TD RAN RAN-99020

UMTS YY.22 V1.0.0 (1999-01)

Technical Report

UMTS Terrestrial Radio Access Network (UTRAN); Description of the RLC protocol (UMTS YY.22 version 1.0.0)

UMTS

Universal Mobile Telecommunications System

ETSI

Reference
DTR/SMG-02YY22U (07c00ics.PDF)

Keywords
Digital cellular telecommunications system,
Universal Mobile Telecommunication System
(UMTS), UTRAN

ETSI

Postal address
F-06921 Sophia Antipolis Cedex - FRANCE

Office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Internet
secretariat@etsi.fr
Individual copies of this ETSI deliverable
can be downloaded from
http://www.etsi.org

Copyright Notification

No part may be reproduced except as authorized by written permission.
The copyright and the foregoing restriction extend to reproduction in all media.

© European Telecommunications Standards Institute 1999.
All rights reserved.

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available **free of charge** from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://www.etsi.org/ipr).
Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Specification (TS) has been produced by the Special Mobile Group (SMG) of the European Telecommunications Standards Institute (ETSI).
The contents of this TS are subject to continuing work within TC-SMG and may change following formal TC-SMG approval.

1. Scope

The scope of this description is to describe the RLC protocol. A description document is intermediate between a stage 2 document and a protocol specification. Once completed, it should be sufficient for manufacturers to start some " high level design " activities. It should allow as well to assess the complexity of the associated protocol. After the completion of a description document, the drafting of the protocol specification should not have to face difficulties which would impact the other protocols i.e. the radio interface protocol architecture should be stable. This means that some procedures which are felt critical in terms of complexity will need to be studied in more details in the description document so that no problem is faced in the writing of the final protocol.

The following lists typical contents for a description document :

1) list of procedures
2) logical flow diagrams for normal procedures
3) logical description of message (where it should be possible to guess roughly the size of the various information elements)
4) principles for error handling
5) some exceptional procedures which are felt critica
6) It should, as far as possible, have the same format and outline as the final specification

The following is not covered

1) exact message format
2) all scenarios

2. References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] UMTS XX.XX, UTRAN Architecture description;
[2] Vocabulary used in the UMTS L2&L3 Expert Group;
[3] UMTS YY.01, MS-UTRAN Radio Interface Protocol Architecture ;Stage 2;
[4] UMTS YY.02, Layer 1; General requirements;
[5] UMTS YY.03, UE States and Procedures in Connected Mode;
[6] UMTS YY.04, Description of procedures in idle Mode;
[7] UMTS YY.21, Description of MAC protocol;
[8] UMTS YY.31, Description of RRC protocol.

3. Definitions and Abbreviations

For the purposes of the present document, the following abbreviations apply:

ARQ	Automatic Repeat Request
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
Control-	
CC	Call Control
CCCH	Common Control Channel
CCH	Control Channel
CCTrCH	Coded Composite Transport Channel
CN	Core Network
CRC	Cyclic Redundancy Check
DC	Dedicated Control (SAP)
DCCH	Dedicated Control Channel

DCH	Dedicated Channel
DL	Downlink
DSCH	Downlink Shared Channel
DTCH	Dedicated Traffic Channel
FACH	Forward Link Access Channel
FCS	Frame Check Sequence
FDD	Frequency Division Duplex
GC	General Control (SAP)
HO	Handover
ITU	International Telecommunication Union
kbps	kilo-bits per second
L1	Layer 1 (physical layer)
L2	Layer 2 (data link layer)
L3	Layer 3 (network layer)
LAC	Link Access Control
MAC	Medium Access Control
MS	Mobile Station
MM	Mobility Management
Nt	Notification (SAP)
PCCH	Paging Control Channel
PCH	Paging Channel
PDU	Protocol Data Unit
PHY	Physical layer
PhyCH	Physical Channels
RACH	Random Access Channel
RLC	Radio Link Control
RNTI	Radio Network Temporary Identity
RRC	Radio Resource Control
SAP	Service Access Point
SCCH	Synchronization Control Channel
SCH	Synchronization Channel
SDU	Service Data Unit
TCH	Traffic Channel
TDD	Time Division Duplex
TFI	Transport Format Indicator
TFCI	Transport Format Combination Indicator
TPC	Transmit Power Control
U-	User-
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications System
URA	UTRAN Registration Area
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

