Title

Transparent-RLC Concept Paper (Version 2)

Source

AT&T Wireless

Abstract

This contribution proposes a concept paper for transparent RLC (Radio Link Control). It uses the following three-part template adopted in GAHW-010241 [8]: identify requirements, recommend concept, and identify impact on specifications.

The requirements section uses the model proposed by Alan Cooper in *The Inmates are Running the Asylum – Why High-Tech Products Drive Us Crazy and How to Restore the Sanity*.

Questions and comments appear in magenta within angled brackets, *e.g.*, <comment>.

Proposals appear in blue, *e.g.*, proposal.

This contribution is available in *Acrobat* and *Word* formats. The *Acrobat* format is smaller and has fewer display artifacts.

Recommendation

For information.

History

Document	Date	Description	Editor
GP-012336	26 Nov 2001	First draft.	AWS
G2-020012	14 Jan 2002	Second draft. Add voice link to concert configuration. Remove following requirements: segmentation, reassembly, and SDU discard. Update services provided by T-RLC and services expected from MAC. Update T-RLC functions. Update sequences. Add T-RLC reference model. Specify T-RLC process using SDL. Specify MAC-status procedure using SDL. Update references.	AWS

Contents

1. Requirements

This document presents requirements for T-RLC (Transparent Radio Link Control). Based on these requirements, it develops concepts, and from the concepts, assesses the impact on new and existing standards. To focus requirements, it proposes persona, as suggested by Alan Cooper in *The Inmates are Running the Asylum* [1].

1.1 Persona

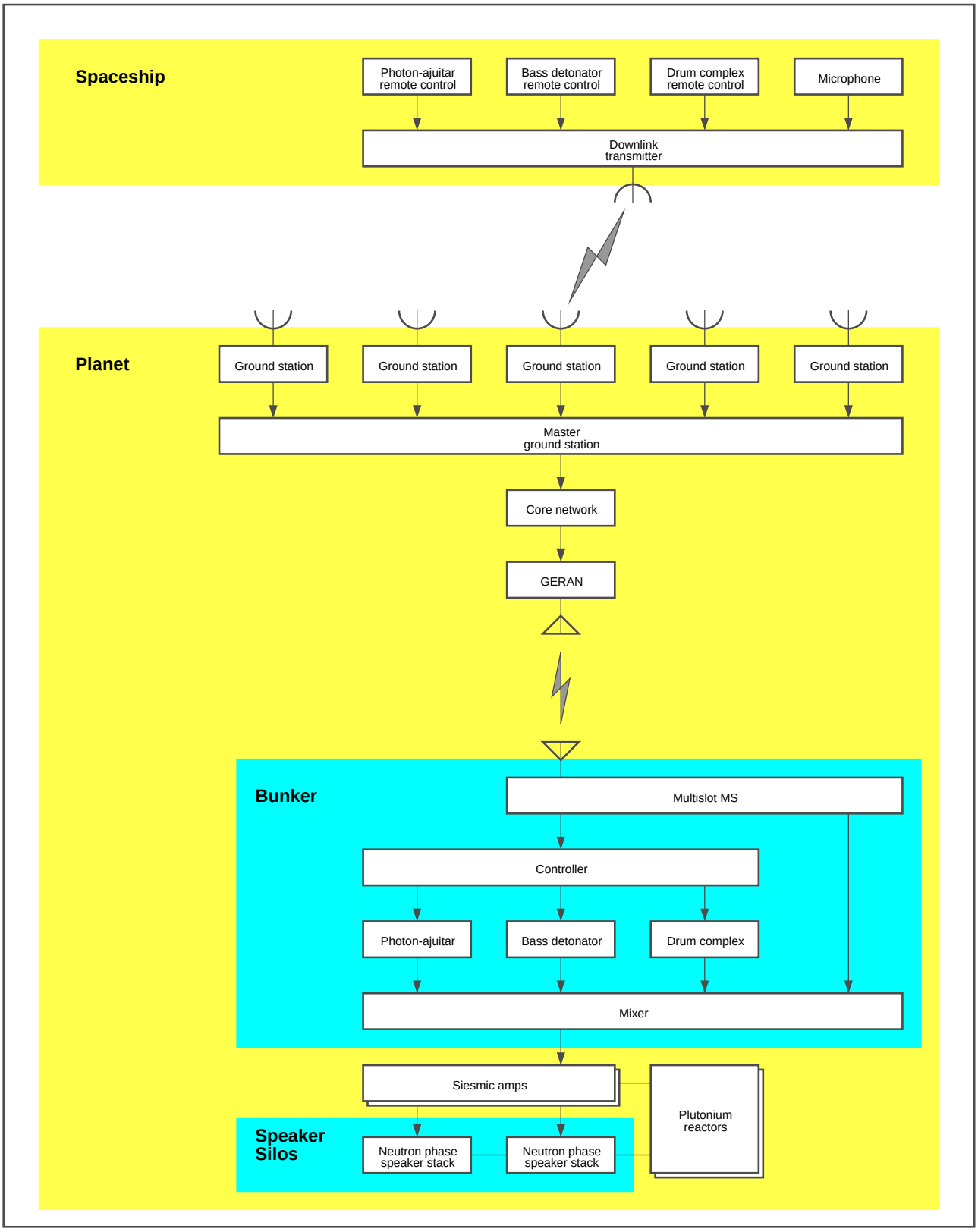
According to the *Hitchhiker's Guide to the Galaxy* [9], *Disaster Area*, a plutonium rock band from the *Gagrakacka Mind Zones*, is not only the loudest rock band in the galaxy, but in fact is the loudest noise of any kind. Regular concertgoers judge that the best sound balance is usually heard from within large concrete bunkers 37 miles from the stage. The musicians play their instruments by remote control from within a heavily insulated spaceship that stays in orbit around the planet, or more frequently, around a completely different planet. Many worlds have now banned *Disaster Area's* act, most commonly because the band's public-address system contravenes local strategic-arms-limitations treaties.

