7.2 RLC

7.2.1 General

For UM tests, the UM test DRB is set up using the Generic Procedure described in clause 4.5 of [18], with the parameters described in clause 4.8.2.1.3.1 of [18], except for the tests that explicitly specify a different DRB configuration.

For AM tests, the AM test DRB is set up using the Generic Procedure described in clause 4.5 of [18], with the parameters described in clause 4.8.2.1.3.2 of [18], except for the tests that explicitly specify a different DRB configuration.

Unless specified otherwise in the test procedure sequence, the data field of each RLC PDU transmitted by the SS contains a complete RLC SDU.

7.2.2 Unacknowledged mode

7.2.2.1 UM RLC / Segmentation and reassembly / 5-bit SN / Framing info field

7.2.2.1.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 5 bit SN configured UMD PDU containing a FI field set to 00 }
    then { UE correctly decodes the received UMD PDU }
           }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 5 bit SN configured UMD PDU containing a FI field set to 01 }
    then { UE correctly decodes the received UMD PDU }
           }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 5 bit SN configured UMD PDU containing a FI field set to 11 }
    then { UE correctly decodes the received UMD PDU }
           }
```

(4)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 5 bit SN configured UMD PDU containing a FI field set to 10 }
    then { UE correctly decodes the received UMD PDU }
           }
```

7.2.2.1.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.322, clause 6.2.1.3 and 6.2.2.6.

[TS 36.322, clause 6.2.1.3]

…

An UM RLC entity is configured by RRC to use either a 5 bit SN or a 10 bit SN. When the 5 bit SN is configured, the length of the fixed part of the UMD PDU header is one byte. When the 10 bit SN is configured, the fixed part of the UMD PDU header is identical to the fixed part of the AMD PDU header, except for D/C, RF and P fields all being replaced with R1 fields. The extension part of the UMD PDU header is identical to the extension part of the AMD PDU header (regardless of the configured SN size).

…

[TS 36.322, clause 6.2.2.6]

Length: 2 bits.

The FI field indicates whether a RLC SDU is segmented at the beginning and/or at the end of the Data field. Specifically, the FI field indicates whether the first byte of the Data field corresponds to the first byte of a RLC SDU, and whether the last byte of the Data field corresponds to the last byte of a RLC SDU. The interpretation of the FI field is provided in Table 6.2.2.6-1.

Table 6.2.2.6-1: FI field interpretation

Value	Description
00	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
01	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.
10	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
11	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.

7.2.2.1.3 Test description

7.2.2.1.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.2.1.3.1-1 applicable for the configured UM DRB.

- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

Table 7.2.2.1.3.1-1: RLC parameters

Uplink RLC sn-FieldLength	 size5
Downlink RLC sn-FieldLength	 size5

7.2.2.1.3.2 Test procedure sequence

Table 7.2.2.1.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits UMD PDU#1 containing a complete RLC SDU#1 (FI field = 00).	<--	UMD PDU#1	-	-
2	Check: Does the UE transmit RLC SDU#1?	-->	(RLC SDU#1)	1	P
3	The SS transmits UMD PDU#2 containing the first segment of RLC SDU#2 (FI field = 01).	<--	UMD PDU#2	-	-
4	The SS transmits UMD PDU#3 containing the second segment of RLC SDU#2 (FI field = 11).	<--	UMD PDU#3	-	-
5	The SS transmits UMD PDU#4 containing the last segment of RLC SDU#2 (FI field = 10).	<--	UMD PDU#4	-	-
6	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	2,3, 4	P

7.2.2.1.3.3 Specific message contents

None.

7.2.2.2 UM RLC / Segmentation and reassembly / 10-bit SN / Framing info field

7.2.2.2.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 10 bit SN configured UMD PDU containing a FI field set to 0 0 }
    then { UE correctly decodes the received UMD PDU }
            }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 10 bit SN configured UMD PDU containing a FI field set to 01 }
    then { UE correctly decodes the received UMD PDU }
            }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 10 bit SN configured UMD PDU containing a FI field set to 11 }
    then { UE correctly decodes the received UMD PDU }
            }
```

(4)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 10 bit SN configured UMD PDU containing a FI field set to 10 }
    then { UE correctly decodes the received UMD PDU }
            }
```

7.2.2.2.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.322, clause 6.2.1.3 and 6.2.2.6.

[TS 36.322, clause 6.2.1.3]

…

An UM RLC entity is configured by RRC to use either a 5 bit SN or a 10 bit SN. When the 5 bit SN is configured, the length of the fixed part of the UMD PDU header is one byte. When the 10 bit SN is configured, the fixed part of the UMD PDU header is identical to the fixed part of the AMD PDU header, except for D/C, RF and P fields all being

replaced with R1 fields. The extension part of the UMD PDU header is identical to the extension part of the AMD PDU header (regardless of the configured SN size).

…

[TS 36.322, clause 6.2.2.6]

Length: 2 bits.

The FI field indicates whether a RLC SDU is segmented at the beginning and/or at the end of the Data field. Specifically, the FI field indicates whether the first byte of the Data field corresponds to the first byte of a RLC SDU, and whether the last byte of the Data field corresponds to the last byte of a RLC SDU. The interpretation of the FI field is provided in Table 6.2.2.6-1.

Table 6.2.2.6-1: FI field interpretation

Value	Description
00	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
01	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.
10	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
11	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.

7.2.2.2.3 Test description

7.2.2.2.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

7.2.2.2.3.2 Test procedure sequence

Table 7.2.2.2.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits UMD PDU#1 containing a complete RLC SDU#1 (FI field = 00).	<--	UMD PDU#1	-	-
2	Check: Does the UE transmit RLC SDU#1?	-->	(RLC SDU#1)	1	P
3	The SS transmits UMD PDU#2 containing the first segment of RLC SDU#2 (FI field = 01).	<--	UMD PDU#2	-	-
4	The SS transmits UMD PDU#3 containing the second segment of RLC SDU#2 (FI field = 11).	<--	UMD PDU#3	-	-
5	The SS transmits UMD PDU#4 containing the last segment of RLC SDU#2 (FI field = 10).	<--	UMD PDU#4	-	-
6	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	2, 3, 4	P

7.2.2.2.3.3 Specific message contents

None.

7.2.2.3 UM RLC / Reassembly / 5-bit SN / LI value > PDU size

7.2.2.3.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a 5 bit SN configured RLC PDU with Length Indicator value larger than RLC PDU
size }
    then { UE discards the RLC PDU }
          }
```

7.2.2.3.2 Conformance requirements

See TS 36.322 clauses 6.2.2.5 and 5.5.1

References: The conformance requirements covered in the present TC are specified in: TS 36.322, clause 5.5.1 and 6.2.2.5.

[TS 36.322, clause 5.5.1]

When an RLC entity receives an RLC PDU that contains reserved or invalid values, the RLC entity shall:

- discard the received PDU.

[TS 36.322, clause 6.2.2.5]

Length: 11 bits.

The LI field indicates the length in bytes of the corresponding Data field element present in the RLC data PDU delivered/received by an UM or an AM RLC entity. The first LI present in the RLC data PDU header corresponds to the first Data field element present in the Data field of the RLC data PDU, the second LI present in the RLC data PDU header corresponds to the second Data field element present in the Data field of the RLC data PDU, and so on. The value 0 is reserved.

7.2.2.3.3 Test description

7.2.2.3.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.2.3.3.1-1 applicable for the configured UM DRB.

- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

Table 7.2.2.3.3.1-1: RLC parameters

Uplink RLC sn-FieldLength	size5
Downlink RLC sn-FieldLength	size5

7.2.2.3.3.2 Test procedure sequence

Table 7.2.2.3.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	EXCEPTION: the behaviour described in table 7.2.2.3.3.2-2 runs in parallel with steps 1 to 5 below.	-	-	-	-
1	The SS transmits UMD PDU#1 containing first segment of RLC SDU#1.	<--	UMD PDU#1 (SN=0)	-	-
2	The SS transmits UMD PDU#2 containing last segment of RLC SDU#1 and first segment of RLC SDU#2.	<--	UMD PDU#2 (SN=1)	-	-
3	The SS transmits UMD PDU#3 containing last segment of RLC SDU#2, first segment of RLC SDU#3 and with Length Indicator that points beyond the end of the UMD PDU#3.	<--	UMD PDU#3 (SN=2)	-	-
4	The SS transmits UMD PDU#4 containing last segment of RLC SDU#3.	<--	UMD PDU#4 (SN=3)	-	-
5	The SS transmits UMD PDU#5 containing RLC SDU#4.	<--	UMD PDU#5 (SN=4)	-	-

Table 7.2.2.3.3.2-2: Parallel behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The UE transmits RLC SDU#1.	-->	(RLC SDU#1)	-	-
2	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	F
3	Check: Does the UE transmit RLC SDU#3?	-->	(RLC SDU#3)	1	F
4	The UE transmits RLC SDU#4.	-->	(RLC SDU#4)	-	-

7.2.2.3.3.3 Specific message contents

None.

7.2.2.4 UM RLC / Reassembly / 10-bit SN / LI value > PDU size

7.2.2.4.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives an RLC PDU with Length Indicator value larger than RLC PDU size }
    then { UE discards the RLC PDU }
          }
```

7.2.2.4.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.322, clause 5.5.1.

[TS 36.322, clause 5.5.1]

When an RLC entity receives an RLC PDU that contains reserved or invalid values, the RLC entity shall:

- discard the received PDU.

7.2.2.4.3 Test description

7.2.2.4.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

7.2.2.4.3.2 Test procedure sequence

Table 7.2.2.4.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	EXCEPTION: The behaviour described in table 7.2.2.4.3.2-2 runs in parallel with steps 1 to 5 below.	-	-	-	-
1	The SS transmits UMD PDU#1 containing first segment of RLC SDU#1.	<--	UMD PDU#1 (SN=0)	-	-
2	The SS transmits UMD PDU#2 containing last segment of RLC SDU#1 and first segment of RLC SDU#2.	<--	UMD PDU#2 (SN=1)	-	-
3	The SS transmits UMD PDU#3 containing last segment of RLC SDU#2, first segment of RLC SDU#3 and with Length Indicator that points beyond the end of the RLC PDU#3.	<--	UMD PDU#3 (SN=2)	-	-
4	The SS transmits UMD PDU#4 containing last segment of RLC SDU#3.	<--	UMD PDU#4 (SN=3)	-	-
5	The SS transmits UMD PDU#5 containing RLC SDU#4.	<--	UMD PDU#5 (SN=4)	-	-

Table 7.2.2.4.3.2-2: Parallel behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	Check: Does the UE transmit RLC SDU#1?	-->	(RLC SDU#1)	1	P
2	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	F
3	Check: Does the UE transmit RLC SDU#3?	-->	(RLC SDU#3)	1	F
4	Check: Does the UE transmit RLC SDU#4?	-->	(RLC SDU#4)	1	P

7.2.2.4.3.3 Specific message contents

None.

7.2.2.5 UM RLC / Correct use of sequence numbering

7.2.2.5.1 UM RLC / 5-bit SN / Correct use of sequence numbering

7.2.2.5.1.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits the first PDU }
    then { UE sets the sequence Number field equal to 0 }
           }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits subsequent PDUs }
    then { SN incremented by 1 for each PDU transmitted }
           }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state and an UM RLC DRB is configured using 5 bit SN }
ensure that {
  when { UE transmits more than 32 PDUs }
    then { UE wraps the Sequence Number after transmitting the 32 PDU }
           }
```

(4)

```
with { UE in E-UTRA RRC_CONNECTED state and an UM RLC DRB is configured using 5 bit SN }
ensure that {
  when { more than 32 PDUs are sent to UE }
    then { UE accepts PDUs with SNs that wrap around every 32 PDU }
           }
```

7.2.2.5.1.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322, clause 5.1.2.1.1, 5.1.2.2, 6.2.1.3, 6.2.2.3 and 7.1.

[TS 36.322, clause 5.1.2.1.1]

When delivering a new UMD PDU to lower layer, the transmitting UM RLC entity shall:

- set the SN of the UMD PDU to VT(US), and then increment VT(US) by one.

[TS 36.322, clause 5.1.2.2]

The receiving UM RLC entity shall maintain a reordering window according to state variable VR(UH) as follows:

- a SN falls within the reordering window if (VR(UH) – UM_Window_Size) <= SN < VR(UH);
- a SN falls outside of the reordering window otherwise.

When receiving an UMD PDU from lower layer, the receiving UM RLC entity shall:

- either discard the received UMD PDU or place it in the reception buffer (see sub clause 5.1.2.2.2);
- if the received UMD PDU was placed in the reception buffer:
  - update state variables, reassemble and deliver RLC SDUs to upper layer and start/stop *t-Reordering* as needed (see sub clause 5.1.2.2.3);

…

When an UMD PDU with SN = x is received from lower layer, the receiving UM RLC entity shall:

- if VR(UR) < x < VR(UH) and the UMD PDU with SN = x has been received before; or
- if (VR(UH) – UM_Window_Size) <= x < VR(UR):
  - discard the received UMD PDU;
- else:
  - place the received UMD PDU in the reception buffer.

…

When an UMD PDU with SN = x is placed in the reception buffer, the receiving UM RLC entity shall:

- if x falls outside of the reordering window:
  - update VR(UH) to x + 1;
  - reassemble RLC SDUs from any UMD PDUs with SN that falls outside of the reordering window, remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
  - if VR(UR) falls outside of the reordering window:

- set VR(UR) to (VR(UH) – UM_Window_Size);

- if the reception buffer contains an UMD PDU with SN = VR(UR):
  - update VR(UR) to the SN of the first UMD PDU with SN > current VR(UR) that has not been received;
  - reassemble RLC SDUs from any UMD PDUs with SN < updated VR(UR), remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;

…

[TS 36.322, clause 6.2.1.3]

…

An UM RLC entity is configured by RRC to use either a 5 bit SN or a 10 bit SN. When the 5 bit SN is configured, the length of the fixed part of the UMD PDU header is one byte. When the 10 bit SN is configured, the fixed part of the UMD PDU header is identical to the fixed part of the AMD PDU header, except for D/C, RF and P fields all being replaced with R1 fields. The extension part of the UMD PDU header is identical to the extension part of the AMD PDU header (regardless of the configured SN size).

…

[TS 36.322, clause 6.2.2.3]

…

The SN field indicates the sequence number of the corresponding UMD…The sequence number is incremented by one for every UMD...

[TS 36.322, clause 7.1]

…

All state variables and all counters are non-negative integers.

…

All state variables related to UM data transfer can take values from 0 to $[2^{[sn\text{-}FieldLength]} – 1]$. All arithmetic operations contained in the present document on state variables related to UM data transfer are affected by the UM modulus (i.e. final value = [value from arithmetic operation] modulo $2^{[sn\text{-}FieldLength]}$.

…

When performing arithmetic comparisons of state variables or SN values, a modulus base shall be used.

…

VR(UH) – UM_Window_Size shall be assumed as the modulus base at the receiving side of an UM RLC entity. This modulus base is subtracted from all the values involved, and then an absolute comparison is performed (e.g. (VR(UH) – UM_Window_Size) <= SN < VR(UH) is evaluated as [(VR(UH) – UM_Window_Size) – (VR(UH) – UM_Window_Size)] modulo $2^{[sn\text{-}FieldLength]}$ <= [SN – (VR(UH) – UM_Window_Size)] modulo $2^{[sn\text{-}FieldLength]}$ < [VR(UH) – (VR(UH) – UM_Window_Size)] modulo $2^{[sn\text{-}FieldLength]}$).

…

Each transmitting UM RLC entity shall maintain the following state variables:

a) VT(US)

This state variable holds the value of the SN to be assigned for the next newly generated UMD PDU. It is initially set to 0, and is updated whenever the UM RLC entity delivers an UMD PDU with SN = VT(US).

Each receiving UM RLC entity shall maintain the following state variables:

a) VR(UR) – UM receive state variable

This state variable holds the value of the SN of the earliest UMD PDU that is still considered for reordering. It is initially set to 0.

b) VR(UX) – UM t-Reordering state variable

This state variable holds the value of the SN following the SN of the UMD PDU which triggered t-Reordering.

c) VR(UH) – UM highest received state variable

This state variable holds the value of the SN following the SN of the UMD PDU with the highest SN among received UMD PDUs, and it serves as the higher edge of the reordering window. It is initially set to 0.

7.2.2.5.1.3 Test description

7.2.2.5.1.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.2.5.1.3.1-1 applicable for the configured UM DRB.
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

Table 7.2.2.5.1.3.1-1: RLC parameters

Uplink RLC sn-FieldLength	size5
Downlink RLC sn-FieldLength	size5

7.2.2.5.1.3.2 Test procedure sequence

Table 7.2.2.5.1.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
-	EXCEPTION: Step 3 to 4 is executed 31 times.	-	-	-	-
1	The SS transmits an UMD PDU. SN equals 0.	<--	UMD PDU	-	-
2	Check: Does the UE transmit an UMD PDU with SN = 0?	-->	UMD PDU	1	P
3	The SS transmits an UMD PDU. SN equals 1 and is incremented for each PDU transmitted.	<--	UMD PDU	-	-
4	Check: Does the UE transmit an UMD PDU with SN increased by 1 compared with the previous one?	-->	UMD PDU	2	P
5	The SS transmits an UMD PDU. SN equals 0.	<--	UMD PDU	-	-
6	Check: Does the UE transmit an UMD PDU with SN=0?	-->	UMD PDU	3, 4	P

7.2.2.5.1.3.3 Specific message contents

None.

7.2.2.5.2 UM RLC / 10-bit SN / Correct use of Sequence numbering

7.2.2.5.2.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits the first PDU }
    then { UE sets the Sequence Number field equal to 0 }
           }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits subsequent PDUs }
    then { SN incremented by 1 for each PDU transmitted }
           }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state and an UM RLC DRB is configured using 10 bit SN }
ensure that {
  when { UE transmits more than 1024 PDUs }
    then { UE wraps the Sequence Number after transmitting the 1024 PDU }
           }
```

(4)

```
with { UE in E-UTRA RRC_CONNECTED state and an UM RLC DRB is configured using 10 bit SN }
ensure that {
  when { more than 1024 PDUs are sent to UE }
    then { UE accepts PDUs with SNs that wrap around every 1024 PDU }
           }
```

7.2.2.5.2.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322, clause 5.1.2.1.1, 5.1.2.2, 6.2.1.3, 6.2.2.3 and 7.1.

[TS 36.322, clause 5.1.2.1.1]

When delivering a new UMD PDU to lower layer, the transmitting UM RLC entity shall:

- set the SN of the UMD PDU to VT(US), and then increment VT(US) by one.

[TS 36.322, clause 5.1.2.2]

The receiving UM RLC entity shall maintain a reordering window according to state variable VR(UH) as follows:

- a SN falls within the reordering window if (VR(UH) – UM_Window_Size) <= SN < VR(UH);
- a SN falls outside of the reordering window otherwise.

When receiving an UMD PDU from lower layer, the receiving UM RLC entity shall:

- either discard the received UMD PDU or place it in the reception buffer (see sub clause 5.1.2.2.2);
- if the received UMD PDU was placed in the reception buffer:
  - update state variables, reassemble and deliver RLC SDUs to upper layer and start/stop *t-Reordering* as needed (see sub clause 5.1.2.2.3);

…

When an UMD PDU with SN = x is received from lower layer, the receiving UM RLC entity shall:

- if VR(UR) < x < VR(UH) and the UMD PDU with SN = x has been received before; or
- if (VR(UH) – UM_Window_Size) <= x < VR(UR):
  - discard the received UMD PDU;

- else:
  - place the received UMD PDU in the reception buffer.

…

When an UMD PDU with SN = x is placed in the reception buffer, the receiving UM RLC entity shall:

- if x falls outside of the reordering window:
  - update VR(UH) to x + 1;
  - reassemble RLC SDUs from any UMD PDUs with SN that falls outside of the reordering window, remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
  - if VR(UR) falls outside of the reordering window:
    - set VR(UR) to (VR(UH) – UM_Window_Size);
- if the reception buffer contains an UMD PDU with SN = VR(UR):
  - update VR(UR) to the SN of the first UMD PDU with SN > current VR(UR) that has not been received;
  - reassemble RLC SDUs from any UMD PDUs with SN < updated VR(UR), remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;

  …

[TS 36.322, clause 6.2.1.3]

…

An UM RLC entity is configured by RRC to use either a 5 bit SN or a 10 bit SN. When the 5 bit SN is configured, the length of the fixed part of the UMD PDU header is one byte. When the 10 bit SN is configured, the fixed part of the UMD PDU header is identical to the fixed part of the AMD PDU header, except for D/C, RF and P fields all being replaced with R1 fields. The extension part of the UMD PDU header is identical to the extension part of the AMD PDU header (regardless of the configured SN size).

…

[TS 36.322, clause 6.2.2.3]

…

The SN field indicates the sequence number of the corresponding UMD…The sequence number is incremented by one for every UMD...

[TS 36.322, clause 7.1]

…

All state variables and all counters are non-negative integers.

…

All state variables related to UM data transfer can take values from 0 to $[2^{[sn\text{-}FieldLength]} – 1]$. All arithmetic operations contained in the present document on state variables related to UM data transfer are affected by the UM modulus (i.e. final value = [value from arithmetic operation] modulo $2^{[sn\text{-}FieldLength]}$).

…

When performing arithmetic comparisons of state variables or SN values, a modulus base shall be used.

…

VR(UH) – UM_Window_Size shall be assumed as the modulus base at the receiving side of an UM RLC entity. This modulus base is subtracted from all the values involved, and then an absolute comparison is performed (e.g. (VR(UH) – UM_Window_Size) <= SN < VR(UH) is evaluated as [(VR(UH) – UM_Window_Size) – (VR(UH) – UM_Window_Size)] modulo $2^{[sn\text{-}FieldLength]}$ <= [SN – (VR(UH) – UM_Window_Size)] modulo $2^{[sn\text{-}FieldLength]}$ < [VR(UH) – (VR(UH) – UM_Window_Size)] modulo $2^{[sn\text{-}FieldLength]}$).

…

Each transmitting UM RLC entity shall maintain the following state variables:

a) VT(US)

This state variable holds the value of the SN to be assigned for the next newly generated UMD PDU. It is initially set to 0, and is updated whenever the UM RLC entity delivers an UMD PDU with SN = VT(US).

Each receiving UM RLC entity shall maintain the following state variables:

a) VR(UR) – UM receive state variable

This state variable holds the value of the SN of the earliest UMD PDU that is still considered for reordering. It is initially set to 0.

b) VR(UX) – UM *t-R*eordering state variable

This state variable holds the value of the SN following the SN of the UMD PDU which triggered *t-Reordering*.

c) VR(UH) – UM highest received state variable

This state variable holds the value of the SN following the SN of the UMD PDU with the highest SN among received UMD PDUs, and it serves as the higher edge of the reordering window. It is initially set to 0.

7.2.2.5.2.3 Test description

7.2.2.5.2.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- UE is in state Loopback Activated (state 4) according to [18] with PDCP Data PDUs using 7 bit SN length.
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

7.2.2.5.2.3.2 Test procedure sequence

Table 7.2.2.5.2.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
-	EXCEPTION: Steps 3 to 4 are executed 1023 times.	-	-	-	-
1	The SS transmits an UMD PDU. SN equals 0.	<--	UMD PDU	-	-
2	Check: Does the UE transmit an UMD PDU with SN = 0?	-->	UMD PDU	1	P
3	The SS transmits an UMD PDU. SN equals 1 and is incremented for each PDU transmitted.	<--	UMD PDU	-	-
4	Check: Does the UE transmit an UMD PDU with SN increased by 1 compared with the previous one?	-->	UMD PDU	2	P
5	The SS transmits an UMD PDU. SN equals 0.	<--	UMD PDU	-	-
6	Check: Does the UE transmit an UMD PDU with SN=0?	-->	UMD PDU	3, 4	P

7.2.2.5.2.3.3 Specific message contents

None.

7.2.2.6 UM RLC / Concatenation, segmentation and reassembly

7.2.2.6.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { The UE has multiple RLC SDUs in the transmission buffer that fits into the available UMD
PDU size }
    then { The UE concatenates the RLC SDUs in the transmission buffer into one UMD PDU and
transmits it}
      }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { The UE receives UMD PDUs containing concatenated RLC SDUs}
    then { The UE reassembles the RLC SDUs in accordance with the Framing Info and Length Indicators
indicated in UMD PDUs }
      }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { The UE has RLC SDU in the transmission buffer that does not fit into the available UMD PDU
size }
    then { The UE segments the RLC SDU in accordance with the Framing Info and Length Indicators
indicated in UMD PDUs }
      }
```

7.2.2.6.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322, clause 4.2.1.2.2, 4.2.1.2.3, 4.4, 6.2.1.3 and 6.2.2.6.

[TS 36.322, clause 4.2.1.2.2]

When a transmitting UM RLC entity forms UMD PDUs from RLC SDUs, it shall:

- segment and/or concatenate the RLC SDUs so that the UMD PDUs fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity notified by lower layer;

- include relevant RLC headers in the UMD PDU.

[TS 36.322, clause 4.2.1.2.3]

When a receiving UM RLC entity receives UMD PDUs, it shall:

…

- reassemble RLC SDUs from the reordered UMD PDUs (not accounting for RLC PDUs for which losses have been detected) and deliver the RLC SDUs to upper layer in ascending order of the RLC SN;

…

[TS 36.322, clause 4.4]

The following functions are supported by the RLC sub layer:

…

- concatenation, segmentation and reassembly of RLC SDUs (only for UM and AM data transfer);

…

[TS 36.322, clause 6.2.1.3]

UMD PDU consists of a Data field and an UMD PDU header.

UMD PDU header consists of a fixed part (fields that are present for every UMD PDU) and an extension part (fields that are present for an UMD PDU when necessary). The fixed part of the UMD PDU header itself is byte aligned and consists of a FI, an E and a SN. The extension part of the UMD PDU header itself is byte aligned and consists of E(s) and LI(s).

An UM RLC entity is configured by RRC to use either a 5 bit SN or a 10 bit SN. When the 5 bit SN is configured, the length of the fixed part of the UMD PDU header is one byte. When the 10 bit SN is configured, the fixed part of the UMD PDU header is identical to the fixed part of the AMD PDU header, except for D/C, RF and P fields all being replaced with R1 fields. The extension part of the UMD PDU header is identical to the extension part of the AMD PDU header (regardless of the configured SN size).

An UMD PDU header consists of an extension part only when more than one Data field elements are present in the UMD PDU, in which case an E and a LI are present for every Data field element except the last. Furthermore, when an UMD PDU header consists of an odd number of LI(s), four padding bits follow after the last LI.

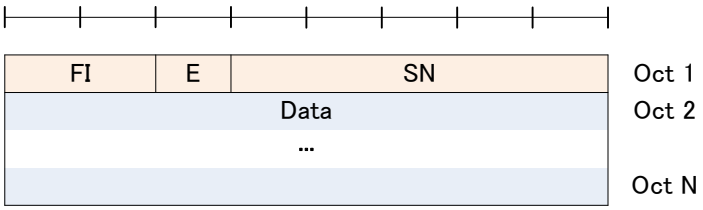

Figure 6.2.1.3-1: UMD PDU with 5 bit SN (No LI)

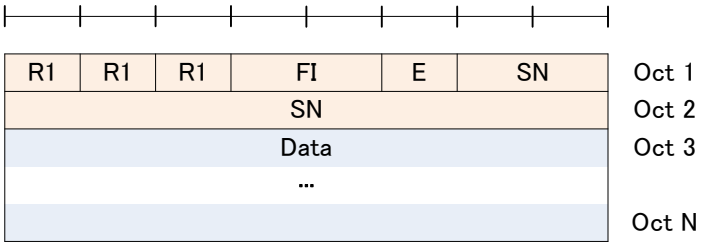

Figure 6.2.1.3-2: UMD PDU with 10 bit SN (No LI)

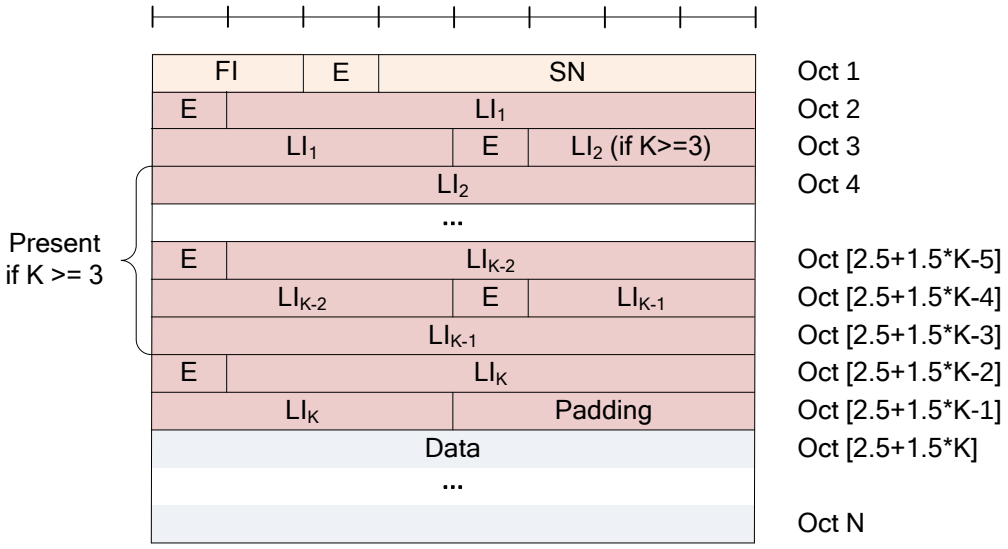

Figure 6.2.1.3-3: UMD PDU with 5 bit SN (Odd number of LIs, i.e. K = 1, 3, 5, …)

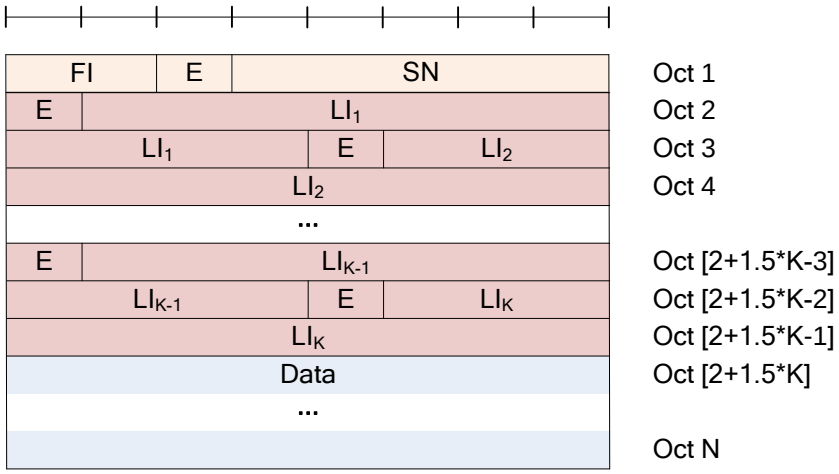

Figure 6.2.1.3-4: UMD PDU with 5 bit SN (Even number of LIs, i.e. K = 2, 4, 6, …)

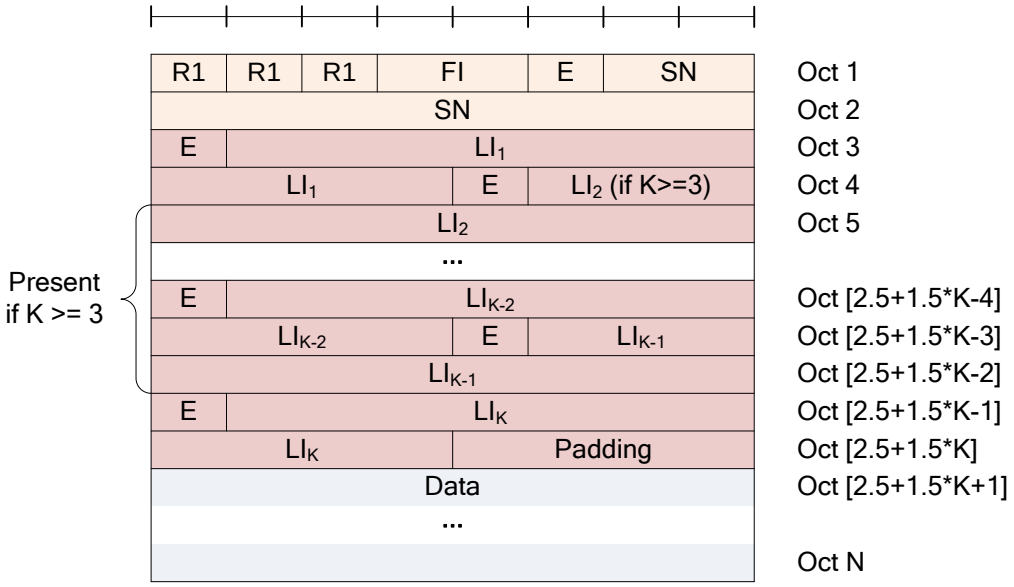

Figure 6.2.1.3-5: UMD PDU with 10 bit SN (Odd number of LIs, i.e. K = 1, 3, 5, …)

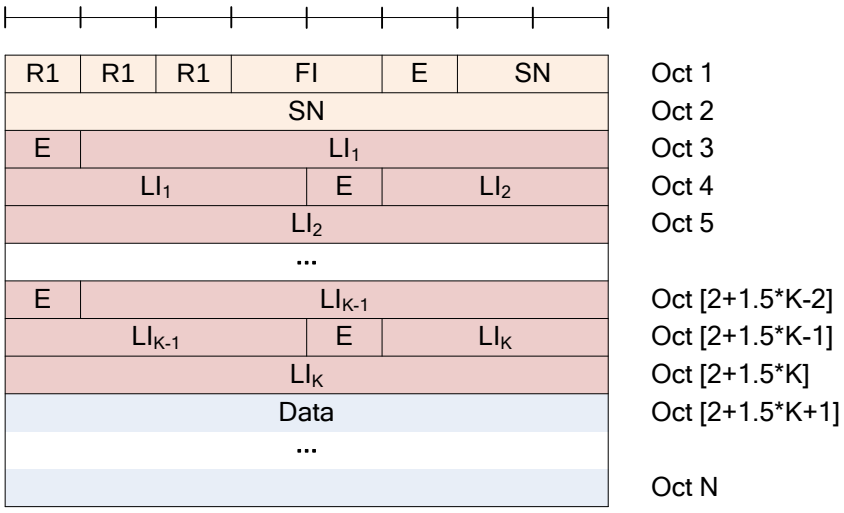

Figure 6.2.1.3-6: UMD PDU with 10 bit SN (Even number of LIs, i.e. K = 2, 4, 6, …)

[TS 36.322, clause 6.2.2.6]

Length: 2 bits.

The FI field indicates whether a RLC SDU is segmented at the beginning and/or at the end of the Data field. Specifically, the FI field indicates whether the first byte of the Data field corresponds to the first byte of a RLC SDU, and whether the last byte of the Data field corresponds to the last byte of a RLC SDU. The interpretation of the FI field is provided in Table 6.2.2.6-1.

Table 6.2.2.6-1: FI field interpretation

Value	Description
00	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
01	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.
10	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
11	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.

7.2.2.6.3 Test description

7.2.2.6.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

7.2.2.6.3.2 Test procedure sequence

Table 7.2.2.6.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS does not allocate any uplink grant.	-	-	-	-
2	The SS transmits UMD PDU#1. This PDU carries SDU#1 with size of 50 bytes.	<--	UMD PDU#1 (RLC SDU#1)	-	-
3	The SS transmits UMD PDU#2. This PDU carries SDU#2 with size of 50 bytes.	<--	UMD PDU#2 (RLC SDU#2)	-	-
4	SS transmits UL grants to enable UE to return RLC SDU#1 and RLC SDU#2 both in one UMD PDU.	<--	(UL grants)	-	-
5	Check: Does UE transmit RLC SDU#1 and RLC SDU#2 within UMD PDU with FI field set to '00', E field in the fixed part set to '1', first E field in the extension part set to '0' and first LI field set to 50 bytes?	-->	UMD PDU#1 (RLC SDU#1 and RLC SDU#2)	1	P
5A	The SS does not allocate any uplink grant.	-	-	-	-
6	SS transmits an UMD PDU#3 including RLC SDU#3 and RLC SDU#4 each with size of 50 bytes. Header of UMD PDU#3 contains FI='00', E='1', SN=2, E_1='0', LI_1='50'.	<--	UMD PDU#3 (RLC SDU#3 and RLC SDU#4)	-	-
7	The SS waits for 60 ms and then allocates 2 UL grants (UL grant allocation type 2) with a time spacing of 5 ms to enable UE to return each RLC SDU in one UMD PDU.	<--	(UL grants)	-	-
8	Check: Does UE transmit RLC SDU#3 within an UMD PDU with FI field set to '00' and E field in the fixed part set to '0'?	-->	UMD PDU#3 (RLC SDU#3)	2	P
9	Check: Does UE transmit RLC SDU#4 within an UMD PDU with FI field set to '00' and E field in the fixed part set to '0'?	-->	UMD PDU#4 (RLC SDU#4)	2	P
10	The SS transmits UMD PDU#4. This PDU carries SDU#5 with size of 50 bytes.	<--	UMD PDU#4 (RLC SDU#5)	-	-
11	The SS waits for 60 ms and then allocates 2 UL grants (UL grant allocation type 2) with a time spacing of 5 ms to enable UE to return RLC SDU#5 in two UMD PDUs.	<--	(UL grants)	-	-
12	Check: Does UE transmit 1st part of RLC SDU#5 within UMD PDU#5 with FI field set to '01' and E field in the fixed part set to '0'?	-->	UMD PDU#5	3	P
13	Check: Does UE transmit last part of RLC SDU#5 within an UMD PDU#6 with FI field set to '10'and E field in the fixed part set to '0'?	-->	UMD PDU#6	3	P

7.2.2.6.3.3 Specific message contents

None.

7.2.2.7 UM RLC / In sequence delivery of upper layer PDUs without residual loss of RLC PDUs / Maximum re-ordering delay below *t-Reordering*

7.2.2.7.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives missing PDUs whose SN is within the reordering window before t-Reordering has
expired }
    then { RLC reassembles and reorders the UMD PDUs and delivers them to the upper layer in
sequence }
            }
```

7.2.2.7.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322, clause 5.1.2.2.