4. General

4.1. Objective

4.2. Overview on sublayer architecture

4.2.1 Model of RLC

Figure 1 gives an overview model of the RLC layer. The figure illustrates two peer entities, one in the UE and one in the UTRAN. Though it is not shown in the figure the RLC layer may consist of several entities. A RLC entity offers three kinds of data transfer services to the higher layers. The services are transparent mode, unacknowledged mode and

acknowledged mode data transfer. The entities have one transmitting side and one receiving side. More detailed descriptions of the transmitting and receiving sides are given in subsections 4.2.1 and 4.2.2.

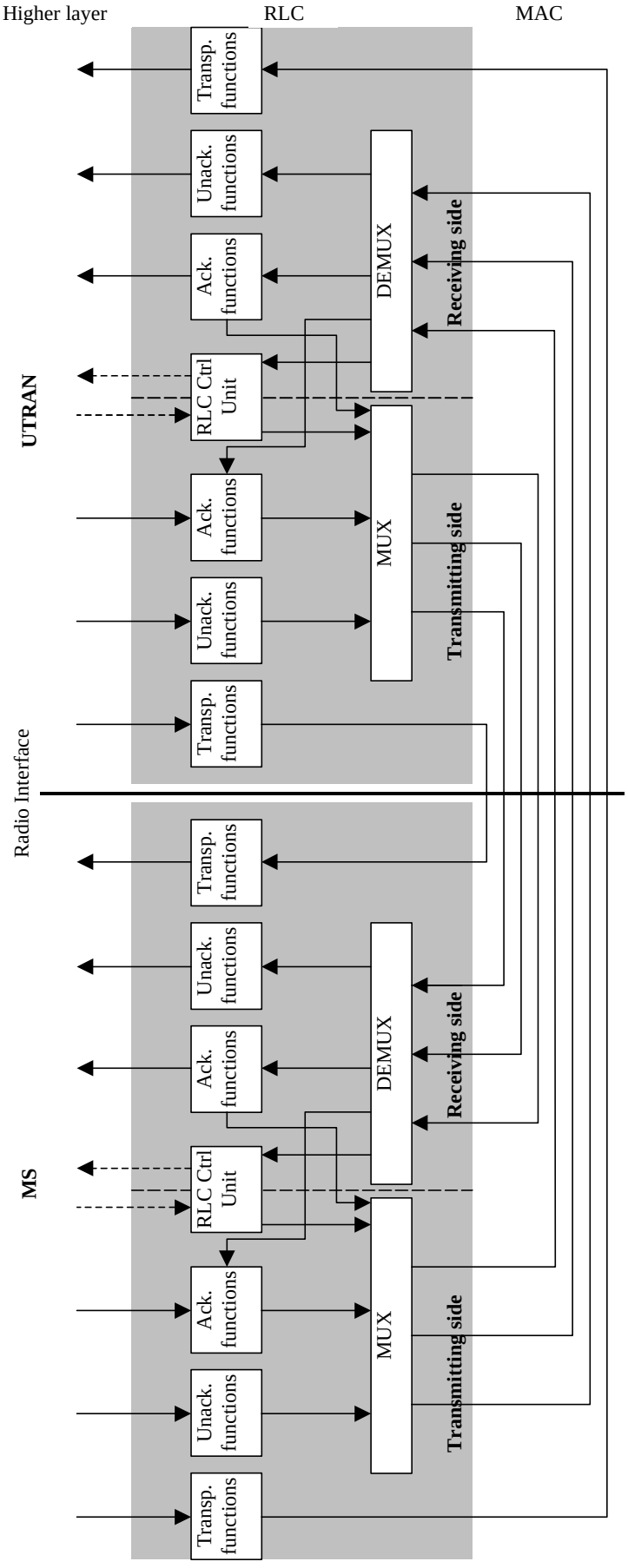

Figure 1. Overview model of RLC.

