

DDN Throttling

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Feature Description

The MME supports Downlink Data Notification (DDN) Throttling. With this feature, the MME is provisioned to reject non-priority (traffic based on ARP and LAPI) DDN Requests when the UE is in idle mode. Additionally, the MME dynamically requests the S-GW to reduce the number of DDN Requests based on a throttling factor and a throttling delay specified in the DDN Ack message.

MME supports the following functions for DDN Throttling:

- Rejection of DDN requests when configured congestion threshold is reached.
- Allows the configuration of cause value to be sent in DDN Ack message when DDN is rejected during congestion.
- Allows DDN rejection based on ARP.
- Allows DDN rejection based on LAPI.
- Allows configuration of DDN throttling factor and throttling delay values to be sent in DDN Ack message to SGW during congestion.

A valid license key is required to enable DDN Throttling. Contact your Cisco Account or Support representative for information on how to obtain a license.

How It Works

The SGW determines whether a bearer needs DDN throttling based on the bearer's ARP priority level and operator policy (operator's configuration in the SGW of the ARP priority levels to be considered as priority or non- priority traffic). While throttling, the SGW throttles the DDN Requests for low and normal bearers based on priority. The MME determines whether a Downlink Data Notification request is priority or non-priority traffic on the basis of the ARP priority level that was received from the SGW and operator policy.

Congestion Control Profile supports DDN Throttling. The Congestion Control policy allows the operator to configure three different action profiles critical, major and minor based on the congestion level. During

Congestion the operator configures the action to be taken using action profiles. Congestion Action profile allows configuration of DDN Throttling parameters.

When congestion threshold is reached the following actions are taken on DDN requests based on the operator configuration:

- Reject all DDN requests based on ARP and LAPI. DDN Ack message is sent with failure cause to the SGW. Paging is not initiated.
- Reject all DDN requests if ARP or LAPI values are not configured.
- Enable SGW Throttling. DDN Ack message is sent to the SGW with throttling factor and throttling delay values.

Session Manager

The Session Manager is configured to handle DDN requests based on the DDN's current congestion status and the operator configuration. Session Manager stores the congestion status information along with S1-AP or NAS messages received from the MME manager. This data is used to handle DDN requests.

The Session Manger handles congestion for incoming DDN requests in the following ways:

- If the congestion status does not indicate any congestion, session manager initiates paging without any change in existing behavior.
- If the congestion threshold is reached, session manager either decides to reject DDN requests or enable throttling DDN requests towards SGW, based on the action profile corresponding to the threshold level. A throttling factor and throttling delay is added to the DDN Ack message and is sent to the SGW. If DDN Rejection is based on **reject ddn** configuration then DDN Ack will not contain any throttling factor and throttling delay value.
- If the action profile indicates DDN requests to be rejected, the sessmgr does not initiate paging. A DDN Ack message is sent with the configured cause value. The default cause value is "Unable to page UE".
- If the action profile indicates throttling in SGW is enabled, then the sessmgr includes the throttling factor and the throttling delay value in the DDN Ack, which is sent to the SGW. If action profile indicates DDN requests to be rejected, then throttling parameters are not included in the DDN Ack message.
- If **reject ddn** is configured with arp-watermark, and if the PDN has multiple bearer and ARP values, the DDN requests are serviced depending on the following scenarios:
  - If DDN is received without bearer ID and ARP value, then the DDN requests are allowed and all bearers remain active. The DDN requests will not be rejected unless MME receives the ARP values and all bearers remain active, as part of the paging procedures.
  - If DDN is received with a bearer ID but not an ARP value, the DDN requests are still allowed and all bearers will be active as part of a paging procedure. But, if a stored ARP value matches with the configured arp-watermark value, DDN requests are rejected.



Important The action to reject DDN requests or enable SGW throttling is independent of each other. The operator can configure either or both actions for each action profile.

If there is a configuration change in DDN Throttling parameters, then the action is applied only upon receiving the next DDN request.

- If configuration is modified to disable throttling, then it will come into effect immediately while processing the next DDN. MME shall send throttling IE so that it de-activates the DDN throttling timer at SGW.

- If configuration is modified to change throttling values, throttling begins after a delay of few seconds. The new throttling value is sent to the SGW when the ongoing throttling time (timer = previously sent timestamp + new throttling delay) expires.



Important If the Session Manager crashes, the SGW list with throttling information is lost on recovery. In this condition, the throttling parameter information is sent to the SGW even before the ongoing throttling expires. If congestion persists after session manager recovery, the throttling parameters are sent again for recovery.

Limitations

Memory Impact -- There is a negligible impact on memory, which stores the SGW information created to process the incoming DDN throttling request. A list of SGW entries are created in this process. The following information is stored in the SGW:

- SGW IP address
- Congestion Status time at which throttling status were sent in the DDN Ack
- Timestamp Congestion status for which throttling information was last sent

The above mentioned information is required to keep the Session Manager in sync with the SGW's throttling status. However, to keep the memory impact minimal the SGW information list is created only during congestion and throttling factors are configured in the action profile. On completion of DDN throttling, congestion is cleared and the SGW entry in the list is deleted to process the subsequent DDN request.