[TS 36.322, clause 5.1.2.2]

The receiving UM RLC entity shall maintain a reordering window according to state variable VR(UH) as follows:

- a SN falls within the reordering window if (VR(UH) – UM_Window_Size) <= SN < VR(UH);
- a SN falls outside of the reordering window otherwise.

When receiving an UMD PDU from lower layer, the receiving UM RLC entity shall:

- either discard the received UMD PDU or place it in the reception buffer (see sub clause 5.1.2.2.2);
- if the received UMD PDU was placed in the reception buffer:
  - update state variables, reassemble and deliver RLC SDUs to upper layer and start/stop *t-Reordering* as needed (see sub clause 5.1.2.2.3);

…

When an UMD PDU with SN = x is received from lower layer, the receiving UM RLC entity shall:

- if VR(UR) < x < VR(UH) and the UMD PDU with SN = x has been received before; or
- if (VR(UH) – UM_Window_Size) <= x < VR(UR):
  - discard the received UMD PDU;
- else:
  - place the received UMD PDU in the reception buffer.

…

When an UMD PDU with SN = x is placed in the reception buffer, the receiving UM RLC entity shall:

- if x falls outside of the reordering window:
  - update VR(UH) to x + 1;
  - reassemble RLC SDUs from any UMD PDUs with SN that falls outside of the reordering window, remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
  - if VR(UR) falls outside of the reordering window:
    - set VR(UR) to (VR(UH) – UM_Window_Size);
- if the reception buffer contains an UMD PDU with SN = VR(UR):
  - update VR(UR) to the SN of the first UMD PDU with SN > current VR(UR) that has not been received;
  - reassemble RLC SDUs from any UMD PDUs with SN < updated VR(UR), remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
- if *t-Reordering* is running:
  - if VR(UX) <= VR(UR); or
  - if VR(UX) falls outside of the reordering window and VR(UX) is not equal to VR(UH)::
    - stop and reset *t-Reordering*;
- if *t-Reordering* is not running (includes the case when *t-Reordering* is stopped due to actions above):

- if VR(UH) > VR(UR):
  - start *t-Reordering*;
  - set VR(UX) to VR(UH).

7.2.2.7.3 Test description

7.2.2.7.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble

- UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.2.7.3.1-1 applicable for the configured UM DRB.
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

Table 7.2.2.7.3.1-1: RLC parameters

Downlink RLC *t-Reordering*	ms200

7.2.2.7.3.2 Test procedure sequence

Table 7.2.2.7.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits an UMD PDU. This PDU carries SDU#1. SN equals 0.	<--	UMD PDU#1	-	-
2	The UE transmits RLC SDU#1.	-->	(RLC SDU#1)	-	-
2A	The SS does not allocate any uplink grant.	-	-	-	-
3	The SS transmits an UMD PDU. This PDU contains the last part of SDU#4. SN equals 3. The UE starts *t-Reordering*.	<--	UMD PDU#4	-	-
4	The SS transmits an UMD PDU. This PDU contains the last part of SDU#3, and the 1st part of SDU#4. SN equals 2.	<--	UMD PDU#3	-	-
5	The SS transmits an UMD PDU. This PDU carries SDU#2 and the 1st part of SDU#3. SN equals 1. (Note)	<--	UMD PDU#2	-	-
5A	The SS waits for 60 ms and then allocates 3 UL grants (UL grant allocation type 2) with a time spacing of 5 ms of size enough for the UE to loop back one SDU in one UMD PDU	-	-	-	-
6	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	P
7	Check: Does the UE transmit RLC SDU#3?	-->	(RLC SDU#3)	1	P
8	Check: Does the UE transmit RLC SDU#4?	-->	(RLC SDU#4)	1	P
Note: The UE stops *t-Reordering*, reassembles UMD PDUs and delivers RLC SDU#2, RLC SDU#3 and RLC SDU#4 to the upper layer in sequence.					

7.2.2.7.3.3 Specific message contents

None.

7.2.2.8 UM RLC / In sequence delivery of upper layer PDUs without residual loss of RLC PDUs / Maximum re-ordering delay exceeds *t-Reordering*

7.2.2.8.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { a PDU is received out of order after t-Reordering has expired }
    then { UE discards the corresponding PDU and delivers all correctly received RLC SDUs to upper
layer in the correct order }
            }
```

7.2.2.8.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.322, clause 5.1.2.2.2, 5.1.2.2.3 and 5.1.2.2.4.

[TS 36.322, clause 5.1.2.2.2]

When an UMD PDU with SN = x is received from lower layer, the receiving UM RLC entity shall:

- if VR(UR) < x < VR(UH) and the UMD PDU with SN = x has been received before; or
- if (VR(UH) – UM_Window_Size) <= x < VR(UR):
  - discard the received UMD PDU;
- else:
  - place the received UMD PDU in the reception buffer.

[TS 36.322, clause 5.1.2.2.3]

When an UMD PDU with SN = x is placed in the reception buffer, the receiving UM RLC entity shall:

- if x falls outside of the reordering window:
  - update VR(UH) to x + 1;
  - reassemble RLC SDUs from any UMD PDUs with SN that falls outside of the reordering window, remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
  - if VR(UR) falls outside of the reordering window:
    - set VR(UR) to (VR(UH) – UM_Window_Size);
- if the reception buffer contains an UMD PDU with SN = VR(UR):
  - update VR(UR) to the SN of the first UMD PDU with SN > current VR(UR) that has not been received;
  - reassemble RLC SDUs from any UMD PDUs with SN < updated VR(UR), remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
- if *t-Reordering* is running:
  - if VR(UX) <= VR(UR); or
  - if VR(UX) falls outside of the reordering window and VR(UX) is not equal to VR(UH):
    - stop and reset *t-Reordering*;
- if *t-Reordering* is not running (includes the case when *t-Reordering* is stopped due to actions above):
  - if VR(UH) > VR(UR):

- start *t-Reordering*;
- set VR(UX) to VR(UH).

[TS 36.322, clause 5.1.2.2.4]

When *t-Reordering* expires, the receiving UM RLC entity shall:

- update VR(UR) to the SN of the first UMD PDU with SN >= VR(UX) that has not been received;
- reassemble RLC SDUs from any UMD PDUs with SN < updated VR(UR), remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
- if VR(UH) > VR(UR):
  - start *t-Reordering*;
  - set VR(UX) to VR(UH).

7.2.2.8.3 Test description

7.2.2.8.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.2.8.3.1-1 applicable for the configured UM DRB.
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

Table 7.2.2.8.3.1-1: RLC parameters

Downlink RLC *t-Reordering*	 ms200

7.2.2.8.3.2 Test procedure sequence

Table 7.2.2.8.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits RLC PDU#1 containing first segment of RLC SDU#1. Note T_1	<--	UMD PDU#1	-	-
2	The SS does not transmit RLC PDU#2 containing last segment of RLC SDU#1.	-	-	-	-
3	The SS transmits RLC PDU#3 containing RLC SDU#2.	<--	UMD PDU#3	-	-
3A	Check 1: Does the UE transmit RLC SDU#2 after t-Reordering (200 ms) expiry? Note T_2 Check 2: Is ($T_2 - T_1$) > t-reordering?	-->	(RLC SDU#2)	1	P
3B	The SS transmits RLC PDU#2 containing last segment of RLC SDU#1.	<--	UMD PDU#2	-	-
4	Check: Does the UE transmit RLC SDU#1 within 100 ms?	-->	(RLC SDU#1)	1	F

7.2.2.8.3.3 Specific message contents

None.

7.2.2.9 UM RLC / In sequence delivery of upper layer PDUs with residual loss of RLC PDUs / Maximum re-ordering delay exceeds *t-Reordering*

7.2.2.9.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE detects that RLC PDUs constructing different RLC SDUs are lost }
    then { UE delivers all received RLC SDUs to upper layer in the correct order }
           }
```

7.2.2.9.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.322, clause 5.1.2.2.2, 5.1.2.2.3 and 5.1.2.2.4.

[TS 36.322, clause 5.1.2.2.2]

When an UMD PDU with SN = x is received from lower layer, the receiving UM RLC entity shall:

- if VR(UR) < x < VR(UH) and the UMD PDU with SN = x has been received before; or
- if (VR(UH) – UM_Window_Size) <= x < VR(UR):
  - discard the received UMD PDU;
- else:
  - place the received UMD PDU in the reception buffer.

[TS 36.322, clause 5.1.2.2.3]

When an UMD PDU with SN = x is placed in the reception buffer, the receiving UM RLC entity shall:

- if x falls outside of the reordering window:
  - update VR(UH) to x + 1;
  - reassemble RLC SDUs from any UMD PDUs with SN that falls outside of the reordering window, remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
  - if VR(UR) falls outside of the reordering window:
    - set VR(UR) to (VR(UH) – UM_Window_Size);
- if the reception buffer contains an UMD PDU with SN = VR(UR):
  - update VR(UR) to the SN of the first UMD PDU with SN > current VR(UR) that has not been received;
  - reassemble RLC SDUs from any UMD PDUs with SN < updated VR(UR), remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
- if *t-Reordering* is running:
  - if VR(UX) <= VR(UR); or
  - if VR(UX) falls outside of the reordering window and VR(UX) is not equal to VR(UH):
    - stop and reset *t-Reordering*;

- if *t-Reordering* is not running (includes the case when *t-Reordering* is stopped due to actions above):
  - if VR(UH) > VR(UR):
    - start *t-Reordering*;
    - set VR(UX) to VR(UH).

[TS 36.322, clause 5.1.2.2.4]

When *t-Reordering* expires, the receiving UM RLC entity shall:

- update VR(UR) to the SN of the first UMD PDU with SN >= VR(UX) that has not been received;
- reassemble RLC SDUs from any UMD PDUs with SN < updated VR(UR), remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in ascending order of the RLC SN if not delivered before;
- if VR(UH) > VR(UR):
  - start *t-Reordering*.;
  - set VR(UX) to VR(UH).

7.2.2.9.3 Test description

7.2.2.9.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.2.9.3.1-1 applicable for the configured UM DRB.
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

Table 7.2.2.9.3.1-1: RLC parameters

Downlink RLC *t-Reordering*	ms200

7.2.2.9.3.2 Test procedure sequence

Table 7.2.2.9.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits UMD PDU#1 containing first segment of RLC SDU#1.	<--	UMD PDU#1	-	-
2	The SS does not transmit UMD PDU#2 containing last segment of RLC SDU#1.	-	-	-	-
3	The SS transmits UMD PDU#3 containing first segment of RLC SDU#2.	<--	UMD PDU#3	-	-
4	The SS transmits UMD PDU#4 containing last segment of RLC SDU#2.	<--	UMD PDU#4	-	-
5	The SS transmits UMD PDU#5 containing first segment of RLC SDU#3.	<--	UMD PDU#5	-	-
6	The SS does not transmit UMD PDU#6 containing last segment of RLC SDU#3.	-	-	-	-
7	The SS transmits UMD PDU#7 containing first segment of RLC SDU#4.	<--	UMD PDU#7	-	-
8	The SS transmits UMD PDU#8 containing last segment of RLC SDU#4.	<--	UMD PDU#8	-	-
9	Wait for 200 ms to ensure that *t-Reordering* for the UMD PDU#2 expires.	-	-	-	-
10	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	P
11	Wait for 200 ms to ensure that *t-Reordering* for the UMD PDU#6 expires.	-	-	-	-
12	Check: Does the UE transmit RLC SDU#4?	-->	(RLC SDU#4)	1	P

7.2.2.9.3.3 Specific message contents

None.

7.2.2.10 UM RLC / Duplicate detection of RLC PDUs

7.2.2.10.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives duplicate UMD PDUs }
    then { UE discards the duplicate UMD PDUs }
           }
```

(2)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when {  UE receives UMD PDUs whose SN is within the reordering window and duplicate UMD PDUs }
    then { UE discards the duplicate UMD PDUs }
           }
```

7.2.2.10.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322, clause 4.2.1.2.3 and 5.1.2.2.2.

[TS 36.322, clause 4.2.1.2.3]

When a receiving UM RLC entity receives UMD PDUs, it shall:

- detect whether or not the UMD PDUs have been received in duplication, and discard duplicated UMD PDUs;
- reorder the UMD PDUs if they are received out of sequence;
- detect the loss of UMD PDUs at lower layers and avoid excessive reordering delays;

- reassemble RLC SDUs from the reordered UMD PDUs (not accounting for RLC PDUs for which losses have been detected) and deliver the RLC SDUs to upper layer in ascending order of the RLC SN;

…

[TS 36.322, clause 5.1.2.2.2]

When an UMD PDU with SN = x is received from lower layer, the receiving UM RLC entity shall:

- if VR(UR) < x < VR(UH) and the UMD PDU with SN = x has been received before; or
- if (VR(UH) – UM_Window_Size) <= x < VR(UR):
  - discard the received UMD PDU;

  …

7.2.2.10.3 Test description

7.2.2.10.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.2.10.3.1-1.

Table 7.2.2.10.3.1-1: RLC settings

Parameter	Value
t-Reordering	ms100

- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

7.2.2.10.3.2 Test procedure sequence

Table 7.2.2.10.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits an UMD PDU. This PDU carries SDU#1. SN equals 0.	<--	UMD PDU#1	-	-
2	The UE transmits RLC SDU#1.	-->	(RLC SDU#1)	-	-
3	The SS transmits an UMD PDU. This PDU carries SDU#1. SN equals 0.	<--	UMD PDU#1	-	-
4	Check: Does the UE transmit RLC SDU#1?	-->	(RLC SDU#1)	1	F
5	The SS transmits an UMD PDU. This PDU contains SDU#2 and the 1st part of SDU# 3. SN equals 1.	<--	UMD PDU#2	-	-
6	The UE transmit RLC SDU#2.	-->	(RLC SDU#2)	-	-
7	The SS transmits an UMD PDU. This PDU contains SDU#2 and the 1st part of SDU#3. SN equals 1.	<--	UMD PDU#2	-	-
8	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	F
9	The SS transmits an UMD PDU. This PDU contains the last part of SDU#3. SN equals 2.	<--	UMD PDU#3	-	-
10	The UE transmits RLC SDU#3.	-->	(RLC SDU#3)	-	-
10A	The SS ignores scheduling requests and does not allocate any uplink grant.	-	-	-	-
10B	The SS enables the indication of scheduling requests till step 15.	-	-	-	-
11	After 100 ms the SS transmits an UMD PDU. This PDU carries SDU#5. SN equals 4.	<--	UMD PDU#5	-	-
12	The SS transmits an UMD PDU. This PDU carries SDU#6. SN equals 5.	<--	UMD PDU#6	-	-
13	The SS transmits an UMD PDU. This PDU contains the last part of SDU#3. SN equals 2.	<--	UMD PDU#3	-	-
14	Check: Does the UE transmit scheduling request before transmission of UMD PDU at step 15?	-->	(SR)	2	F
15	After 75 ms from step 11 the SS transmits an UMD PDU. This PDU carries SDU#4. SN equals 3.	<--	UMD PDU#4	-	-
15A	The SS waits for 60 ms and then allocates 1 UL grant of size enough for the UE to loop back 3 RLC SDU in one UMD PDU	<--	(UL Grant)	-	-
16	SS receives SDU#4, SDU#5 and SDU#6 in a single PDU	-->	(RLC SDU#4, RLC SDU#5 and RLC SDU#6)	1,2	P
17	Void				
18	Void				

7.2.2.10.3.3 Specific message contents

None.

7.2.2.11 UM RLC / RLC re-establishment procedure

7.2.2.11.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { RLC re-establishment is performed upon request by RRC }
    then { The UE discards all UMD PDUs where no RLC SDUs can be reassembled }
      }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { RLC re-establishment is performed upon request by RRC }
```

```
    then { The UE resets variable VT(US), VR(UH) and VR(UR) to its initial value }
      }
```

7.2.2.11.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322, clause 4.2.1.2.3 and 5.4.

[TS 36.322, clause 4.2.1.2.3]

At the time of RLC re-establishment, the receiving UM RLC entity shall:

- if possible, reassemble RLC SDUs from the UMD PDUs that are received out of sequence and deliver them to upper layer;
- discard any remaining UMD PDUs that could not be reassembled into RLC SDUs;
- initialize relevant state variables and stop relevant timers.

[TS 36.322, clause 5.4]

RLC re-establishment is performed upon request by RRC, and the function is applicable for AM, UM and TM RLC entities.

When RRC indicates that an RLC entity should be re-established, the RLC entity shall:

…

- if it is a receiving UM RLC entity:
  - when possible, reassemble RLC SDUs from UMD PDUs with SN < VR(UH), remove RLC headers when doing so and deliver all reassembled RLC SDUs to upper layer in ascending order of the RLC SN, if not delivered before;
  - discard all remaining UMD PDUs;

…

- reset all state variables to their initial values.

7.2.2.11.3 Test description

7.2.2.11.3.1 Pre-test conditions

System Simulator:

- Cell 1

UE:

None.

Preamble:

- UE is in Loopback Activated state (state 4) according to TS 36.508 clause 4.5 [18] with the exceptions listed in table 7.2.2.11.3.1-1 applicable for the configured UM DRB.
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

Table 7.2.2.11.3.1-1: RLC parameters

Downlink RLC *t-Reordering*	ms200

7.2.2.11.3.2 Test procedure sequence

Table 7.2.2.11.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits UMD PDU#1. Header of UMD PDU#1 contains SN=0. This PDU carries RLC SDU#1.	<--	UMD PDU#1	-	-
2	The UE transmits RLC SDU#1.	-->	(RLC SDU#1)	-	-
3	The SS transmits UMD PDU#2. Header of UMD PDU#2 contains SN=1. This PDU carries the 1st segment of SDU#2.	<--	UMD PDU#2	-	-
4	SS performs a RRC Connection Reconfiguration procedure including the *mobilityControlInfo* IE in *RRCConnectionReconfiguration* triggering RLC re-establishment.	-	-	-	-
5	The SS transmits UMD PDU#3. Header of UMD PDU#3 contains SN=2. This PDU carries the last segment of RLC SDU#2. The UE starts *t-Reordering*.	<--	UMD PDU#3	-	-
6	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	F
7	300 ms (1.5 * *t-Reordering*) after step 5 the SS transmits UMD PDU#4. Header of UMD PDU#4 contains SN=3. This PDU carries RLC SDU#3.	<--	UMD PDU#4	-	-
8	The UE transmit RLC SDU#3. Header of UMD PDU carrying RLC SDU#3 contains SN=0.	-->	(RLC SDU#3)	-	-
9	The SS transmits UMD PDU#5. Header of UMD PDU#5 contains SN=4. This PDU carries RLC SDU#4.	<--	UMD PDU#5	-	-
10	The UE transmits RLC SDU#4. Header of UMD PDU carrying RLC SDU#4 contains SN=1.	-->	(RLC SDU#4)	-	-
11	SS performs a RRC Connection Reconfiguration procedure including the *MobilityControlInfo* IE in *RRCConnectionReconfiguration* triggering RLC re-establishment.	-	-	-	-
12	The SS transmits UMD PDU#6. Header of UMD PDU#6 contains SN=0. This PDU carries RLC SDU#5.	<--	UMD PDU#6	-	-
13	Check 1: Does the UE transmit RLC SDU#5? Check 2: Does header of UMD PDU carrying RLC SDU#5 contain SN=0?	-->	(RLC SDU#5)	2	P

7.2.2.11.3.3 Specific message contents

Table 7.2.2.11.3.3-1: *RRCConnectionReconfiguration* (step 4 and step 11, Table 7.2.2.11.3.2-1)

Derivation Path: 36.508, Table 4.6.1-8, condition HO

Table 7.2.2.11.3.3-2: *MobilityControlInfo* (step 4 and step 11, Table 7.2.2.11.3.2-1)

Derivation Path: 36.508, Table 4.6.5-1			
Information Element	**Value/remark**	**Comment**	**Condition**
MobilityControlInfo ::= SEQUENCE {			
targetPhysCellId	PhysicalCellIdentity of Cell 1		
carrierFreq	Not present		
}			

7.2.3 Acknowledged mode

7.2.3.1 AM RLC / Concatenation and reassembly

7.2.3.1.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { The UE has multiple RLC SDUs in the transmission buffer that fits into the available AMD
PDU size }
    then { The UE concatenates the RLC SDUs in the transmission buffer into an AMD PDU and transmits
it}
      }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { The UE receives an AMD PDUs containing concatenated RLC }
    then { The UE reassembles the RLC SDUs in accordance with the Framing Info and Length Indicators
indicated in AMD PDUs }
      }
```

7.2.3.1.2 Conformance requirements

References: The conformance requirements covered in the current TC are specified in: TS 36.322, clauses 4.2.1.3.2 , 4.2.1.3.3, 6.2.1.4 and 6.2.2.6.

[TS 36.322, clause 4.2.1.3.2]

When the transmitting side of an AM RLC entity forms AMD PDUs from RLC SDUs, it shall:

- segment and/or concatenate the RLC SDUs so that the AMD PDUs fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity notified by lower layer.

…

[TS 36.322, clause 4.2.1.3.3]

When the receiving side of an AM RLC entity receives RLC data PDUs, it shall:

....

- reassemble RLC SDUs from the reordered RLC data PDUs and deliver the RLC SDUs to upper layer in sequence.

…

[TS 36.322, clause 6.2.1.4]

AMD PDU consists of a Data field and an AMD PDU header.

AMD PDU header consists of a fixed part (fields that are present for every AMD PDU) and an extension part (fields that are present for an AMD PDU when necessary). The fixed part of the AMD PDU header itself is byte aligned and consists of a D/C, a RF, a P, a FI, an E and a SN. The extension part of the AMD PDU header itself is byte aligned and consists of E(s) and LI(s).

An AMD PDU header consists of an extension part only when more than one Data field elements are present in the AMD PDU, in which case an E and a LI are present for every Data field element except the last. Furthermore, when an AMD PDU header consists of an odd number of LI(s), four padding bits follow after the last LI.

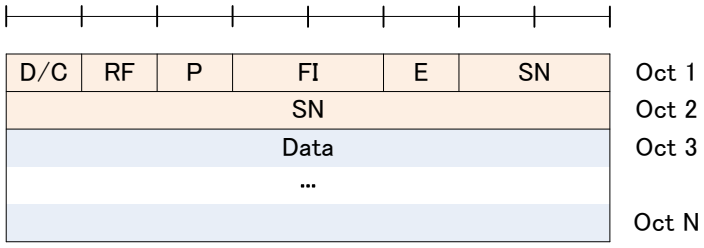

Figure 6.2.1.4-1: AMD PDU (No LI)

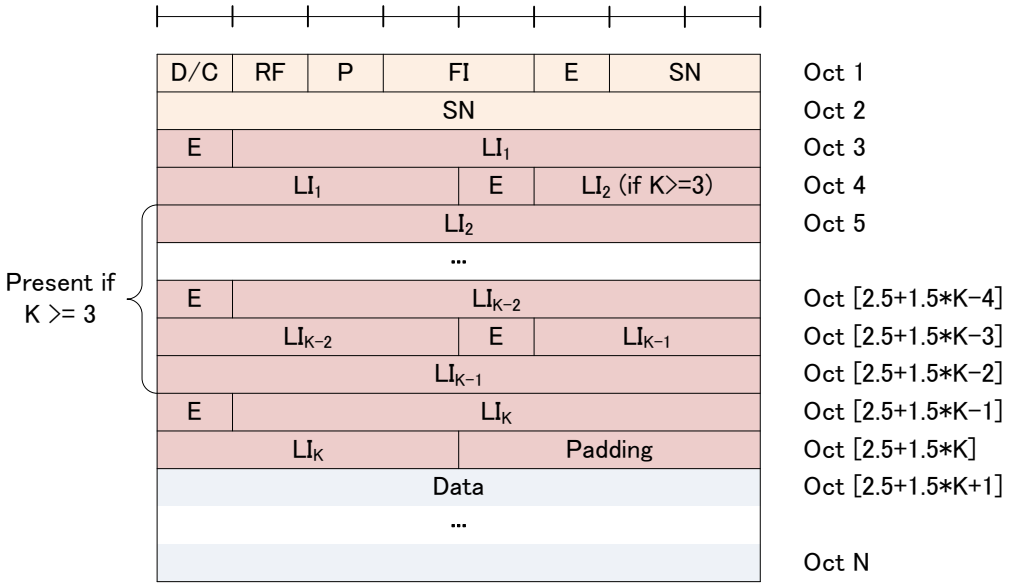

Figure 6.2.1.4-2: AMD PDU (Odd number of LIs, i.e. K = 1, 3, 5, ...)

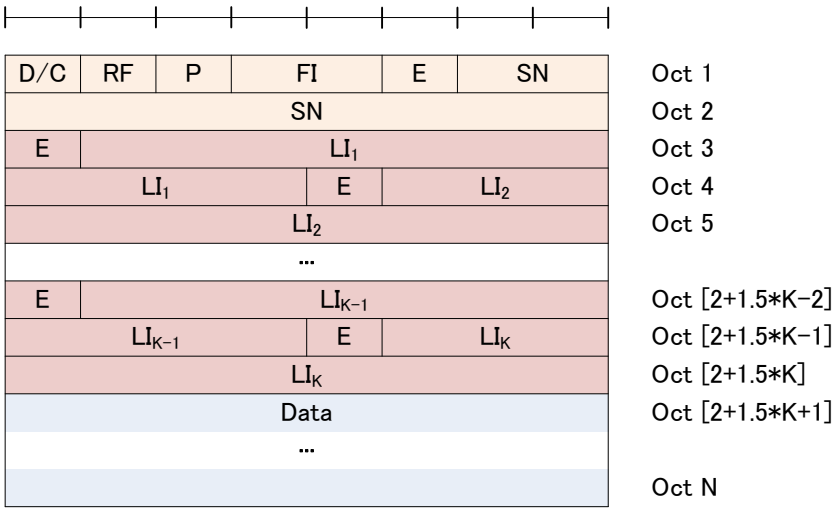

Figure 6.2.1.4-3: AMD PDU (Even number of LIs, i.e. K = 2, 4, 6, ...)

[TS 36.322, clause 6.2.2.6]

The FI field indicates whether a RLC SDU is segmented at the beginning and/or at the end of the Data field. Specifically, the FI field indicates whether the first byte of the Data field corresponds to the first byte of a RLC SDU, and whether the last byte of the Data field corresponds to the last byte of a RLC SDU. The interpretation of the FI field is provided in Table 6.2.2.6-1.

Table 6.2.2.6-1: FI field interpretation

Value	Description
00	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
01	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.
10	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
11	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.

7.2.3.1.3 Test description

7.2.3.1.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.3.1.3.1-1.

Table 7.2.3.1.3.1-1: RLC settings

Parameter	Value
t-StatusProhibit	500 ms

7.2.3.1.3.2 Test procedure sequence

Table 7.2.3.1.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	During the whole test sequence, the SS should not allocate UL grants unless when explicitly stated so in the procedure.	-	-	-	-
2	The SS transmits an AMD PDU including two RLC SDUs of size 40 bytes each with poll bit set to '1'.	<--	AMD PDU(AMD PDU header(D/C='1', RF='0', P='1', FI='00',E='1', SN='0',E_1='0', LI_1='40' bytes), 2 RLC SDUs of 40 bytes)	-	-
3	The SS waits for 60 ms and the allocates an UL grant (UL grant allocation type 3) of size 776 bits (Note 1).	<--	(UL grant, 776 bits)	-	-
4	Check: Does the UE transmit a STATUS PDU with positive acknowledgement?	-->	STATUS PDU (ACK SN=1)	2	P
5	Check: Does the UE transmit two RLC SDUs within an AMD PDU with FI field set to '00', first E field in the fixed part set to '1', first E field in the extension part set to '0', first LI field set to 40 bytes?	-->	AMD PDU(AMD PDU header(P='1', FI='00', E='1',SN=0, E_1='0', LI_1='40')), two RLC SDUs of size 40 bytes)	1, 2	P
6	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=1)	-	-
7	After 500 ms the SS transmits an AMD PDU including three RLC SDU of size 40 bytes with P field set to "1".	<--	AMD PDU(AMD PDU header(D/C='1', RF='0', P='1', FI='00',E='1', SN='1', E_1='1', LI_1='40' bytes, E_2='0', LI_2='40' bytes), three RLC SDUs of size 40 bytes)	-	-
8	The SS waits for 60 ms and then allocates an UL grant (UL grant allocation type 3) of size 1096 bits. (Note 2).	<--	(UL grant, 1096 bits)	-	-
9	Check: Does the UE transmit a STATUS PDU with positive acknowledgement?	-->	STATUS PDU (ACK SN=2)	2	P
10	Check: Does the UE transmit three RLC SDUs within an AMD PDU with FI field set to "00", first E field in the fixed part set to '1', first E field in the extension part set to '1', first LI field set to 40 bytes, second E field in the extension part set to '0', second LI field set to 40 bytes and P field set to "1"?	-->	AMD PDU(AMD PDU header(P='1', FI='00', SN=1, E_1='1', LI_1='40', E_2='0', LI_2='40'), three RLC SDUs of size 40 bytes)	1, 2	P
11	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=2)	-	-

Note 1 UL grant of 776 bits (I_{TBS}=11, N_{PRB}=4, see TS 36.213 Table 7.1.7.2.1-1) is chosen such that UE will fit two RLC SDUs of 40 bytes within one AMD PDU. MAC PDU of 776 bits=97 bytes fits an AMD PDU payload of 80 bytes (two 40 byte RLC SDUs) + 4 bytes AMD PDU header + 13 bytes spare for MAC header and possible RLC STATUS PDU and BSR report.

Note 2 UL grant of 1096 bits (I_{TBS}=8, N_{PRB}=8, see TS 36.213 Table 7.1.7.2.1-1) is chosen such that UE will fit three RLC SDUs of 40 bytes within one AMD PDU. MAC PDU of 1096 bits=137 bytes fits an AMD PDU payload of 120 bytes (three 40 byte RLC SDUs) + 5 bytes AMD PDU header + 12 bytes spare for MAC header and possible RLC STATUS PDU and BSR report.

7.2.3.1.3.3 Specific message contents

None.