4.2.1.1 Model of transmitting side

A model of the transmitting side of a RLC entity is presented in Figure below.

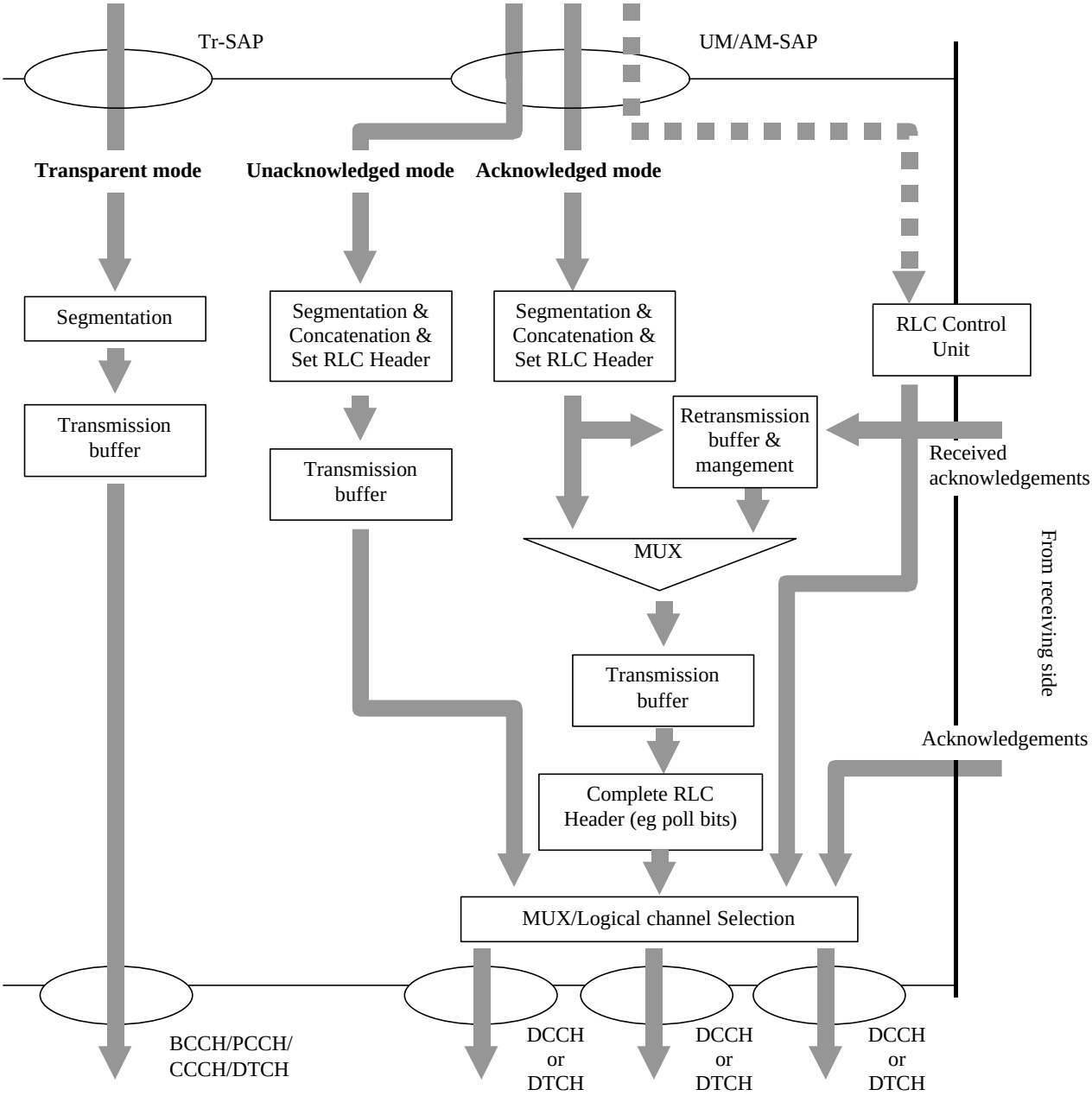

Figure 2. The transmitting side of a RLC entity.

