

Reduced Capability Support

Table 1: Feature History

Feature name	Release information	Description
Reduced Capability support on SMF	2025.03.0	

Feature name	Release information	Description

		This feature allows the UPF to support High Latency Communication sessions for Reduced Capabilities UEs.
		
		UPF supports the extended buffering of Mobile Terminated data and thus ensures power efficiency and overall performance of RedCap devices.
		
		Commands enhanced:
		
		• **sx-protocol supported-features ddnd dbdm udbc**: This CLI indicates the support of buffering functionality.
		
		• **user-plane-service schema** *schema_name* : This CLI is enhanced with new RedCap-related parameters to be configured.
		
		• These show CLIs are enhanced to support RedCap functionality:
		
		  • **show user-plane-service statistics rat all**
		
		  • **show subscribers user-plane-only callid** *callid* **bar full all**
		
		  • **show configuration context EPC**
		
		  • **show bulkstats variables user-plane-service**
		
		  • **show bulkstats schema**
		
		  • **show bulkstats data**
		
		Default settings:
		Disabled—Configuration required to Enable

Reduced Capability (RedCap) is a new 5G standard, developed specifically for UEs that do not require the full capabilities of 5G. The RedCap UEs are the IoT devices (such as wearables, industrial sensors, and so

on) that awake only when they receive a message. For the rest of the time, the RedCap UEs are either in power-saving mode or are unreachable.

The RedCap UEs use High Latency Communication (HLCOM) functionality, which introduces extended buffering of Mobile Terminated (MT) data, when the the 5G UEs are either in power-saving mode or are unreachable.

This feature allows the UPF to support the connectivity of RedCap UEs using a new RAT type, **NR_REDCAP**. UPF buffers Mobile Terminated (MT) data for longer durations, thus ensures timely delivery of packets. The efficient buffering of MT data significantly contributes to the power efficiency and overall performance of RedCap devices.

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- Configure RedCap support on UPF, on page 5
- Monitoring and troubleshooting, on page 7

How Reduced Capability support on UPF works

Workflow

These steps highlight the UPF's process of handling the RedCap UE's connectivity with 5G network:

1. **RAT type reception:** The UPF receives the RedCap RAT type **NR_REDCAP with value 27**over the N4 interface.
2. **RAT types processing:** UPF receives the RedCap RAT type in the **ratType IE (3GPP IE)** only. All the other RAT types are populated in both the **subscriberParams IE (proprietary IE)** and **ratType IE (3GPP IE)**.

   If UPF receives the RAT type value in both IEs, it prioritizes the 3GPP ratType IE over the subscriberParams IE, otherwise, it honors the subscriberParams IE values.
3. **DDN BAR level buffering initialization:** SMF creates an empty BAR and associates it with FARs during the session establishment.
4. **Feature capability indication:** UPF advertises its support for one of these key features to SMF and stores them in the UP function feature context:
   - **DDND:** The UP function supports the buffering parameter **Downlink Data Notification Delay**. If the DDND feature is enabled on the UPF, it delays sending PFCP Session Report Request messages by the time specified in this IE, with reference to the first packet arrival timestamp.
   - **UDBC:** The UP function supports the **UL/DL Buffering Control** buffering parameter, in the PFCP Session Modification Request. If the UDBC feature is enabled, the UPF buffers the number of downlink packets suggested by the SMF.

     This value takes precedence over any default or locally configured buffer limits.
   - **DBDM (DBD):** The UP function supports buffering parameters **DL Buffering Duration** and **DL Buffering Suggested Packet Count** in the PFCP Session Modification Request.

     If the DBDM feature is enabled, the UPF buffers downlink data packets for the specified duration, extending the buffering window.

The **DL Buffering Suggested Packet Count** IE indicates the number of downlink data packets, when the extended buffering of downlink data packet is required in the UP function. The packets that exceed the limit are discarded.

These features are enabled or disabled via UPF CLI configurations.

When a RedCap UE enters the Idle mode, the SMF sends N4 modification requests containing updated BARs with specific supported features, that are, DDND, UDBC, or DBDM.