7.2.3.2 AM RLC / Segmentation and reassembly / No PDU segmentation

7.2.3.2.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
  ensure that {
    when { the UE has a RLC SDU with larger size than available AMD PDU size in the transmission
buffer }
```

```
      then { the UE segments the RLC SDU in accordance with the available AMD PDU size }
        }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { the UE receives AMD PDUs containing a segmented RLC SDU }
    then { the UE reassembles the RLC SDUs in accordance with the Framing Info and Length Indicators
indicated in the AMD PDUs }
      }
```

7.2.3.2.2 Conformance requirements

References: The conformance requirements covered in the current TC are specified in: TS 36.322, clauses 4.2.1.3.2, 4.2.1.3.3 and 6,2.2.6.

[TS 36.322, clause 4.2.1.3.2]

When the transmitting side of an AM RLC entity forms AMD PDUs from RLC SDUs, it shall:

- segment and/or concatenate the RLC SDUs so that the AMD PDUs fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity notified by lower layer.

…

[TS 36.322, clause 4.2.1.3.3]

When the receiving side of an AM RLC entity receives RLC data PDUs, it shall:

....

- reassemble RLC SDUs from the reordered RLC data PDUs and deliver the RLC SDUs to upper layer in sequence.

…

[TS 36.322, clause 6.2.2.6]

…

The FI field indicates whether a RLC SDU is segmented at the beginning and/or at the end of the Data field. Specifically, the FI field indicates whether the first byte of the Data field corresponds to the first byte of a RLC SDU, and whether the last byte of the Data field corresponds to the last byte of a RLC SDU. The interpretation of the FI field is provided in Table 6.2.2.6-1.

Table 6.2.2.6-1: FI field interpretation

Value	Description
00	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
01	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.
10	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
11	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.

7.2.3.2.3 Test description

7.2.3.2.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].

7.2.3.2.3.2 Test procedure sequence

Table 7.2.3.2.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
1	During the whole test sequence, the SS should not allocate UL grants unless when explicitly stated so in the procedure.	-	-	-	-
2	The SS transmits a RLC SDU of size 80 bytes segmented into two AMD PDUs. The two AMD PDUs are transmitted in separate TTIs.	<--	(RLC SDU#1) AMD PDU#1(FI='01',SN=0) AMD PDU#2(FI='10',SN=1)	-	-
3	60 ms after step 2 the SS allocates 2 UL grants (UL grant allocation type 2) with a time spacing of 5 ms of size 392 bits. (Note 1).	<--	(UL grants)	-	-
4	Check: Does the UE return a RLC SDU with equal content as sent in downlink in step 2 segmented into two AMD PDUs and received in different TTIs? (Note2: Details for AMD PDU#2)	-->	(RLC SDU#1) AMD PDU#1 AMD PDU#2	1,2	P
5	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=2)	-	-
6	The SS sends a RLC SDU of size 120 bytes octets segmented into three AMD PDUs.	<--	(RLC SDU#2) AMD PDU#1(FI='01',SN=2) AMD PDU#2(FI='11',SN=3) AMD PDU#3(FI='10',SN=4)	-	-
7	60 ms after step 6 the SS allocates 3 UL grants (UL grant allocation type 2) with a time spacing of 5 ms of size 392 bits. (Note 1).	<--	(UL grants)	-	-
8	Check: Does the UE return a RLC SDU with equal content as sent in downlink in step 6 segmented into three AMD PDUs where each AMD PDU is received in different TTI? (Note2: Details for AMD PDU#3)	-->	(RLC SDU#2) AMD PDU#1 AMD PDU#2 AMD PDU#3	1,2	P
9	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=5)	-	-

Note 1: UL grant of 392 bits (I_{TBS}=8, N_{PRB}=3, see TS 36.213 Table 7.1.7.2.1-1) is chosen to force the UE to segment the returned UL RLC SDU into multiple AMD PDUs. An UL grant of 392 bits=49 bytes allows the UE to transmit one AMD PDU of maximum 46 bytes (49 bytes – 2 byte AMD PDU header - minimum 1 byte MAC header). UE at step 4 and step 8 during transmission of AMD PDU#1 will transmit BSR MCE which will take 2 bytes and hence AMD PDU size will be 44 bytes.

Note2: Polling bit will be set for this PDU by the UE and SS transmits a STATUS PDU.

7.2.3.2.3.3 Specific message contents

None.

7.2.3.3 AM RLC / Segmentation and reassembly / Framing info field

7.2.3.3.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives an AMD PDU or an AMD PDU segment containing a FI field set to 00 }
    then { UE correctly decodes the received AMD PDU or AMD PDU segment }
           }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives an AMD PDU or an AMD PDU segment containing a FI field set to 01 }
    then { UE correctly decodes the received AMD PDU or AMD PDU segment }
           }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives an AMD PDU or an AMD PDU segment containing a FI field set to 11 }
    then { UE correctly decodes the received AMD PDU or AMD PDU segment}
           }
```

(4)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives an AMD PDU or an AMD PDU segment containing a FI field set to 10 }
    then { UE correctly decodes the received AMD PDU or AMD PDU segment }
           }
```

7.2.3.3.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.322, clause 6.2.2.6.

[TS 36.322, clause 6.2.2.6]

Length: 2 bits.

The FI field indicates whether a RLC SDU is segmented at the beginning and/or at the end of the Data field. Specifically, the FI field indicates whether the first byte of the Data field corresponds to the first byte of a RLC SDU, and whether the last byte of the Data field corresponds to the last byte of a RLC SDU. The interpretation of the FI field is provided in Table 6.2.2.6-1.

Table 6.2.2.6-1: FI field interpretation

Value	Description
00	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
01	First byte of the Data field corresponds to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.
10	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field corresponds to the last byte of a RLC SDU.
11	First byte of the Data field does not correspond to the first byte of a RLC SDU. Last byte of the Data field does not correspond to the last byte of a RLC SDU.

7.2.3.3.3 Test description

7.2.3.3.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].

7.2.3.3.3.2 Test procedure sequence

Table 7.2.3.3.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits AMD PDU#1 containing a complete RLC SDU#1 (FI field = 00).	<--	AMD PDU#1	-	-
2	Check: Does the UE transmit RLC SDU#1?	-->	(RLC SDU#1)	1	P
2A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=1)	-	-
3	The SS transmits AMD PDU#2 containing the first segment of RLC SDU#2 (FI field = 01).	<--	AMD PDU#2	-	-
4	The SS transmits AMD PDU#3 containing the second segment of RLC SDU#2 (FI field = 11).	<--	AMD PDU#3	-	-
5	The SS transmits AMD PDU#4 containing the last segment of RLC SDU#2 (FI field = 10).	<--	AMD PDU#4	-	-
6	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	2,3, 4	P
6A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=2)	-	-
7	The *t-PollRetransmit* timer for RLC PDU#5 expires and SS assumes that the transmission of AMD PDU#5 containing a complete RLC SDU#3 and a complete RLC SDU#4 is failed and consider RLC PDU#5 for re-transmission	-	-	-	-
8	The SS transmits AMD PDU segment containing a complete RLC SDU#3 (FI field = 00).	<--	AMD PDU segment	-	-
9	Check: Does the UE transmit RLC SDU#3?	-->	(RLC SDU#3)	1	P
9A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=3)	-	-
10	The SS transmits AMD PDU segment containing the first segment of RLC SDU#4 (FI field = 01).	<--	AMD PDU segment	-	-
11	The SS transmits AMD PDU segment containing the second segment of RLC SDU#4 (FI field = 11).	<--	AMD PDU segment	-	-
12	The SS transmits AMD PDU segment containing the last segment of RLC SDU#4 (FI field = 10).	<--	AMD PDU segment	-	-
13	Check: Does the UE transmit RLC SDU#4?	-->	(RLC SDU#4)	2,3, 4	P
14	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=4)	-	-

7.2.3.3.3.3 Specific message contents

None.

7.2.3.4 AM RLC / Segmentation and reassembly / Different numbers of length indicators

7.2.3.4.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives an AMD PDU or an AMD PDU segment with no LI field }
    then { UE correctly decodes the received AMD PDU or AMD PDU segment }
          }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives an AMD PDU or an AMD PDU segment with one LI field }
    then { UE correctly decodes the received AMD PDU or AMD PDU segment }
          }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives an AMD PDU or an AMD PDU segment with two LI fields }
    then { UE correctly decodes the received AMD PDU or AMD PDU segment }
           }
```

7.2.3.4.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.322, clause 6.2.2.5.

[TS 36.322, clause 6.2.2.5]

Length: 11 bits.

The LI field indicates the length in bytes of the corresponding Data field element present in the RLC data PDU delivered/received by an UM or an AM RLC entity. The first LI present in the RLC DATA PDU header corresponds to the first Data field element present in the Data field of the RLC DATA PDU, the second LI present in the RLC DATA PDU header corresponds to the second Data field element present in the Data field of the RLC DATA PDU, and so on. The value 0 is reserved.

7.2.3.4.3 Test description

7.2.3.4.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.3.4.3.1-1.

Table 7.2.3.4.3.1-1: RLC settings

Parameter	Value
t-Reordering	150 ms

7.2.3.4.3.2 Test procedure sequence

Table 7.2.3.4.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	During the whole test sequence, the SS should not allocate UL grants unless when explicitly stated so in the procedure.	-	-	-	-
1	The SS transmits AMD PDU#1 containing a complete RLC SDU#1 without LI field.	<--	AMD PDU#1	-	-
2	The SS transmits an uplink grant allowing the UE to transmit 1 RLC SDU.	<--	(UL grant)	-	-
3	Check: Does the UE transmit an AMD PDU containing RLC SDU#1?	-->	AMD PDU (RLC SDU#1)	1	P
3A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=1)	-	-
4	The SS transmits AMD PDU#2 containing a complete RLC SDU#2 and a complete RLC SDU#3 with one LI field.	<--	AMD PDU#2	-	-
5	The SS waits for 60 ms then assigns an UL grant sufficient for the UE to loopback RLC SDU#2 and RLC SDU#3.	<--	(UL grant)	-	-
6	Check: Does the UE transmit an AMD PDU containing RLC SDU#2 and RLC SDU#3 in its data field?	-->	AMD PDU (RLC SDU#2, RLC SDU#3)	2	P
7	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=2)	-	-
8	The SS transmits AMD PDU#3 containing a complete RLC SDU#4, a complete RLC SDU#5 and a complete RLC SDU#6 with two LI fields.	<--	AMD PDU#3	-	-
9	The SS waits for 60 ms then assigns an UL grant sufficient for the UE to loopback RLC SDU#4, RLC SDU#5 and RLC SDU#6.	<--	(UL grant)	-	-
10	Check: Does the UE transmit an AMD PDU containing RLC SDU#4, RLC SDU#5 and RLC SDU#6 in its data field?	-->	AMD PDU (RLC SDU#4, RLC SDU#5, RLC SDU#6)	3	P
11	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=3)	-	-
12	Void	-	-	-	-
13	The *t-PollRetransmit* timer for AMD PDU#4 expires and SS assumes that the transmission of AMD PDU#4 containing a complete RLC SDU#7, a complete RLC SDU#8, a complete RLC SDU#9, a complete RLC SDU#10, a complete RLC SDU#11 and a complete RLC SDU#12 is failed and consider AMD PDU#4 for re-transmission.	-	-	-	-
14	The SS transmits AMD PDU segment containing a complete RLC SDU#7 without LI field.	<--	AMD PDU segment	-	-
15	The SS waits for 60 ms and then assigns an uplink grant (UL grant allocation type 3) allowing the UE to transmit 1 RLC SDU.	<--	(UL grant)	-	-
16	Check: Does the UE transmit an AMD PDU containing RLC SDU#7?	-->	AMD PDU (RLC SDU#7)	1	P
16A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=4)	-	-
17	The SS transmits AMD PDU segment containing a complete RLC SDU#8 and a complete RLC SDU#9 with one LI field.	<--	AMD PDU segment	-	-
18	The SS waits for 60 ms and then assigns an UL grant (UL grant allocation type 3) sufficient for the UE to loopback RLC SDU#8 and RLC SDU#9.	<--	(UL grant)	-	-
19	Check: Does the UE transmit an AMD PDU containing RLC SDU#8 and RLC SDU#9 in its data field?	-->	AMD PDU (RLC SDU#8, RLC SDU#9)	2	P
20	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=5)	-	-

21	The SS transmits AMD PDU segment containing a complete RLC SDU#10, a complete RLC SDU#11 and a complete RLC SDU#12 with two LI fields.	<--	AMD PDU segment	-	-
22	The SS waits for 60 ms and then assigns an UL grant (UL grant allocation type 3) sufficient for the UE to loopback RLC SDU#10, RLC SDU#11 and RLC SDU#12.	<--	(UL grant)	-	-
23	Check: Does the UE transmit an AMD PDU containing RLC SDU#10, RLC SDU#11 and RLC SDU#12 in its data field?	-->	AMD PDU (RLC SDU#10, RLC SDU#11, RLC SDU#12)	3	P
24	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=6)	-	-
25	Void	-	-	-	-

7.2.3.4.3.3 Specific message contents

None.

7.2.3.5 AM RLC / Reassembly / LI value > PDU size

7.2.3.5.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives PDU with "Length Indicators" that point beyond the end of the PDU }
    then { UE discards PDU }
          }
```

7.2.3.5.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clauses 5.5.1 and 6.2.2.5.

[TS 36.322, clause 5.5.1]

When an RLC entity receives an RLC PDU that contains reserved or invalid values, the RLC entity shall:

- discard the received PDU.

[TS 36.322, clause 6.2.2.5]

Length: 11 bits.

The LI field indicates the length in bytes of the corresponding Data field element present in the RLC data PDU. The first LI present in the RLC data PDU header corresponds to the first Data field element present in the Data field of the RLC data PDU, the second LI present in the RLC data PDU header corresponds to the second Data field element present in the Data of the RLC data PDU, and so on. The value 0 is reserved.

7.2.3.5.3 Test description

7.2.3.5.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with the loopback size set to 98 bytes.

7.2.3.5.3.2 Test procedure sequence

Table 7.2.3.5.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
0	During the whole test sequence, the SS should not allocate UL grants unless when explicitly stated so in the procedure.	-	-	-	-
1	The SS transmits an AMD PDU containing the first half (50 bytes) of SDU#1 in its data field to the UE.	<--	AMD PDU#1 (SN = 0)	-	-
2	The SS transmits an AMD PDU containing the second half (50 bytes) of SDU#1 and the first half (50 bytes) of SDU#2 in its data field to the UE. LI associated with PDU#2 has a value > PDU size, i.e. > 100.	<--	AMD PDU#2 (SN=1)	-	-
3	The SS transmits an AMD PDU containing the second half (50 bytes) of SDU#2 and the first half (50 bytes) of SDU#3 in its data field to the UE.	<--	AMD PDU#3 (SN=2)	-	-
4	The SS transmits an AMD PDU containing the second half (50 bytes) of SDU#3 in its data field to the UE.	<--	AMD PDU#4 (SN=3)	-	-
4A	100 ms after step 4 t he SS assigns an UL grant (UL grant allocation type 3) of size 56 bits (Note 1).	<--	(UL grant, 56 bits)	-	-
5	Check: Does the UE transmit a STATUS PDU with NACK_SN field set to 1?	-->	STATUS PDU	1	P
6	The SS transmits an AMD PDU containing the second half (50 bytes) of SDU#1 and the first half (50 bytes) of SDU#2 in its data field to the UE. The LI is correct.	<--	AMD PDU#2 (SN=1)	-	-
6A	The SS waits for 60 ms to ensure UE RLC has all the required SDU available in UL for loopback.				
6B	The SS transmits an UL grant (UL grant allocation type 3) of size 2536 bits (Note 2).	<--	(UL grant, 2536 bits)	-	-
7	Check: Does the UE transmit RLC SDU#1, SDU#2, and SDU#3? (Note 3: Details for RLC PDU carrying RLC SDU#3)	-->	AMD PDU(RLC SDU#1, RLC SDU#2, RLC SDU#3)	1	P
8	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=1)	-	-

Note 1: UL grant of 56 bits (I_{TBS}=1, N_{PRB}=2, see TS 36.213 Table 7.1.7.2.1-1) is chosen such that UE will be enabled to send the status PDU.
Note 2: UL grant of 2536 bits (I_{TBS}=13, N_{PRB}=10, see TS 36.213 Table 7.1.7.2.1-1) is chosen such that UE will fit all 3 SDU in one AMD PDU.
Note 3: In step 7, poll is set so SS will send STATUS PDU to UE in step 8.

7.2.3.5.3.3 Specific message contents

None.

7.2.3.6 AM RLC / Correct use of sequence numbering

7.2.3.6.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits the first PDU }
    then { UE sets the Sequence Number field equal to 0 }
          }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
```

```
ensure that {
  when { UE transmits subsequent PDUs }
    then { SN incremented by 1 for each PDU transmitted }
           }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits more than 1024 PDUs }
    then { UE wraps the Sequence Number after transmitting the 1024 PDU }
           }
```

(4)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { more than 1024 PDUs are sent to UE }
    then { UE accepts PDUs with SNs that wrap around every 1024 PDU }
           }
```

7.2.3.6.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clauses 5.1.3.1.1, 6.2.2.3 and 7.1.

[TS 36.322, clause 5.1.3.1.1]

The transmitting side of an AM RLC entity shall prioritize transmission of RLC control PDUs over RLC data PDUs. The transmitting side of an AM RLC entity shall prioritize retransmission of RLC data PDUs over transmission of new AMD PDUs.

The transmitting side of an AM RLC entity shall maintain a transmitting window according to state variables VT(A) and VT(MS) as follows:

- a SN falls within the transmitting window if VT(A) <= SN < VT(MS);
- a SN falls outside of the transmitting window otherwise.

The transmitting side of an AM RLC entity shall not deliver to lower layer any RLC data PDU whose SN falls outside of the transmitting window.

When delivering a new AMD PDU to lower layer, the transmitting side of an AM RLC entity shall:

- set the SN of the AMD PDU to VT(S), and then increment VT(S) by one.

The transmitting side of an AM RLC entity can receive a positive acknowledgement (confirmation of successful reception by its peer AM RLC entity) for a RLC data PDU by the following:

- STATUS PDU from its peer AM RLC entity.

When receiving a positive acknowledgement for an AMD PDU with SN = VT(A), the transmitting side of an AM RLC entity shall:

- set VT(A) equal to the SN of the AMD PDU with the smallest SN, whose SN falls within the range VT(A) <= SN <= VT(S) and for which a positive acknowledgment has not been received yet.
- if positive acknowledgements have been received for all AMD PDUs associated with a transmitted RLC SDU :- send an indication to the upper layers of successful delivery of the RLC SDU.

[TS 36.322, clause 6.2.2.3]

Length: 10bits for AMD PDU, AMD PDU segments and STATUS PDUs. ...

The SN field indicates the sequence number of the corresponding ... AMD PDU. For an AMD PDU segment, the SN field indicates the sequence number of the original AMD PDU from which the AMD PDU segment was constructed from. The sequence number is incremented by one for every ... AMD PDU.

[TS 36.322, clause 7.1]

...

All state variables and all counters are non-negative integers.

All state variables related to AM data transfer can take values from 0 to 1023. All arithmetic operations contained in the present document on state variables related to AM data transfer are affected by the AM modulus (i.e. final value = [value from arithmetic operation] modulo 1024).

AMD PDUs ... are numbered integer sequence numbers (SN) cycling through the field: 0 to 1023 for AMD PDU ...

...

c) VT(S) – Send state variable

This state variable holds the value of the SN to be assigned for the next newly generated AMD PDU. It is initially set to 0, and is updated whenever the AM RLC entity delivers an AMD PDU with SN = VT(S).

...

7.2.3.6.3 Test description

7.2.3.6.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- UE is in state Loopback Activated (state 4) according to [18].

7.2.3.6.3.2 Test procedure sequence

Table 7.2.3.6.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
-	During the whole test sequence, the SS should not allocate UL grants unless when explicitly stated so in the procedure.	-	-	-	-
-	EXCEPTION: SS is configured 500ms in advance for step 1 and 2. Step 1 is executed 512 times such that 1 AMD PDU is transmitted every second radio frame. (Note 1) . Step 2 is started 60 ms after the first DL AMD PDU has been transmitted in step 1 (Note 1).	-	-	-	-
-	EXCEPTION: In parallel to steps 1 and 2, the behaviour described in table 7.2.3.6.3.2-2 is running.	-	-	-	-
1	The SS transmits an AMD PDU to the UE. SN equals 0 and is incremented for each PDU transmitted (Note 1).	<--	AMD PDU	-	-
2	The SS transmits 1 UL grant (UL grant allocation type 2) in every second radio frame to enable the UE to return each received AMD PDU in one looped back AMD PDU (Note 1).	<--	(UL grants)	-	-
2A	The SS does not allocate any uplink grant.	-	-	-	-
-	EXCEPTION: SS is configured 500ms in advance for step 2B and 2C.Step 2B is executed 512 times such that 1 AMD PDU is transmitted every second radio frame. (Note 1) . Step 2C is started 60 ms after the first DL AMD PDU has been transmitted in step 2B (Note 1).	-	-	-	-
-	EXCEPTION: In parallel to steps 2B and 2C, the behaviour described in table 7.2.3.6.3.2-3 is running.	-	-	-	-
2B	The SS transmits an AMD PDU to the UE. SN equals 512 and is incremented for each PDU transmitted.	<--	AMD PDU	-	-
2C	The SS transmits 1 UL grant (UL grant allocation type 2) in every second radio frame to enable the UE to return each received AMD PDU in one looped back AMD PDU (Note 1). .	<--	(UL grants)	-	-
3	The SS transmits an AMD PDU to the UE. SN equals 0.	<--	AMD PDU	-	-
4	Void	-	-	-	-
4A	The SS starts the UL default grant transmission	-	-	-	-
5	Check: Does the UE transmit an AMD PDU with SN=0?	-->	AMD PDU	3,4	P
6	The SS transmits a STATUS PDU with ACK_SN = 1.	<--	STATUS PDU	-	-

Note 1: 20 ms gap between transmissions both in DL and UL respectively allows TTCN to tolerate one HARQ retransmission (FDD/TDD) per transport block, if such happen (TS 36.523-3).

Note 2: Delaying first UL grant for 60 ms, ensures that UE UL buffer does not become empty every time one UL AMD PDU is sent i.e. UE does not enable polling for every UL AMD PDU. SS continuously transmits the grants until it has received all PDUs in UL.

Table 7.2.3.6.3.2-2: Parallel behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	Check: Does the UE transmit an AMD PDU with SN = 0?	-->	AMD PDU	1	P
-	EXCEPTION: Steps 2 and 3a1 are executed 511 times.	-	-	-	-
2	Check: Does the UE transmit an AMD PDU with SN increased by 1 compared with the previous one?	-->	AMD PDU	2	P
	EXCEPTION: Step 3a1 describes behaviour that depends on the contents of the AMD PDU transmitted at Step 2.	-	-	-	-
3a1	IF the UE has set the poll bit in the AMD PDU transmitted at Step 2 THEN the SS transmits a Status Report.	<--	STATUS PDU	-	-

Table 7.2.3.6.3.2-3: Parallel behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	EXCEPTION: Steps 1 and 2a1 are executed 512 times.	-	-	-	-
1	Check: Does the UE transmit an AMD PDU with SN increased by 1 compared with the previous one?	-->	AMD PDU	2	P
	EXCEPTION: Step 2a1 describes behaviour that depends on the contents of the AMD PDU transmitted at Step 1.	-	-	-	-
2a1	IF the UE has set the poll bit in the AMD PDU transmitted at Step 1 THEN the SS transmits a Status Report.	<--	STATUS PDU	-	-

7.2.3.6.3.3 Specific message contents

None.

7.2.3.7 AM RLC / Control of transmit window

7.2.3.7.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state with DRB established and pending uplink data for
transmission}
ensure that {
  when { AMD PDUs in transmission buffer fall outside VT(A) <= SN < VT(MS) }
   then { UE does not transmit these AMD PDUs }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state with DRB established and pending uplink data for
transmission }
ensure that {
  when { receiving a STATUS PDU where ACK_SN acknowledges at least one AMD PDU not yet acknowledged
}
    then { UE transmits AMD PDUs within updated window range}
 }
```

7.2.3.7.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clauses 5.1.3.1.1, 7.1 and 7.2.

[TS 36.322, clause 5.1.3.1.1]

...

The transmitting side of an AM RLC entity shall maintain a transmitting window according to state variables VT(A) and VT(MS) as follows:

- a SN falls within the transmitting window if VT(A) <= SN < VT(MS);
- a SN falls outside of the transmitting window otherwise.

The transmitting side of an AM RLC entity shall not deliver to lower layer any RLC data PDU whose SN falls outside of the transmitting window.

When delivering a new AMD PDU to lower layer, the transmitting side of an AM RLC entity shall:

- set the SN of the AMD PDU to VT(S), and then increment VT(S) by one.

The transmitting side of an AM RLC entity can receive a positive acknowledgement (confirmation of successful reception by its peer AM RLC entity) for a RLC data PDU by the following:

- STATUS PDU from its peer AM RLC entity.

When receiving a positive acknowledgement for an AMD PDU with SN = VT(A), the transmitting side of an AM RLC entity shall:

- set VT(A) equal to the SN of the AMD PDU with the smallest SN, whose SN falls within the range VT(A) <= SN <= VT(S) and for which a positive acknowledgment has not been received yet.
- if positive acknowledgements have been received for all AMD PDUs associated with a transmitted RLC SDU :
  - send an indication to the upper layers of successful delivery of the RLC SDU.

[TS 36.322, clause 7.2]

a) AM_Window_Size

This constant is used by both the transmitting side and the receiving side of each AM RLC entity to calculate VT(MS) from VT(A), and VR(MR) from VR(R). AM_Window_Size = 512.

...

[TS 36.322, clause 7.1]

…

a) VT(A) – Acknowledgement state variable

This state variable holds the value of the SN of the next AMD PDU for which a positive acknowledgment is to be received in-sequence, and it serves as the lower edge of the transmitting window). It is initially set to 0, and is updated whenever the AM RLC entity receives a positive acknowledgment for an AMD PDU with SN = VT(A).

b) VT(MS) – Maximum send state variable

This state variable equals VT(A) + AM_Window_Size, and it serves as the higher edge of the transmitting window.

...

7.2.3.7.3 Test description

7.2.3.7.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- UE is in state Loopback Activated (state 4) according to [18] with the loopback size set to 100 bytes, and with the expectations listed in table 7.2.3.7.3.1-1.

Table 7.2.3.7.3.1-1: RLC Settings

Parameter	Value
PollPDU	pInfinity
PollByte	kBinfinity
t-PollRetransmit	ms300

Table 7.2.3.7.3.1-2: SchedulingRequest-Config

Derivation Path: 36.508 Table 4.6.3-20			
Information Element	**Value/remark**	**Comment**	**Condition**
dsr-TransMax	n8		

7.2.3.7.3.2 Test procedure sequence

Table 7.2.3.7.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	The SS does not allocate any uplink grant.	-	-	-	-
-	EXCEPTION: The SS is configured for step 1 and 1A 500ms in advance. Step 1 is repeated W+1 times, where W = AM_Window_Size. The transmission is performed every second radio frame. (Note 2). Step 1A is started 100 ms after the first DL AMD PDU has been transmitted in step 1.	-	-	-	-
-	EXCEPTION: In parallel to steps 1 and 1A, the behaviour described in table 7.2.3.7.3.2-2 is running.	-	-	-	-
1	The SS transmits an AMD PDU containing a SDU to the UE.	<--	AMD PDU	-	-
1A	In the following steps the SS transmits 1 UL grant (UL grant allocation type 2) in every second radio frame to enable the UE to return each received AMD PDU in one looped back AMD PDU. (Note 2)	<--	(UL grants)	-	-
1B	Void	-	-	-	-
1C	Check: Does the UE transmit an AMD PDU with the Poll bit set and with the contents of the SDU?	-->	AMD PDU(SN=W-1), Poll	1	P
1D	The SS starts the UL default grant transmission	-	-	-	-
2	Check: Does the UE transmit an AMD PDU within *t-PollRetransmit*/2?	-->	AMD PDU	1	F
3	The SS transmits a STATUS PDU to acknowledge the W uplink AMD PDUs with SN=0 to SN=W-1. ACK_SN = W.	<--	STATUS PDU	-	-
3A	Check: Does the UE transmit an AMD PDU with the Poll bit set and with the contents of the SDU?	-->	AMD PDU(SN=W), Poll	2	P
3B	The SS transmits a STATUS PDU with ACK_SN = W+1.	<--	STATUS PDU	-	-
Note 1: SDUs are numbered 1,2, …, W+1 Note 2: 20 ms gap between transmissions both in DL and UL respectively allows TTCN to tolerate one HARQ retransmission (FDD/TDD) per transport block, if such happen (TS 36.523-3).					

Table 7.2.3.7.3.2-2: Parallel behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	EXCEPTION: Step 1 is executed W-1 times.	-	-	-	-
1	The UE transmits an AMD PDU with the same data as received in the corresponding DL AMD PDU.	-->	AMD PDU	-	-

7.2.3.7.3.3 Specific message contents

None.

7.2.3.8 AM RLC / Control of receive window

7.2.3.8.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { the UE receives AMD PDUs with SN outside the upper boundary of the receive window }
    then { the UE discards these AMD PDUs }
          }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { the receive window has been moved }
    then { UE continues accepting AMD PDUs within updated window range }
          }
```

7.2.3.8.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clauses 5.1.3.2.1 and 7.2.

[TS 36.322, clause 5.1.3.2.1]

The receiving side of an AM RLC entity shall maintain a receiving window according to state variables VR(R) and VR(MR) as follows:

- a SN falls within the receiving window if VR(R) <= SN < VR(MR);
- a SN falls outside of the receiving window otherwise.

When receiving a RLC data PDU from lower layer, the receiving side of an AM RLC entity shall:

- either discard the received RLC data PDU or place it in the reception buffer (see sub clause 5.1.3.2.2);
- if the received RLC data PDU was placed in the reception buffer:
  - update state variables, reassemble and deliver RLC SDUs to upper layer and start/stop *t-Reordering* as needed (see sub clause 5.1.3.2.3).

When *t-Reordering* expires, the receiving side of an AM RLC entity shall:

- update state variables and start *t-Reordering* as needed (see sub clause 5.1.3.2.4).

[TS 36.322, clause 7.2]

a) AM_Window_Size

This constant is used by both the transmitting side and the receiving side of each AM RLC entity to calculate VT(MS) from VT(A), and VR(MR) from VR(R). AM_Window_Size = 512.

...

7.2.3.8.3 Test description

7.2.3.8.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with a loopback size of 0 byte.

7.2.3.8.3.2 Test procedure sequence

Table 7.2.3.8.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
-	EXCEPTION: SS is configured 500ms in advance for step 1. Step 1 shall be repeated W times, where W is AM_Window_Size. Polling bit enabled for the Wth RLC PDU transmitted. The SS shall set the Sequence Number field for the first AMD PDU to 0 and increment it by 1 for every execution of Step 1. The transmission is performed in every second radio frame.(Note 3)	-	-	-	-
1	The SS transmits an AMD PDU to the UE	<--	AMD PDU		
2	Check: Does the UE transmit a STATUS PDU acknowledging W PDUs? (ACK_SN = W)	-->	STATUS PDU	1	P
3	The SS transmits the (W+1)th AMD PDU to the UE with the Sequence Number field set to ((2W mod 1024) = 0) and the Polling bit set.	<--	AMD PDU	-	-
4	Check: does the UE transmit a STATUS PDU acknowledging W PDUs? (ACK_SN = W) (Note 1)	-->	STATUS PDU	1	P
5	The SS transmits the (W+2)th AMD PDU to the UE with the Sequence Number field set to W and the Polling bit set.	<--	AMD PDU	-	-
6	Check: Does the UE transmit a STATUS PDU acknowledging W +1 PDUs? (ACK_SN field = W+1) (Note 2)	-->	STATUS PDU	2	P
Note 1: This shows that the UE has discarded the (W+1)th PDU. Note 2: This shows that the UE did not discard the (W+2)th PDU and has updated the Receive Window correctly. Note 3: 20 ms gap between transmissions both in DL and UL respectively allows TTCN to tolerate one HARQ retransmission (FDD/TDD) per transport block, if such happen (TS 36.523-3).					

7.2.3.8.3.3 Specific message contents

None.

7.2.3.9 AM RLC / Polling for status

7.2.3.9.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { last data in the buffer was transmitted }
   then { UE transmits a Poll }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { the t-PollRetransmit timer expires }
   then { UE transmits a Poll }
}
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { PDU_WITHOUT_POLL=pollPDU }
   then { UE transmits a Poll }
}
```