RLC offers three kinds of data transfer services to the higher layers through the RLC-SAP. The services are transparent mode, unacknowledged mode and acknowledged mode data transfer. The protocol machines are independent for the different modes and linkage between them is possible. If the logical channel is a DCCH then there is only one DCCH. The dashed line illustrates the possibility to transfer higher layer data during the establishment of an RLC *link [Note: This could be useful in the control plane but it is for further study]*. A RLC entity can provide unacknowledged and acknowledged mode data transfer simultaneously, but not transparent mode data transfer. Therefore are these services provided through different SAPs, Tr-SAP and UM/AM-SAP. The data flow through the transmitting side of an RLC entity for these services are described below.

1. **Transparent mode data transfer**
   RLC receives SDUs from the higher layers. RLC might segment the SDUs into appropriate RLC PDUs without adding any overhead. How to perform the segmentation is decided upon when the service is established. RLC

delivers the RLC PDUs to MAC through either a BCCH, PCCH, DCCH, or a DTCH. Which type of logical channel depends on if the higher layer is located in the control plane (BCCH, PCCH, DCCH) or user plane (DTCH).

2. **Unacknowledged mode data transfer**
   RLC receives SDUs from the higher layers. If the SDU is too large it is segmented into appropriate RLC PDUs. The SDU might also be concatenated with other SDUs. RLC adds a header and the PDU is placed in the transmission buffer. The MUX then decides which PDUs and when the PDUs are delivered to MAC. The MUX also decides which logical channel that should be used. The number of logical channels that is needed is decided upon when the service is established (e.g. in the figure there is three logical channels). The type of the logical channels depends on if the higher layer is located in the control plane (DCCH) or in the user plane (DTCH).
3. **Acknowledged mode data transfer**
   RLC receives SDUs from the higher layers. The SDUs are segmented and/or concatenated to PDUs of fixed length. The length of the PDUs is decided upon when the service is established. After that RLC adds a header and the PDU is placed in the retransmission buffer and the transmission buffer. The MUX then decides which PDUs and when the PDUs are delivered to MAC, e.g. it could be useful to send RLC control PDUs on one logical channel and data PDUs on another logical channel. The PDUs are delivered to the MUX via a function that sets the poll bit in the PDUs.
   The retransmission buffer also receives acknowledgements from the receiving side, which are used to indicate retransmissions of PDUs and when to delete a PDU from the retransmission buffer.

The RLC control unit controls the RLC entity and handles control signalling between the peer entities (e.g. establishment and release of a RLC link). It is split between the transmitting and receiving side.

4.2.2 Model of receiving side

A model of the receiving side of an RLC entity is presented in Figure below.