Figure 1 shows the configuration of *Disaster Area's* next concert over and on the red world of *Kakrafoon.* This document assumes GERAN will provide the final link to the bunkered instruments physically located below the speaker silos. GERAN will also provide the voice link for *Disaster Area's* lead singer.

As anyone who has played the photon-ajuitar will tell you, timing is critical, far more important than timing for the bass detonator or megabang drum complex. For this reason, the photon-ajuitar control stream requires a slightly higher quality of service than the other two streams. Also, reproducing the nuance of the photon-ajuitar requires the highest data rate of the 3 instruments. The bass detonator requires the next-highest rate, and the megabang drum complex requires the lowest rate. The relative ratio of data rates is as follows: 4, 2, 1.

Since *Disaster Area's* lyrics are indecipherable in any known language, the voice link can be a regular telephony-quality connection. Most concertgoers agree that the 200 Hz motorboat buzz caused by GSM telephones actually improves the band's vocals.

Figure 1: Disaster Area's Kakrafoon Concert Configuration



1.2 User-based requirements

T-RLC shall allow data to be transported with small end-to-end delay.

T-RLC shall allow data to be transported with small variation in delay, *i.e.*, it shall support isochronous operation.

T-RLC shall allow multiple data streams to be transported with small relative delay, *e.g.*, stream 1, 2, 3, and 4 may be delayed by 5 seconds, but the difference in their delays shall not exceed 40 ms. These streams may have various bit rates.

1.3 System-based requirements

T-RLC shall meet the following requirements:

- No protocol information shall be added to T-RLC PDUs, *i.e.*, a T-RLC PDU shall not have a header.
- T-RLC may be stopped and continued.