(4)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { BYTE_WITHOUT_POLL=pollByte }
   then { UE transmits a Poll }
}
```

7.2.3.9.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clauses 5.2.2.

[TS 36.322, clause 5.2.2]

…

Upon assembly of a new AMD PDU, the transmitting side of an AM RLC entity shall:

- increment PDU_WITHOUT_POLL by one;
- increment BYTE_WITHOUT_POLL by every new byte of Data field element that it maps to the Data field of the RLC data PDU;
- if PDU_WITHOUT_POLL >= *pollPDU*; or
- if BYTE_WITHOUT_POLL >= *pollByte*;
  - include a poll in the RLC data PDU as described below.

Upon assembly of an AMD PDU or AMD PDU segment, the transmitting side of an AM RLC entity shall:

- if both the transmission buffer and the retransmission buffer becomes empty (excluding transmitted RLC data PDU awaiting for acknowledgements) after the transmission of the RLC data PDU; or
- if no further RLC data PDU can be transmitted after the transmission of the RLC data PDU (e.g. due to window stalling);
  - include a poll in the RLC data PDU as described below.

To include a poll in a RLC data PDU, the transmitting side of an AM RLC entity shall:

- set the P field of the RLC data PDU to "1";
- set PDU_WITHOUT_POLL to 0;
- set BYTE_WITHOUT_POLL to 0;

After delivering a RLC data PDU including a poll to lower layer and after incrementing of VT(S) if necessary, the transmitting side of an AM RLC entity shall:

- set POLL_SN to VT(S) – 1;
- if *t-PollRetransmit* is not running:

- start *t-PollRetransmit*;

- else:

  - restart *t-PollRetransmit*;

[TS 36.322, clause 5.2.2.3]

Upon expiry of *t-PollRetransmit*, the transmitting side of an AM RLC entity shall:

- if both the transmission buffer and the retransmission buffer are empty (excluding transmitted RLC data PDU awaiting for acknowledgements); or

- if no new RLC data PDU can be transmitted (e.g. due to window stalling):

  - consider the AMD PDU with SN = VT(S) – 1 for retransmission;

  - consider any AMD PDU which has not been positively acknowledged for retransmission;

- include a poll in a RLC data PDU as described in section 5.2.2.1.

7.2.3.9.3 Test description

7.2.3.9.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.3.9.3.1-1 and 7.2.3.9.3.1-2.

Table 7.2.3.9.3.1-1: RLC Settings

Parameter	Value
pollPDU	p256
pollByte	kB25
t-PollRetransmit	ms400

Table 7.2.3.9.3.1-2: SchedulingRequest-Config

Derivation Path: 36.508 Table 4.6.3-20			
Information Element	**Value/remark**	**Comment**	**Condition**
dsr-TransMax	n8		

7.2.3.9.3.2 Test procedure sequence

Table 7.2.3.9.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
0	During the whole test sequence, the SS should not allocate UL grants unless when explicitly stated so in the procedure.	-	-	-	-
1	The SS transmits 4 AMD PDUs such that 1 AMD PDU is sent every second radio frame, each containing an RLC SDU of 2 560 bits. (Note 2)	<--	AMD PDU (SN=0) AMD PDU (SN=1) AMD PDU (SN=2) AMD PDU (SN=3)	-	-
-	EXCEPTION: In parallel to the events described in step 1A, the step specified in Table 7.2.3.9.3.2-2 should take place.	-	-	-	-
1A	The SS waits for 100 ms after the first DL AMD PDU has been transmitted in step 1, then starts assigning UL grants (UL grant allocation type 2) in every second radio frame of size 2 600 bits. (Note 1) (Note 2)	-	-	-	-
2	Check 1: Does the UE transmit an AMD PDU with a SN in range 0 to 3 and P=1? Record time T_B. Check 2: Is (T_B – T_A) = *t-PollRetransmit*?	-->	AMD PDU	2	P
2A	The SS starts the UL default grant transmission	-	-	-	-
3	Upon receiving the Poll, the SS transmits an RLC Status Report.	<--	STATUS PDU	-	-
4	Check: Does the UE retransmit an AMD PDU within 1 sec?	-->	AMD PDU	2	F
5	SS performs an RRC Connection Reconfiguration procedure changing *pollPDU* to p4.	-	-	-	-
5A	The SS does not allocate any UL grant.	-	-	-	-
6	The SS transmits 8 AMD PDUs such that 1 AMD PDU is sent every second radio frame, each containing an RLC SDU of 2 560 bits. (Note 2)	<--	AMD PDU (SN=4) AMD PDU (SN=5) ... AMD PDU (SN=11)	-	-
-	EXCEPTION: In parallel to the events described in step 6A, the step specified in Table 7.2.3.9.3.2-3 should take place.	-	-	-	-
6A	The SS waits for 100 ms after the first DL AMD PDU has been transmitted in step 6, then starts assigning UL grants (UL grant allocation type 2) in every second radio frame of size 2 600 bits. (Note 1) (Note 2)	-	-	-	-
7	The SS transmits a Status Report with ACK_SN=12, NACK_SN=4, NACK_SN=5, NACK_SN=6, NACK_SN=8 and NACK_SN=9.	<--	STATUS PDU	-	-
8	Check: Does the UE transmit AMD PDUs with the following SN and P values? AMD PDU, SN=4, P=0 AMD PDU, SN=5, P=0 AMD PDU, SN=6, P=0 AMD PDU, SN=8, P=0 AMD PDU, SN=9, P=1	-->	AMD PDU (SN=4, P=0) AMD PDU (SN=5, P=0) AMD PDU (SN=6, P=0) AMD PDU (SN=8, P=0) AMD PDU (SN=9, P=1)	3	P
8AA	The SS starts the UL default grant transmission	-	-	-	-
8A	The SS transmits a Status Report with ACK_SN=12 and no NACK_SN.	<--	STATUS PDU	-	-
9	SS performs an RRC Connection Reconfiguration procedure changing *pollPDU* to p256.	-	-	-	-
9A	The SS does not allocate any UL grant.	-	-	-	-
10	After 500 ms the SS transmits 160 AMD PDUs such that 1 AMD PDU is sent every second	<--	AMD PDU (SN=12) AMD PDU (SN=13)	-	-

	radio frame, each containing an RLC SDU of size 2 560 bits. (Note 2)		... AMD PDU (SN=171)		
-	EXCEPTION: In parallel to the events described in step 10A, the steps specified in Table 7.2.3.9.3.2-4 should take place.	-	-	-	-
10A	The SS waits for 100 ms after the first DL AMD PDU has been transmitted in step 10, then starts assigning UL grants (UL grant allocation type 2) in every second radio frame of size 2600 bits. (Note 1) (Note 2)	-	-	-	-
10B	The SS starts the UL default grant transmission	-	-	-	-
Note 1: UL grant of 2600 bits (I_{TBS}=14, N_{PRB}=9, see TS 36.213 Table 7.1.7.2.1-1) is chosen to allow the UE to loop back one SDU of size 2560 bits and one short BSR (8 bits) into each MAC PDU sent in the uplink (2600 bits - 16 bit AMD PDU header - 8 bit MAC BSR subheader - 8 bit MAC PDU subheader). The UE will include an SDU of size 2560 bits and one short BSR in the looped back MAC PDU. Note 2: 20ms gap between transmissions both in DL and UL respectively allows TTCN to tolerate one HARQ retransmission (FDD/TDD) per transport block, if such happen (TS 36.523-3).					

Table 7.2.3.9.3.2-2: Parallel behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	Check: Does the UE transmit 4 AMD PDUs, with only the last one having the poll bit set? Record time T_A when the PDU with the poll bit set is received at the SS.	-->	AMD PDUs	1	P

Table 7.2.3.9.3.2-3: Parallel behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	Check: Does the UE transmit 8 AMD PDUs, with the poll bit set only in the 4th and the 8th PDUs?	-->	AMD PDUs	3	P

Table 7.2.3.9.3.2-4: Parallel behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	Check: Does the UE transmit 79 AMD PDUs, with the poll bit set only in the last (79th) one? (Note 1)	-->	AMD PDUs	1,4	P
2	The SS transmits an RLC Status Report.	<--	STATUS PDU	-	-
3	Check: Does the UE transmit 79 AMD PDUs, with the poll bit set only in the last (158th) one? (Note 1)	-->	AMD PDUs	1,4	P
4	The SS transmits an RLC Status Report.	<--	STATUS PDU	-	-
5	Check: Does the UE transmit 2 AMD PDUs, with the poll bit set only in the last (160th) one?	-->	AMD PDUs	1,4	P
6	The SS transmits an RLC Status Report.	<--	STATUS PDU	-	-
Note 1: (2560 bits x 79 PDUs) / 8 = 25 280 > 25 KB, with 1 kB = 1000 bytes (TS 36.331, cl. 3.2)					

7.2.3.9.3.3 Specific message contents

None.

7.2.3.10 AM RLC / Receiver status triggers

7.2.3.10.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { Reception failure of an RLC data PDU is detected }
   then { UE initiates Status Reporting when t-Reordering expires }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { Status Reporting is triggered and t-StatusProhibit is running}
   then { UE wait until t-StatusProhibit has expired to send Status Report }
}
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { Polling from peer AM RLC entity is detected and the sequence number of the PDU that carries
the Poll is less than VR(MS) }
   then { UE initiates Status Reporting }
}
```

(4)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { Polling from peer AM RLC entity is detected and the sequence number of the PDU that carries
the Poll is greater than or equal to VR(MS) }
   then { UE waits until VR(MS) becomes greater than the sequence number of the PDU with the Poll
before initiating Status Reporting }
}
```

(5)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { the UE needs to send a Status Report and the UL grant is not large enough to accommodate
the whole report }
   then { UE includes as many NACK SNs in the Status Report as allowed by the UL grant }
}
```

7.2.3.10.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clause 5.2.3.

[TS 36.322, clause 5.2.3]

An AM RLC entity sends STATUS PDUs to its peer AM RLC entity in order to provide positive and/or negative acknowledgements of RLC PDUs (or portions of them).

RRC configures whether or not the status prohibit function is to be used an AM RLC entity.

Triggers to initiate STATUS reporting include:

- Polling from its peer AM RLC entity:
  - When a RLC data PDU with SN = x and the P field set to "1" is received from lower layer, the receiving side of an AM RLC entity shall:
    - if the PDU is to be discarded as specified in subclause 5.1.3.2.2; or
    - if x < VR(MS) or x >= VR(MR):
      - trigger a STATUS report;

- else:
  - delay triggering the STATUS report until x < VR(MS) or x >= VR(MR).

NOTE: This ensures that the RLC Status report is transmitted after HARQ reordering.

- Detection of reception failure of an RLC data PDU:
  - The receiving side of an AM RLC entity shall trigger a STATUS report when *t-Reordering* expires.

NOTE: The expiry of T_reordering triggers both VR(MS) to be updated and a STATUS report to be triggered, but the STATUS report shall be triggered after VR(MS) is updated.

When STATUS reporting has been triggered, the receiving side of an AM RLC entity shall:

- if *t-StatusProhibit* is not running:
  - at the first transmission opportunity indicated by lower layer, construct a STATUS PDU and deliver it to lower layer;
- else:
  - at the first transmission opportunity indicated by lower layer after *t-StatusProhibit* expires, construct a single STATUS PDU even if status reporting was triggered several times while *t-StatusProhibit* was running and deliver it to lower layer;

When a STATUS PDU has been delivered to lower layer, the receiving side of an AM RLC entity shall:

- start *t-StatusProhibit*.

When constructing a STATUS PDU, the AM RLC entity shall:

- for the AMD PDUs with SN such that VR(R) <= SN < VR(MS) that has not been completely received yet, in increasing SN order of PDUs and increasing byte segment order within PDUs, starting with SN = VR(R) up to the point where the resulting STATUS PDU still fits to the total size of RLC PDU(s) indicated by lower layer:
  - for an AMD PDU for which no byte segments have been received yet for an AMD PDU:
    - include in the STATUS PDU a NACK_SN which is set to the SN of the AMD PDU;
  - for a continuous sequence of byte segments of a partly received AMD PDU that have not been received yet :
    - include in the STATUS PDU a set of NACK_SN, SOstart and SOend
- set the ACK_SN to the SN of the next not received RLC Data PDU which is not indicated as missing in the resulting STATUS PDU.

7.2.3.10.3 Test description

7.2.3.10.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble

- The UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.3.10.3.1-1.

Table 7.2.3.10.3.1-1: RLC settings

Parameter	Value
t-Reordering	ms150
t-StatusProhibit	ms300
t-PollRetransmit	ms500

7.2.3.10.3.2 Test procedure sequence

Table 7.2.3.10.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	The SS ignores scheduling requests and does not allocate any uplink grant.	-	-	-	-
1	The SS transmits 4 AMD PDUs with SN=0, 1, 2, and 4. The SS sets the P field of all the AMD PDUs to 0. Record time T_A when the AMD PDU with SN=4 is sent.	<--	AMD PDU (SN=0, P=0) AMD PDU (SN=1, P=0) AMD PDU (SN=2, P=0) AMD PDU (SN=4, P=0)	-	-
1A	The SS waits for 60 ms after the transmission of the first AMD PDU to ensure UE RLC has all the required SDUs available and then assigns 3 UL grants (UL grant allocation type 2) with a time spacing of 5 ms of size 840 bits (UL Grant Allocation type 2). (Note 1, Note 5)	<--	(UL grants, 840 bits)	-	-
1B	The UE transmits RLC SDU#1.	-->	(RLC SDU#1)	-	-
1C	The UE transmits RLC SDU#2.	-->	(RLC SDU#2)	-	-
1D	The UE transmits RLC SDU#3.	-->	(RLC SDU#3)	-	-
1E	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-
1F	The SS starts the UL default grant transmission	-	-	-	-
2	Check 1: Does the UE transmit a Status Report with NACK_SN=3 and ACK_SN=5? Record time T_B Check 2: (T_B – T_A) = *t-Reordering*	-->	STATUS PDU	1	P
3	100 ms after the Status Report is received at Step 2, the SS transmits 4 AMD PDUs with SN=5, 6, 8 and 9. The SS sets the P field of all the AMD PDUs to 0.	<--	AMD PDU (SN=5, P=0) AMD PDU (SN=6, P=0) AMD PDU (SN=8, P=0) AMD PDU (SN=9, P=0)	-	-
3A	Void	-	-	-	-
3B	Check 1: Does the UE transmit a Status Report with NACK_SN=3, ACK_SN=7? Record time T_C Check 2: (T_C – T_B) = *t-StatusProhibit*	-->	STATUS PDU	2	P
3C	Void	-	-	-	-
4	The UE transmit a Status Report with NACK_SN=3, NACK_SN=7 and ACK_SN=10	-->	STATUS PDU		
4A	The SS ignores scheduling requests unless otherwise specified and does not allocate any uplink grant and is configured for Uplink Grant Allocation Type 3.	-	-	-	-
5	Void	-	-	-	-
6	After 300 ms the SS transmits 2 AMD PDUs with SN=3, SN=7. The SS sets the P field of all the AMD PDUs to 0 except for that of the AMD PDU with SN=7.	<--	AMD PDU (SN=3, P=0) AMD PDU (SN=7, P=1)	-	-
6A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns 1 UL grant (UL grant allocation type 3) of size 40 bits. (Note 2)	<--	(UL grant, 40 bits)	-	-
7	Check: Does the UE transmit a Status Report with no NACK_SN and ACK_SN = 10?	-->	STATUS PDU	3	P
7A	In the subframe following the one scheduled in step 6A the SS assigns 7 UL grants (UL grant allocation type 2) with a time spacing of 5 ms of size 840 bits. (Note 1)	<--	(UL grant, 840 bits)	-	-
7B	The UE transmits RLC SDU#4.	-->	(RLC SDU#4)	-	-
7C	The UE transmits RLC SDU#5.	-->	(RLC SDU#5)	-	-
7D	The UE transmits RLC SDU#6.	-->	(RLC SDU#6)	-	-
7E	The UE transmits RLC SDU#7.	-->	(RLC SDU#7)	-	-
7F	The UE transmits RLC SDU#8.	-->	(RLC SDU#8)	-	-
7G	The UE transmits RLC SDU#9.	-->	(RLC SDU#9)	-	-
7H	The UE transmits RLC SDU#10.	-->	(RLC SDU#10)	-	-

7I	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-
8	Void	-	-	-	-
9	After 300 ms the SS transmits an AMD PDU with SN=10 and P=0, and an AMD PDU with SN=12 and P=1.	<--	AMD PDU (SN=10, P=0) AMD PDU (SN=12, P=1)	-	-
9A	Check: Does the UE transmits a scheduling request within *t-Reordering* / 2 ms?	-->	(SR)	4	F
10	Within *t-Reordering* / 2 ms after Step 9, the SS transmits an AMD PDU with SN=11 and P=0. Note: AMD PDUs with SN 10,11 and 12 carry RLC SDU #11.	<--	AMD PDU (SN=11, P=0)	-	-
10 A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns 1 UL grant (UL grant allocation type 3) of size 40 bits. (Note 2)	<--	(UL grants, 40 bits)	-	-
11	Check: Does the UE transmit a Status Report with no NACK_SN and ACK_SN=13?	-->	STATUS PDU	4	P
11 A	The SS assigns 1 UL grant (UL grant allocation type 3) of size 840 bits. (Note 1)	<--	(UL grant, 840 bits)	-	-
11 B	The UE transmit RLC SDU#11.	-->	(RLC SDU#11)	-	-
11 C	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-
12	Void	-	-	-	-
13	Void	-	-	-	-
14	After 300 ms the SS transmits an AMD PDU with SN=13 and P=0, and an AMD PDU with SN=19 and P=1.	<--	AMD PDU (SN=13, P=0) AMD PDU (SN=19, P=1)	-	-
15	The SS waits for *t-Reordering* ms to ensure expiry.	-	-	-	-
16	Void	-	-	-	-
17	60 ms after step 15 the SS assigns an UL grant (UL grant allocation type 3) of size 72 bits. (Note 3)	<--	(UL Grant)	-	-
18	Void	-	-	-	-
-	Steps 18a1 and 18b1 depends on the UE behaviour; the "lower case letter" identifies a step sequence that takes place if a specific behaviour happens	-	-	-	-
18a 1	Check: Does the UE transmit a Status Report with ACK_SN=16 and 2 NACK_SNs: 14 and 15?	-->	STATUS PDU	5	P
18b 1	Check: Does the UE transmit a Status Report with ACK_SN=18 and 4 NACK_SNs: 14,15, 16 and 17?	-->	STATUS PDU	5	P
19	Void	-	-	-	-
20	Void	-	-	-	-
21	After 300 ms The SS transmits an AMD PDU with SN=14 and P=1.	<--	AMD PDU (SN=14, P=1)	-	-
22	60 ms after step 21 the SS assigns an UL grant (UL grant allocation type 3) of size 72 bits. (Note 4)	<--	(UL Grant)	-	-
23	Check: Does the UE transmit a Status Report with ACK_SN=20 and 4 NACK_SNs: 15, 16, 17 and 18?	-->	STATUS PDU	5	P
24	60 ms after step 22 t he SS transmits 4 AMD PDU with SN=15, 16, 17, 18. Note: AMD PDUs with SN 13 to 19 carry RLC SDU #12.	<--	AMD PDU (SN=15, P=0) AMD PDU (SN=16, P=0) AMD PDU (SN=17, P=0) AMD PDU (SN=18, P=0)	-	-
24 A	60 ms after step 24 the SS assigns 1 UL grant (UL grant allocation type 3) of size 840 bits. (Note 1)	<--	(UL grant, 840 bits)	-	-
25	The UE loopbacks the complete RLC SDU.	-->	(RLC SDU#12)	-	-
26	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-

Note 1: UL grant of 840 bits (I_{TBS}=14, N_{PRB}=3, see TS 36.213 Table 7.1.7.2.1-1) is chosen to allow the UE to transmit one PDU at a time.

Note 2: UL grant of 40 bits (I_{TBS}=3, N_{PRB}=1, see TS 36.213 Table 7.1.7.2.1-1) is chosen to allow the UE to transmit a

Status Report with ACK_SN and (8-bit short BSR + 2x 8-bit MAC PDU subheader + 4-bit D/C/CPT + 10-bit ACK_SN + 1-bit E1 + 1bit padding).
Note 3: UL grant of 72 bits (I_{TBS}=2, N_{PRB}=2, see TS 36.213 Table 7.1.7.2.1-1) is chosen to allow the UE to transmit (a Status Report with ACK_SN and 2 NACK_SNs (3x 8-bit MAC PDU subheader +8-bit Short BSR + 4-bit D/C/CPT + 10-bit ACK_SN + 1-bit E1 + 2 x (12-bit NACK_SN/E1/E2) + 1-bit Padding)) or (a Status Report with ACK_SN and 4 NACK_SNs (8-bit MAC PDU subheader +4-bit D/C/CPT + 10-bit ACK_SN + 1-bit E1 + 4 x (12-bit NACK_SN/E1/E2) +1-bit padding)).
Note 4: UL grant of 72 bits (I_{TBS}=2, N_{PRB}=2, see TS 36.213 Table 7.1.7.2.1-1) is chosen to allow the UE to transmit a Status Report with ACK_SN and 4 NACK_SNs (8-bit MAC PDU subheader + 4-bit D/C/CPT + 10-bit ACK_SN + 1-bit E1 + 4 x (12-bit NACK_SN/E1/E2) +1-bit padding).
Note 5: The first AMD PDU is transmitted in subframe #4. This subframe is as well suitable for the transmission of UL grants in TDD.

7.2.3.10.3.3 Specific message contents

None.

7.2.3.11 Void

7.2.3.12 Void

7.2.3.13 AM RLC / Reconfiguration of RLC parameters by upper layers

7.2.3.13.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { t-PollRetransmit value is changed during reconfiguration of RLC parameters by upper layers
}
   then { UE starts using new t-PollRetransmit value }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { t-Reordering value is changed during reconfiguration of RLC parameters by upper layers }
   then { UE starts using new t-Reordering value }
}
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state and using AM RLC }
ensure that {
  when { t-StatusProhibit value is changed during reconfiguration of RLC parameters by upper layers}
   then { UE starts using new t-StatusProhibit value }
}
```

7.2.3.13.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clause 5.2.2, 5.2.2.1, 5.2.2.2, 5.2.2.3 and 5.2.3.

[TS 36.322, clause 5.2.2]

An AM RLC entity can poll its peer AM RLC entity in order to trigger STATUS reporting at the peer AM RLC entity.

[TS 36.322, clause 5.2.2.1]

Upon assembly of a new AMD PDU, the transmitting side of an AM RLC entity shall:

- increment PDU_WITHOUT_POLL by one;
- increment BYTE_WITHOUT_POLL by every new byte of Data field element that it maps to the Data field of the RLC data PDU;
- if PDU_WITHOUT_POLL >= *pollPDU*; or

- if BYTE_WITHOUT_POLL >= *pollByte*;
    - include a poll in the RLC data PDU as described below.

Upon assembly of a AMD PDU or AMD PDU segment, the transmitting side of an AM RLC entity shall:

- if both the transmission buffer and the retransmission buffer becomes empty (excluding transmitted RLC data PDU awaiting for acknowledgements) after the transmission of the RLC data PDU; or
- if no new RLC data PDU can be transmitted after the transmission of the RLC data PDU (e.g. due to window stalling);
    - include a poll in the RLC data PDU as described below.

To include a poll in a RLC data PDU, the transmitting side of an AM RLC entity shall:

- set the P field of the RLC data PDU to "1";
- set PDU_WITHOUT_POLL to 0;
- set BYTE_WITHOUT_POLL to 0;

After delivering a RLC data PDU including a poll to lower layer and after incrementing of VT(S) if necessary, the transmitting side of an AM RLC entity shall:

- set POLL_SN to VT(S) – 1;
- if *t-PollRetransmit* is not running:
    - start *t-PollRetransmit*;
- else:
    - restart *t-PollRetransmit*;

[TS 36.322, clause 5.2.2.2]

Upon reception of a STATUS report from the receiving RLC AM entity the transmitting side of an AM RLC entity shall:

- if the STATUS report comprises a positive or negative acknowledgement for the RLC data PDU with sequence number equal to POLL_SN:
    - if the *t-PollRetransmit* is running:
        - stop and reset *t-PollRetransmit*.

[TS 36.322, clause 5.2.2.3]

Upon expiry of *t-PollRetransmit*, the transmitting side of an AM RLC entity shall:

- if both the transmission buffer and the retransmission buffer are empty (excluding transmitted RLC data PDU awaiting for acknowledgements); or
- if no new RLC data PDU can be transmitted (e.g. due to window stalling):
    - consider the AMD PDU with SN = VT(S) – 1 for retransmission; or
    - consider any AMD PDU which has not been positively acknowledged for retransmission;
- include a poll in a RLC data PDU as described in section 5.2.2.1.

[TS 36.322, clause 5.2.3]

An AM RLC entity sends STATUS PDUs to its peer AM RLC entity in order to provide positive and/or negative acknowledgements of RLC PDUs (or portions of them).

RRC configures whether or not the status prohibit function is to be used for an AM RLC entity.

Triggers to initiate STATUS reporting include:

- Polling from its peer AM RLC entity:
  - When a RLC data PDU with SN = x and the P field set to "1" is received from lower layer, the receiving side of an AM RLC entity shall:
    - if the PDU is to be discarded as specified in subclause 5.1.3.2.2; or
    - if x < VR(MS) or x >= VR(MR):
      - trigger a STATUS report;
    - else:
      - delay triggering the STATUS report until x < VR(MS) or x >= VR(MR).

NOTE: This ensures that the RLC Status report is transmitted after HARQ reordering.

- Detection of reception failure of an RLC data PDU:
  - The receiving side of an AM RLC entity shall trigger a STATUS report when *t-Reordering* expires.

NOTE: The expiry of T_reordering triggers both VR(MS) to be updated and a STATUS report to be triggered, but the STATUS report shall be triggered after VR(MS) is updated.

When STATUS reporting has been triggered, the receiving side of an AM RLC entity shall:

- if *t-StatusProhibit* is not running:
  - at the first transmission opportunity indicated by lower layer, construct a STATUS PDU and deliver it to lower layer;
- else:
  - at the first transmission opportunity indicated by lower layer after *t-StatusProhibit* expires, construct a single STATUS PDU even if status reporting was triggered several times while T_status_prohibit was running and deliver it to lower layer;

When a STATUS PDU has been delivered to lower layer, the receiving side of an AM RLC entity shall:

- start *t-StatusProhibit*.

When constructing a STATUS PDU, the AM RLC entity shall:

- for the AMD PDUs with SN such that VR(R) <= SN < VR(MS) that has not been completely received yet, in increasing SN order of PDUs and increasing byte segment order within PDUs, starting with SN = VR(R) up to the point where the resulting STATUS PDU still fits to the total size of RLC PDU(s) indicated by lower layer:
  - for an AMD PDU for which no byte segments have been received yet :
    - include in the STATUS PDU a NACK_SN which is set to the SN of the AMD PDU;
  - for a continuous sequence of byte segments of a partly received AMD PDU that have not been received yet
    - include in the STATUS PDU a set of NACK_SN, SOstart and SOend
- set the ACK_SN to the SN of the next not received RLC Data PDU which is not indicated as missing in the resulting STATUS PDU.

7.2.3.13.3 Test description

7.2.3.13.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.3.13.3.1-1.

Table 7.2.3.13.3.1-1: RLC settings

Parameter	Value
t-Reordering	ms150
t-StatusProhibit	ms300
t-PollRetransmit	ms400
pollPDU	pInfinity
pollByte	kBinfinity

7.2.3.13.3.2 Test procedure sequence

Table 7.2.3.13.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
1	Void	-	-	-	-
	The SS ignores scheduling requests and does not allocate any uplink grant.	-	-	-	-
2	The SS transmits 4 AMD PDUs with P=0 and SN=0, 1, 2 and 4. The SS record time T_A when AMD PDU#5 (with SN=4) is sent.	<--	AMD PDU#1 (SN=0, P=0) AMD PDU#2 (SN=1, P=0) AMD PDU#3 (SN=2, P=0) AMD PDU#5 (SN=4, P=0)	-	-
2A	The SS waits for 60 ms after the transmission of the first AMD PDU to ensure UE RLC has all the required SDUs available and then assigns 3 UL grants of size 840 bits (UL Grant Allocation type 2) with a time spacing of 5 ms. (Note 2, Note 5)	<--	(UL grants, 840 bits)	-	-
2B	The UE transmits RLC SDU#1.	-->	(RLC SDU#1)	-	-
2C	The UE transmits RLC SDU#2.	-->	(RLC SDU#2)	-	-
2D	The UE transmits RLC SDU#3.	-->	(RLC SDU#3)	-	-
2E	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-
2F	The SS starts the UL default grant transmission	-	-	-	-
3	Check 1: Does the UE transmit a STATUS PDU with NACK_SN=3 and ACK_SN=5? Record time T_B. Check 2: Is (T_B – T_A) = *t-Reordering*?	-->	STATUS PDU	-	-
4	100 ms after the Status Report received at Step 3, he SS sends 4 AMD PDUs with P=0 and SN=5, 6, 8 and 9.	<--	AMD PDU#6 (SN=5, P=0) AMD PDU#7 (SN=6, P=0) AMD PDU#9 (SN=8, P=0) AMD PDU#10 (SN=9, P=0)	-	-
4A	Check 1: Does the UE transmit a Status Report with NACK_SN=3, ACK_SN=7? Record time T_C Check 2: (T_C – T_B) = *t-StatusProhibit?*	-->	STATUS PDU	-	-
5	The UE transmits a STATUS PDU with NACK_SN=3, NACK_SN=7 and ACK_SN=10.	-->	STATUS PDU	-	-
6	The SS ignores scheduling requests and does not allocate any uplink grant.	-	-	-	-
7	After 300 ms the SS transmits 3 AMD PDUs with SN=3, 7 and 9. The SS sets the P field of all the AMD PDUs to 0 except for that of the AMD PDU with SN=9.	<--	AMD PDU#4 (SN=3, P=0) AMD PDU#8 (SN=7, P=0) AMD PDU#10 (SN=9, P=1)	-	-
7A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns 1 UL grant of size 40 bits (UL Grant Allocation type 3). (Note 3)	<--	(UL grant, 40 bits)	-	-
8	The UE transmits a Status Report with no NACK_SN and ACK_SN = 10.	-->	STATUS PDU	-	-
8A	In the subframe following the one scheduled in step 7A the SS assigns 7 UL grants of size 840 bits (UL Grant Allocation type 2) with a time spacing of 5 ms. (Note 2)	<--	(UL grants, 840 bits)	-	-

8B	The UE transmits RLC SDU#4.	-->	(RLC SDU#4)	-	-
8C	The UE transmits RLC SDU#5.	-->	(RLC SDU#5)	-	-
8D	The UE transmits RLC SDU#6.	-->	(RLC SDU#6)	-	-
8E	The UE transmits RLC SDU#7.	-->	(RLC SDU#7)	-	-
8F	The UE transmits RLC SDU#8.	-->	(RLC SDU#8)	-	-
8G	The UE transmits RLC SDU#9.	-->	(RLC SDU#9)	-	-
8H	The UE transmits RLC SDU#10.	-->	(RLC SDU#10)	-	-
8I	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-
9	The SS transmits an AMD PDU to the UE.	<--	AMD PDU#11 (SN=10, P=0)	-	-
9A	The SS starts the UL default grant transmission	-	-	-	-
10	The UE transmits an AMD PDU with the same data as received in the corresponding DL AMD PDU. Record time T_D.	-->	AMD PDU#11 (SN=10, P=1)	-	-
11	Check 1: Does the UE set the poll bit as both the transmission and retransmission buffers become empty? Record time T_E. Check 2: Is (T_E – T_D) = *t-PollRetransmit*?	-->	AMD PDU#11 (SN=10, P=1)	1	P
11A	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-
12	The SS reconfigures RLC in the UE and sets: - *t-Reordering* to ms200, - *t-StatusProhibit* to ms400, - *t-PollRetransmit* to ms500. (Note 1)	-	-	-	-
-	The SS ignores scheduling requests and does not allocate any uplink grant.	-	-	-	-
13	The SS transmits 4 AMD PDUs with P=0 and SN=11, 12, 13 and 15. The SS record time T_F when AMD PDU#16 (with SN=15) is sent.	<--	AMD PDU#12 (SN=11, P=0) AMD PDU#13 (SN=12, P=0) AMD PDU#14 (SN=13, P=0) AMD PDU#16 (SN=15, P=0)	-	-
13A	The SS waits for 60 ms after the transmission of the first AMD PDU to ensure UE RLC has all the required SDUs available and then assigns 3 UL grants of size 840 bits (UL Grant Allocation type 2) with a time spacing of 5 ms. (Note 2, Note 5)	<--	(UL grants, 840 bits)	-	-
13B	The UE transmits RLC SDU#12.	-->	(RLC SDU#12)	-	-
13C	The UE transmits RLC SDU#13.	-->	(RLC SDU#13)	-	-
13D	The UE transmits RLC SDU#14.	-->	(RLC SDU#14)	-	-
13E	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-
13F	The SS starts the UL default grant transmission	-	-	-	-
14	Check 1: Does the UE transmit a STATUS PDU with NACK_SN=14 and ACK_SN=16? Record time T_G. Check 2: Is (T_G – T_F) = updated value of *t-Reordering*?	-->	STATUS PDU	2	P
15	100 ms after the Status Report received at Step 14, t he SS sends 4 AMD PDUs with P=0 and SN=16, 17, 19 and 20.	<--	AMD PDU#17 (SN=16, P=0) AMD PDU#18 (SN=17, P=0) AMD PDU#20 (SN=19, P=0) AMD PDU#21 (SN=20, P=0)	-	-
15A	Check 1: Does the UE transmit a STATUS PDU with NACK_SN=14 and ACK_SN=18? Record time T_H. Check 2: Is (T_H – T_G) = updated value of *t-StatusProhibit*?	-->	STATUS PDU	3	P
16	The UE transmits a STATUS PDU with NACK_SN=14, NACK_SN=18 and ACK_SN=21.	-->	STATUS PDU	-	-
17	The SS ignores scheduling requests and does not allocate any uplink grant.	-	-	-	-
18	After 450 ms the SS transmits 3 AMD PDUs	<--	AMD PDU#15 (SN=14, P=0)	-	-

	with SN=14, 18 and 20. The SS sets the P field of all the AMD PDUs to 0 except for that of the AMD PDU with SN=20.		AMD PDU#19 (SN=18, P=0) AMD PDU#21 (SN=20, P=1)		
18A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns 1 UL grant of size 40 bits (UL Grant Allocation type 3). (Note 3)	<--	(UL grant, 40 bits)	-	-
19	The UE transmits a Status Report with no NACK_SN and ACK_SN = 21.	-->	STATUS PDU	-	-
19A	In the subframe following the one scheduled in step 18A the SS assigns 7 UL grants of size 840 bits (UL Grant Allocation type 2) with a time spacing of 5 ms. (Note 2)	<--	(UL grants, 840 bits)	-	-
19B	The UE transmits RLC SDU#15.	-->	(RLC SDU#15)	-	-
19C	The UE transmits RLC SDU#16.	-->	(RLC SDU#16)	-	-
19D	The UE transmits RLC SDU#17.	-->	(RLC SDU#17)	-	-
19E	The UE transmits RLC SDU#18.	-->	(RLC SDU#18)	-	-
19F	The UE transmits RLC SDU#19.	-->	(RLC SDU#19)	-	-
19G	The UE transmits RLC SDU#20.	-->	(RLC SDU#20)	-	-
19H	The UE transmits RLC SDU#21.	-->	(RLC SDU#21)	-	-
19I	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-
20	The SS transmits an AMD PDU to the UE.	<--	AMD PDU#22 (SN=21, P=0)	-	-
20A	The SS starts the UL default grant transmission	-	-	-	-
21	The UE transmits an AMD PDU with the same data as received in the corresponding DL AMD PDU. Record time T_I.	-->	AMD PDU#22 (SN=21, P=1)	-	-
22	Check 1: Does the UE set the poll bit as both the transmission and retransmission buffers become empty? Record time T_J. Check 2: Is ($T_J - T_I$) = updated value of *t-PollRetransmit*?	-->	AMD PDU#22 (SN=21, P=1)	1	P
23	The SS transmits a STATUS PDU	<--	STATUS PDU	-	-

Note 1: The RRC Connection Reconfiguration procedure is performed.
Note 2: UL grant of 840 bits (ITBS=14, NPRB=3, see TS 36.213 Table 7.1.7.2.1-1) is chosen to allow the UE to transmit one PDU at a time.
Note 3: UL grant of 40 bits (ITBS=3, NPRB=1, see TS 36.213 Table 7.1.7.2.1-1) is chosen to allow the UE to transmit a Status Report with ACK_SN and (16-bit short BSR + 8-bit MAC PDU subheader + 4-bit D/C/CPT + 10-bit ACK_SN + 1-bit E1 + 1bit padding).
Note 4: Every DL AMD PDU contains 1 RLC SDU size of 100 bytes.
Note 5: The first AMD PDU is transmitted in subframe #4. This subframe is as well suitable for the transmission of UL grants in TDD.

7.2.3.13.3.3 Specific message contents

None.

7.2.3.14 AM RLC / In sequence delivery of upper layers PDUs

7.2.3.14.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives duplicate AMD PDUs }
    then { UE discards the duplicate AMD PDUs }
          }
```