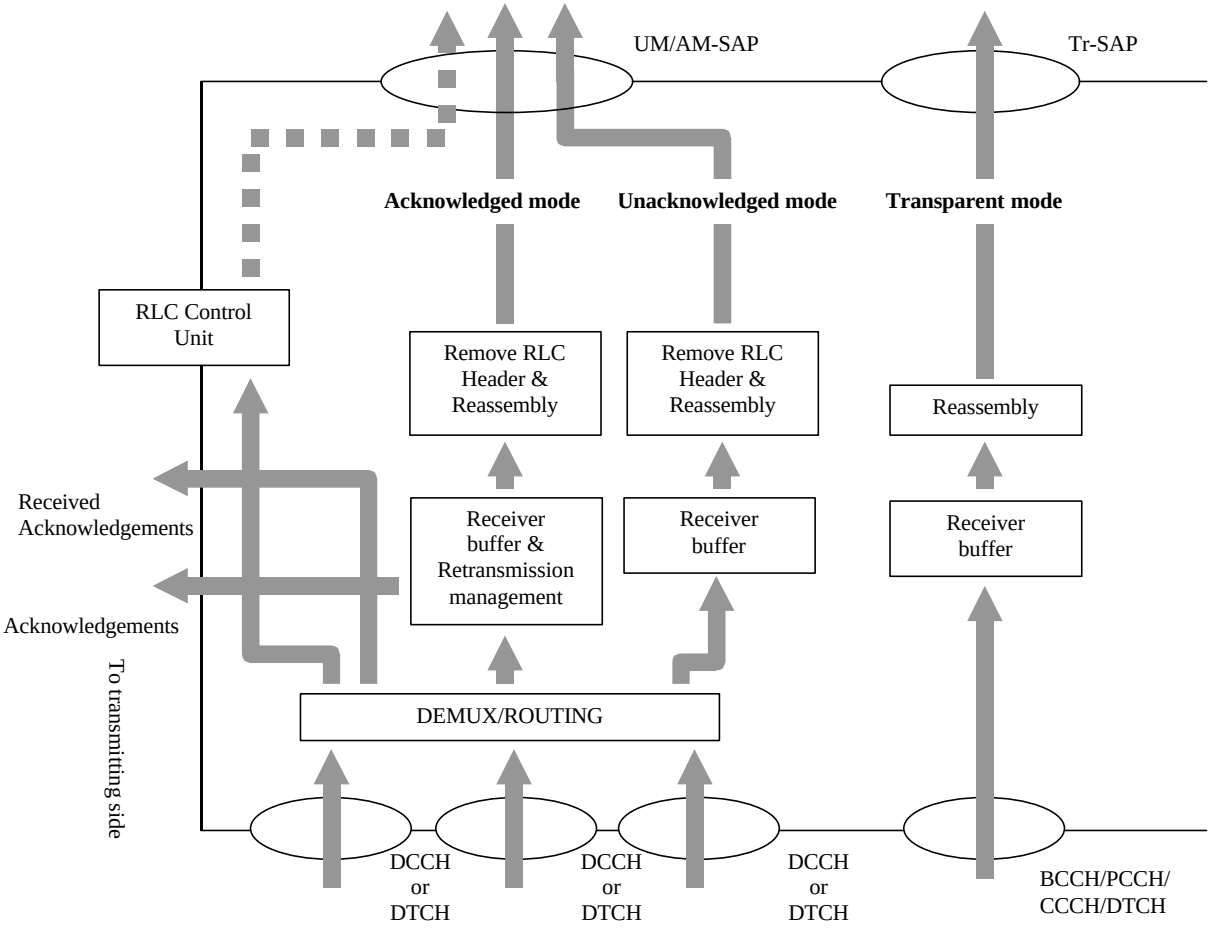

Figure 3. RLC receiver entity.

The data flow through the receiving side of an RLC entity for the three different data transfer services are described below.

1. **Transparent mode data transfer**
   RLC receives PDUs through either a DCCH or a DTCH from the MAC sublayer. RLC reassembles (if segmentation

has been performed) the PDUs into RLC SDUs. How to perform the reassembling is decided upon when the service is established. RLC delivers the RLC SDUs to the higher layer through the RLC-SAP.

2. **Unacknowledged mode data transfer**
   RLC receives PDUs through one of the logical channels from the MAC sublayer. RLC removes header from the PDUs and reassembles the PDUs (if segmentation has been performed) into RLC SDUs. After that the SDUs are delivered to the higher layer.
3. **Acknowledged mode data transfer**
   RLC receives PDUs through one of the logical channels from the MAC sublayer. The PDUs are placed in the receiver buffer until a complete SDU has been received. The receiver buffer requests retransmissions of PDUs by sending negative acknowledgements to the peer entity. After that the headers are removed from the PDUs and the PDUs are reassembled into a SDU. Finally the SDU is delivered to the higher layer.