Unlike the UTRAN RLC specified in 25.322 [4], the GERAN T-RLC will not meet the following requirements:

- T-RLC may provide segmentation and reassembly.
- T-RLC may provide time-based SDU discard. SDUs shall be discarded without peer-to-peer signalling.

As such, the GERAN T-RLC will not provide all services expected by the PDCP layer specified in 25.323 [5].

1.4 User-based scenarios

The following user-based scenarios will be used to develop the concepts in § 2:

- Transport voice from the microphone, located in the spaceship, to the mixer located in a concrete bunker below the planet's surface.
- Transport streaming control data from three remote controls and voice from the microphone, all located in the spaceship, to their corresponding three instruments and mixer, all located in a concrete bunker below the planet's surface. <This scenario may not be supported by release-5 T-RLC.>

1.5 System-based scenarios

The following system-based scenarios will be used to develop the concepts in § 2:

- Configure T-RLC for use by a radio bearer.
- Release T-RLC.

2. Concept

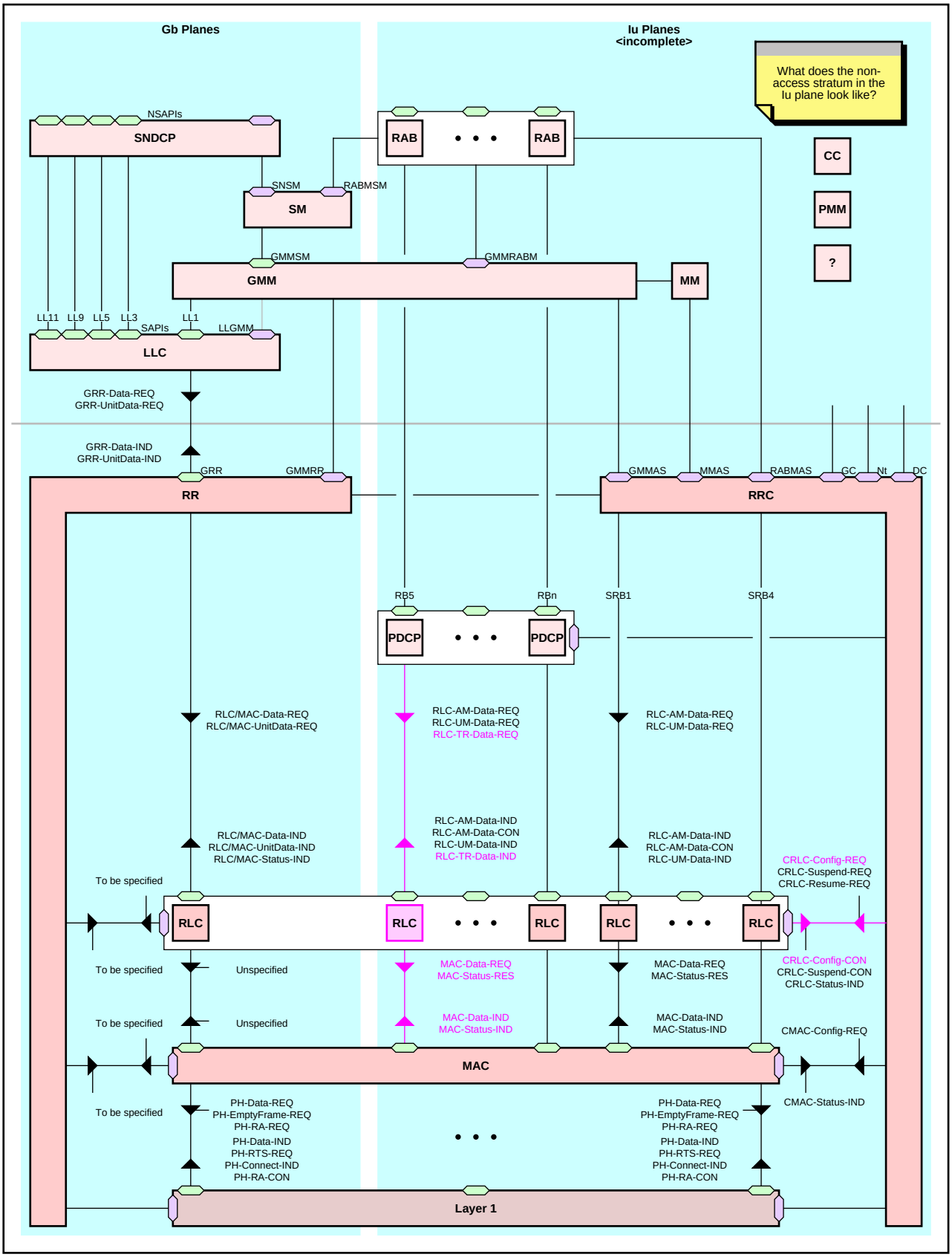
This section uses concepts from X.200 [10], X.210 [11], Z.100 [12], and Z.120 [13]. These concepts are not intended to unnecessarily constrain implementations.