(2)

```
with { UE in E-UTRAN RRC_CONNECTED state }
```

```
ensure that {
  when { UE receives an AMD PDU with a SN gap }
    then { UE sends STATUS PDU to request retransmissions of PDUs in the SN gap}
           }
```

(3)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives PDUs within a SN gap }
 then { RLC reassembles and reorders the AMD PDUs and deliver them to the upper layer in sequence }
            }
```

7.2.3.14.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clause 4.2.1.3.3.

[TS 36.322, clause 4.2.1.3.3]

When the receiving side of an AM RLC entity receives RLC data PDUs, it shall:

- detect whether or not the RLC data PDUs have been received in duplication, and discard duplicated RLC data PDUs;
- reorder the RLC data PDUs if they are received out of sequence;
- detect the loss of RLC data PDUs at lower layers and request retransmissions to its peer AM RLC entity;
- reassemble RLC SDUs from the reordered RLC data PDUs and deliver the RLC SDUs to upper layer in sequence.

...

7.2.3.14.3 Test description

7.2.3.14.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].

7.2.3.14.3.2 Test procedure sequence

Table 7.2.3.14.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits an AMD PDU to the UE. This PDU carries SDU#1.	<--	AMD PDU#1 (SN=0)		
2	The SS transmits an AMD PDU to the UE. This PDU carries SDU#1.	<--	AMD PDU#1 (SN=0)	-	-
3	Check: Does the UE transmit RLC SDU#1? (Note)	-->	(RLC SDU#1)	1	P
3A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=1)	-	-
4	The SS transmits an AMD PDU to the UE. This PDU contains SDU#2, and the 1st part of SDU#3.	<--	AMD PDU#2 (SN=1)	-	-
5	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	P
5A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=2)	-	-
6	The SS transmits an AMD PDU to the UE. This PDU contains SDU#2, and the 1st part of SDU#3.	<--	AMD PDU#2 (SN=1)	-	-
7	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	F
8	The SS transmits an AMD PDU to the UE. This PDU contains the 2nd part of SDU#3.	<--	AMD PDU#3 (SN=2)	-	-
9	Check: Does the UE transmit RLC SDU#3?	-->	(RLC SDU#3)	1	P
9A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=3)	-	-
10	The SS transmits an AMD PDU to the UE. This PDU contains the last part of SDU#6.	<--	AMD PDU#6 (SN=5)	-	-
11	The SS transmits an AMD PDU to the UE. This PDU contains the 2nd part of SDU#5, and the 1st part of SDU#6.	<--	AMD PDU#5 (SN=4)	-	-
11A	The SS does not allocate any uplink grant.	-	-	-	-
12	The SS transmits an AMD PDU to the UE. This PDU carries SDU#4 and the 1st part of SDU#5.	<--	AMD PDU#4 (SN=3)	-	-
12A	The SS waits for 60 ms then assigns an UL grant sufficient for the UE to loopback SDU#4, SDU#5 and SDU#6.	<--	(UL grant)	-	-
13	Check: Does the UE transmit an AMD PDU containing RLC SDU#4, RLC SDU#5 and RLC SDU#6 in its data field?	-->	AMD PDU (RLC SDU#4, RLC SDU#5, RLC SDU#6)	3	P
14	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=4)	-	-
15	Void	-	-	-	-
16	The SS transmits an AMD RLC PDU to the UE. This PDU contains the last part of SDU#9.	<--	AMD PDU#9 (SN=8, P=1)	-	-
17	Check: Does the UE transmit a STATUS PDU NACK_SN/E1/E2 fields set correctly to inform SS of missing PDUs #7, #8, (ACK_SN =9, NACK_SN = 6, NACK_SN = 7)?	-->	STATUS PDU	2	P
18	The SS transmits an AMD PDU to the UE. This PDU contains SDU#8, and the 1st part of SDU#9.	<--	AMD PDU#8 (SN=7)	-	-
18A	The SS does not allocate any uplink grant.	-	-	-	-
19	The SS transmits an AMD PDU to the UE. This PDU carries SDU#7.	<--	AMD PDU#7 (SN=6)	-	-
19A	The SS waits for 60 ms then assigns an UL grant sufficient for the UE to loopback SDU#7, SDU#8 and SDU#9.	<--	(UL grants)	-	-
20	Check: Does the UE transmit an AMD PDU containing RLC SDU#7, RLC SDU#8 and RLC SDU#9 in its data field?	-->	AMD PDU (RLC SDU#7, RLC SDU#8, RLC SDU#9)	3	P
21	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=5)	-	-
22	Void	-	-	-	-
Note: UE may transmit RLC SDU #1 between Step 1 and Step 2.					

7.2.3.14.3.3 Specific message contents

None.

7.2.3.15 AM RLC / Re-ordering of RLC PDU segments

7.2.3.15.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives RLC AM PDU segments }
    then { UE reorders RLC AMD PDU segments received out of sequence }
           }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { t-Reordering expires }
    then { Set VR(MS) to SN of the first AMD PDU with SN >= VR(X) for which not all byte segments
have been received }
 }
```

7.2.3.15.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clauses 4.2.1.3.3, 5.1.3.2.1, 5.1.3.2.2, 5.1.2.3.3 and 5.1.2.3.4.

[TS 36.322, clause 4.2.1.3.3]

When the receiving side of an AM RLC entity receives RLC data PDUs, it shall:

...

- detect the loss of RLC data PDUs at lower layers and request retransmissions to its peer AM RLC entity;
- reassemble RLC SDUs from the reordered RLC data PDUs and deliver the RLC SDUs to upper layer in sequence.

...

[TS 36.322, clause 5.1.3.2.1]

The receiving side of an AM RLC entity shall maintain a receiving window according to state variables VR(R) and VR(MR) as follows:

- a SN falls within the receiving window if VR(R) <= SN < VR(MR);
- a SN falls outside of the receiving window otherwise.

When receiving a RLC data PDU from lower layer, the receiving side of an AM RLC entity shall:

- either discard the received RLC data PDU or place it in the reception buffer (see sub clause 5.1.3.2.2);
- if the received RLC data PDU was placed in the reception buffer:
  - update state variables, reassemble and deliver RLC SDUs to upper layer and start/stop *t-Reordering* as needed (see sub clause 5.1.3.2.3).

When *t-Reordering* expires, the receiving side of an AM RLC entity shall:

- update state variables and start *t-Reordering* as needed (see sub clause 5.1.3.2.4).

[TS 36.322, clause 5.1.3.2.2]

When a RLC data PDU is received from lower layer, where the RLC data PDU contains byte segment numbers y to z of an AMD PDU with SN = x, the receiving side of an AM RLC entity shall:

- if x falls outside of the receiving window; or
- if byte segment numbers y to z of the AMD PDU with SN = x have been received before:
  - discard the received RLC data PDU;
- else:
  - place the received RLC data PDU in the reception buffer;
  - if some byte segments of the AMD PDU contained in the RLC data PDU have been received before:
    - discard the duplicate byte segments.

[TS 36.322, clause 5.1.3.2.3]

When a RLC data PDU with SN = x is placed in the reception buffer, the receiving side of an AM RLC entity shall:

- if all byte segments of the AMD PDU with SN = VR(MS) are received:
  - update VR(MS) to the SN of the first AMD PDU with SN > current VR(MS) for which not all byte segments have been received;
- if x = VR(R):
  - if all byte segments of the AMD PDU with SN = VR(R) are received:
    - update VR(R) to the SN of the first AMD PDU with SN > current VR(R) for which not all byte segments have been received;
    - update VR(MR) to the updated VR(R) + AM_Window_Size;
  - reassemble RLC SDUs from any byte segments of AMD PDUs with SN that falls outside of the receiving window and in-sequence byte segments of the AMD PDU with SN = VR(R), remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper layer in sequence if not delivered before;
- if x >= VR(H)
  - update VR(H) to x+ 1;
- if *t-Reordering* is running:
  - if VR(X) = VR(R); or
  - if VR(X) falls outside of the receiving window and VR(X) is not equal to VR(MR):
    - stop and reset *t-Reordering*;
- if *t-Reordering* is not running (includes the case *t-Reordering* is stopped due to actions above):
  - if VR (H) > VR(R):
    - start *t-Reordering*;
    - set VR(X) to VR(H).

[TS 36.322, clause 5.1.3.2.4]

When *t-Reordering* expires, the receiving side of an AM RLC entity shall:

- update VR(MS) to the SN of the first AMD PDU with SN >= VR(X) for which not all byte segments have been received;
- if VR(H) > VR(MS):
  - start *t-Reordering*;
  - set VR(X) to VR(H).

7.2.3.15.3 Test description

7.2.3.15.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with a loop back size of 98 bytes.

7.2.3.15.3.2 Test procedure sequence

Table 7.2.3.15.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
1	The SS transmits one AMD PDU containing SDU#8 (100 bytes) in its data field to the UE. SN=7 indicates the loss of 7 PDUs.	<--	AMD PDU#8 (SN=7)	-	-
2	The SS transmits one AMD PDU segment containing 50 bytes of SDU#1 in its data field to the UE. This AMD PDU segment carries part 1 of AMD PDU#1, which contained SDU#1 (100 bytes) in its data field. SO=0 and LSF=0.	<--	AMD PDU#1 (SN=0) segment 1	-	-
3	The SS transmits one AMD PDU segment containing 50 bytes of SDU#2 in its data field to the UE. This AMD PDU segment carries part 2 of AMD PDU#2, which contained SDU#2 (100 bytes) in its data field. SO=50 and LSF=1.	<--	AMD PDU#2 (SN=1) segment 2	-	-
4	The SS transmits one AMD PDU segment containing 50 bytes of SDU#3 in its data field to the UE. This AMD PDU segment carries part 1 of AMD PDU#3, which contained SDU#3 (100 bytes) in its data field. SO=0 and LSF=0.	<--	AMD PDU#3 (SN=2) segment 1	-	-
5	The SS transmits one AMD PDU segment containing 50 bytes of SDU#4 in its data field to the UE. This AMD PDU segment carries part 2 of AMD PDU#4, which contained SDU#4 (100 bytes) in its data field. SO=50 and LSF=1.	<--	AMD PDU#4 (SN=3) segment 2	-	-
6	The SS transmits one AMD PDU segment containing 50 bytes of SDU#4 in its data field to the UE. This AMD PDU segment carries part 1of AMD PDU#4, which contained SDU#4 (100 bytes) in its data field. SO=0 and LSF=0.	<--	AMD PDU#4 (SN=3) segment 1	-	-
7	The SS transmits one AMD PDU segment containing 50 bytes of SDU#1 in its data field to the UE. This AMD PDU segment carries part 2 of AMD PDU#1, which contained SDU#1 (100 bytes) in its data field. SO=50 and LSF=1.	<--	AMD PDU#1 (SN=0) segment 2	-	-
8	Void				
9	The SS transmits one AMD PDU segment containing 50 bytes of SDU#2 in its data field to the UE. This AMD PDU segment carries part 1 of AMD PDU#2, which contained SDU#2 (100 bytes) in its data field. SO=0 and LSF=0.	<--	AMD PDU#2 (SN=1) segment 1	-	-
10	Void				
11	The SS transmits one AMD PDU segment containing 50 bytes of SDU#3 in its data field to the UE. This AMD PDU segment carries part 2 of PDU#3, which contained SDU#3 (100 bytes) in its data field. SO=50 and LSF=1.	<--	AMD PDU#3 (SN=2) segment 2	-	-
11A	The SS transmits one AMD PDU segment containing 50 bytes of SDU#7 in its data field to the UE. This AMD PDU segment carries part 1 of PDU #7, which contained SDU#7 (100 bytes) in its data field. SO=0 and LSF=0.	<--	AMD PDU#7 (SN=6) segment 1	-	-
11B	The SS transmits one AMD PDU segment containing 50 bytes of SDU#6 in its data field to the UE. This AMD PDU segment carries segment 2 of AMD PDU#6, which contained SDU#6 (100 bytes) in its data field. SO=50 and LSF=1.	<--	AMD PDU#6 (SN=5) segment 2	-	-

11C	The SS waits for 60 ms then SS transmits 4 uplink grants (UL grant allocation type 2) with a time spacing of 5 ms, each allowing the UE to transmit 1 RLC SDU.	<--	(UL grants)	-	-
11D	Check: Does the UE transmit an RLC SDU containing SDU#1 in its data field?	-->	(RLC SDU#1)	1	P
11E	Check: Does the UE transmit an RLC SDU containing SDU#2 in its data field?	-->	(RLC SDU#2)	1	P
12	Check: Does the UE transmit an RLC SDU containing SDU#3 in its data field?	-->	(RLC SDU#3)	1	P
13	Check: Does the UE transmit an RLC SDU containing SDU#4 in its data field?	-->	(RLC SDU#4)	1	P
14	The SS transmits an RLC STATUS PDU to the UE. This PDU acks PDUs up to those including SDU#4. ACK_SN=4.	<--	STATUS PDU	-	-
15	Void				
16	Void				
17	Wait for *t-Reordering* to run out at the UE side.	-	-	-	-
18	Check: Does the UE transmit a Status Report with NACK_SN=4, NACK_SN=5 with SOStart=0 and SOEnd=49, and NACK_SN=6 with SOStart=50 and SOEnd=32767 (special SOEnd value), and ACK_SN=8?	-->	STATUS PDU	2	P
19	The SS transmits one AMD PDU segment containing 50 bytes of SDU#7 in its data field to the UE. This AMD PDU segment carries part 2 of AMD PDU#7, which contained SDU#7 (100 bytes) in its data field. SO=50 and LSF=1.	<--	AMD PDU#7 (SN=6) segment 2	-	-
20	The SS transmits one AMD PDU segment containing 50 bytes of SDU#6 in its data field to the UE. This AMD PDU segment carries part 1 of AMD PDU#6, which contained SDU#6 (100 bytes) in its data field. SO=0 and LSF=0.	<--	AMD PDU#6 (SN=5) segment 1	-	-
21	The SS transmits one AMD PDU segment containing 50 bytes of SDU#5 in its data field to the UE. This AMD PDU segment carries part 1 of AMD PDU#5, which contained SDU#5 (100 bytes) in its data field. SO=0 and LSF=0.	<--	AMD PDU#5 (SN=4) segment 1	-	-
22	Wait for *t-Reordering* to run out at the UE side.	-	-	-	-
23	Check: Does the UE transmit a Status Report with NACK_SN=4 with SOStart=50 and SOEnd=32767 (special SOEnd value), and ACK_SN=8?	-->	STATUS PDU	2	P
24	The SS transmits one AMD PDU segment containing 50 bytes of SDU#5 in its data field to the UE. This AMD PDU segment carries part 2 of AMD PDU#5, which contained SDU#5 (100 bytes) in its data field. SO=50 and LSF=1.	<--	AMD PDU#5 (SN=4) segment 2	-	-
24A	The SS waits for 60 ms then SS transmits 4 uplink grants (UL grant allocation type 2) with a time spacing of 5 ms, each allowing the UE to transmit 1 RLC SDU.	<--	(UL grants)	-	-
25	Check: Does the UE transmit an RLC SDU containing SDU#5 in its data field?	-->	(RLC SDU#5)	1	P
26	Check: Does the UE transmit an RLC SDU containing SDU#6 in its data field?	-->	(RLC SDU#6)	1	P
27	Check: Does the UE transmit an RLC SDU containing SDU#7 in its data field?	-->	(RLC SDU#7)	1	P
28	Check: Does the UE transmit an RLC SDU containing SDU#8 in its data field?	-->	(RLC SDU#8)	1	P
29	The SS transmits an RLC STATUS PDU to the UE. This PDU acks PDUs up to those including SDU#7. ACK_SN=8.	<--	STATUS PDU	-	-

7.2.3.15.3.3 Specific message contents

None.

7.2.3.16 AM RLC / Re-transmission of RLC PDU without re-segmentation

7.2.3.16.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives a STATUS PDU including a NACK_SN for missing AMD PDUs and missing AMD PDUs can
fit into within the total size of RLC PDU(s) indicated by lower layer at the particular transmission
opportunity}
then { UE successfully retransmits missing AMD PDUs without re-segmentation}
       }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { NACK received for missing AMD PDUs and RETX_COUNT < maxRetxThreshold }
then { UE retransmits AMD PDUs   }
       }
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { an AMD PDU or a portion of an AMD PDU is considered for retransmission and if RETX_COUNT =
maxRetxThreshold }
then { UE indicates to upper layers that max retransmission has been reached }
       }
```

7.2.3.16.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clause 5.2.1.

[TS 36.322 clause 5.2.1]

The transmitting side of an AM RLC entity can receive a negative acknowledgement (notification of reception failure by its peer AM RLC entity) for an AMD PDU or a portion of an AMD PDU by the following:

- STATUS PDU from its peer AM RLC entity.

When receiving a negative acknowledgement for an AMD PDU or a portion of an AMD PDU by a STATUS PDU from its peer AM RLC entity, the transmitting side of the AM RLC entity shall:

- if the SN of the corresponding AMD PDU falls within the range VT(A) <= SN < VT(S):
  - consider the AMD PDU or the portion of the AMD PDU for which a negative acknowledgement was received for retransmission.

When an AMD PDU or a portion of an AMD PDU is considered for retransmission, the transmitting side of the AM RLC entity shall:

- if the AMD PDU is considered for retransmission for the first time:
  - set the RETX_COUNT associated with the AMD PDU to zero;
- else, if it (the AMD PDU or the portion of the AMD PDU that is considered for retransmission) or a portion of it is not pending for retransmission already:
  - increment the RETX_COUNT;
- if RETX_COUNT = *maxRetxThreshold*:
  - indicate to upper layers that max retransmission has been reached.

When retransmitting an AMD PDU, the transmitting side of an AM RLC entity shall:

- if the AMD PDU can entirely fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity:
  - deliver the AMD PDU as it is except for the P field (the P field should be set according to sub clause 5.2.2) to lower layer;
- otherwise:
  - segment the AMD PDU form a new AMD PDU segment which will fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity and deliver the new AMD PDU segment to lower layer.

When retransmitting a portion of an AMD PDU, the transmitting side of an AM RLC entity shall:

- segment the portion of the AMD PDU as necessary, form a new AMD PDU segment which will fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity and deliver the new AMD PDU segment to lower layer.

When forming a new AMD PDU segment, the transmitting side of an AM RLC entity shall:

- only map the Data field of the original AMD PDU to the Data field of the new AMD PDU segment;
- set the header of the new AMD PDU segment in accordance with the description in sub clause 6.;
- set the P field according to sub clause 5.2.2.

7.2.3.16.3 Test description

7.2.3.16.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with a loopback size of 98 bytes with the exceptions listed in table 7.2.3.16.3.1-1.

Table 7.2.3.16.3.1-1: PDCP-Config-DRB-AM

Information Element	Value/remark	Comment	Condition
PDCP-Config-DRB-AM ::= SEQUENCE {			
rlc-AM SEQUENCE {			
statusReportRequired	FALSE		
}			
}			

7.2.3.16.3.2 Test procedure sequence

Table 7.2.3.16.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS transmits one AMD PDU containing SDU#1 (100 bytes) in its data field.	<--	AMD PDU#1	-	-
2	The UE transmits one AMD PDU containing SDU#1 in its data field.	-->	AMD PDU#1 (SN=0)	-	-
3	The SS transmits one AMD PDU containing SDU#2 (100 bytes) in its data field.	<--	AMD PDU#2	-	-
4	The UE transmits one AMD PDU containing SDU#2 in its data field.	-->	AMD PDU#2 (SN=1)	-	-
5	The SS transmits an RLC STATUS PDU. ACK_SN=2, NACK_SN=0.	<--	STATUS PDU	-	-
6	Check: Does the UE transmit the AMD PDU not yet acknowledged?	-->	AMD PDU#1 (SN=0)	1	P
7	The SS transmits an RLC STATUS PDU. ACK_SN=2.	<--	STATUS PDU	-	-
8	The SS transmits one AMD PDU containing SDU#3 (100 bytes) in its data field.	<--	AMD PDU#3	-	-
9	The UE transmits an AMD PDU containing SDU#3 in its data field.	-->	AMD PDU#3 (SN=2)	-	-
-	EXCEPTION: Step 10 to 11 shall be repeated *maxRetxThreshold* times	-	-	-	-
10	The SS transmits an RLC STATUS PDU. ACK_SN =3 and NACK_SN =2.	<--	STATUS PDU	-	-
11	Check: Does the UE retransmit the AMD PDU not yet acknowledged?	-->	AMD PDU#3 (SN=2)	2	P
12	The SS transmits an RLC STATUS PDU. ACK_SN =3 and NACK_SN =2.	<--	STATUS PDU	-	-
13	Check: Does the UE transmit an RRC Connection Re-establishment Request message? Note 1		-	3	P
14	The SS transmits *RRCConnectionReestablishment* message.	-	-	-	-
15	The UE transmits *RRCConnectionReestablishmentComplete* message.	-	-	-	-
16	The SS transmits an *RRCConnectionReconfiguration* message to resume SRB2 and DRB1.	-	-	-	-
-	EXCEPTION: Step 17 and Step 18 can happen in any order.	-	-	-	-
17	The UE transmits an *RRCConnectionReconfigurationComplete* message.	-	-	-	-
18	The UE retransmits the AMD PDU not yet acknowledged. Note 2.	-->	AMD PDU#3 (SN=0)	-	-
Note 1: The RRC Connection Re-establishment procedure is initiated. See 36.331 cl. 5.3.7.2 and 5.3.11.3. Note 2: The PDCP PDU contained in this AMD PDU carries PDCP SN=2.					

7.2.3.16.3.3 Specific message contents

Table 7.2.3.16.3.3-1: *RRCConnectionReconfiguration* (step 16, Table 7.2.3.16.3.2-1)

Derivation Path: 36.508, Table 4.6.1-8			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReconfiguration ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
rrcConnectionReconfiguration-r8 SEQUENCE {			
radioResourceConfigDedicated	RadioResourceConfigDedicated-HO		
}			
}			
}			
}			

7.2.3.17 AM RLC / Re-segmentation RLC PDU / SO, FI, LSF

7.2.3.17.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { AMD PDU to be retransmitted does not fit in new allocated TBS }
then { UE segments AMD PDU into AMD PDU segments }
 }
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { AMD PDU segment to be retransmitted does not fit in new allocated TBS }
then { UE resegments AMD PDU segment to fit TBS }
 }
```

7.2.3.17.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clauses 4.2.1.3.2, 5.2.1, 6.2.1.4 and 6.2.1.5.

[TS 36.322, clause 4.2.1.3.2]

When the transmitting side of an AM RLC entity forms AMD PDUs from RLC SDUs, it shall:

- segment and/or concatenate the RLC SDUs so that the AMD PDUs fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity notified by lower layer.

The transmitting side of an AM RLC entity supports retransmission of RLC data PDUs (ARQ):

- if the RLC data PDU to be retransmitted does not fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity notified by lower layer, the AM RLC entity can re-segment the RLC data PDU into AMD PDU segments;

- the number of re-segmentation is not limited.

When the transmitting side of an AM RLC entity forms AMD PDUs from RLC SDUs received from upper layer or AMD PDU segments from RLC data PDUs to be retransmitted, it shall:

- include relevant RLC headers in the RLC data PDU.

[TS 36.322 clause 5.2.1]

...

When retransmitting an AMD PDU, the transmitting side of an AM RLC entity shall:

- if the AMD PDU can entirely fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity:
  - deliver the AMD PDU as it is except for the P field (the P field should be set according to sub clause 5.2.2) to lower layer;
- otherwise:
  - segment the AMD PDU form a new AMD PDU segment which will fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity and deliver the new AMD PDU segment to lower layer.

When retransmitting a portion of an AMD PDU, the transmitting side of an AM RLC entity shall:

- segment the portion of the AMD PDU as necessary form a new AMD PDU segment which will fit within the total size of RLC PDU(s) indicated by lower layer at the particular transmission opportunity and deliver the new AMD PDU segment to lower layer.

When forming a new AMD PDU segment, the transmitting side of an AM RLC entity shall:

- only map the Data field of the original AMD PDU to the Data field of the new AMD PDU segment;
- set the header of the new AMD PDU segment in accordance with the description in sub clause 6.;
- set the P field according to sub clause 5.2.2.

[TS 36.322, clause 6.2.1.4]

AMD PDU consists of a Data field and an AMD PDU header.

AMD PDU header consists of a fixed part (fields that are present for every AMD PDU) and an extension part (fields that are present for an AMD PDU when necessary). The fixed part of the AMD PDU header itself is byte aligned and consists of a D/C, a RF, a P, a FI, an E and a SN. The extension part of the AMD PDU header itself is byte aligned and consists of E(s) and LI(s).

An AMD PDU header consists of an extension part only when more than one Data field elements are present in the AMD PDU, in which case an E and a LI are present for every Data field element except the last. Furthermore, when an AMD PDU header consists of an odd number of LI(s), four padding bits follow after the last LI

....

[TS 36.322, clause 6.2.1.5]

AMD PDU segment consists of a Data field and an AMD PDU segment header.

AMD PDU segment header consists of a fixed part (fields that are present for every AMD PDU segment) and an extension part (fields that are present for an AMD PDU segment when necessary). The fixed part of the AMD PDU segment header itself is byte aligned and consists of a D/C, a RF, a P, a FI, an E, a SN, a LSF and a SO. The extension part of the AMD PDU segment header itself is byte aligned and consists of E(s) and LI(s).

An AMD PDU segment header consists of an extension part only when more than one Data field elements are present in the AMD PDU segment, in which case an E and a LI are present for every Data field element except the last. Furthermore, when an AMD PDU segment header consists of an odd number of LI(s), four padding bits follow after the last LI.

...

7.2.3.17.3 Test description

7.2.3.17.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with a loop back size of 98 bytes and the exceptions listed in table 7.2.3.17.3.1-1 applicable for the configured AM DRB.

Table 7.2.3.17.3.1-1: RLC settings

Parameter	Value
t-PollRetransmit	ms150

7.2.3.17.3.2 Test procedure sequence

Table 7.2.3.17.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
0	The SS stops the UL grant transmission.	-	-	-	-
1	The SS transmits one AMD PDU containing SDU#1 (100 bytes) in its data field.	<--	AMD PDU#1	-	-
1A	60 ms after step 1 the SS assigns one default grant (UL grant allocation type 2). (Note 6)	<--	(UL grant, 840 bits)	-	-
2	The UE transmits an AMD PDU with the same data contents as received in the corresponding part of DL PDU#1?	-->	AMD PDU#1 (SN=0)	-	-
3	20 ms after step 1 The SS transmits one AMD PDU containing SDU#2 (100 bytes) in its data field.	<--	AMD PDU#2	-	-
3A	60 ms after step 3 the SS assigns one default grant (UL grant allocation type 2). (Note 6)	<--	(UL grant, 840 bits)	-	-
4	The UE transmits an AMD PDU with the same data contents as received in the corresponding part of DL PDU#2?	-->	AMD PDU#2 (SN=1)	-	-
5	Void	-	-	-	-
6	The SS transmits a STATUS PDU. This PDU nacks the AMD PDU with SN=0. NACK_SN=0 and ACK_SN=2.	<--	STATUS PDU	-	-
6A	The SS waits for 20 ms and then allocates 2 UL grants (UL grant allocation type 2) of size 472 bits such that there is 20 ms gap between UL grants (Note 1, Note 4)	<--	(UL grants, 472 bits)	-	-
7	Check: Does the UE transmit an AMD PDU segment with SO=0, LSF=0 and the same data contents at the received positions as in the original AMD PDU?	-->	AMD PDU#1 segment 1 (SN=0)	1	P
8	Check: Does the UE transmit an AMD PDU segment with SO=<x>, LSF=1 and the same data contents at the received positions as in the original AMD PDU? (Note 3)	-->	AMD PDU#1 segment 2 (SN=0)	1	P
9	Void	-	-	-	-
10	After 100 ms the SS transmits a STATUS PDU. This PDU nacks the AMD PDU with SN=0. NACK_SN=0, SOStart=0, SOEnd=<x-1> and ACK_SN =2. (Note 3, Note 5)	<--	STATUS PDU	-	-
10A	The SS waits for 20 ms and then allocates 2 UL grants (UL grant allocation type 2) of size 328 bits such that there is 20 ms gap between UL grants (Note 2) (Note 4)	<--	(UL grants, 472 bits)	-	-
11	Check: Does the UE transmit an AMD PDU segment with SO=0, LSF=0 and the same data contents at the received positions as in the original AMD PDU?	-->	AMD PDU#1 segment 1, 1st part (SN=0)	2	P
12	Check: Does the UE transmit an AMD PDU segment with SO=<y>, LSF=0 and the same data contents at the received positions as in the original AMD PDU? (Note 3)	-->	AMD PDU#1 segment 1, 2nd part (SN=0)	2	P
13	The SS transmits a STATUS PDU. This PDU acks the AMD PDUs with SN=0 and SN=1. ACK_SN=2.	<--	STATUS PDU	-	-

Note 1: UL grant of 472 bits (I_{TBS}=7, N_{PRB}=4, see TS 36.213 Table 7.1.7.2.1-1) is chosen such that UE will segment into 2 AMD PDUs. MAC PDU of 472 bits=59 bytes fits an AMD PDU payload of >= 50 bytes + 2 bytes AMD PDU header + 2 bytes of segment header + ? bytes spare for MAC header and possible RLC STATUS PDU and BSR report.

Note 2: UL grant of 328 bits (I_{TBS}=5, N_{PRB}=4, see TS 36.213 Table 7.1.7.2.1-1) is chosen such that UE will segment into 2 AMD PDUs. MAC PDU of 328 bits=41 bytes fits an AMD PDU payload of >= 25 bytes + 2 bytes AMD PDU header + 2 bytes of segment header + ? bytes spare for MAC header and possible RLC STATUS PDU and BSR report.

Note 3: The values x and y depend upon the need of the UE to add RLC STATUS PDU and BSR report. The TBS has been chosen to ensure that the PDUs to be resegmented can be carried in 2 segments.

Note 4: 20 ms gap between transmissions both in DL and UL respectively allows TTCN to tolerate one HARQ retransmission (FDD/TDD) per transport block, if such happen (TS 36.523-3).
Note 5: As <x> becomes available in step 8 only the transmission in step 10 can only be scheduled afterwards. This requires a 100 ms activation time.
Note 6: UL grant of 840 bits (I_{TBS}=14, N_{PRB}=3, see TS 36.213 Table 7.1.7.2.1-1) is chosen to allow the UE to transmit one PDU at a time.

7.2.3.17.3.3 Specific message contents

None.

7.2.3.18 AM RLC / Reassembly / AMD PDU reassembly from AMD PDU segments, Segmentation Offset and Last Segment Flag fields

7.2.3.18.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives AM PDU segments }
    then { UE delivers reassembled RLC SDU to upper layer}
          }
```

(2)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives RLC AM PDU segments without segment header extension part }
    then { UE correctly reassembles RLC AMD PDU segments into RLC AMD PDUs }
          }
```

(3)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives RLC AM PDU segments with segment header extension part }
    then { UE correctly reassembles RLC AMD PDU segments into RLC AMD PDUs }
          }
```

(4)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives duplicate RLC AM PDU segments }
    then { UE discards duplicate RLC AMD PDU segments }
          }
```

(5)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE receives RLC AM PDU segments out of sequence }
    then { UE delivers reassembled RLC SDU to upper layer }
          }
```

(6)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives RLC AMD PDU segments with segments lost }
    then { UE transmits STATUS PDU to request retransmission of missing segments }
          }
```

(7)

```
with { UE in E-UTRAN RRC_CONNECTED state }
ensure that {
  when { UE receives overlapping RLC AMD PDU segments }
    then { UE discards duplicate RLC AMD PDU byte segments }
          }
```

7.2.3.18.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.322 clauses 4.2.1.3.3, 5.1.3.2.2, 6.2.1.4 and 6.2.1.5.

[TS 36.322, clause 4.2.1.3.3]

When the receiving side of an AM RLC entity receives RLC data PDUs, it shall:

- detect whether or not the RLC data PDUs have been received in duplication, and discard duplicated RLC data PDUs;
- reorder the RLC data PDUs if they are received out of sequence;
- detect the loss of RLC data PDUs at lower layers and request retransmissions to its peer AM RLC entity;
- reassemble RLC SDUs from the reordered RLC data PDUs and deliver the RLC SDUs to upper layer in sequence.

...

[TS 36.322, clause 5.1.3.2.2]

When a RLC data PDU is received from lower layer, where the RLC data PDU contains byte segment numbers y to z of an AMD PDU with SN = x, the receiving side of an AM RLC entity shall:

- if x falls outside of the receiving window; or
- if byte segment numbers y to z of the AMD PDU with SN = x have been received before:
  - discard the received RLC data PDU;
- else:
  - place the received RLC data PDU in the reception buffer;
  - if some byte segments of the AMD PDU contained in the RLC data PDU have been received before:
    - discard the duplicate byte segments.

[TS 36.322, clause 6.2.1.4]

AMD PDU consists of a Data field and an AMD PDU header.

AMD PDU header consists of a fixed part (fields that are present for every AMD PDU) and an extension part (fields that are present for an AMD PDU when necessary). The fixed part of the AMD PDU header itself is byte aligned and consists of a D/C, a RF, a P, a FI, an E and a SN. The extension part of the AMD PDU header itself is byte aligned and consists of E(s) and LI(s).

An AMD PDU header consists of an extension part only when more than one Data field elements are present in the AMD PDU, in which case an E and a LI are present for every Data field element except the last. Furthermore, when an AMD PDU header consists of an odd number of LI(s), four padding bits follow after the last LI.

...

[TS 36.322, clause 6.2.1.5]

AMD PDU segment consists of a Data field and an AMD PDU segment header.

AMD PDU segment header consists of a fixed part (fields that are present for every AMD PDU segment) and an extension part (fields that are present for an AMD PDU segment when necessary). The fixed part of the AMD PDU segment header itself is byte aligned and consists of a D/C, a RF, a P, a FI, an E, a SN, a LSF and a SO. The extension part of the AMD PDU segment header itself is byte aligned and consists of E(s) and LI(s).