The receiving side also receives acknowledgements from the peer entity. The acknowledgements are passed to the retransmission buffer on the transmitting side.
The RLC control unit controls the RLC entity and handles control signalling between the peer entities (e.g. establishment and release of a RLC link). It is split between the transmitting and receiving side.

5. Functions

For a detailed description of the following functions see [3].

- Connection Control;
- Segmentation and reassembly;
- Concatenation;
- Padding;
- Transfer of user data;
- Error correction;
- In-sequence delivery of higher layer PDUs;
- Duplicate Detection;
- Flow control;
- Protocol error detection and recovery.

The following potential function(s) are regarded as further study items:

- Suspend/resume function;
- Keep Alive;
- FCS error detection and handling;
- Ciphering.

6. Services provided to upper layers

For a detailed description of the following functions see [3].
RLC connection establishment/release
Transparent data transfer Service
Following functions are needed to support transparent data transfer:

- Segmentation and reassembly
- Transfer of user data;

Unacknowledged data transfer Service
Following functions are needed to support unacknowledged data transfer:

- Segmentation and reassembly
- Concatenation
- Transfer of user data;

Acknowledged data transfer Service
Following functions are needed to support acknowledged data transfer:

- Segmentation and reassembly
- Concatenation
- Transfer of user data
- Error correction
- In-sequence delivery of higher layer PDUs
- Duplicate detection
- Flow Control

- Protocol error detection and recovery;

QoS setting;

Notification of unrecoverable errors.

Table 1. RLC modes and functions in UE downlink side

Service	Functions	CCCH	DCCH	DTCH
Transparent Service	Applicability	+	-	+
	Segmentation	-	-	+
Unacknowledged Service	Applicability	-	+	+
	Segmentation	-	+	+
	Concatenation	-	+	+
Acknowledged Service	Applicability	-	+	+
	Segmentation	-	+	+
	Concatenation	-	+	+
	Flow Control	-	+	+
	Error Correction	-	+	+
	Protocol error correction & recovery	-	+	+

Table 2. RLC modes and functions in UE uplink side

Service	Functions	SCCH	BCCH	PCCH	CCCH	DCCH	DTCH
Transparent Service	Applicability	+	+	+	+	-	+
	Reassembly	+	+	+	-	-	+
Unacknowledged Service	Applicability	+	+	+	-	+	+
	Reassembly	+	+	+	-	+	+
Acknowledged Service	Applicability	-	-	-	-	+	+
	Reassembly	-	-	-	-	+	+
	Error correction	-	-	-	-	+	+
	Flow Control	-	-	-	-	+	+
	In sequence delivery	-	-	-	-	+	+
	Duplicate detection	-	-	-	-	+	+
	Protocol error correction & recovery	-	-	-	-	+	+

Table 3. RLC modes and functions in UTRAN downlink side

Service	Functions	SCCH	BCCH	PCCH	CCCH	DCCH	DTCH
Transparent Service	Applicability	+	+	+	+	-	+
	Segmentation	+	+	+	-	-	+
Unacknowledged Service	Applicability	+	+	+	-	+	+
	Segmentation	+	+	+	-	+	+
	Concatenation	+	+	+	-	+	+
Acknowledged Service	Applicability	-	-	-	-	+	+
	Segmentation	-	-	-	-	+	+
	Concatenation	-	-	-	-	+	+
	Flow Control	-	-	-	-	+	+
	Error Correction	-	-	-	-	+	+
	Protocol error correction & recovery	-	-	-	-	+	+

Table 4. RLC modes and functions in UTRAN uplink side

Service	Functions	CCCH	DCCH	DTCH
Transparent Service	Applicability	+	-	+
	Reassembly	-	-	+
Unacknowledged Service	Applicability	-	+	+
	Reassembly	-	+	+
Acknowledged Service	Applicability	-	+	+
	Reassembly	-	+	+
	Error correction	-	+	+
	Flow Control	-	+	+
	In sequence delivery	-	+	+
	Duplicate detection	-	+	+
	Protocol error correction & recovery	-	+	+

7. Services expected from MAC

For a detailed description of the following functions see [3].