2.1 Position in protocol stack

Figure 2 shows the position of T-RLC in the GERAN protocol stack. T-RLC, its interlayer reference points, and its related interlayer service primitives appear in magenta.

T-RLC, part of the RLC layer, resides between PDCP (Packet-Data Convergence Protocol) and MAC (Medium Access Control). Under RRC control, the RLC layer manager (RLCM) configures RLC to contain none to multiple T-RLC entities.

Figure 2: T-RLC position in GERAN protocol stack



2.2 Services provided by T-RLC

T-RLC provides the following services to the upper layers:

- Transparent data transport.

If T-RLC were to completely support PDCP, it would also provide the following services:

- Discard of stale T-RLC SDUs.

2.3 Services expected from MAC

T-RLC requires the following services from MAC:

- Data transport.
- Scheduling.
- Ciphering.

If T-RLC were to completely support PDCP, it would also expect the following services from MAC:

- T-RLC PDU size selection.
- MAC SDU group identification (used for T-RLC SDU reassembly).

2.4 Functions

T-RLC provides the following functions:

- None.

If T-RLC were to completely support PDCP, it would provide the following functions:

- Segmenting individual T-RLC SDUs into multiple transmitted T-RLC PDUs. Reassembling multiple received T-RLC PDUs into individual T-RLC SDUs.