When you enable or disable the RedCap feature after switchover, it triggers Sx Update Request.

5. **Dynamic buffering:** UPF honors the Suggested Buffering Packet Count or DL Buffering Suggested Packet Count IE received from SMF. If these IEs are not present, UPF considers FAR level buffering with the default value of **buffering-limit far-max-packets**, that is five packets.

   UPF discards any packet that exceeds the determined buffer limit are discarded, and corresponding **DDN drop counters** are incremented for monitoring.

   If the SMF sends the DL Suggested Buffer Packet Count, UPF overrides the Suggested Buffer Packet Count or Buffer Cap present in the UPF configuration.

   The parameter "Suggested Buffer Packet Count" suggests the UPF for BAR level buffering, else UPF follows FAR-level buffering. Therefore, UPF is always expecting a value in this parameter from SMF, for BAR-level buffering. However, this value should be non-zero to honor BAR-level buffering and extend it further.

   Since the purpose of the parameter "DL Buffering Suggested Packet Count" is to extend the buffering, is suggested in the "Suggested Buffer Packet Count", therefore the "DL Buffering Suggested Packet Count" supports "Suggested Buffer Packet Count" and cannot be sent without "Suggested Buffer Packet Count".

6. **'Idle' to 'Active' transition:** When a UE transitions from the idle state to active state, the UPF automatically resets the buffering parameters stored in the BAR context.

7. **EDR support:** UPF updates **NR RedCap** or **NR eRedCap** RAT type in EDR.

8. **Handover support:** UPF supports the handover from RedCap to 4G in the Idle mode. In all the other scenarios, handover happens in the Active mode.

IEs supported in different Sx message procedures

Table 2: IEs supported in different Sx message procedures

Sx messages	Sx Establishment Request	Sx Modification Request
Downlink Data Notification Delay	No Requirement	No Requirement
Suggested Buffering Packet Count	No Requirement	Yes (UDBC)
DL Buffering Duration	No	Yes (DBDM)
DL Buffering Suggested Packet Count	No	Yes (DBDM)

Limitations

These are the known limitations of this feature:

- The configuration **buffering-limit far-max-packets** provide FAR-level buffering packet count. It can be used when the Suggested Buffering Packet Count is missing.

  Therefore, this configuration value is superseded by the Suggested Buffer Packet Count information shared by SMF in the modification request, while the UE is going into idle state. The UPF derived cap limit caps the suggested buffer packet count.

- There is no instance or session level cap limit. These limits are applicable to visited calls.
- If the first DL packets are discarded post extending the limits (DL Buffering Duration or DL Buffering Suggested Packet Count), the UPF will not send the DDN Report.

Configure RedCap support on UPF

Follow these steps to enable RedCap support on UPF:

Note These steps are not sequential in nature.

Procedure

Step 1 Confiure RedCap buffering parameters on UPF.

Step 2 Configure the bulkstats parameters for RedCap and E-RedCap support on UPF.

Configure the RedCap buffering parameters

This task allows you to configure the buffering parameters on UPF.

Procedure

Step 1 Use the CLI **sx-service** *sx_service* to create an instance of the Sx service profile.

Example:

```
[local]qvpc-si# configure
[local] qvpc-si (config)# context EPC
[EPC] qvpc-si (config-ctx)# sx-service sx1
[EPC]Asm-PureP-CPlane(config-sx-service)#
```

Step 2 Use the CLI **[no] sx-protocol supported-features ddnd dbdm udbc** to configure the buffering parameters. Save and exit the current configuration mode.

Example:

```
[EPC]Asm-PureP-CPlane(config-sx-service)# sx-protocol supported-features ddnd dbdm udbc
[EPC] qvpc-si (config-ctx)# exit
[EPC] qvpc-si (config)# exit
[EPC] qvpc-si#
```

Step 3 Use the CLI **show configuration context EPC** to verify the configured supported buffering parameters.