An AMD PDU segment header consists of an extension part only when more than one Data field elements are present in the AMD PDU segment, in which case an E and a LI are present for every Data field element except the last.

Furthermore, when an AMD PDU segment header consists of an odd number of LI(s), four padding bits follow after the last LI.

...

7.2.3.18.3 Test description

7.2.3.18.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with a loop back size of 98 bytes.

7.2.3.18.3.2 Test procedure sequence

Table 7.2.3.18.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message/PDU/SDU		
1	The SS transmits an AMD PDU containing the first half (50 bytes) of SDU#1 in its data field. This PDU is in error (SN falls outside of the receiving window) and is to be discarded by the UE.	<--	AMD PDU#1 (SN=WindowSize+3)	-	-
2	The SS transmits an AMD PDU containing SDU#2 (100 bytes) in its data field with the P-bit set.	<--	AMD PDU#2 (SN=1, P=1)	-	-
3	The UE transmits a STATUS PDU with NACK_SN field indicating missing PDU#1. ACK_SN=2, NACK_SN=0.	-->	STATUS PDU	-	-
3A	The SS stops the UL grant transmission.	-	-	-	-
4	After 100 ms the SS transmits an AMD PDU segment of AMD PDU#1 (AMD PDU#1 carries SDU#1) containing the first 50 bytes of SDU#1 in its data field. SO=0 and LSF=0. No header extension part is provided.	<--	AMD PDU#1 (SN=0) segment 1	-	-
5	The SS transmits an AMD PDU segment of AMD PDU#1 (AMD PDU#1 carries SDU#1) containing the last 50 bytes of SDU#1 in its data field with the P-bit set. SO=50 and LSF=1. No header extension part is provided.	<--	AMD PDU #1 (SN=0, P=1) segment 2	-	-
5A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns one default UL grant (UL grant allocation type 3).	<--	(UL grant)	-	-
6	Check: Does the UE transmit a STATUS PDU with ACK_SN=2, thus acknowledging the reception of PDUs with SN=0 and SN=1, and no NACK_SN provided?	-->	STATUS PDU	2	P
7	Check: Does the UE transmit RLC SDU#1 and RLC SDU#2?	-->	AMD PDU (RLC SDU#1, RLC SDU#2)	1	P
8	Void	-	-	-	-
8A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=1)	-	-
9	After 100 ms the SS transmits an AMD PDU segment of AMD PDU#3 (AMD PDU#3 carries SDU#3 and SDU#4) containing the last 50 bytes of SDU#4 in its data field, with the P-bit set. FI=10, SO=150 and LSF=1. No header extension part is provided.	<--	AMD PDU#3 (SN=2, P=1) segment 2	-	-
9A	100 ms after step 9 the SS assigns one default grant (UL grant allocation type 3).	<--	(UL grant)	-	-
10	The UE transmits a STATUS PDU NACK_SN field for receipt of PDU#3. ACK_SN=3, NACK_SN=2, SOStart=0/SOEnd=149.	-->	STATUS PDU	-	-
11	After 100 ms the SS transmits an AMD PDU segment of AMD PDU#3 (AMD PDU#3 carries SDU#3 and SDU#4) containing SDU#3 (100 bytes) and the first 50 bytes of SDU#4 in its data field, with the P-bit set. FI=01, SO=0 and LSF=0. Header extension part present: E in fixed part header=1, E in extension part header=0, LI=100.	<--	AMD PDU#3 (SN=2, P=1) segment 1	-	-
11A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns one default UL grant (UL grant allocation type 3).	<--	(UL grant)	-	-
12	Check: Does the UE transmit a STATUS PDU with ACK_SN=3?	-->	STATUS PDU	3	P
13	Void	-	-	-	-
14	Check: Does the UE transmit RLC SDU#3 and RLC SDU#4?	-->	AMD PDU (RLC SDU#3, RLC SDU#4)	1,5	P

14A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=2)	-	-
15	After 100 ms the SS transmits an AMD PDU segment of AMD PDU#4 (AMD PDU#4 carries SDU#5) containing the first 50 bytes of SDU#5 in its data field. SO=0 and LSF=0. No header extension part is provided.	<--	AMD PDU#4 (SN=3) segment 1	-	-
16	The SS transmits an AMD PDU segment of AMD PDU#4 (AMD PDU#4 carries SDU#5) containing the first 50 bytes of SDU#5 in its data field. SO=0 and LSF=0. No header extension part is provided.	<--	AMD PDU#4 (SN=3) segment 1	-	-
17	The SS transmits an AMD PDU segment of AMD PDU#4 (AMD PDU#4 carries SDU#5) containing the last 50 bytes of SDU#5 in its data field, with the P-bit set. SO=50 and LSF=1. No header extension part is provided.	<--	AMD PDU#4 (SN=3, P=1) segment 2	-	-
17A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns one default UL grant (UL grant allocation type 3).	<--	(UL grant)	-	-
18	Check: Does the UE transmit a STATUS PDU with ACK_SN=4, thus acknowledging the reception of PDUs with SN=0 to SN=3, and no NACK_SN provided?	-->	STATUS PDU	4	P
19	Check: Does the UE transmit RLC SDU#5?	-->	(RLC SDU#5)	1	P
19A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=3)	-	-
20	After 100 ms the SS transmits an AMD PDU segment of AMD PDU#6 (AMD PDU#6 carries SDU#7) containing the last 50 bytes of SDU#7 in its data field, with the P-bit set. This AMD PDU segment is sent with SN=5. SO=50 and LSF=1. No header extension part is provided.	<--	AMD PDU#6 (SN=5, P=1) segment 2	-	-
20A	100 ms after step 20 the SS assigns one default grant (UL grant allocation type 3).	<--	(UL grant)	-	-
21	Check: Does the UE transmit a STATUS PDU with ACK_SN=6, thus acknowledging the reception of PDUs with SN=0 to SN=5, and NACK_SN=4, E1/E2 field for receipt of PDU#5 and NACK_SN=5, SOStart=0/SOEnd=49 for segment 1 of PDU#6?	-->	STATUS PDU	6	P
22	After 100 ms the SS transmits an AMD PDU segment of AMD PDU#6 (AMD PDU#6 carries SDU#7) containing the first 50 bytes of SDU#7 in its data field. SO=0 and LSF=0. No header extension part is provided.	<--	AMD PDU#6 (SN=5) segment 1	-	-
23	The SS transmits one AMD PDU containing SDU#6 (100 bytes) in its data field, with the P-bit set.	<--	AMD PDU#5 (SN=4, P=1)	-	-
23A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns one default UL grant (UL grant allocation type 3).	<--	(UL grant)	-	-
24	The UE transmits a STATUS PDU with ACK_SN=6, thus acknowledging the reception of PDUs with SN=0 to SN=5, and no NACK_SN provided.	-->	STATUS PDU	-	-
25	Void	-	-	-	-
26	Check: Does the UE transmit RLC SDU#6 and RLC SDU#7?	-->	AMD PDU (RLC SDU#6, RLC SDU#7)	2,5	P
26A	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=4)	-	-
27	After 100 ms the SS transmits an AMD PDU segment of AMD PDU#7 (AMD PDU#7 carries SDU#8, SDU#9 and SDU#10) containing the last 20 bytes of SDU#9 and the complete SDU#10 (100 bytes) in its data field, with the	<--	AMD PDU#7 (SN=6, P=1) segment 3	-	-

	P-bit set. FI=10, SO=180 and LSF=1. Header extension part present: E in fixed part header=1, E in extension part header=0, LI=20.				
27A	100 ms after step 27 the SS assigns one default grant (UL grant allocation type 3).	<--	(UL grant)	-	-
28	The UE transmits a STATUS PDU NACK_SN field for receipt of PDU#7. ACK_SN=7, NACK_SN=6, SOStart=0/SOEnd=179.	-->	STATUS PDU	-	-
29	After 100 ms the SS transmits an AMD PDU segment of AMD PDU#7 (AMD PDU#7 carries SDU#8, SDU#9 and SDU#10) containing the last 20 bytes of SDU#8 and the complete SDU#9 in its data field, with the P-bit set. FI=10, SO=80 and LSF=0. Header extension part present: E in fixed part header=1, E in extension part header=0, LI=20.	<--	AMD PDU#7 (SN=6, P=1) segment 2	-	-
29A	30 ms after step 29 the SS assigns one default grant (UL grant allocation type 3).	<--	(UL grant)	-	-
30	The UE transmits a STATUS PDU NACK_SN field for receipt of PDU#7. ACK_SN=7, NACK_SN=6, SOStart=0/SOEnd=79.	-->	STATUS PDU	7	P
31	60 ms after step 29 the SS transmits an AMD PDU segment of AMD PDU#7 (AMD PDU#7 carries SDU#8, SDU#9 and SDU#10) containing the first 80 bytes of SDU#8 in its data field, with the P-bit set. SO=0 and LSF=0. No header extension part is provided. Note 4	<--	AMD PDU#7 (SN=6, P=1) segment 1	-	-
31A	The SS waits for 60 ms to ensure UE RLC has all the required SDUs available and then assigns one default UL grant (UL grant allocation type 3).	<--	(UL grant)	-	-
32	Check: Does the UE transmit a STATUS PDU with ACK_SN=7, thus acknowledging the reception of PDUs with SN=0 to SN=6, and no NACK_SN provided?	-->	STATUS PDU	7	P
33	Void	-	-	-	-
34	Void	-	-	-	-
35	Check: Does the UE transmit RLC SDU#8, RLC SDU#9 and RLC SDU#10?	-->	AMD PDU (RLC SDU#8, RLC SDU#9, RLC SDU#10)	7	P
36	The SS transmits a STATUS PDU.	<--	STATUS PDU (ACK SN=5)	-	-

Note 1: From steps 4 onwards, the transmission of AMD PDUs is scheduled. The activation time of 100 ms for the first of possibly several AMD PDUs is greater than *t-StatusProhibit*, and therefore there is no need to wait for the expiry of this timer. Subsequent AMD PDU transmissions are using subsequent TTIs.

Note 2: In steps 6-8, 12-14, 18-19, 24-26, 32-35 the STATUS PDU and the AMD PDU consisting of one or more RLC SDUs are received as a PDU list in one TTI.

Note 3: In step 29A it is assumed that the UE will react upon the AMD PDU within 30 ms.

Note 4: Step 31 shall be executed within 60 ms after step 29 to ensure that the UE receives the AMD PDU before the expiry of *t-Reordering* at the UE.

7.2.3.18.3.3 Specific message contents

None.

7.2.3.19 Void

7.2.3.20 AM RLC / Duplicate detection of RLC PDUs

7.2.3.20.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE is in AM mode and receives duplicated RLC data PDUs having the same sequence number }
    then { UE discards the duplicated RLC data PDUs }
```

}

7.2.3.20.2 Conformance requirements

References: The conformance requirements covered in the current TC are specified in: TS 36.322, clause 4.2.1.3.3.

[TS 36.322, clause 4.2.1.3.3]

When the receiving side of an AM RLC entity receives RLC data PDUs, it shall:

- detect whether or not the RLC data PDUs have been received in duplication, and discard duplicated RLC data PDUs;

…

7.2.3.20.3 Test description

7.2.3.20.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].

7.2.3.20.3.2 Test procedure sequence

Table 7.2.3.20.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	SS creates 3 RLC SDUs of size 40 bytes segmented into two AMD PDUs each. AMD PDU#1 and AMD PDU#2 belong to RLC SDU#1, AMD PDU#3 and #4 belong to RLC SDU#2 and AMD PDU#5 and #6 belong to RLC SDU#3. SS transmits AMD PDU#1 with SN=0, AMD PDU#2 with SN=1 and AMD PDU#3 twice with SN=2.	<--	RLC AMD PDU#1 (SN=0) RLC AMD PDU#2 (SN=1) RLC AMD PDU#3 (SN=2) RLC AMD PDU#3 (SN=2)	-	-
2	Check: Does the UE transmit RLC SDU#1? (Note 1)	-->	(RLC SDU#1)	1	P
3	SS transmits AMD PDU#4 with SN=3.	<--	RLC AMD PDU#4 (SN=3)	-	-
4	Check: Does the UE transmit RLC SDU#2?	-->	(RLC SDU#2)	1	P
5	SS transmits AMD PDU#6 twice with SN=5.	<--	RLC AMD PDU#6 (SN=5) RLC AMD PDU#6 (SN=5)	-	-
6	SS transmits AMD PDU#5 twice with SN=4.	<--	RLC AMD PDU#5 (SN=4) RLC AMD PDU#5 (SN=4)	-	-
7	Check: Does the UE transmit RLC SDU#3 once? (Note 2)	-->	(RLC SDU#3)	1	P
Note 1: The duplicated AMD PDU#3 have been discarded by the conformant UE in step 1. Note 2: The duplicated AMD PDU#5 and AMD PDU#6 have been discarded by the conformant UE in steps 5 and 6.					

7.2.3.20.3.3 Specific message content

None.

7.2.3.21 AM RLC / RLC re-establishment at RRC connection reconfiguration including *mobilityControlInfo* IE

7.2.3.21.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE is requested to perform a RRC Connection reconfiguration including mobilityControlInfo
IE }
    then { UE discards the remaining AMD PDUs; and discards all RLC SDUs in the transmitting side;
and reset all state variables to their initial values.  }
}
```

7.2.3.21.2 Conformance requirements

References: The conformance requirements covered in the current TC are specified in: TS 36.322, clause 5.4 and TS 36.331 clause 5.3.5.4.

[TS 36.322, clause 5.4]

RLC re-establishment is performed upon request by RRC, and the function is applicable for AM, UM and TM RLC entities.

When RRC indicates that an RLC entity should be re-established, the RLC entity shall:

…

- if it is an AM RLC entity:
  - when possible, reassemble RLC SDUs from any byte segments of AMD PDUs with SN < VR(MR) in the receiving side, remove RLC headers when doing so and deliver all reassembled RLC SDUs to upper layer in ascending order of the RLC SN, if not delivered before;
  - discard the remaining AMD PDUs and byte segments of AMD PDUs in the receiving side;
  - discard all RLC SDUs and AMD PDUs in the transmitting side;
  - discard all RLC control PDUs.
- stop and reset all timers;
- reset all state variables to their initial values.

[TS 36.331, clause 5.3.5.4]

If the *RRCConnectionReconfiguration* message includes the *mobilityControlInfo* and the UE is able to comply with the configuration included in this message, the UE shall:

….

1> re-establish RLC for all RBs that are established;

…

7.2.3.21.3 Test description

7.2.3.21.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] with the exceptions listed in table 7.2.3.21.3.1-1.

Table 7.2.3.21.3.1-1: RLC settings

Parameter	Value
t-Reordering	ms150
t-PollRetransmit	ms150

7.2.3.21.3.2 Test procedure sequence

Table 7.2.3.21.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	The SS ignores scheduling requests and does not allocate any uplink grant.	-	-	-	-
1	SS creates 3 RLC SDUs of size 40 bytes segmented into two AMD PDUs each. AMD PDU#1 and AMD PDU#2 belong to RLC SDU#1, AMD PDU#3 and #4 belong to RLC SDU#2 and AMD PDU#5 and #6 belong to RLC SDU#3. SS transmits AMD PDU#1 (SN=0), AMD PDU#2 (SN=1) and AMD PDU#4 (SN=3).	<--	AMD PDU#1 AMD PDU#2 AMD PDU#4	-	-
1A	60 ms after step 1 the SS allocates 1 UL grant of default size (UL grant allocation type 3).	<--	(UL grant)		
2	The UE returns RLC SDU#1.	-->	(RLC SDU#1)	-	-
3	SS does not acknowledge the reception of RLC SDU#1.	-	-	-	-
4	90 ms after step 1 SS performs a RRC Connection Reconfiguration procedure including the *mobilityControlInfo* IE triggering RLC-reestablishment. (Note 1)	-	-	-	-
4AA	The SS starts the UL default grant transmissions	-	-	-	-
4A	The UE retransmits RLC SDU #1. (Note 1A)	-->	(RLC SDU#1)	-	-
4B	SS transmits a STATUS PDU (ACK_SN = 1).	<--	STATUS PDU	-	-
5	SS transmits AMD PDU#5 with SN=0 and the P field set to "1"	<--	AMD PDU#5	-	-
6	Check: Does the UE transmit a STATUS PDU? (Note 2)	-->	STATUS PDU (ACK_SN = 1)	1	P
7	SS transmits AMD PDU#6 with SN=Receiving_AM_Window_Size+2	<--	AMD PDU#6	-	-
8	Check: Does the UE return RLC SDU#3 within 1s? (Note 3)	-->	(RLC SDU#3)	1	F
9	SS transmits AMD PDU#6 with SN=1	<--	AMD PDU#6	-	-
10	Check: Does the UE return RLC SDU#3 with its first AMD PDU set to SN=1?	-->	(RLC SDU#3)	1	P

Note 1: Upon a RLC re-establishment a conformant UE discards any remaining AMD PDUs in the receiver and transmitter side, stops and resets all timers and resets all state variables to their initial values.
Note 1A: The UE will retransmit the PDCP SDU associated with RLC SDU#1 in accordance to TS 36.323 clause 5.2.1.1.
Note 2: AMD PDU#4 is discarded by a conformant UE in step 4.
Note 3: AMD PDU#6 is discarded by a conformant UE due to being outside the receiving window size.

7.2.3.21.3.3 Specific message contents

Table 7.2.3.21.3.3-1: *RRCConnectionReconfiguration* (step 4, table 7.2.3.21.3.2-1)

Derivation Path: 36.508 table 4.6.1-8: RRCConnectionReconfiguration, condition HO			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReconfiguration ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
rrcConnectionReconfiguration-r8 SEQUENCE {			
mobilityControlInfo SEQUENCE {			
targetPhysCellId	Set to the physical cell identity of cell 1		
carrierFreq	Not present		
}			
radioResourceConfigCommon	Not present		
}			
}			
}			
}			

7.3 PDCP

7.3.1 Maintenance of PDCP sequence numbers for radio bearers

7.3.1.1 Maintenance of PDCP sequence numbers / User plane / RLC AM

7.3.1.1.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits a PDCP Data SDU on a DRB mapped on AM RLC }
    then { UE increments SN with 1 for each transmitted PDU for SN=0 to Maximum_PDCP_SN }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits a PDCP Data SDU on a DRB mapped on AM RLC and, after incrementation,
Next_PDCP_TX_SN is larger than the Maximum_PDCP_SN }
    then { UE sets SN to 0 in the next transmitted PDCP SDU}
}
```

7.3.1.1.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clause 5.1.1, 5.1.2.2 and 6.2.3.

[TS 36.323, clause 5.1.1]

At reception of a PDCP SDU from upper layers, the UE shall:

- *discardTimer*start the associated with this PDCP SDU (if configured);

For a PDCP SDU received from upper layers, the UE shall:

- associate the PDCP SN corresponding to Next_PDCP_TX_SN to this PDCP SDU;
- perform header compression of the PDCP SDU (if configured) as specified in the subclause 5.5.4;
- perform integrity protection (if applicable), and ciphering (if applicable) using COUNT based on TX_HFN and the PDCP SN associated with this PDCP SDU as specified in the subclause 5.7 and 5.6, respectively;
- increment Next_PDCP_TX_SN by one;

- if Next_PDCP_TX_SN > Maximum_PDCP_SN:
  - set Next_PDCP_TX_SN to 0;
  - increment TX_HFN by one;
- submit the resulting PDCP Data PDU to lower layer.

[TS 36.323, clause 5.1.2.1.2]

For DRBs mapped on RLC AM, at reception of a PDCP Data PDU from lower layers, the UE shall:

- if received PDCP SN – Last_Submitted_PDCP_RX_SN > Reordering_Window or 0 <= Last_Submitted_PDCP_RX_SN – received PDCP SN < Reordering_Window:
  - if received PDCP SN > Next_PDCP_RX_SN:
    - decipher the PDCP PDU as specified in the subclause 5.6, using COUNT based on RX_HFN - 1 and the received PDCP SN;
  - else:
    - decipher the PDCP PDU as specified in the subclause 5.6, using COUNT based on RX_HFN and the received PDCP SN;
  - perform header decompression (if configured) as specified in the subclause 5.5.5;
  - discard this PDCP SDU;
- else if Next_PDCP_RX_SN – received PDCP SN > Reordering_Window:
  - increment RX_HFN by one;
  - use COUNT based on RX_HFN and the received PDCP SN for deciphering the PDCP PDU;
  - set Next_PDCP_RX_SN to the received PDCP SN + 1;
- else if received PDCP SN – Next_PDCP_RX_SN > =Reordering_Window:
  - use COUNT based on RX_HFN – 1 and the received PDCP SN for deciphering the PDCP PDU;
- else if received PDCP SN >= Next_PDCP_RX_SN:
  - use COUNT based on RX_HFN and the received PDCP SN for deciphering the PDCP PDU;
  - set Next_PDCP_RX_SN to the received PDCP SN + 1;
- if Next_PDCP_RX_SN is larger than Maximum_PDCP_SN:
  - set Next_PDCP_RX_SN to 0;
  - increment RX_HFN by one;
- else if received PDCP SN < Next_PDCP_RX_SN:
  - use COUNT based on RX_HFN and the received PDCP SN for deciphering the PDCP PDU;
- if the PDCP PDU has not been discarded in the above:
  - perform deciphering and header decompression (if configured) for the PDCP PDU as specified in the subclauses 5.6 and 5.5.5, respectively;
- if a PDCP SDU with the same PDCP SN is stored:
  - discard this PDCP SDU;
- else:
  - store the PDCP SDU;

- if the PDCP PDU received by PDCP is not due to the re-establishment of lower layers:
  - deliver to upper layers in ascending order of the associated COUNT value:
    - all stored PDCP SDU(s) with an associated COUNT value less than the COUNT value associated with the received PDCP SDU;
    - all stored PDCP SDU(s) with consecutively associated COUNT value(s) starting from the COUNT value associated with the received PDCP SDU;
  - set Last_Submitted_PDCP_RX_SN to the PDCP SN of the last PDCP SDU delivered to upper layers;
- else if received PDCP SN = Last_Submitted_PDCP_RX_SN + 1 or received PDCP SN = Last_Submitted_PDCP_RX_SN – Maximum_PDCP_SN:
  - deliver to upper layers in ascending order of the associated COUNT value:
    - all stored PDCP SDU(s) with consecutively associated COUNT value(s) starting from the COUNT value associated with the received PDCP SDU;
  - set Last_Submitted_PDCP_RX_SN to the PDCP SN of the last PDCP SDU delivered to upper layers.

[TS 36.323, clause 6.2.3]

Figure 6.2.3.1 shows the format of the PDCP Data PDU when a 12 bit SN length is used. This format is applicable for PDCP Data PDUs carrying data from DRBs mapped on RLC AM or RLC UM.

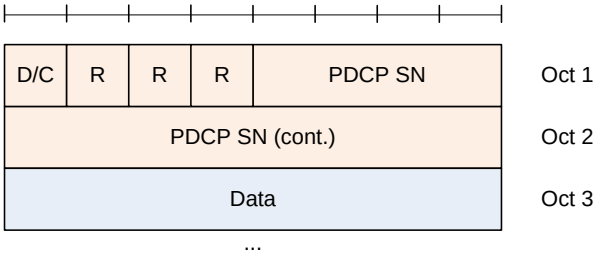

Figure 6.2.3.1: PDCP Data PDU format for DRBs using a 12 bit SN

7.3.1.1.3 Test description

7.3.1.1.3.1 Pre-test conditions

System Simulator

- Cell 1
- SS PDCP set to Transparent Mode

UE:

None.

Preamble

- The UE is in state Loopback Activated (state 4) according to [18].

7.3.1.1.3.2 Test procedure sequence

Table 7.3.1.1.3.2-1: Main behaviour

St	Procedure	Message Sequence	TP	Verdict

		U - S	Message		
-	EXCEPTION: Steps 1 and 2 shall be repeated for k=0 to Maximum_PDCP_SN (increment=1).				
1	SS transmits a PDCP Data PDU on DRB1 containing one IP packet without header compression.	<--	PDCP Data PDU (SN = k)		
2	CHECK: Does UE transmit a PDCP Data PDU with SN=0 for the first iteration and then incremented by 1 at each iteration?	-->	PDCP Data PDU (SN = k)	1	P
3	SS transmits a PDCP Data PDU on DRB1 containing one IP packet without header compression.	<--	PDCP Data PDU (SN = 0)		
4	CHECK: Does UE transmit a PDCP Data PDU with SN=0?	-->	PDCP Data PDU (SN = 0)	2	P
5	SS sends a PDCP Data PDU on DRB1 containing one IP packet without header compression.	<--	PDCP Data PDU (SN = 1)		
6	CHECK: Does UE transmit a PDCP Data PDU with SN=1?	-->	PDCP Data PDU (SN = 1)	1	P

7.3.1.1.3.3 Specific message contents

None

7.3.1.2 Maintenance of PDCP sequence numbers / User plane / RLC UM / Short PDCP SN (7 bits)

7.3.1.2.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits a PDCP Data SDU on a DRB mapped on UM RLC and configured for short PDCP SN
size (7 bits)}
    then { UE increments SN with 1 for each transmitted PDU for SN=0 to Maximum_PDCP_SN }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits a PDCP Data SDU on a DRB mapped on UM RLC and configured for short PDCP SN
size (7 bits); and, after incrementation,  Next_PDCP_TX_SNis larger than  the Maximum_PDCP_SN }
    then { UE sets SN to 0 in the next transmitted PDCP SDU}
}
```

7.3.1.2.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clause 5.1.1 , 5.1.2.1.3 and 6.2.4.

[TS 36.323, clause 5.1.1]

At reception of a PDCP SDU from upper layers, the UE shall:

- start the *discardTimer* associated with this PDCP SDU (if configured);

For a PDCP SDU received from upper layers, the UE shall:

- associate the PDCP SN corresponding to Next_PDCP_TX_SN to this PDCP SDU;
- perform header compression of the PDCP SDU (if configured) as specified in the subclause 5.5.4;
- perform integrity protection (if applicable), and ciphering (if applicable) using COUNT based on TX_HFN and the PDCP SN associated with this PDCP SDU as specified in the subclause 5.7 and 5.6, respectively;
- increment Next_PDCP_TX_SN by one;

- if Next_PDCP_TX_SN > Maximum_PDCP_SN:
  - set Next_PDCP_TX_SN to 0;
  - increment TX_HFN by one;
- submit the resulting PDCP Data PDU to lower layer.

[TS 36.323, clause 5.1.2.1.3]

For DRBs mapped on RLC UM, at reception of a PDCP Data PDU from lower layers, the UE shall:

- if received PDCP SN < Next_PDCP_RX_SN:
  - increment RX_HFN by one;
- decipher the PDCP Data PDU using COUNT based on RX_HFN and the received PDCP SN as specified in the subclause 5.6;
- set Next_PDCP_RX_SN to the received PDCP SN + 1;
- if Next_PDCP_RX_SN > Maximum_PDCP_SN:
  - set Next_PDCP_RX_SN to 0;
  - increment RX_HFN by one;
- perform header decompression (if configured) of the deciphered PDCP Data PDU as specified in the subclause 5.5.5;
- deliver the resulting PDCP SDU to upper layer.

[TS 36.323, clause 6.2.4]

Figure 6.2.4.1 shows the format of the PDCP Data PDU when a 7 bit SN length is used. This format is applicable for PDCP Data PDUs carrying data from DRBs mapped on RLC UM.

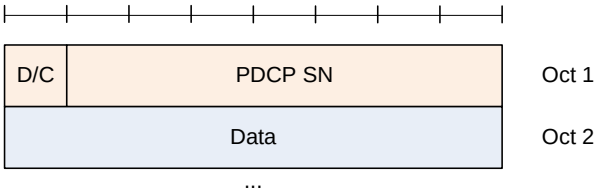

Figure 6.2.4.1: PDCP Data PDU format for DRBs using 7 bit SN

7.3.1.2.3 Test description

7.3.1.2.3.1 Pre-test conditions

System Simulator

- Cell 1
- SS PDCP set to Transparent Mode

UE:

None.

Preamble

- The UE is in state Loopback Activated (state 4) according to [18].

- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

7.3.1.2.3.2 Test procedure sequence

Table 7.3.1.2.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	EXCEPTION: Steps 1 and 2 shall be repeated for k=0 to Maximum_PDCP_SN (increment=1).				
1	SS transmits a PDCP Data PDU on UM DRB containing one IP packet without header compression.	<--	PDCP Data PDU (SN = k)		
2	CHECK: Does UE transmit a PDCP Data PDU with SN=0 for the first iteration and then incremented by 1 at each iteration?	-->	PDCP Data PDU (SN = k)	1	P
3	SS transmits a PDCP Data PDU on UM DRB containing one IP packet without header compression.	<--	PDCP Data PDU (SN = 0)		
4	CHECK: Does UE transmit a PDCP Data PDU with SN=0?	-->	PDCP Data PDU (SN = 0)	2	P
5	SS sends a PDCP Data PDU on UM DRB containing one IP packet without header compression.	<--	PDCP Data PDU (SN = 1)		
6	CHECK: Does UE transmit a PDCP Data PDU with SN=1?	-->	PDCP Data PDU (SN = 1)	1	P

7.3.1.2.3.3 Specific message contents

None

7.3.1.3 Maintenance of PDCP sequence numbers / User plane / RLC UM / Long PDCP SN (12 bits)

7.3.1.3.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits a PDCP Data SDU on a DRB mapped on UM RLC and configured for long PDCP SN size
(12 bits)}
    then { UE increments SN with 1 for each transmitted PDU for SN=0 to Maximum_PDCP_SN }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE transmits a PDCP Data SDU on a DRB mapped on UM RLC and configured for long PDCP SN size
(12 bits); and, after incrementation, Next_PDCP_TX_SN is larger than the Maximum_PDCP_SN limit }
    then { UE sets SN to 0 in the next transmitted PDCP SDU}
}
```

7.3.1.3.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clause 5.1.1 , 5.1.2.1.3 and 6.2.3.

[TS 36.323, clause 5.1.1]

At reception of a PDCP SDU from upper layers, the UE shall:

- start the *discardTimer* associated with this PDCP SDU (if configured);

For a PDCP SDU received from upper layers, the UE shall:

- associate the PDCP SN corresponding to Next_PDCP_TX_SN to this PDCP SDU;

- perform header compression of the PDCP SDU (if configured) as specified in the subclause 5.5.4;
- perform integrity protection (if applicable), and ciphering (if applicable) using COUNT based on TX_HFN and the PDCP SN associated with this PDCP SDU as specified in the subclause 5.7 and 5.6, respectively;
- increment Next_PDCP_TX_SN by one;
- if Next_PDCP_TX_SN > Maximum_PDCP_SN:
  - set Next_PDCP_TX_SN to 0;
  - increment TX_HFN by one;
- submit the resulting PDCP Data PDU to lower layer.

[TS 36.323, clause 5.1.2.1.3]

For DRBs mapped on RLC UM, at reception of a PDCP Data PDU from lower layers, the UE shall:

- if received PDCP SN < Next_PDCP_RX_SN:
  - increment RX_HFN by one;
- decipher the PDCP Data PDU using COUNT based on RX_HFN and the received PDCP SN as specified in the subclause 5.6;
- set Next_PDCP_RX_SN to the received PDCP SN + 1;
- if Next_PDCP_RX_SN > Maximum_PDCP_SN:
  - set Next_PDCP_RX_SN to 0;
  - increment RX_HFN by one;
- perform header decompression (if configured) of the deciphered PDCP Data PDU as specified in the subclause 5.5.5;
- deliver the resulting PDCP SDU to upper layer.

[TS 36.323, clause 6.2.3]

Figure 6.2.3.1 shows the format of the PDCP Data PDU when a 12 bit SN length is used. This format is applicable for PDCP Data PDUs carrying data from DRBs mapped on RLC AM or RLC UM.

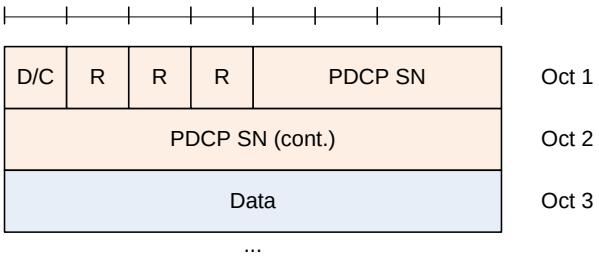

Figure 6.2.3.1: PDCP Data PDU format for DRBs using a 12 bit SN

7.3.1.3.3 Test description

7.3.1.3.3.1 Pre-test conditions

System Simulator

- Cell 1
- SS PDCP set to Transparent Mode

UE:

None.

Preamble

- The UE is in state Loopback Activated (state 4) according to [18] with the RLC UM bearer configured for long PDCP SN size (12 bits).
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

7.3.1.3.3.2 Test procedure sequence

Table 7.3.1.3.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
-	EXCEPTION: Steps 1 and 2 shall be repeated for k=0 to Maximum_PDCP_SN (increment=1).				
1	SS transmits a PDCP Data PDU on UM DRB containing one IP packet without header compression.	<--	PDCP Data PDU (SN = k)		
2	CHECK: Does UE transmit a PDCP Data PDU with SN=0 for the first iteration and then incremented by 1 at each iteration?	-->	PDCP Data PDU (SN = k)	1	P
3	SS transmits a PDCP Data PDU on UM DRB containing one IP packet without header compression.	<--	PDCP Data PDU (SN = 0)		
4	CHECK: Does UE transmit a PDCP Data PDU with SN=0?	-->	PDCP Data PDU (SN = 0)	2	P
5	SS sends a PDCP Data PDU on UM DRB containing one IP packet without header compression.	<--	PDCP Data PDU (SN = 1)		
6	CHECK: Does UE transmit a PDCP Data PDU with SN=1?	-->	PDCP Data PDU (SN = 1)	1	P

7.3.1.3.3.3 Specific message contents

None

7.3.2 Void

7.3.3 PDCP ciphering and deciphering

7.3.3.1 Ciphering and deciphering / Correct functionality of EPS AS encryption algorithms / SNOW 3G

7.3.3.1.1 Test Purpose (TP)

(1)

```
with { UE in RRC_IDLE/E-UTRA RRC_CONNECTED state }
ensure that {
  when { Functionality of EPS AS encryption algorithms with SNOW 3G is taken into use }
       then { UE performs correct AS ciphering function in PDCP entities associated with SRBs. }
}
```

7.3.3.1.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.323, clause 5.6, TS 33.401, clause 5.1.3.2 and TS 36.331, clause 6.3.3.

[TS 36.323, clause 5.6]

The ciphering function includes both ciphering and deciphering and is performed in PDCP. For the control plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3) and the MAC-I (see subclause 6.3.4). For the user plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3); ciphering is not applicable to PDCP Control PDUs.

The ciphering algorithm and key to be used by the PDCP entity are configured by upper layers [3] and the ciphering method shall be applied as specified in [6].

The ciphering function is activated by upper layers [3]. After security activation, the ciphering function shall be applied to all PDCP PDUs indicated by upper layers [3] for the downlink and the uplink, respectively.

The parameters that are required by PDCP for ciphering are defined in [6] and are input to the ciphering algorithm. The required inputs to the ciphering function include the COUNT value, and DIRECTION (direction of the transmission: set as specified in [6]).The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (the ciphering keys for the control plane and for the user plane are K_{RRCenc} and K_{UPenc}, respectively).

[TS 33.401, clause 5.1.3.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key except Null ciphering algorithm.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Encryption Algorithm (EEA) will be assigned a 4-bit identifier. Currently, the following values have been defined for NAS, RRC and UP ciphering:

…

"0001_2" 128-EEA1 SNOW 3G based algorithm

…

The remaining values have been reserved for future use.

UEs and eNBs shall implement EEA0, 128-EEA1 and 128-EEA2 for both RRC signalling ciphering and UP ciphering. UEs and eNBs may implement 128-EEA3 for both RRC signalling ciphering and UP ciphering.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

***SecurityAlgorithmConfig* field descriptions**
cipheringAlgorithm
Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm
Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.3.1.3 Test description

7.3.3.1.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

- None.

Preamble:

- The UE shall be in Registered Idle Mode (State 2) according to [18].

7.3.3.1.3.2 Test procedure sequence

Table 7.3.3.1.3.2-1: Main Behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS sends a *Paging* message to the UE on the appropriate paging block, and including the UE identity in one entry of the IE *pagingRecordLists*.	<--	*Paging (PCCH)*	-	-
2	Check: Does The UE transmit a *RRCConnectionRequest* message without related PDCP Data PDU being ciphered?	-->	*RRCConnectionRequest*	1	P
3	The SS transmits an *RRCConnectionSetup* message. This message related PDCP Data PDU should not be integrity protected and ciphered.	<--	*RRCConnectionSetup*	-	-
4	Check: Does the UE transmit a *RRCConnectionSetupComplete* message to confirm the successful completion of the connection establishment and to initiate the session management procedure by including the SERVICE REQUEST message (State3), and without related PDCP Data PDU being ciphered?	-->	*RRCConnectionSetupComplete*	1	P
5	The SS transmits a *SecurityModeCommand* message to activate EPS AS encryption algorithm security. The message related PDCP Data PDU should be integrity protected but not ciphered.	<--	*SecurityModeCommand*	-	-
6	Check: Does the UE transmit a *SecurityModeComplete* message and establishes the initial security configuration without the message related PDCP Data PDU being ciphered?	-->	*SecurityModeComplete*	1	P
7	The SS configures a new data radio bearer, associated with the default EPS bearer context. This message related PDCP Data PDU should be integrity protected and ciphered. The COUNT of this message related PDCP Data PDU can be used for deciphering.	<--	*RRCConnectionReconfiguration*	-	-
8	The UE transmits a *RRCConnectionReconfigurationComplete* message to confirm the establishment of the new data radio bearer, associated with the default EPS bearer context. This message related PDCP Data PDU should be integrity protected and ciphered. The COUNT of this message related PDCP Data PDU can be used for deciphering.	-->	*RRCConnectionReconfigurationComplete*	1	P

7.3.3.1.3.3 Specific message contents

Table 7.3.3.1.3.3-1 *SecurityModeCommand* (step 6, Table 7.3.3.1.3.2-1)

Derivation Path: TS36.508 clause 4.6.1 table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
SecurityModeCommand ::= SEQUENCE {			
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
criticalExtensions CHOICE {			
c1 CHOICE{			
securityModeCommand-r8 SEQUENCE {			
securityConfigSMC SEQUENCE {			
securityAlgorithmConfig SEQUENCE {			
cipheringAlgorithm	eea1		
integrityProtAlgorithm	Default value specified in TS 36.508		
}			
nonCriticalExtension SEQUENCE {}	Not present		
}			
}			
}			
}			
}			

7.3.3.2 Ciphering and deciphering / Correct functionality of EPS UP encryption algorithms / SNOW 3G

7.3.3.2.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE is requested to achieve functionality of EPS UP encryption algorithms with SNOW 3G }
      then { UE performs correct UP ciphering function in PDCP entities associated with DRBs. }
}
```

7.3.3.2.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.323, clause 5.6, TS 33.401, clause 5.1.3.2 and TS 36.331, clause 6.3.3.