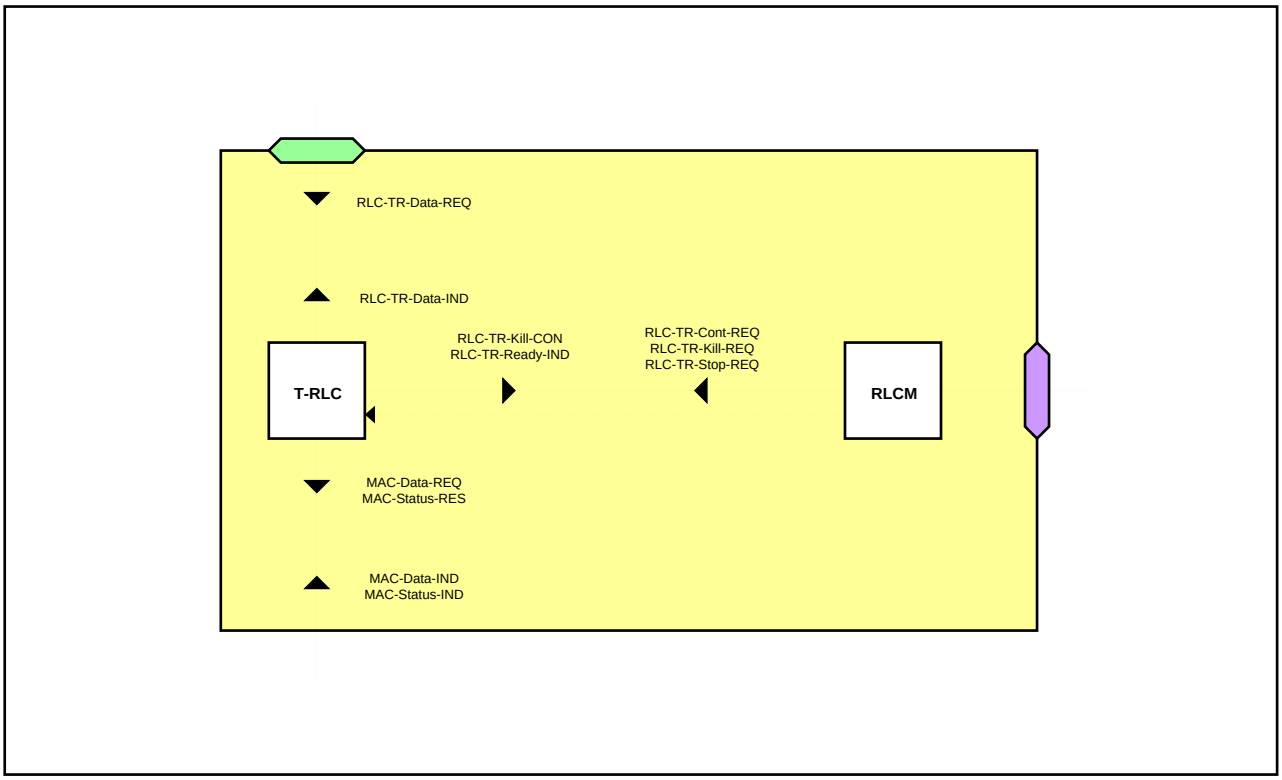
  Since T-RLC has no header that would support reassembly, RRC will have to configure MAC to know how many T-RLC PDUs (MAC SDUs) constitute a T-RLC SDU. RRC peers will have to agree on the segmenting scheme at service establishment and then appropriately configure MAC peers. MAC peers will likely keep track of the T-RLC segments by monitoring frame numbers, *e.g.*, every four frames starting at frame 0 constitute the four T-RLC PDUs that carry the segments of a T-RLC SDU.

- Discarding stale T-RLC SDUs. Each SDU has its own timer, but each timer has the same configurable start value.

2.5 Structure

Figure 3 shows a reference model for T-RLC. This model, commonly known as a functional block diagram, is not intended to constrain implementations.

Figure 3: T-RLC reference model



2.6 Signals

T-RLC uses three types of signals:

- T-RLC SDUs received from higher layers.
- T-RLC PDUs sent via lower layers to the T-RLC peer.
- Service primitives for providing service to higher layers, for providing interfunction communication within the RLC layer, and for obtaining service from layer 1.

2.6.1 T-RLC SDUs

A T-RLC SDU is a bit string of length greater than 0.

2.6.2 T-RLC PDUs

A T-RLC PDU is a bit string of length greater than 0. It contains one T-RLC SDU. Unlike most PDUs, it does not contain a header.

2.6.3 Service Primitives

T-RLC uses the following service primitives:

Primitive	Route	Description
CRLC-Config-CON	RRC←RLCM	RLCM (RLC Manager) confirms configuration of RLC elements.
CRLC-Config-REQ	RRC→RLCM	RRC requests configuration of RLC elements.
MAC-Data-IND	T-RLC←MAC	MAC indicates it is delivering an SDU received from its peer.
MAC-Data-REQ	T-RLC→MAC	T-RLC requests MAC transport data to the T-RLC peer.
MAC-Status-IND	T-RLC←MAC	MAC indicates one of the following: it is polling for data, it is ready to transport data.
MAC-Status-RES	T-RLC→MAC	T-RLC responds that it has data to send.
RLC-TR-Cont-REQ	RCLM→T-RLC	RLCM requests that T-RLC continue transporting data.
RLC-TR-Data-IND	PDCP←T-RLC	T-RLC indicates it is delivering an SDU received from its peer.
RLC-TR-Data-REQ	PDCP→T-RLC	The higher layer requests T-RLC transport data to the higher-layer peer.
RLC-TR-Kill-REQ	RCLM→T-RLC	RLCM requests T-RLC kill itself.
RLC-TR-Kill-CON	RCLM←T-RLC	T-RLC confirms it is about to die.
RLC-TR-Ready-IND	RCLM←T-RLC	T-RLC indicates it is ready to transport data.
RLC-TR-Stop-REQ	RCLM→T-RLC	RLCM requests that T-RLC stop transporting data.