Example:

```
[local]qvpc-si# show configuration context EPC
config
  context EPC
       sx-service sx1
      instance-type userplane
      bind ipv4-address 20.20.20.106
      no sx-protocol heartbeat interval
      sx-protocol supported-features ddnd
      sx-protocol supported-features udbc
      sx-protocol supported-features dbdm
   exit
```

Configure the bulkstats for RedCap

This task allows you to configure the bulkstats attributes to capture the stats for the RedCap feature.

Procedure

Step 1 Use the CLI **bulkstats mode** to enter the Bulkstats mode.

Example:

```
[local]UPF1(config)# bulkstats mode
[local]UPF1(config-bulkstats)#
```

Step 2 Use the CLI **user-plane-service schema** to configure the RedCap-related parameters in the bulkstats. Save and exit from the current configuration mode.

Example:

```
[local]UPF1(config-bulkstats)# user-plane-service schema upSch1 format PPM,
user-plane-service,upSch1,%curr-pdn-rat-nr-redcap%,%uplink-total-pkts-pdn-rat-nr-redcap%,
%uplink-total-bytes-pdn-rat-nr-redcap%,%uplink-total-pkts-dropped-pdn-rat-nr-redcap%,
%uplink-total-bytes-dropped-pdn-rat-nr-redcap%,%downlink-total-pkts-pdn-rat-nr-redcap%,
%downlink-total-bytes-pdn-rat-nr-redcap%,%downlink-total-pkts-dropped-pdn-rat-nr-redcap%,
%downlink-total-bytes-dropped-pdn-rat-nr-redcap%,

[local]UPF1(config-bulkstats)# exit
[local]UPF1(config)# exit
[local]UPF1#
```

Step 3 Use the CLI **show bulkstats variables user-plane-service** to verify the configured bulkstats:

Example:

```
[local]UPF1# show bulkstats variables user-plane-service
Index   Schema                Variable Name                                 Data Type  Key  Counter Type
----- --------- ------------------------------------------------  ------------ ---- ------------
9     user-plane-service %curr-pdn-rat-nr-redcap%                          Int64     0   Gauge
10    user-plane-service %curr-pdn-rat-nr-eredcap%                         Int64     0   Gauge
52    user-plane-service %uplink-total-pkts-pdn-rat-nr-redcap%             Int64     0   Counter
53    user-plane-service %uplink-total-bytes-pdn-rat-nr-redcap%            Int64     0   Counter
54    user-plane-service %uplink-total-pkts-dropped-pdn-rat-nr-redcap%     Int64     0   Counter
55    user-plane-service %uplink-total-bytes-dropped-pdn-rat-nr-redcap%    Int64     0   Counter
56    user-plane-service %downlink-total-pkts-pdn-rat-nr-redcap%           Int64     0   Counter
57    user-plane-service %downlink-total-bytes-pdn-rat-nr-redcap%          Int64     0   Counter
58    user-plane-service %downlink-total-pkts-dropped-pdn-rat-nr-redcap%   Int64     0   Counter
59    user-plane-service %downlink-total-bytes-dropped-pdn-rat-nr-redcap%  Int64     0   Counter
60    user-plane-service %uplink-total-pkts-pdn-rat-nr-eredcap%            Int64     0   Counter
61    user-plane-service %uplink-total-bytes-pdn-rat-nr-eredcap%           Int64     0   Counter
62    user-plane-service %uplink-total-pkts-dropped-pdn-rat-nr-eredcap%    Int64     0   Counter
63    user-plane-service %uplink-total-bytes-dropped-pdn-rat-nr-eredcap%   Int64     0   Counter
64    user-plane-service %downlink-total-pkts-pdn-rat-nr-eredcap%          Int64     0   Counter
65    user-plane-service %downlink-total-bytes-pdn-rat-nr-eredcap%         Int64     0   Counter
66    user-plane-service %downlink-total-pkts-dropped-pdn-rat-nr-eredcap%  Int64     0   Counter
67    user-plane-service %downlink-total-bytes-dropped-pdn-rat-nr-eredcap% Int64     0   Counter
```

Monitoring and troubleshooting

This section discusses the show commands used for supporting this feature.