Data transfer;

8. Elements for layer-to-layer communication

8.1. Primitives between RLC and higher layers

The primitives between RLC and upper layers are shown in Table 8.1-1.

Table 8.1-1 Primitives between RLC and upper layers

Generic Name	Parameter			
	Req.	ind.	resp.	conf.
RLC-AM-DATA	MU	MU	Not Defined	Not Defined
RLC-UM-DATA	MU	MU	Not Defined	Not Defined
RLC-TR-DATA	MU	MU	Not Defined	Not Defined

Each Primitive is defined as follows:

a) RLC-AM-DATA req./ind.

It is used for acknowledged data transmission mode of point-to-point connection between the same level user entities.

[Editor's note: Confirmation for the RLC-AM-DATA procedure is FFS.]

b) RLC-UM-DATA req./ind.

It is used for unacknowledged data transmission mode of point-to-point connection between the same level user entities.

c) RLC-TR-DATA req./ind.

It is used for trasparent data transmission mode of point-to-point connection between the same level user entities.

The parameter Message Unit (MU) is mapped on MU field on RLC PDU transparently in the case of RLC-AM-DATA req. or RLC-UM-DATA req. And the MU field of RLC PDU received is mapped on MU in the case of RLC-AM-DATA ind. or RLC-UM-DATA ind. transparently. Length of MU must be n octets (n is integer).

9. Elements for peer-to-peer communication

In unacknowledged transmission, only one type of unacknowledged data PDU is exchanged between peer RLC entities In acknowledged transmission, both (acknowledged) data PDUs and control PDUs are exchanged between peer RLC entities.

9.1. Protocol data units

(List of PDU´s, encoding of PDU´s (if applicable))

9.2. Formats and parameters

(PDU formats, PDU parameters, information element encodings, other formats employed in specific functions, if applicable, e.g. if a segmentation of PDUs is performed and further protocol information added after segmentation, formats for multiplexing/demultiplexing)

9.3. Protocol states

(Description of states, provision of state transition diagram(s))

9.4. State variables

9.5. Timers

9.6. Protocol Parameters

(e.g. max, min values of state variables to be initialized)

9.7. Specific functions

(description of specific protocol functions, if applicable, e.g. flow control)

10. Handling of unknown, unforeseen and erroneous protocol data

11. Elementary procedures

(Examples: idle, data transfer, RLC connection setup, RLC connection release, re-synchronisation)

History

Document history		
Date	Version	Comment
August 1998	0.0.0	Created
September 1998	0.0.1	Rapporteur inserted.
November 1998	0.0.3	Section 8 deleted.
November 1998	0.0.2	RLC Services and Functions and Services Expected from the MAC inserted; Layer-to-layer communication data flow cases inserted in section 8.
December 1998	0.0.4	Figure 1 added in Section 4.2;
January 1999	0.0.6	Padding function added in Section 5; Primitives between RLC and upper layers included in Section 8.1.
January 1999	0.0.5	Figure 1 removed in Section 4.2; Sections 4 and 5 of Tdoc 021/99 included in Sections 6 and 4 respectively. Bullets in Section 7 removed
January 1999	1.0.0	Re-formatted for SMG#28 Clause renumbered
Rapporteur for UMTS YY.22 is:		
Riccardo Santaniello CSELT Tel. : +39 011 228 7422 Fax : +39 011 228 7055 Email : riccardo.santaniello@cselt.it		
This document is written in Microsoft Word version 6.0c/95.		