Standards Compliance

The DDN Throttling feature complies with the following standards:

- 3gpp TS 29.274, Version 10.4.0, Tunneling Protocol for Control plane (GTPv2-C).
- 3gpp TS 23.401, Version 10.4.0, General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access.

Configuring DDN Throttling

This section documents the configuration procedures for DDN Throttling and related functionality.

Configuring DDN Throttling Factor and Throttling Delay

reject

The **ddn** is a newly added keyword to this command. This keyword allows the operator to reject DDN requests during congestion. The operator can reject DDN requests based on ARP or LAPI values or both. An option is provided to reject all DDN requests without using ARP/LAPI values.

```
configure
  lte-policy
    congestion-action-profile  profile_name
      reject ddn [ arp-watermark  arpwatermark_value [ cause cause_value ] |
```

```
cause cause_value | lapi [ cause cause_value ] ]
       none ddn [ lapi | arp-watermark ]
       end
```

Notes:

- The ddn keyword configures action to be taken for all DDN requests
- The lapi keyword indicates that DDN reject is applicable for UEs with LAPI.
- The arp-watermark keyword indicates that DDN reject is applicable for ARP values greater than or equal to the ARP specified. The ARP value ranges from 1 through 15.
- The cause keyword rejects DDN with the specified cause value. The valid cause value ranges from 1 through 255. The default value is 90 with the display message “Unable to page ue”.
- none disables DDN configuration.

Important If the value of arp-watermark does not match with the DDN's ARP value, then the DDN notifications is not rejected, and all bearers remain active.

ddn sgw-throttling

The **sgw-throttling**, **throttle factor** and **delay** are new keywords added to this command. This Command allows the operator to configure the throttling factor and throttling delay values to be sent in DDN Ack message.

Important Throttling delay value will be converted internally to seconds, minutes or hours as defined in the 3gpp Spec 29.274.

```
configure
  lte-policy
    congestion-action-profile  profile_name
      ddn sgw-throttling throttle-factor percentage_value delay delay_time
      no ddn sgw-throttling
      end
```

Notes:

- The **sgw-throttling** keyword enables DDN throttling towards SGW.
- The **throttle-factor** keyword indicates throttling factor as a percentage from 1 to 100.
- The **delay** keyword indicates the amount of time taken for throttling delay in seconds. The delay value ranges from 2 to 1116000 seconds.
- **no** removes DDN throttling towards SGW.

Verifying the DDN Throttling Configuration

The following command displays the configuration fields in the Congestion Action Profile for the DDN Throttling feature:

```
show lte-policy congestion-action-profile name test
Congestion Action Profile test
none handovers
none combined-attaches
none ps-attaches
none addn-pdn-connects
none addn-brr-requests
none brr-ctxt-mod-requests
none service-request
none tau-request
none s1-setups
none init-ues
none ddn
ddn sgw-throttling throttle-factor 3 delay 1116000
none paging
no exclude-emergency-events
no exclude-voice-events
```

Monitoring and Troubleshooting DDN Throttling

This section provides information on how to monitor congestion control.

DDN Throttling Show Command(s) and/or Outputs

This section provides information regarding show commands and/or their outputs in support of enhanced congestion control.

show congestion-control statistics mme

The command generates a display that provides a concise listing of congestion control statistics. The command offers four keyword options: **critcal | full | major | minor**

In the output example below, the critical keyword has been included in the command so only Critical information is shown. The displayed fields are the same when the full, major, or minor options are used with the command.

```
Critical Congestion Policy Action
    Congestion Policy Applied           :    0 times
    PS attaches
                    Rejected            :      0 times
                    Dropped             :      0 times
    PS attaches
                    Rejected            :      0 times
                    Dropped             :      0 times
    Combined attaches
                    Rejected            :      0 times
                    Dropped             :      0 times
    S1-Setup
                    Rejected            :      0 times
                    Dropped             :      0 times
    Handover
                    Rejected            :      0 times
                    Dropped             :      0 times
    Addn-pdn-connect
                    Rejected            :      0 times
                    Dropped             :      0 times
    Addn-brr-connect
                    Rejected            :      0 times
```

```
                Dropped             :      0 times
Service-Request
                Rejected            :      0 times
                Dropped             :      0 times
TAU-Request
                Rejected            :      0 times
                Dropped             :      0 times
S1AP Overload Start Sent            :      2 times
S1AP Overload Stop  Sent            :      2 times
Excluded Emergency Events           :      0 times
Excluded Voice Events               :      0 times
DDN Request
                Rejected            :      0 times
                   ARP-Based        :      0 times
                   LAPI-Based       :      0 times
```

Notes:

- The DDN Request field indicates the number of DDN requests rejected based on the CLI configuration in the Congestion Action Profile.
- The Rejected field provides information on the total number of DDN rejections based on the CLI configuration.
- The ARP-based field indicates the number of DDN rejected based on the ARP value. For example, reject ddn arp-watermark 10 increments the counter once the ARP value of DDN requests received is 10 and above.
- The LAPI-Based field indicates the number of DDN rejected based on the LAPI value.



Important For LAPI based UEs, both cli are valid, it means if DDN rejection happened due to ARP-based condition then only ARP-based counter will be incremented.