show user-plane-service statistics rat all

The show command **show user-plane-service statistics rat all** displays the number of packets and bytes in unlink and downlink directions for NR RedCap RAT type.

```
[local]cnUPF# show user-plane-service statistics rat all
  Current Subscribers:
    5G NR:               0
    EUTRAN:              0
    WLAN:                0
    GERAN:               0
    UTRAN:               0
    NR REDCAP            1
    NR EREDCAP           0
    Unknown:             0

  Data Statistics:
    5G NR:
      Uplink:                              Downlink:
        Total Pkts:                    0    Total Pkts:                    0
        Total Bytes:                   0    Total Bytes:                   0
        Total Dropped Pkts:            0    Total Dropped Pkts:            0
        Total Dropped Bytes:           0    Total Dropped Bytes:           0
    EUTRAN:
      Uplink:                              Downlink:
        Total Pkts:                    0    Total Pkts:                    0
        Total Bytes:                   0    Total Bytes:                   0
        Total Dropped Pkts:            0    Total Dropped Pkts:            0
        Total Dropped Bytes:           0    Total Dropped Bytes:           0
    WLAN:
      Uplink:                              Downlink:
```

```
      Total Pkts:                    0    Total Pkts:                    0
      Total Bytes:                   0    Total Bytes:                   0
      Total Dropped Pkts:            0    Total Dropped Pkts:            0
      Total Dropped Bytes:           0    Total Dropped Bytes:           0
  GERAN:
    Uplink:                           Downlink:
      Total Pkts:                    0    Total Pkts:                    0
      Total Bytes:                   0    Total Bytes:                   0
      Total Dropped Pkts:            0    Total Dropped Pkts:            0
      Total Dropped Bytes:           0    Total Dropped Bytes:           0
  UTRAN:
    Uplink:                           Downlink:
      Total Pkts:                    0    Total Pkts:                    0
      Total Bytes:                   0    Total Bytes:                   0
      Total Dropped Pkts:            0    Total Dropped Pkts:            0
      Total Dropped Bytes:           0    Total Dropped Bytes:           0
  NR REDCAP:
    Uplink:                           Downlink:
      Total Pkts:                    0    Total Pkts:                    3
      Total Bytes:                   0    Total Bytes:                   410
      Total Dropped Pkts:            0    Total Dropped Pkts:            0
      Total Dropped Bytes:           0    Total Dropped Bytes:           0
  NR EREDCAP:
    Uplink:                           Downlink:
      Total Pkts:                    0    Total Pkts:                    0
      Total Bytes:                   0    Total Bytes:                   0
      Total Dropped Pkts:            0    Total Dropped Pkts:            0
      Total Dropped Bytes:           0    Total Dropped Bytes:           0
  Unknown:
    Uplink:                           Downlink:
      Total Pkts:                    0    Total Pkts:                    0
      Total Bytes:                   0    Total Bytes:                   0
      Total Dropped Pkts:            0    Total Dropped Pkts:            0
      Total Dropped Bytes:           0    Total Dropped Bytes:           0
```

show bulkstats data

The show command **show bulkstats data** displays the data related to secondary server state.

```
[local]UPF1# show bulkstats data
Bulk Statistics Server Configuration:
  Server State:                  Enabled
  File Limit:                    7500 KB
  Sample Interval:               15 minutes (0D 0H 15M)
  Transfer Interval:             480 minutes (0D 8H 0M)
  Receiver Mode:                 Secondary-on-failure
  Historical Data Collection:    Disabled
.
.
.
Pending Data for File 1:
-----------------------
PPM,user-plane-service,upSch1,1,44,1977,0,0,136,7451,58,2320
```

