRX timer re-starts only for the remaining time of the total time configured before session recovery. This is to ensure that the UE and MME are in sync with respect to the paging occasion.

Limitations and Restrictions

The eDRX feature is compatible only with IoT devices. It is not available for all Mobile Stations (MS), that is, only those MSs and their respective Base Service Stations (BSS) that have the extended coverage parameters are supported by the SGSN.

Standards Compliance

The eDRX feature complies with the following standards:

- 3GPP TS 23.682 version 13.4.0, Architecture enhancements to facilitate communications with packet data networks and applications (Release 13)
- 3GPP TS 24.302 version 13.5.0, Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3 (Release 13)

- 3GPP TS 23.401 version 13.5.0, General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access.
- 3GPP TS 29.274 version 13.5.0, 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunneling Protocol for Control plane (GTPv2-C); Stage 3
- 3GPP TS 36.304 version 13.3.0, Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode
- 3GPP TS 36.300 version 13.2.0, Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2
- 3GPP TS 36.413 version 13.1.0, Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)
- 3GPP TS 24.008 version 13.5.0, Mobile radio interface Layer 3 specification; Core network protocols; Stage 3

Configuring eDRX on the MME

Enabling eDRX on MME

Use the following configuration to enable the eDRX feature on the MME in the Call Control Profile Configuration mode. The configuration provides options to configure:

- Accept eDRX parameters: Paging Time Window (PTW) and eDRX cycle length value, from the UE
- PTW and eDRX cycle length value
- Downlink buffer duration in DDN ACK when unable to page UE
- "DL Buffering Suggested Packet Count" in DDN ACK when unable to page UE

```
configure
  call-control-profile profile_name
    edrx { ptw ptw_value edrx-cycle cycle_length_value | ue-requested } [
dl-buf-duration [ packet-count packet_count_value ] ]
    remove { edrx | nb-iot edrx }
    end
```

Notes:

- The **remove** keyword disables the eDRX configuration on the MME.
- The **edrx** keyword configures extended discontinuous reception parameters.
- The **ue-requested** keyword specifies the accepted UE requested values of the of the Paging Time Window (PTW) and the eDRX cycle length received from the UE in the Attach Request/TAU Request message be accepted.
- The **ptw** *ptw_value* keyword configures the PTW value.

  In releases prior to 21.2: *ptw_value* is an integer ranging from 0 to 20.

In 21.2 and later releases: *ptw_value* is an integer ranging from 0 to 15. The values 0 to 15 are mapped to 2.56, 5.12, 7.68, 10.24, 12.80, 15.36, 17.92, 20.48, 23.04, 25.60, 28.16, 30.72, 33.28, 35.84, 38.40 and 40.96 seconds.

- The **edrx-cycle** keyword configures the eDRX cycle length. The *cycle_length_value* is an integer value in seconds from 5.12 to 2621.44. It is a multiple of 2 starting from 5.12 up to 2621.44 seconds (for example: 5.12, 10.24, 20.48, and so on).
- The **dl-buf-duration** keyword sends Downlink Buffer Duration data in the DDN ACK message when MME is unable to page the UE.
- The **packet-count** keyword sends "DL Buffering Suggested Packet Count" in DDN ACK when the UE cannot be paged. The *packet_count_value* is an integer from 0 to 65535. If the *packet_count_value* is not configured locally, the subscription provided value for the *packet_count_value* is used. The subscription value can be 0 in which case the packet count IE will not be sent for that subscriber even if it is configured locally.
- This command is disabled by default.

Verifying eDRX on the MME

Execute the following command to verify the configured values.

show call-control-profile full name *profile_name*

```
Extended DRX:
    Paging Time Window                                : 10 Seconds
    eDRX Cycle Length                                 : 512 Seconds
    Downlink Buffer Duration in DDN Ack               : Enabled
    DL Buffering Suggested Packet count in DDN Ack    : 10
```

Configuring Hyper SFN Synchronization

This section describes the Hyper-SFN Synchronization start time and reference time configuration.