[TS 36.323, clause 5.6]

The ciphering function includes both ciphering and deciphering and is performed in PDCP. For the control plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3) and the MAC-I (see subclause 6.3.4). For the user plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3); ciphering is not applicable to PDCP Control PDUs.

The ciphering algorithm and key to be used by the PDCP entity are configured by upper layers [3] and the ciphering method shall be applied as specified in [6].

The ciphering function is activated by upper layers [3]. After security activation, the ciphering function shall be applied to all PDCP PDUs indicated by upper layers [3] for the downlink and the uplink, respectively.

The parameters that are required by PDCP for ciphering are defined in [6] and are input to the ciphering algorithm. The required inputs to the ciphering function include the COUNT value, and DIRECTION (direction of the transmission: 0 for uplink, 1 for downlink).The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (the ciphering keys for the control plane and for the user plane are K_{RRCenc} and K_{UPenc}, respectively).

[TS 33.401, clause 5.1.3.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key except Null ciphering algorithm.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Encryption Algorithm (EEA) will be assigned a 4-bit identifier. Currently, the following values have been defined for NAS, RRC and UP ciphering:

…

"0001_2" 128-EEA1 SNOW 3G based algorithm

…

The remaining values have been reserved for future use.

UEs and eNBs shall implement EEA0, 128-EEA1 and 128-EEA2 for both RRC signalling ciphering and UP ciphering. UEs and eNBs may implement 128-EEA3 for both RRC signalling ciphering and UP ciphering.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

***SecurityAlgorithmConfig* field descriptions**
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.3.2.3 Test description

7.3.3.2.3.1 Pre-test conditions

System Simulator:

- Cell 1.

UE:

- None.

Preamble

- The UE shall be in Loopback Activation state (State 4) according to TS36.508.

7.3.3.2.3.2 Test procedure sequence

Table 7.3.3.2.3.2-1: Main Behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	SS Transmits PDCP PDU on DRB ciphered.	<--	PDCP PDU	-	-
2	Check: Does the UE transmit loop backed PDCP PDU ciphered.	-->	PDCP PDU	1	P

7.3.3.2.3.3 Specific message contents

Table 7.3.3.2.3.3-1 *SecurityModeCommand* (in the preamble)

Derivation Path: TS36.508 clause 4.6.1 table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
SecurityModeCommand ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
securityModeCommand-r8 SEQUENCE {			
securityConfigSMC SEQUENCE {			
cipheringAlgorithm	eea1		
}			
nonCriticalExtension SEQUENCE {}	Not present		
}			
}			
}			
}			

7.3.3.3 Ciphering and deciphering / Correct functionality of EPS AS encryption algorithms / AES

7.3.3.3.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE is requested to achieve functionality of EPS AS encryption algorithms with AES }
      then { UE performs correct AS ciphering function in PDCP entities associated with SRBs. }
}
```

7.3.3.3.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.323, clause 5.6 , TS 33.401, clause 5.1.3.2 and TS 36.331, clause 6.3.3.

[TS 36.323, clause 5.6]

The ciphering function includes both ciphering and deciphering and is performed in PDCP. For the control plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3) and the MAC-I (see subclause 6.3.4). For the user plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3); ciphering is not applicable to PDCP Control PDUs.

The ciphering algorithm and key to be used by the PDCP entity are configured by upper layers [3] and the ciphering method shall be applied as specified in [6].

The ciphering function is activated by upper layers [3]. After security activation, the ciphering function shall be applied to all PDCP PDUs indicated by upper layers [3] for the downlink and the uplink, respectively.

The parameters that are required by PDCP for ciphering are defined in [6] and are input to the ciphering algorithm. The required inputs to the ciphering function include the COUNT value, and DIRECTION (direction of the transmission: set as specified in [6]).The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (the ciphering keys for the control plane and for the user plane are K_{RRCenc} and K_{UPenc}, respectively).

[TS 33.401, clause 5.1.3.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key except Null ciphering algorithm.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Encryption Algorithm (EEA) will be assigned a 4-bit identifier. Currently, the following values have been defined for NAS, RRC and UP ciphering:

…

"0010_2" 128-EEA2 AES based algorithm

…

The remaining values have been reserved for future use.

UEs and eNBs shall implement EEA0, 128-EEA1 and 128-EEA2 for both RRC signalling ciphering and UP ciphering. UEs and eNBs may implement 128-EEA3 for both RRC signalling ciphering and UP ciphering.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

***SecurityAlgorithmConfig* field descriptions**
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.3.3.3 Test description

7.3.3.3.3.1 Pre-test conditions

Same Pre-test conditions as in clause 7.3.3.1.3.1.

7.3.3.3.3.2 Test procedure sequence

Same Test procedure sequence as in Table 7.3.3.1.3.2.

7.3.3.3.3.3 Specific message contents

Table 7.3.3.3.3.3-1 *SecurityModeCommand* (step 6)

Derivation Path: TS36.508 clause 4.6.1 table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
SecurityModeCommand ::= SEQUENCE {			
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
criticalExtensions CHOICE {			
c1 CHOICE{			
securityModeCommand-r8 SEQUENCE {			
securityConfigSMC SEQUENCE {			
securityAlgorithmConfig SEQUENCE {			
cipheringAlgorithm	eea2		
}			
nonCriticalExtension SEQUENCE {}	Not present		
}			
}			
}			
}			

7.3.3.4 Ciphering and deciphering / Correct functionality of EPS UP encryption algorithms / AES

7.3.3.4.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE is requested to achieve functionality of EPS UP encryption algorithms with AES }
      then { UE performs correct UP ciphering function in PDCP entities associated with DRBs. }
}
```

7.3.3.4.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.323, clause 5.6 , TS 33.401, clause 5.1.3.2 and TS 36.331, clause 6.3.3.

[TS 36.323, clause 5.6]

The ciphering function includes both ciphering and deciphering and is performed in PDCP. For the control plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3) and the MAC-I (see subclause 6.3.4). For the user plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3); ciphering is not applicable to PDCP Control PDUs.

The ciphering algorithm and key to be used by the PDCP entity are configured by upper layers [3] and the ciphering method shall be applied as specified in [6].

The ciphering function is activated by upper layers [3]. After security activation, the ciphering function shall be applied to all PDCP PDUs indicated by upper layers [3] for the downlink and the uplink, respectively.

The parameters that are required by PDCP for ciphering are defined in [6] and are input to the ciphering algorithm. The required inputs to the ciphering function include the COUNT value, and DIRECTION (direction of the transmission: set as specified in [6]).The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (the ciphering keys for the control plane and for the user plane are K_{RRCenc} and K_{UPenc}, respectively).

[TS 33.401, clause 5.1.3.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key except Null ciphering algorithm.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Encryption Algorithm (EEA) will be assigned a 4-bit identifier. Currently, the following values have been defined for NAS, RRC and UP ciphering:

…

"0010_2" 128-EEA2 AES based algorithm

…

The remaining values have been reserved for future use.

UEs and eNBs shall implement EEA0, 128-EEA1 and 128-EEA2 for both RRC signalling ciphering and UP ciphering. UEs and eNBs may implement 128-EEA3 for both RRC signalling ciphering and UP ciphering.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

SecurityAlgorithmConfig field descriptions
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.3.4.3 Test description

7.3.3.4.3.1 Pre-test conditions

Same Pre-test conditions as in clause 7.3.3.2.3.1.

7.3.3.4.3.2 Test procedure sequence

Same Test procedure sequence as in Table 7.3.3.2.3.2.

7.3.3.4.3.3 Specific message contents

Table 7.3.3.4.3.3-1 *SecurityModeCommand* (in the preamble)

Derivation Path: TS36.508 clause 4.6.1 table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
SecurityModeCommand ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
securityConfigSMC SEQUENCE { securityModeCommand-r8 SEQUENCE {			
securityAlgorithmConfig SEQUENCE {			
cipheringAlgorithm	eea2		
	Not present		
}			
nonCriticalExtension SEQUENCE {}	Not present		
}			
}			
}			
}			

7.3.3.5 Ciphering and deciphering / Correct functionality of EPS AS encryption algorithms / ZUC

7.3.3.5.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE is requested to achieve functionality of EPS AS encryption algorithms with ZUC }
      then { UE performs correct AS ciphering function in PDCP entities associated with SRBs. }
}
```

7.3.3.5.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.323, clause 5.6, TS 33.401, clause 5.1.3.2 and TS 36.331, clause 6.3.3.

[TS 36.323, clause 5.6]

The ciphering function includes both ciphering and deciphering and is performed in PDCP. For the control plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3) and the MAC-I (see subclause 6.3.4). For the user plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3); ciphering is not applicable to PDCP Control PDUs.

The ciphering algorithm and key to be used by the PDCP entity are configured by upper layers [3] and the ciphering method shall be applied as specified in [6].

The ciphering function is activated by upper layers [3]. After security activation, the ciphering function shall be applied to all PDCP PDUs indicated by upper layers [3] for the downlink and the uplink, respectively.

The parameters that are required by PDCP for ciphering are defined in [6] and are input to the ciphering algorithm. The required inputs to the ciphering function include the COUNT value, and DIRECTION (direction of the transmission: set as specified in [6]).The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (the ciphering keys for the control plane and for the user plane are K_{RRCenc} and K_{UPenc}, respectively).

[TS 33.401, clause 5.1.3.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key except Null ciphering algorithm.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Encryption Algorithm (EEA) will be assigned a 4-bit identifier. Currently, the following values have been defined for NAS, RRC and UP ciphering:

…

"0011_2" 128-EEA3 ZUC based algorithm

The remaining values have been reserved for future use.

UEs and eNBs shall implement EEA0, 128-EEA1 and 128-EEA2 for both RRC signalling ciphering and UP ciphering. UEs and eNBs may implement 128-EEA3 for both RRC signalling ciphering and UP ciphering.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

***SecurityAlgorithmConfig* field descriptions**
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.3.5.3 Test description

7.3.3.5.3.1 Pre-test conditions

Same Pre-test conditions as in clause 7.3.3.1.3.1.

7.3.3.5.3.2 Test procedure sequence

Same Test procedure sequence as in Table 7.3.3.1.3.2.

7.3.3.5.3.3 Specific message contents

Table 7.3.3.5.3.3-1: *SecurityModeCommand* (step 6)

Derivation Path: TS36.508 clause 4.6.1 table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
SecurityModeCommand ::= SEQUENCE {			
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
criticalExtensions CHOICE {			
c1 CHOICE{			
securityModeCommand-r8 SEQUENCE {			
securityConfigSMC SEQUENCE {			
securityAlgorithmConfig SEQUENCE {			
cipheringAlgorithm	eea3-v11xy		
}			
nonCriticalExtension SEQUENCE {}	Not present		
}			
}			
}			
}			

7.3.3.6 Ciphering and deciphering / Correct functionality of EPS UP encryption algorithms / ZUC

7.3.3.6.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE is requested to achieve functionality of EPS UP encryption algorithms with ZUC }
       then { UE performs correct UP ciphering function in PDCP entities associated with DRBs. }
}
```

7.3.3.6.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: TS 36.323, clause 5.6, TS 33.401, clause 5.1.3.2 and TS 36.331, clause 6.3.3.

[TS 36.323, clause 5.6]

The ciphering function includes both ciphering and deciphering and is performed in PDCP. For the control plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3) and the MAC-I (see subclause 6.3.4). For the user plane, the data unit that is ciphered is the data part of the PDCP PDU (see subclause 6.3.3); ciphering is not applicable to PDCP Control PDUs.

The ciphering algorithm and key to be used by the PDCP entity are configured by upper layers [3] and the ciphering method shall be applied as specified in [6].

The ciphering function is activated by upper layers [3]. After security activation, the ciphering function shall be applied to all PDCP PDUs indicated by upper layers [3] for the downlink and the uplink, respectively.

The parameters that are required by PDCP for ciphering are defined in [6] and are input to the ciphering algorithm. The required inputs to the ciphering function include the COUNT value, and DIRECTION (direction of the transmission: 0 for uplink, 1 for downlink).The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (the ciphering keys for the control plane and for the user plane are K_{RRCenc} and K_{UPenc}, respectively)

[TS 33.401, clause 5.1.3.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key except Null ciphering algorithm.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Encryption Algorithm (EEA) will be assigned a 4-bit identifier. Currently, the following values have been defined for NAS, RRC and UP ciphering:

…

"0011_2" 128-EEA3 ZUC based algorithm

The remaining values have been reserved for future use.

UEs and eNBs shall implement EEA0, 128-EEA1 and 128-EEA2 for both RRC signalling ciphering and UP ciphering. UEs and eNBs may implement 128-EEA3 for both RRC signalling ciphering and UP ciphering.

UEs and MMEs shall implement EEA0, 128-EEA1 and 128-EEA2 for NAS signalling ciphering. UEs and MMEs may implement 128-EEA3 for NAS signalling ciphering.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

***SecurityAlgorithmConfig* field descriptions**
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.3.6.3 Test description

7.3.3.6.3.1 Pre-test conditions

Same Pre-test conditions as in clause 7.3.3.2.3.1.

7.3.3.6.3.2 Test procedure sequences

Same Test procedure sequence as in Table 7.3.3.2.3.2.

7.3.3.6.3.3 Specific message contents

Table 7.3.3.6.3.3-1: *SecurityModeCommand* (in the preamble)

Derivation Path: TS36.508 clause 4.6.1 table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
SecurityModeCommand ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
securityModeCommand-r8 SEQUENCE {			
securityConfigSMC SEQUENCE {			
CipheringAlgorithm	eea3-v11xy		
}			
nonCriticalExtension SEQUENCE {}	Not present		
}			
}			
}			
}			

7.3.4 PDCP integrity protection

7.3.4.1 Integrity protection / Correct functionality of EPS AS integrity algorithms / SNOW3G

7.3.4.1.1 Test Purpose (TP)

(1)

```
with { UE in RRC_IDLE/E-UTRA RRC_CONNECTED state }
ensure that {
  when { Functionality of EPS AS integrity algorithms with SNOW3G is taken into use }
       then { UE performs the integrity protection function in PDCP entities associated with SRBs. }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { SecurityModeCommand fails the integrity protection check }
       then { UE transmits SecurityModeFailure message and continues using the configuration used
prior to the reception of the SecurityModeCommand message }
}
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE has AS security activated and integrity check fails }
       then { UE initiates RRC connection re-establishment procedure }
}
```

7.3.4.1.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clauses 5.7, clause 5.1.2.2, TS 33.401 clause 5.1.4.2 and TS 36.331 clause 6.3.3.

[TS 36.323, clause 5.7]

The integrity protection function includes both integrity protection and integrity verification and is performed in PDCP for PDCP entities associated with SRBs. The data unit that is integrity protected is the PDU header and the data part of the PDU before ciphering.

The integrity protection algorithm and key to be used by the PDCP entities are configured by upper layers [3] and the integrity protection method shall be applied as specified in [6].

The integrity protection function is activated by upper layers [3]. After security activation, the integrity protection function shall be applied to all PDUs including and subsequent to the PDU indicated by upper layers [3] for the downlink and the uplink, respectively.

NOTE: As the RRC message which activates the integrity protection function is itself integrity protected with the configuration included in this RRC message, this message needs first be decoded by RRC before the integrity protection verification could be performed for the PDU in which the message was received.

The parameters that are required by PDCP for integrity protection are defined in [6] and are input to the integrity protection algorithm. The required inputs to the integrity protection function include the COUNT value, and DIRECTION (direction of the transmission: set as specification in [6]). The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (K_{RRCint}).

At transmission, the UE computes the value of the MAC-I field and at reception it verifies the integrity of the PDCP PDU by calculating the X-MAC based on the input parameters as specified above. If the calculated X-MAC corresponds to the received MAC-I, integrity protection is verified successfully.

[TS 36.323, clause 5.1.2.2]

- if integrity verification is not applicable:
  - if received PDCP SN < Next_PDCP_RX_SN:
    - increment RX_HFN by one;
  - set Next_PDCP_RX_SN to the received PDCP SN + 1;
  - if Next_PDCP_RX_SN > Maximum_PDCP_SN:
    - set Next_PDCP_RX_SN to 0;
    - increment RX_HFN by one;
  - deliver the resulting PDCP SDU to upper layer;
- else, if integrity verification is applicable and the integrity verification fails:
  - discard the received PDCP Data PDU;
- indicate the integrity verification failure to upper layer.

[TS 33.401, clause 5.1.4.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Integrity Algorithm (EIA) will be assigned a 4-bit identifier. Currently, the following values have been defined:

…

"0001_2" 128-EIA1 SNOW 3G

…

The remaining values have been reserved for future use.

UEs and eNBs shall implement 128-EIA1 and 128-EIA2 for RRC signalling integrity protection. UEs and eNBs may implement 128-EIA3 for RRC signalling integrity protection.

…

UEs shall implement EIA0 for integrity protection of NAS and RRC signalling. As specified in clause 5.1.4.1 of this specification, EIA0 is only allowed for unauthenticated emergency calls. EIA0 shall not be used for integrity protection between RN and DeNB.

Implementation of EIA0 in MMEs and eNBs is optional, EIA0, if implemented, shall be disabled in MMEs and eNBs in the deployments where support of unauthenticated emergency calling is not a regulatory requirement.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

SecurityAlgorithmConfig field descriptions
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.4.1.3 Test description

7.3.4.1.3.1 Pre-test conditions

System Simulator:

- Cell 1

UE:

None.

Preamble:

- The UE is in state Registered, Idle Mode (State 2) according to [18].

7.3.4.1.3.2 Test procedure sequence

Table 7.3.4.1.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS sends a Paging message to the UE on the appropriate paging block, and including the UE identity in one entry of the IE *pagingRecordLists*.	-	*Paging (PCCH)*	-	-
2	The UE transmit a *RRCConnectionRequest* message .	-->	*RRCConnectionRequest*	-	-
3	The SS transmits an *RRCConnectionSetup* message.	<--	*RRCConnectionSetup*	-	-
4	Does: The UE transmit a *RRCConnectionSetupComplete* message to confirm the successful completion of the connection establishment and to initiate the session management procedure by including the SERVICE REQUEST message without related PDCP Data PDU being integrity protected?	-->	*RRCConnectionSetupComplete*	1	P
5	The SS transmits a *SecurityModeCommand* message to activate AS security with SNOW3G integrity algorithms protected.	<--	*SecurityModeCommand*	-	-
6	Check: Does the UE transmit a *SecurityModeComplete* message with SNOW3G integrity algorithms and RRC integrity key protected and establish the initial security configuration.	-->	*SecurityModeComplete*	1	P
7	Check: Does the *SecurityModeComplete* message from the UE pass the SS' integrity protection check.	-	-	1	P
8	The SS transmits an *RRCConnectionRelease* message.	<--	*RRCConnectionRelease*	-	-
9	Wait for 5 s for the UE to enter E-UTRA RRC_IDLE state.			-	-
10	The SS transmits a *Paging* message including a matched identity.	<--	*Paging*	-	-
11	The UE transmit an *RRCConnectionRequest* message.	-->	*RRCConnectionRequest*	-	-
12	The SS transmits an *RRCConnectionSetup* message.	<--	*RRCConnectionSetup*	-	-
13	The UE transmits an *RRCConnectionSetupComplete* message. This message includes a SERVICE REQUEST message.	-->	*RRCConnectionSetupComplete*	-	-
14	The SS transmits a SecurityModeCommand message. MAC-I is calculated in such way, it will result in integrity check failure on UE side.	<--	*SecurityModeCommand*	-	-
15	Check: Does the UE transmit a SecurityModeFailure message without integrity protection nor ciphering?	-->	*SecurityModeFailure*	2	P
16	The SS transmits a SecurityModeCommand message to activate AS security with SNOW3G integrity algorithms protected.	<--	*SecurityModeCommand*	-	-
17	The UE transmits a *SecurityModeComplete* message. The message related PDCP Data PDU should be integrity protected but not ciphered.	-->	*SecurityModeComplete*	-	-
18	The SS transmits an *UECapabilityEnquiry* message to initiate the UE radio access capability transfer procedure. MAC-I is calculated in such way, it will result in integrity check failure on UE side.	<--	*UECapabilityEnquiry*	-	-
19	Check: Does the UE transmit a *RRCConnectionReestablishmentRequest* message on Cell 1?	-->	*RRCConnectionReestablishment Request*	3	P

20	The SS transmits a *RRCConnectionReestablishment* message	<--	*RRCConnectionReestablishment*	-	-
21	The UE transmits *RRCConnectionReestablishmentComplete* message.	-->	*RRCConnectionReestablishment Complete*	-	-
21 A	The SS transmits an *RRCConnectionReconfiguration* message.	<--	*RRCConnectionReconfiguration*	-	-
21 B	The UE transmits an *RRCConnectionReconfigurationComplete* message.	-->	*RRCConnectionReconfigurationC omplete*	-	-
22	Check: Does the test result of generic test procedure in TS 36.508 subclause 6.4.2.3 indicate that the UE is in E-UTRA RRC_CONNECTED state on Cell 1?	-	-	-	-

7.3.4.1.3.3 Specific message contents

Table 7.3.4.1.3.3-1: *SecurityModeCommand* message (steps 5, 14 and 16, Table 7.3.4.1.3.2-1)

Derivation Path: 36.508 Table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
SecurityModeCommand ::= SEQUENCE {			
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
criticalExtensions CHOICE {			
c1 CHOICE{			
securityModeCommand-r8 SEQUENCE {			
securityConfigSMC SEQUENCE {			
securityAlgorithmConfig SEQUENCE {			
integrityProtAlgorithm	eia1	128-EIA1 SNOW 3G	
}			
}			
}			
}			
}			
}			

Table 7.3.4.1.3.3-2: *RRCConnectionReestablishmentRequest* (step 19, Table 7.3.4.1.3.2-1)

Derivation Path: 36.508, Table 4.6.1-13			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReestablishmentRequest ::= SEQUENCE {			
criticalExtensions CHOICE {			
rrcConnectionReestablishmentRequest-r8 SEQUENCE {			
ue-Identity SEQUENCE {			
c-RNTI	the value of the C-RNTI of the UE		
physCellId	PhysicalCellIdentity of Cell 1		
shortMAC-I	The same value as the 16 least significant bits of the XMAC-I value calculated by SS		
}			
reestablishmentCause	otherFailure		
}			
}			
}			

Table 7.3.4.1.3.3-3: *RRCConnectionReconfiguration* (step 21A, Table 7.3.4.1.3.2-1)

Derivation Path: 36.508 table 4.6.1-8, condition SRB2-DRB(1, 0)

7.3.4.2 Integrity protection / Correct functionality of EPS AS integrity algorithms / AES

7.3.4.2.1 Test Purpose (TP)

(1)

```
with { UE in RRC_IDLE/E-UTRA RRC_CONNECTED state }
ensure that {
  when { Functionality of EPS AS integrity algorithms with AES is taken into use }
       then { UE performs the integrity protection function in PDCP entities associated with SRBs. }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { SecurityModeCommand fails the integrity protection check }
       then { UE transmits SecurityModeFailure message and continues using the configuration used
prior to the reception of the SecurityModeCommand message }
}
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE has AS security activated and integrity check fails }
       then { UE initiates RRC connection re-establishment procedure }
}
```

7.3.4.2.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clauses 5.7, clause 5.1.2.2, TS 33.401 clause 5.1.4.2 and TS 36.331 clause 6.3.3.

[TS 36.323, clause 5.7]

The integrity protection function includes both integrity protection and integrity verification and is performed in PDCP for PDCP entities associated with SRBs. The data unit that is integrity protected is the PDU header and the data part of the PDU before ciphering.

The integrity protection algorithm and key to be used by the PDCP entities are configured by upper layers [3] and the integrity protection method shall be applied as specified in [6].

The integrity protection function is activated by upper layers [3]. After security activation, the integrity protection function shall be applied to all PDUs including and subsequent to the PDU indicated by upper layers [3] for the downlink and the uplink, respectively.

NOTE: As the RRC message which activates the integrity protection function is itself integrity protected with the configuration included in this RRC message, this message needs first be decoded by RRC before the integrity protection verification could be performed for the PDU in which the message was received.

The parameters that are required by PDCP for integrity protection are defined in [6] and are input to the integrity protection algorithm. The required inputs to the integrity protection function include the COUNT value, and DIRECTION (direction of the transmission: set as specification in [6]). The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (K_{RRCint}).

At transmission, the UE computes the value of the MAC-I field and at reception it verifies the integrity of the PDCP PDU by calculating the X-MAC based on the input parameters as specified above. If the calculated X-MAC corresponds to the received MAC-I, integrity protection is verified successfully.

[TS 36.323, clause 5.1.2.2]

- if integrity verification is not applicable:
  - if received PDCP SN < Next_PDCP_RX_SN:
    - increment RX_HFN by one;
  - set Next_PDCP_RX_SN to the received PDCP SN + 1;
  - if Next_PDCP_RX_SN > Maximum_PDCP_SN:
    - set Next_PDCP_RX_SN to 0;
    - increment RX_HFN by one;
  - deliver the resulting PDCP SDU to upper layer;
- else, if integrity verification is applicable and the integrity verification fails:
  - discard the received PDCP Data PDU;
- indicate the integrity verification failure to upper layer.

[TS 33.401, clause 5.1.4.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Integrity Algorithm (EIA) will be assigned a 4-bit identifier. Currently, the following values have been defined:

…

"0010_2" 128-EIA2 AES

…

The remaining values have been reserved for future use.

UEs and eNBs shall implement 128-EIA1 and 128-EIA2 for RRC signalling integrity protection. UEs and eNBs may implement 128-EIA3 for RRC signalling integrity protection.

…

UEs shall implement EIA0 for integrity protection of NAS and RRC signalling. As specified in clause 5.1.4.1 of this specification, EIA0 is only allowed for unauthenticated emergency calls. EIA0 shall not be used for integrity protection between RN and DeNB.

Implementation of EIA0 in MMEs and eNBs is optional, EIA0, if implemented, shall be disabled in MMEs and eNBs in the deployments where support of unauthenticated emergency calling is not a regulatory requirement.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

SecurityAlgorithmConfig field descriptions
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.4.2.3 Test description

7.3.4.2.3.1 Pre-test conditions

Same Pre-test conditions as in clause 7.3.4.1.3.1.

7.3.4.2.3.2 Test procedure sequence

Same Test procedure sequence as in table 7.3.4.1.3.2-1, except the integrity protection algorithm is AES.