show bulkstats schema

The show command **show bulkstats schema** displays the data related to RedCap.

```
local]UPF1# show bulkstats schemas
Bulk Statistics Server Configuration:
  Server State:                  Enabled
```

```
  File Limit:                     7500 KB
  Sample Interval:                15 minutes (0D 0H 15M)
  Transfer Interval:              480 minutes (0D 8H 0M)
  Receiver Mode:                  Secondary-on-failure
  Historical Data Collection:     Disabled
._________
.
.
 Schemas for File 1-----------------------------------------
Type              Name      Active-Only Format
------------------ ----------  ----------------------------
user-plane-service   upSch1        No  PPM,
user-plane-service   upSch1,    %curr-pdn-rat-nr-redcap%,
    %uplink-total-pkts-pdn-rat-nr-redcap%,
    %uplink-total-bytes-pdn-rat-nr-redcap%,
    %uplink-total-pkts-dropped-pdn-rat-nr-redcap%,
    %uplink-total-bytes-dropped-pdn-rat-nr-redcap%,
    %downlink-total-pkts-pdn-rat-nr-redcap%,
    %downlink-total-bytes-pdn-rat-nr-redcap%,
    %downlink-total-pkts-dropped-pdn-rat-nr-redcap%,
    %downlink-total-bytes-dropped-pdn-rat-nr-redcap%,
```

show bulkstats variables user-plane-service

The show command **show bulkstats variables user-plane-service** displays the counters related to NR RedCap RAT type.

```
[local]UPF1# show bulkstats variables user-plane-service
Index Schema    Variable Name                                                 Data Type Key
Counter Type
----- --------- ------------------------------------------------------------  --------- ---
------------
.
.
.
9     user-plane-service %curr-pdn-rat-nr-redcap%                                   Int64
     0   Gauge
10    user-plane-service %curr-pdn-rat-nr-eredcap%                                  Int64
     0   Gauge
.
.
.
52    user-plane-service %uplink-total-pkts-pdn-rat-nr-redcap%                      Int64
     0   Counter
53    user-plane-service %uplink-total-bytes-pdn-rat-nr-redcap%                     Int64
     0   Counter
54    user-plane-service %uplink-total-pkts-dropped-pdn-rat-nr-redcap%              Int64
     0   Counter
55    user-plane-service %uplink-total-bytes-dropped-pdn-rat-nr-redcap%             Int64
     0   Counter
56    user-plane-service %downlink-total-pkts-pdn-rat-nr-redcap%                    Int64
     0   Counter
57    user-plane-service %downlink-total-bytes-pdn-rat-nr-redcap%                   Int64
     0   Counter
58    user-plane-service %downlink-total-pkts-dropped-pdn-rat-nr-redcap%            Int64
     0   Counter
59    user-plane-service %downlink-total-bytes-dropped-pdn-rat-nr-redcap%           Int64
     0   Counter
60    user-plane-service %uplink-total-pkts-pdn-rat-nr-eredcap%                     Int64
     0   Counter
61    user-plane-service %uplink-total-bytes-pdn-rat-nr-eredcap%                    Int64
     0   Counter
```

```
62    user-plane-service %uplink-total-pkts-dropped-pdn-rat-nr-eredcap%              Int64
      0   Counter
63    user-plane-service %uplink-total-bytes-dropped-pdn-rat-nr-eredcap%             Int64
      0   Counter
64    user-plane-service %downlink-total-pkts-pdn-rat-nr-eredcap%                    Int64
      0   Counter
65    user-plane-service %downlink-total-bytes-pdn-rat-nr-eredcap%                   Int64
      0   Counter
66    user-plane-service %downlink-total-pkts-dropped-pdn-rat-nr-eredcap%            Int64
      0   Counter
67    user-plane-service %downlink-total-bytes-dropped-pdn-rat-nr-eredcap%           Int64
      0   Counter
```

show sx peers full address

The show command **show sx peers full address** *peer_ip*

```
[local]UPF1# show sx peers full address 192.0.2.1
  Peer IP                     : 192.0.2.1
  Sx Service Id               : 6

  Group Name                  : default
  Current Session             : 1
  Max Session                 : 1

  Negotiated feature
    Load Control              : Disabled
    Overload Control          : Disabled
    EPFAR                     : Disabled
    DDND                      : Enabled
    UDBC                      : Enabled
    DBDM                      : Enabled

  Load Control Information
    Load Sequence Number      : NA
    Load Metric               : NA

  Overload Control Information
    Overload Sequence Number  : NA
    Overload Reduction Metric : NA
    Overload Validity Timer   : NA

  Monitor Group Information
    Monitor Group name        : NA
    Monitor State             : NA
```