Configuring Hyper-SFN Synchronization Start Time

Use the following configuration to configure the Hyper-SFN Synchronization start time in GPS or UTC format.

```
configure
  context context_name
    mme-service service_name
      edrx hsfn-start start_time [ gps | utc ]
      no edrx hsfn-start
      end
```

Notes:

- The **no** option disables the H-SFN synchronization time configuration.
- *start_time*: Specifies the time at which H-SFN=0 starts, entered in GPS or UTC time format. The UTC time format is **YYYY:MM:DD:hh:mm:ss**.
- **gps | utc**:

- **gps**: Specifies the time at which H-SFN=0 starts in GPS format. GPS time starts from 1980:01:06:00:00:00.

  For example: **edrx hsfn-start 2000:03:01:12:34:56 gps**

- **utc**: Specifies the time at which H-SFN=0 starts in UTC format. UTC time starts from 1972:06:30:00:00:00.

  For example: **edrx hsfn-start 2000:03:01:12:34:56 utc**

- The **gps** and **utc** keywords are optional. If not explicitly provided, then H-SFN=0 starts in UTC format.
- After the HSFN-start configuration, the HSFN-reference can be configured to adjust the leap seconds.

Configuring Hyper-SFN Synchronization Reference Time

Use the following configuration to configure the Hyper-SFN Synchronization reference time for leap second adjustment.

```
configure
  context context_name
    mme-service service_name
      edrx hsfn-reference ref_time adjust leap_seconds
      no edrx hsfn-reference
      end
```

Notes:

- *ref_time*: Specifies the reference time in UTC format as **YYYY:MM:DD:hh:mm:ss**.
- **adjust** *leap_seconds*: Specifies the number of leap seconds that need to be adjusted. *leap_seconds* must be an integer from 0 to 100.
  - A maximum of **2** H-SFN reference time configuration is allowed. The first configuration will be the latest leap-second adjustment UTC time and the second configuration will be the next or declared leap-second adjustment UTC time.

    For example:

    Consider the following H-SFN reference time configuration:

    ```
    edrx hsfn-reference 2017:01:01:00:00:00 adjust 5
    ```

    When the next leap second adjustment is announced with new time **2018:01:01:00:00:00**, MME can be configured any time before 2018:01:01 with the following configuration.

    ```
    edrx hsfn-reference 2018:01:01:00:00:00 adjust 6
    ```

    When another leap second adjustment is announced with another new time **2018:06:30:00:00:00**, MME can be configured any time before 2018:06:30 with the following configuration, and deletes the oldest time reference (2017:01:01) configuration.

    ```
    no edrx hsfn-reference 2017:01:01:00:00:00

    edrx hsfn-reference 2018:06:30:00:00:00 adjust 7
    ```

  - For HSFN-Start in GPS format, the number of leap seconds must be provided from 1980:1:06. For example: at 2017:01:01:00:00:00, the number of leap seconds from 1980:1:06 are 18.

- For HSFN-Start in UTC format, the number of leap seconds must be provided from the HSFN-Start time. For example: at 2000:03:01:12:34:5, the number of leap seconds from 2000:03:01:12 are 5.

- The **no** option disables the H-SFN reference time configuration.
- The **edrx hsfn-reference** command is disabled by default.

Verifying H-SFN Synchronization

Use the following command to verify the H-SFN configuration:

show mme-service full *service_name*

```
Extended DRX:
     H-SFN Start            : 2016:03:01:12:34:56 GPS | UTC
     H-SFN UTC Reference    : 1982:1:1:1:1:1
     Adjusted time          : 1
```