7.3.4.2.3.3 Specific message contents

Table 7.3.4.2.3.3-1: SecurityModeCommand message (step 5, 14 and 16, Table 7.3.4.1.3.2-1)

Derivation Path: 36.508 Table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
SecurityModeCommand ::= SEQUENCE {			
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
criticalExtensions CHOICE {			
c1 CHOICE{			
securityModeCommand-r8 SEQUENCE {			
securityConfigSMC SEQUENCE {			
securityAlgorithmConfig SEQUENCE {			
integrityProtAlgorithm	eia2	128-EIA2 AES	
}			
}			
}			
}			
}			
}			

Table 7.3.4.2.3.3-2: *RRCConnectionReestablishmentRequest* (step 19, Table 7.3.4.2.3.2-1)

Derivation Path: 36.508, Table 4.6.1-13			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReestablishmentRequest ::= SEQUENCE {			
criticalExtensions CHOICE {			
rrcConnectionReestablishmentRequest-r8 SEQUENCE {			
ue-Identity SEQUENCE {			
c-RNTI	the value of the C-RNTI of the UE		
physCellId	PhysicalCellIdentity of Cell 1		
shortMAC-I	The same value as the 16 least significant bits of the XMAC-I value calculated by SS		
}			
reestablishmentCause	otherFailure		
}			
}			
}			

7.3.4.3 Integrity protection / Correct functionality of EPS AS integrity algorithms / ZUC

7.3.4.3.1 Test Purpose (TP)

(1)

```
with { UE in RRC_IDLE/E-UTRA RRC_CONNECTED state }
ensure that {
  when { Functionality of EPS AS integrity algorithms with ZUC is taken into use }
       then { UE performs the integrity protection function in PDCP entities associated with SRBs. }
}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { SecurityModeCommand fails the integrity protection check }
       then { UE transmits SecurityModeFailure message and continues using the configuration used
prior to the reception of the SecurityModeCommand message }
}
```

(3)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { UE has AS security activated and integrity check fails }
       then { UE initiates RRC connection re-establishment procedure }
}
```

7.3.4.3.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clause 5.7, clause 5.1.2.2, TS 33.401 clause 5.1.4.2 and TS 36.331 clause 6.3.3

[TS 36.323, clause 5.7]

The integrity protection function includes both integrity protection and integrity verification and is performed in PDCP for PDCP entities associated with SRBs. The data unit that is integrity protected is the PDU header and the data part of the PDU before ciphering.

For RNs, the integrity protection function is performed also for PDCP entities associated with DRBs if integrity protection is configured.

The integrity protection algorithm and key to be used by the PDCP entity are configured by upper layers [3] and the integrity protection method shall be applied as specified in [6].

The integrity protection function is activated by upper layers [3]. After security activation, the integrity protection function shall be applied to all PDUs including and subsequent to the PDU indicated by upper layers [3] for the downlink and the uplink, respectively.

NOTE: As the RRC message which activates the integrity protection function is itself integrity protected with the configuration included in this RRC message, this message needs first be decoded by RRC before the integrity protection verification could be performed for the PDU in which the message was received.

The parameters that are required by PDCP for integrity protection are defined in [6] and are input to the integrity protection algorithm. The required inputs to the integrity protection function include the COUNT value, and DIRECTION (direction of the transmission: set as specified in [6]). The parameters required by PDCP which are provided by upper layers [3] are listed below:

- BEARER (defined as the radio bearer identifier in [6]. It will use the value RB identity –1 as in [3]);
- KEY (K_{RRCint}).
- for RNs, KEY (K_{UPint})

At transmission, the UE computes the value of the MAC-I field and at reception it verifies the integrity of the PDCP PDU by calculating the X-MAC based on the input parameters as specified above. If the calculated X-MAC corresponds to the received MAC-I, integrity protection is verified successfully.

[TS 36.323, clause 5.1.2.2]

if integrity verification is not applicable:

- if received PDCP SN < Next_PDCP_RX_SN:
  - increment RX_HFN by one;
- set Next_PDCP_RX_SN to the received PDCP SN + 1;
- if Next_PDCP_RX_SN > Maximum_PDCP_SN:
  - set Next_PDCP_RX_SN to 0;
  - increment RX_HFN by one;
- deliver the resulting PDCP SDU to upper layer;

- else, if integrity verification is applicable and the integrity verification fails:
  - discard the received PDCP Data PDU;
- indicate the integrity verification failure to upper layer

[TS 33.401, clause 5.1.4.2]

All algorithms specified in this subclause are algorithms with a 128-bit input key.

NOTE: Deviations from the above requirement have to be indicated explicitly in the algorithm identifier list below.

Each EPS Integrity Algorithm (EIA) will be assigned a 4-bit identifier. Currently, the following values have been defined:

…

"0011_2" 128-EIA3 ZUC

The remaining values have been reserved for future use.

UEs and eNBs shall implement 128-EIA1 and 128-EIA2 for RRC signalling integrity protection. UEs and eNBs may implement 128-EIA3 for RRC signalling integrity protection.

…

UEs shall implement EIA0 for integrity protection of NAS and RRC signalling. As specified in clause 5.1.4.1 of this specification, EIA0 is only allowed for unauthenticated emergency calls. EIA0 shall not be used for integrity protection between RN and DeNB.

Implementation of EIA0 in MMEs and eNBs is optional, EIA0, if implemented, shall be disabled in MMEs and eNBs in the deployments where support of unauthenticated emergency calling is not a regulatory requirement.

[TS 36.331, clause 6.3.3]

The IE *SecurityAlgorithmConfig* is used to configure AS integrity protection algorithm (SRBs) and AS ciphering algorithm (SRBs and DRBs). For RNs, the IE *SecurityAlgorithmConfig* is also used to configure AS integrity protection algorithm for DRBs between the RN and the E-UTRAN.

…

SecurityAlgorithmConfig field descriptions
cipheringAlgorithm Indicates the ciphering algorithm to be used for SRBs and DRBs, as specified in TS 33.401 [32, 5.1.3.2].
integrityProtAlgorithm Indicates the integrity protection algorithm to be used for SRBs, as specified in TS 33.401 [32, 5.1.4.2]. For RNs, also indicates the integrity protection algorithm to be used for integrity protection-enabled DRB(s).

7.3.4.3.3 Test description

7.3.4.3.3.1 Pre-test conditions

Same Pre-test conditions as in clause 7.3.4.1.3.1.

7.3.4.3.3.2 Test procedure sequence

Same Test procedure sequence as in table 7.3.4.1.3.2-1, except the integrity protection algorithm is ZUC.

7.3.4.3.3.3 Specific message contents

Table 7.3.4.3.3.3-1: SecurityModeCommand message (step 5, 14 and 16, Table 7.3.4.1.3.2-1)

Derivation Path: 36.508 Table 4.6.1-19			
Information Element	**Value/remark**	**Comment**	**Condition**
SecurityModeCommand ::= SEQUENCE {			
rrc-TransactionIdentifier	RRC-TransactionIdentifier-DL		
criticalExtensions CHOICE {			
c1 CHOICE{			
securityModeCommand-r8 SEQUENCE {			
securityConfigSMC SEQUENCE {			
securityAlgorithmConfig SEQUENCE {			
integrityProtAlgorithm	eia3-v11xy	128-EIA3 ZUC	
}			
}			
}			
}			
}			
}			

Table 7.3.4.3.3.3-2: *RRCConnectionReestablishmentRequest* (step 19, Table 7.3.4.1.3.2-1)

Derivation Path: 36.508, Table 4.6.1-13			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReestablishmentRequest ::= SEQUENCE {			
criticalExtensions CHOICE {			
rrcConnectionReestablishmentRequest-r8 SEQUENCE {			
ue-Identity SEQUENCE {			
c-RNTI	the value of the C-RNTI of the UE		
physCellId	PhysicalCellIdentity of Cell 1		
shortMAC-I	The same value as the 16 least significant bits of the XMAC-I value calculated by SS		
}			
reestablishmentCause	otherFailure		
}			
}			
}			

Table 7.3.4.3.3.3-3: *RRCConnectionReconfiguration* (step 21A, Table 7.3.4.1.3.2-1)

Derivation Path: 36.508 table 4.6.1-8, condition SRB2-DRB(1, 0)

7.3.5 PDCP handover

7.3.5.1 Void

7.3.5.2 PDCP handover / Lossless handover / PDCP sequence number maintenance

7.3.5.2.1 Test Purpose (TP)

(1)

```
with {UE in E-UTRA RRC_CONNECTED state with default RB using RLC-AM}
ensure that {
  when { UE is requested to make a lossless handover by SS }
   then { UE retransmits the unacknowledged data}
          }
```

7.3.5.2.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clause 5.2.1.1.

[TS 36.323, clause 5.2.1.1]

When upper layers request a PDCP re-establishment, the UE shall:

- reset the header compression protocol for uplink (if configured);
- apply the ciphering algorithm and key provided by upper layers during the re-establishment procedure;
- from the first PDCP SDU for which the successful delivery of the corresponding PDCP PDU has not been confirmed by lower layers, perform retransmission or transmission of all the PDCP SDUs already associated with PDCP SNs in ascending order of the COUNT values associated to the PDCP SDU prior to the PDCP re-establishment as specified below:
  - perform header compression of the PDCP SDU (if configured) as specified in the subclause 5.5.4;
  - perform ciphering of the PDCP SDU using the COUNT value associated with this PDCP SDU as specified in the subclause 5.6;
  - submit the resulting PDCP Data PDU to lower layer

7.3.5.2.3 Test description

7.3.5.2.3.1 Pre-test conditions

System Simulator:

- Cell 1 and Cell 2

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18] and table 7.3.5.2.3. 3-2 for SR configuration.

7.3.5.2.3.2 Test procedure sequence

Table 7.3.5.2.3.2.0-1: Time instances of cell power level

	Parameter	Unit	Cell 1	Cell 2	Remark
T1	Cell-specific RS EPRE	dBm/15kHz	-85	-79	

Table 7.3.5.2.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS creates 5 PDCP Data PDUs and the Next_PDCP_TX_SN is set to "0".	-	-	-	-
-	EXCEPTION: Step 2 and 3 A shall be repeated for k=0 to 1(increment=1).	-	-	-	-
2	The SS sends the PDCP Data PDU#k via RLC-AM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN = k. After having sent a PDU, the SS set Next_PDCP_TX_SN= k+1.	<--	PDCP PDU DATA #k	-	-
3	The UE sends the PDCP Data PDU#k via RLC-AM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN = k. Data is previously received data from PDU #k. (Note 1)	-->	PDCP PDU DATA #k	-	-
3A	Wait for the expiry of t-PollRetransmit	-	-	-	-
4	Configure SS not to allocate UL grant to the UE in Cell 1.	-	-	-	-
-	EXCEPTION: Step 5 shall be repeated for m=2 to 4 (increment=1).			-	-
5	The SS sends the PDCP Data PDU #m via RLC-AM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN =m. After having sent a PDU, the SS set Next_PDCP_TX_SN = m+1.	<--	PDCP PDU DATA #m	-	-
5A	The SS changes Cell 2 parameters according to the row "T1" in table 7.3.5.2.3.2.0-1.	-	-	-	-
5B	Configure SS to allocate Default UL grant to the UE in Cell 2 (Note 2). Note: These grants will be requested by the UE to send data after the handover	-	-	-	-
6	The SS requests UE to make a handover to Cell2 with the RRCConnectionReconfiguration message sent on Cell 1.	<--	*RRCConnectionReconfiguration*	-	-
7	SS assigns UL grant during the Random Access procedure to allow the UE to send only *RRCConnectionReconfigurationComplete* message.	-	-	-	-
8	The UE on Cell 2 transmits a RRCConnectionReconfigurationComplete message.	-->	*RRCConnectionReconfigurationComplete*	-	-
8A	The UE send PDCP Control PDUs via RLC-AM RB with the following content to the SS: D/C field = 0 (PDCP control PDU) and PDU Type =000, FMS field = 5.	-->	PDCP STATUS REPORT	-	-
8B	The SS generates a PDCP status report message and sends it to UE: D/C field = 0 (PDCP control PDU) and PDU Type =000, FMS field = 2.	<--	PDCP STATUS REPORT	-	-
8C	Configure SS to allocate Default UL grant to the UE in Cell 2	-	-	-	-
	EXCEPTION: Step 9 shall be repeated for m=2 to 4 (increment=1).	-	-	-	-
9	Check: Does the UE send the PDCP Data PDU #m via RLC-AM RB with the following content to the SS: D/C field = 1 (PDCP Data PDU) and PDCP SN = m?	-->	PDCP PDU DATA #m	1	P

	Data is previously received data from PDU #m.				
Note 1: The SS acknowledges the received data. Note 2: SS transmit an UL grant of 72 bits (ITBS=2, NPRB=2, TS 36.213 Table 7.1.7.2.1-1) to allow UE to transmit only PDCP Status report.					

7.3.5.2.3.3 Specific message contents

Table 7.3.5.2.3.3-1: *RRCConnectionReconfiguration* (step 6, Table 7.3.5.2.3.2-1)

Derivation Path: 36.508, Table 4.6.1-8, condition HO			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReconfiguration ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
rrcConnectionReconfiguration-r8 SEQUENCE {			
mobilityControlInfo SEQUENCE {		MobilityControlInfo -HO	
targetPhysCellId	PhysicalCellIdentity of Cell 2		
carrierFreq	Not present		
}			
}			
}			
}			
}			

Table 7.3.5.2.3. 3-2: SchedulingRequest-Config (RRC Connection Reconfiguration, preamble Table 4.5.3.3-1: Step8)

Derivation Path: 36.508 Table 4.6.3-20			
Information Element	**Value/remark**	**Comment**	**Condition**
dsr-TransMax	n64		

7.3.5.3 PDCP handover / Non-lossless handover PDCP sequence number maintenance

7.3.5.3.1 Test Purpose (TP)

(1)

```
with {UE in E-UTRA RRC_CONNECTED state with bearer using RLC-UM}
ensure that {
  when {UE is requested to make a non-lossless handover by SS}
   then {UE transmits next PDCP Data PDU with SN value 0 }
          }
```

7.3.5.3.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clauses 5.2.1.2.

[TS 36.323, clause 5.2.1.2]

When upper layers request a PDCP re-establishment, the UE shall:

- reset the header compression protocol for uplink (if configured);
- set Next_PDCP_TX_SN, and TX_HFN to 0;
- apply the ciphering algorithm and key provided by upper layers during the re-establishment procedure;
- for each PDCP SDU already associated with a PDCP SN but for which a corresponding PDU has not previously been submitted to lower layers:

- consider the PDCP SDUs as received from upper layer;

- perform transmission of the PDCP SDUs in ascending order of the COUNT value associated to the PDCP SDU prior to the PDCP re-establishment, as specified in the subclause 5.1.1 without restarting the *d*iscard-Timer.

7.3.5.3.3 Test description

7.3.5.3.3.1 Pre-test conditions

System Simulator:

- Cell 1 and Cell 2

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

7.3.5.3.3.2 Test procedure sequence

Table 7.3.5.3.3.2.0-1: Time instances of cell power level

	Parameter	Unit	Cell 1	Cell 2	Remark
T1	Cell-specific RS EPRE	dBm/15k Hz	-85	-79	

Table 7.3.5.3.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS creates 3 PDCP Data PDUs and the Next_PDCP_TX_SN is set to "0".	-	-	-	-
	EXCEPTION: Step 2 and 3 shall be repeated for k=0 to 1 (increment=1).				
2	The SS sends the PDCP Data PDU #k via RLC-UM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN = k. After having sent a PDU, the SS set Next_PDCP_TX_SN= k+1.	<--	PDCP PDU DATA #k	-	-
3	The UE sends the PDCP Data PDU #k via RLC-UM RB with the following content to the SS: D/C field = 1 (PDCP Data PDU) and PDCP SN = k. Data is previously received data PDU #k.	-->	PDCP PDU DATA #k		
3A	The SS changes Cell 2 parameters according to the row "T1" in table 7.3.5.3.3.2.0-1.	-	-	-	-
3B	Configure SS to allocate Default UL grant to the UE in Cell 2 Note: These grants will be requested by the UE to send data after the handover	-	-	-	-
4	The SS requests UE to make a handover to Cell 2 with the *RRCConnectionReconfiguration* message.	<--	*RRCConnectionReconfiguration*		
4A	SS assigns UL grant during the Random Access procedure to allow the UE to send only *RRCConnectionReconfigurationComplete* message.	-	-	-	-
5	The UE transmits a *RRCConnectionReconfigurationComplete* message.	-->	*RRCConnectionReconfigurationComplete*	-	
6	The SS sends the PDCP Data PDU #2 via RLC-UM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN = 2. After having sent a PDU, the SS set Next_PDCP_TX_SN= k+1.	<--	PDCP PDU DATA #2		
7	Check: Does the UE send the PDCP Data PDU #2 via RLC-UM RB with the following content back to the SS: D/C field = 1 (PDCP Data PDU) and PDCP SN = 0. Data is previously received data PDU #2.	-->	PDCP PDU DATA #2	1	P

7.3.5.3.3 Specific message contents

Table 7.3.5.3.3-1: *RRCConnectionReconfiguration* (step 4, 7.3.5.3.3.2-1)

Derivation Path: 36.508, Table 4.6.1-8, condition HO			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReconfiguration ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
rrcConnectionReconfiguration-r8 SEQUENCE {			
mobilityControlInfo SEQUENCE {		MobilityControlInfo -HO	
targetPhysCellId	PhysicalCellIdentity of Cell 2		
carrierFreq	Not present		
}			
}			
}			
}			
}			

7.3.5.4 PDCP handover / Lossless handover / PDCP status report to convey the information on missing or acknowledged PDCP SDUs at handover

7.3.5.4.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state with default RB used RLC-AM mode }
ensure that {
  when { UE is requested to make a handover by SS }
    then { UE creates a PDCP status report to SS}}
```

(2)

```
with { UE in E-UTRA RRC_CONNECTED state with default RB used RLC-AM mode }
ensure that {
  when { UE is requested to make a handover by SS }
    then { UE discards the corresponding PDCP PDU and PDCP SDU according to the PDCP status report
from SS }}
```

7.3.5.4.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clauses 5.3 and 5.4

[TS 36.323, clause 5.3.1]

When upper layers request a PDCP re-establishment, for radio bearers that are mapped on RLC AM, the UE shall:

- if the radio bearer is configured by upper layers to send a PDCP status report in the uplink, compile a status report as indicated below after processing the PDCP Data PDUs that are received from lower layers due to the re-establishment of the lower layers as specified in the subclause 5.2.2.1, and submit it to lower layers as the first PDCP PDU for the transmission, by:
  - setting the FMS field to the PDCP SN of the first missing PDCP SDU;
  - if there is at least one out-of-sequence PDCP SDU stored, allocating a Bitmap field of length in bits equal to the number of PDCP SNs from and not including the first missing PDCP SDU up to and including the last out-of-sequence PDCP SDUs, rounded up to the next multiple of 8;
  - setting as '0' in the corresponding position in the bitmap field for all PDCP SDUs that have not been received as indicated by lower layers, and optionally PDCP SDUs for which decompression have failed;
  - indicating in the bitmap field as '1' for all other PDCP SDUs.

[TS 36.323, clause 5.3.2]

When a PDCP status report is received in the downlink, for radio bearers that are mapped on RLC AM:

- for each PDCP SDU, if any, with the bit in the bitmap set to '1', or with the associated COUNT value less than the COUNT value of the PDCP SDU identified by the FMS field, the successful delivery of the corresponding PDCP SDU is confirmed, and the UE shall process the PDCP SDU as specified in the subclause 5.4.

[TS 36.323, clause 5.4]

When the Discard_Timer expires for a PDCP SDU, or the successful delivery of a PDCP SDU is confirmed by PDCP status report, the UE shall discard the PDCP SDU along with the corresponding PDCP PDU. If the corresponding PDCP PDU has already been submitted to lower layers the discard is indicated to lower layers.

7.3.5.4.3 Test description

TC is applicable to:

- All UEs supporting E-UTRA.

7.3.5.4.3.1 Pre-test conditions

System Simulator:

- Cell 1 and Cell 2

- ROHC is not used for headerCompression settings.

UE:

- UE in UE Loopback Activated test state (state 4) with default RB using RLC-AM in Cell 1 and table 7.3.5.4. 3.3-2 for SR configuration.

7.3.5.4.3.2 Test procedure sequence

Table 7.3.5.4.3.2-1: Time instances of cell power level

	Parameter	Unit	Cell 1	Cell 2	Remark
T1	Cell-specific RS EPRE	dBm/15k Hz	-85	-79	

Table 7.3.5.4.3.2-2: Main Behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	Next_PDCP_TX_SN is set to "0". The SS creates 4 PDCP Data PDUs.		-	-	-
2	The SS sends the PDCP Data PDU #0 via RLC-AM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN =0. The SS sets Next_PDCP_TX_SN = 1.	<--	PDCP DATA PDU #0	-	-
3	The UE sends a PDCP Data PDU #0 via RLC-AM RB with the following content back to the SS: D/C field = 1 (PDCP Data PDU) and PDCP SN = 0 data: previously received packet. (Note 1)	-->	PDCP DATA PDU #0	-	-
4	The SS is configured on Cell 1 not to send RLC acknowledgements (RLC ACK s) to the UE.				
4A	Configure SS not to allocate UL grant to the UE in Cell 1.	-	-	-	-
5	After 100 ms the SS sends the PDCP Data PDU #1 via RLC-AM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN =1. The SS set Next_PDCP_TX_SN = 2.	<--	PDCP DATA PDU#1		
5A	The SS waits for 60 ms and then allocates 1 UL grants (UL grant allocation type 2, Default UL Grant size) to enable UE to return PDCP Data PDU	<--	(UL grants)	-	-
6	The UE sends a PDCP Data PDU #1 via RLC-AM RB with the following content back to the SS: D/C field = 1 (PDCP Data PDU) and PDCP SN = 1 data: previously received packet.	-->	PDCP DATA PDU#1		
6A	The SS changes Cell 2 parameters according to the row "T1" in table 7.3.5.4.3.2-1.	-	-	-	-
6B	The SS ignores scheduling requests and does not allocate any uplink grant in cell 2.	-	-	-	-
7	The SS requests UE to make a handover to Cell2 with the *RRCConnectionReconfiguration* message sent on Cell1.	<--	RRCConnectionReconfiguration message.	-	-
7A	SS assigns UL grant during the Random Access procedure to allow the UE to send only *RRCConnectionReconfigurationComplete* message.	-	-	-	-
8	The UE transmits a *RRCConnectionReconfigurationComplete* message on Cell2.	-->	RRCConnectionReconfigurationComplete message.	-	-
8A	The SS generates a PDCP status report message and sends it to UE: D/C field = 0 (PDCP control PDU) and PDU Type =000, FMS field = 2.	<--	PDCP status report	-	-
8B	SS waits for 500 ms of ensure UE PDCP has discarded PDCP PDU and is ready to transmit PDCP status report and then assigns 1 UL grant (UL grant allocation type 3) of size 72 bits. (Note 2)				
9	Check: Does the UE send PDCP Control PDUs via RLC-AM RB with the following content to the SS: D/C field = 0 (PDCP control	-->	PDCP status report	1	P

	PDU) and PDU Type =000, FMS field = 2.				
10	Void	-	-	-	-
10A	Configure SS to allocate Default UL grant to the UE in Cell 2	-	-	-	-
	EXCEPTION: Step 11 shall be repeated for k=2 to 3 (increment=1).				
11	The SS sends the PDCP Data PDU #k via RLC-AM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN = k. After having sent a PDU, the SS set Next_PDCP_TX_SN = k + 1.	<--	PDCP DATA PDU #k	-	-
12	Check: Does the UE send a PDCP Data PDU#2 via RLC-AM RB with the following content back to the SS: D/C field = 1 (PDCP Data PDU) and PDCP SN = 2 data: previously received packet.	-->	PDCP DATA PDU #2	2	P
13	Check: Does the UE send a PDCP Data PDU#3 via RLC-AM RB with the following content back to the SS: D/C field = 1 (PDCP Data PDU) and PDCP SN = 3 data: previously received packet.	-->	PDCP DATA PDU #3	2	P
Note 1: The SS sends RLC ACK to the UE Note 2: SS transmit an UL grant of 72 bits (ITBS=2, NPRB=2, TS 36.213 Table 7.1.7.2.1-1) to allow UE to transmit only PDCP Status report.					

7.3.5.4.3.3 Specific message contents

Table 7.3.5.4.3.3-1: RRCConnectionReconfiguration (Step 7, table 7.3.5.4.3.2-2)

Derivation Path: 36.508 Table 4.6.1-8			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReconfiguration ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
rrcConnectionReconfiguration-r8 SEQUENCE {			
mobilityControlInfo SEQUENCE {		MobilityControlInfo-HO	
targetPhysCellId	PhysicalCellIdentity of Cell 2		
carrierFreq	Not present		
}			
RadioResourceConfigDedicated-HO {			
drb-ToAddModifyList {			
PDCP-Configuration-DRB-AM {			
discardTimer	infinity		
rlc-AM SEQUENCE {			
statusReportRequired	TRUE		
}			
}			
}			
}			
}			
}			
}			
}			

Table 7.3.5.4.3.3-2: SchedulingRequest-Config (RRC Connection Reconfiguration, preamble Table 4.5.3.3-1: Step8 and table 7.3.5.4.3.2-2, step 7)

Derivation Path: 36.508 Table 4.6.3-20			
Information Element	**Value/remark**	**Comment**	**Condition**
dsr-TransMax	n64		

7.3.5.5 PDCP handover / In-order delivery and duplicate elimination in the downlink

7.3.5.5.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state with default RB using RLC-AM }
ensure that {
  when { UE is requested to make a handover by SS }
    then { UE achieves in-order delivery and duplicate elimination in the downlink }
           }
```

7.3.5.5.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clauses 5.1.2.1.2.

[TS 36.323, clause 5.1.2.1.2]

For DRBs mapped on RLC AM, at reception of a PDCP Data PDU from lower layers, the UE shall:

- if received PDCP SN – Last_Submitted_PDCP_RX_SN > Reordering_Window or 0 <= Last_Submitted_PDCP_RX_SN – received PDCP SN < Reordering_Window:
  - if received PDCP SN > Next_PDCP_RX_SN:
    - decipher the PDCP PDU as specified in the subclause 5.6, using COUNT based on RX_HFN - 1 and the received PDCP SN;
  - else:
    - decipher the PDCP PDU as specified in the subclause 5.6, using COUNT based on RX_HFN and the received PDCP SN;
  - perform header decompression (if configured) as specified in the subclause 5.5.5;
  - discard this PDCP SDU;
- else if Next_PDCP_RX_SN – received PDCP SN > Reordering_Window:
  - increment RX_HFN by one;
  - use COUNT based on RX_HFN and the received PDCP SN for deciphering the PDCP PDU;
  - set Next_PDCP_RX_SN to the received PDCP SN + 1;
- else if received PDCP SN – Next_PDCP_RX_SN >= Reordering_Window:
  - use COUNT based on RX_HFN – 1 and the received PDCP SN for deciphering the PDCP PDU;
- else if received PDCP SN >= Next_PDCP_RX_SN:
  - use COUNT based on RX_HFN and the received PDCP SN for deciphering the PDCP PDU;
  - set Next_PDCP_RX_SN to the received PDCP SN + 1;
  - if Next_PDCP_RX_SN is larger than Maximum_PDCP_SN:
    - set Next_PDCP_RX_SN to 0;

- increment RX_HFN by one;

- else if received PDCP SN < Next_PDCP_RX_SN:
  - use COUNT based on RX_HFN and the received PDCP SN for deciphering the PDCP PDU;
- if the PDCP PDU has not been discarded in the above:
  - perform deciphering and header decompression (if configured) for the PDCP PDU as specified in the subclauses 5.6 and 5.5.5, respectively;
  - if a PDCP SDU with the same PDCP SN is stored:
    - discard this PDCP SDU;
  - else:
    - store the PDCP SDU;
  - if the PDCP PDU received by PDCP is not due to the re-establishment of lower layers:
    - deliver to upper layers in ascending order of the associated COUNT value:
      - all stored PDCP SDU(s) with an associated COUNT value less than the COUNT value associated with the received PDCP SDU;
      - all stored PDCP SDU(s) with consecutively associated COUNT value(s) starting from the COUNT value associated with the received PDCP SDU;
    - set Last_Submitted_PDCP_RX_SN to the PDCP SN of the last PDCP SDU delivered to upper layers;
  - else if received PDCP SN = Last_Submitted_PDCP_RX_SN + 1 or received PDCP SN = Last_Submitted_PDCP_RX_SN – Maximum_PDCP_SN:
    - deliver to upper layers in ascending order of the associated COUNT value:
      - all stored PDCP SDU(s) with consecutively associated COUNT value(s) starting from the COUNT value associated with the received PDCP SDU;
  - set Last_Submitted_PDCP_RX_SN to the PDCP SN of the last PDCP SDU delivered to upper layers.

7.3.5.5.3 Test description

7.3.5.5.3.1 Pre-test conditions

System Simulator:

- Cell 1 and Cell 2

UE:

None.

Preamble:

- The UE is in state Loopback Activated (state 4) according to [18].

7.3.5.5.3.2 Test procedure sequence

Table 7.3.5.5.3.2.0-1: Time instances of cell power level

	Parameter	Unit	Cell 1	Cell 2	Remark
T1	Cell-specific RS EPRE	dBm/15k Hz	-85	-79	

Table 7.3.5.5.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The Next PDCP_TX_SN is set to “0”. The SS creates a PDCP Data PDU#0.	-	-	-	-
2	The SS sends the PDCP Data PDU#0 via RLC-AM RB with the following content to the UE: PDCP Data PDU #0 (D/C field = 1 (PDCP Data PDU) and PDCP SN=0) (Note 1)	<--	PDCP DATA PDU#0	-	-
3	The UE transmits a PDCP Data PDU via RLC-AM RB with the following content back to the SS D/C field = 1 (PDCP Data PDU) and PDCP SN=0 data: previously received packet in PDCP Data PDU#0 (Note 2)	-->	PDCP DATA PDU #0	-	-
4	Next_PDCP_TX_SN is set to 1. The SS creates a PDCP Data PDU#1 (not transmitted).	-	-	-	-
5	The Next_PDCP_TX_SN is set to “2”. The SS creates a PDCP Data PDU #2.	-	-	-	-
6	The SS sends the PDCP Data PDU#2 via RLC-AM RB with the following content to the UE: PDCP Data PDU#1; D/C field = 1 (PDCP Data PDU) and PDCP SN=2 (Note 3)	<--	PDCP DATA PDU #2	-	-
7	Check: Does the UE transmit a PDCP DATA PDU#2?	-->	PDCP DATA PDU#2	1	F
7A	The SS changes Cell 2 parameters according to the row "T1" in table 7.3.5.5.3.2.0-1.	-	-	-	-
7B	Configure SS to allocate Default UL grant to the UE in Cell 2 (Note 6). Note: These grants will be requested by the UE to send data after the handover	-	-	-	-
8	The SS requests UE to make a handover to Cell 2 with the *RRCConnectionReconfiguration* message.	<---	*RRCConnectionReconfiguration*	-	-
8A	SS assigns UL grant during the Random Access procedure to allow the UE to send only RRCConnectionReconfigurationComplete message.	-	-	-	-
9	The UE transmits a *RRCConnectionReconfigurationComplete message* in the new cell.	-->	RRCConnectionReconfigurationComplete	-	-
9A	The UE send PDCP Control PDUs via RLC-AM RB with the following content to the SS: D/C field = 0 (PDCP control PDU) and PDU Type =000, FMS field = 1, Bitmap = 0x80.	-->	PDCP STATUS REPORT	-	-
9B	The SS generates a PDCP status report message and sends it to UE: D/C field = 0 (PDCP control PDU) and PDU Type =000, FMS field = 1.	<--	PDCP STATUS REPORT	-	-
9C	Configure SS to allocate Default UL grant to the UE in Cell 2	-	-	-	-
10	The SS sends the PDCP Data PDU#0 via	<--	PDCP DATA PDU #0	-	-

	RLC-AM RB with the following content to the UE: PDCP Data PDU #0(D/C field = 1 (PDCP Data PDU) and PDCP SN=0) (Note 4)				
11	Check: Does the UE transmit PDCP Data PDU via RLC-AM RB with the following content back to the SS? D/C field = 1 (PDCP Data PDU) and PDCP SN=0 data: previously received packet in PDCP Data PDU #0	-->	PDCP DATA PDU #0	1	F
12	The SS sends the PDCP Data PDU#1 via RLC-AM RB with the following content to the UE: PDCP Data PDU#1 (D/C field = 1 (PDCP Data PDU) and PDCP SN=1) (Note 5)	<--	PDCP DATA PDU #1	-	-
13	Check: Does the UE transmit a PDCP Data PDU via RLC-AM RB with the following content back to the SS? D/C field = 1 (PDCP Data PDU) and PDCP SN=1 data: previously received packet in PDCP Data PDU#1	-->	PDCP DATA PDU #1	1	P
14	Check: Does the UE transmit PDCP Data PDU via RLC-AM RB with the following content back to the SS? D/C field = 1 (PDCP Data PDU) and PDCP SN=2 data: previously received packet in PDCP Data PDU#2	-->	PDCP DATA PDU #2	1	P
Note 1: PDCP Data PDU#0 is sent in RLC PDU#0: SN=0. Note 2: The SS sends RLC ACK to the UE Note 3: PDCP Data PDU #2 is sent in RLC PDU#2: SN=2 Note 4: PDCP Data PDU #0 is sent in RLC PDU#1: SN=1 Note 5: PDCP Data PDU #1 is sent in RLC PDU #2:SN = 2 Note 6: SS transmit an UL grant of 72 bits (ITBS=2, NPRB=2, TS 36.213 Table 7.1.7.2.1-1) to allow UE to transmit only PDCP Status report.					

7.3.5.5.3.3 Specific message contents

Table 7.3.5.5.3.3-1: RRCConnectionReconfiguration (Step 4, Table 7.3.5.5.3.2-1)

Derivation Path: 36.508, Table 4.6.1-8, condition HO			
Information Element	**Value/remark**	**Comment**	**Condition**
RRCConnectionReconfiguration ::= SEQUENCE {			
criticalExtensions CHOICE {			
c1 CHOICE{			
rrcConnectionReconfiguration-r8 SEQUENCE {			
mobilityControlInfo SEQUENCE {		MobilityControlInfo -HO	
targetPhysCellId	PhysicalCellIdentity of Cell 2		
carrierFreq	Not present		
}			
}			
}			
}			
}			

7.3.6 PDCP Others

7.3.6.1 PDCP Discard

7.3.6.1.1 Test Purpose (TP)

(1)

```
with { UE in E-UTRA RRC_CONNECTED state }
ensure that {
  when { the Discard Timer for a PDCP SDU expires }
    then { UE discards the corresponding PDCP SDU }
}
```

7.3.6.1.2 Conformance requirements

References: The conformance requirements covered in the present TC are specified in: 3GPP TS 36.323 clause 5.9.

[TS 36.323, clause 5.4]

When the Discard_Timer expires for a PDCP SDU, or the successful delivery of a PDCP SDU is confirmed by PDCP status report, the UE shall discard the PDCP SDU along with the corresponding PDCP PDU. If the corresponding PDCP PDU has already been submitted to lower layers the discard is indicated to lower layers.

7.3.6.1.3 Test description

7.3.6.1.3.1 Pre-test conditions

System Simulator:

- Cell 1

UE:

None.

Preamble

- The UE is in state Loopback Activated (state 4) according to [18 with the exceptions listed in table 7.3.6.1.3.1-1 applicable for the configured UM DRB and table 7.3.6.1.3.1-2 for SR configuration.
- The condition SRB2-DRB(1,1) is used for step 8 in 4.5.3A.3 according to [18].

Table 7.3.6.1.3.1-1: PDCP Settings

Parameter	Value
Discard_Timer	500 ms

Table 7.3.6.1.3.1-2: SchedulingRequest-Config (preamble Table 4.5.3.3-1: Step8)

Derivation Path: 36.508 Table 4.6.3-20			
Information Element	**Value/remark**	**Comment**	**Condition**
dsr-TransMax	n64		

7.3.6.1.3.2 Test procedure sequence

Table 7.3.6.1.3.2-1: Main behaviour

St	Procedure	Message Sequence		TP	Verdict
		U - S	Message		
1	The SS creates 5 PDCP Data PDUs and the Next_PDCP_TX_SN is set to "0".	-		-	-
2	The SS ignores scheduling requests and does not allocate any uplink grant.	-	-	-	-
	EXCEPTION: Step 3 shall be repeated for k=0 to 2 (increment=1).				
3	The SS sends a PDCP Data PDU via RLC-UM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN = k After having sent a PDU, the SS sets Next_PDCP_TX_SN = k+1.	<--	PDCP DATA PDU (SN=k)	-	-
4	Wait for Discard_Timer Note: According to TS36.508, timer tolerance should be 10% of Discard_Timer or 5 x RTT, whichever is greater. RTT = 8 TTIs for FDD and RTT = 16 TTIs for TDD	-	-	-	-
	EXCEPTION: Step 5 shall be repeated for k=3 to 4 (increment=1).				
5	The SS sends a PDCP Data PDU via RLC-UM RB with the following content to the UE: D/C field = 1 (PDCP Data PDU) and PDCP SN = k After having sent a PDU, the SS set Next_PDCP_TX_SN = k+1.	<--	PDCP DATA PDU (SN=k)	-	-
6	The SS resumes normal UL grant allocation.	-		-	-
7	Check: Does UE transmit a PDCP Data PDU with PDCP SN = 3?	-->	PDCP Data PDU (SN = 3)	1	P
8	Check: Does UE transmit a PDCP Data PDU with PDCP SN = 4?	-->	PDCP Data PDU (SN = 4)	1	P

7.3.6.1.3.3 Specific message contents

None.