Configuring the T3415 eDRX Timer

This section describes how to configure the T3415 eDRX timer. This timer is used to configure the eDRX paging timeout. The **t3415-timeout** keyword is added as part of the **emm** command in the MME Service Configuration mode. The **emm** command is used to configure evolved mobility management timer parameters such as timeout durations for timers and retransmission counts and for Non-Access Stratum (NAS) message retransmission in MME service.

```
configure
   mme-service service_name
      emm { implicit-detach-timeout detach_dur | mobile-reachable-timeout
mob_reach_dur | t3346-timeout t3346_dur | t3412-extended-timeout t3412_ext_dur
| t3412-timeout t3412_dur | t3413-timeout t3413_dur | t3415-timeout t3415_dur
 | t3422-timeout t3422_dur | t3423-timeout t3423_dur | t3450-timeout t3450_dur
 | t3460-timeout t3460_dur | t3470-timeout t3470_dur }
      default emm { implicit-detach-timeout | mobile-reachable-timeout |
t3346-timeout | t3412-extended-timeout | t3412-timeout | t3413-timeout |
 t3415-timeout | t3422-timeout | t3423-timeout | t3450-timeout |
t3460-timeout | t3470-timeout }
```

Notes:

- The keyword **t3415-timeout** *t3415_dur* is used to configure the T3415 paging timeout value. The *t3415_dur* is an integer value in the range 1 up to 20 seconds. The default value is 6 seconds.

Verifying the T3415 eDRX Timer

Execute the **show mme-service full** *service_name* command to verify the configured value of the T3415 timer.

For example: The **T3415 Timeout** parameter displays the configured value of T3415 timer as 3 seconds.

show mme-service full *service_name*

```
T3415 Timeout  :  3s
```

Configuring the T3415 eDRX Timer in LTE Paging Profile Configuration Mode

This section describes how to configure the T3415 eDRX timer in the LTE Paging Profile Configuration mode. This timer is used to configure the eDRX paging timeout. The **t3415-timeout** keyword is added as part of the **paging-stage** command under the LTE Paging Profile Configuration mode. The **paging-stage** command enables the operator to configure different stages of paging in the order of desired execution with parameters that control the pace, volume, and behavior of a given paging stage.

```
configure
   lte-policy policy_name
      paging-profile profile_name
         [ no ] paging-stage level match-criteria { ue-contact-time seconds |
 all } action { last-n-enb-last-tai max-n-enb value | all-enb-last-tai |
all-enb-all-tai } t3413-timeout seconds max-paging-attempts attempts [
t3415-timeout t3415_dur ]
         end
```

Notes:

- The **t3415-timeout** *t3415_dur* keyword is used to configure the T3415 paging timeout value. The *t3415_dur* is an integer ranging from 1 to 20 seconds.
- The **no** keyword disables the configuration.
- There are no re-tries in a paging stage.
- This command is disabled by default.

Monitoring and Troubleshooting eDRX

eDRX Show Command(s) and /or Outputs

This section provides information regarding the show commands and their outputs for the eDRX feature.

show mme-service statistics

The following fields are added to the output of this command.

- EDRX Subscribers - Displays information about the eDRX subscribers.
- Attached Cells - Displays the number of attached subscribers for which eDRX is enabled.
- DDN Rejects - Displays the number of DDNs rejected when eDRX subscribers cannot be paged (UE is out of the paging window).

show egtpc statistics verbose

The following fields are added to the output of 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 (CBR) and Update Bearer Request (UBR) 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 PGW (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.

show lte-policy paging-profile name *profile_name*

The following fields are added to the output of this command.

- Paging Stage
- Paging Action
- Match Criteria
- T3413-Timeout
- Max Paging Attempts
- T3415-Timeout

Troubleshooting

The following troubleshooting steps can be used to verify the eDRX configuration:

- If eDRX is not enabled, verify if the eDRX parameters are configured in the call control profile and the eDRX H-SFN start time is configured for the MME service.
- If paging failures occur, verify the eDRX parameters.

Bulk Statistics

The following bulk statistics are added in the MME Schema in support of the eDRX feature.

- attached-edrx-subscriber - The current number of attached subscribers in eDRX mode.
- ddn-rejects-edrx - The total number of DDN rejects due to eDRX 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.