2.7 Sequences

Sequences in this section derive from the requirements and scenarios of § 1. Figures contain the sequence diagrams. A table following each figure describes message events in the sequence, including the values of directly relevant information elements.

Within each sequence diagram, the following conventions apply:

- Magenta arrows indicate control signals.
- Green arrows indicate user data.
- Heavy vertical lines indicate a stimulus-response relationship between messages.

Unless stated otherwise, the following conditions apply for each sequence:

- Data for the photon-ajuitar will be carried by T-RLC$_1$.
- Data for the bass detonator will be carried by T-RLC$_2$.
- Data for the megabang drum complex will be carried by T-RLC$_3$.
- Voice data will be carried by T-RLC$_4$.

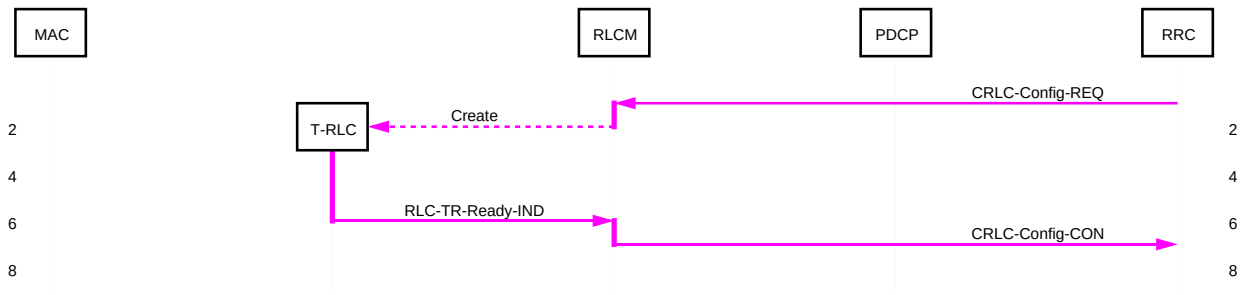
2.7.1 Configure T-RLC

This sequence corresponds to the following system-based scenario:

- Configure T-RLC for use by a transparent radio bearer.

Figure 4 shows RRC configuring the RLC layer to support a transparent radio bearer. To configure 4 transparent radio bears, the sequence would be repeated 4 times.

Figure 4: Configure T-RLC



Line	Description	Direction
1	CRLC-Config-REQ *{action, RBid, QoS}* RRC requests that RLCM set up a transparent RLC to handle data flow from PDCP. RRC initiates this request as part of radio-bearer establishment. • *Action* indicates *setup*. If a T-RLC already exists for this radio bearer and *action* indicates *setup*, RLCM will not reset the T-RLC. • *RBid* identifies the radio bearer. • *QoS* indicates the quality of service to be provided by T-RLC (*e.g.*, 3).	RLCM←RRC
2	Create *{QoS}* RLCM creates a T-RLC process to handle the transparent data flow. • *QoS* indicates the quality of service to be provided by the created T-RLC.	T-RLC←RLCM
6	RLC-TR-Ready-IND The created TRLC indicates that is ready to transport data.	T-RLC→RLCM
7	CRLC-Config-CON *{RBid}* RLCM confirms the transparent RLC is ready to transport data. • *RBid* identifies the radio bearer.	RLCM→RRC

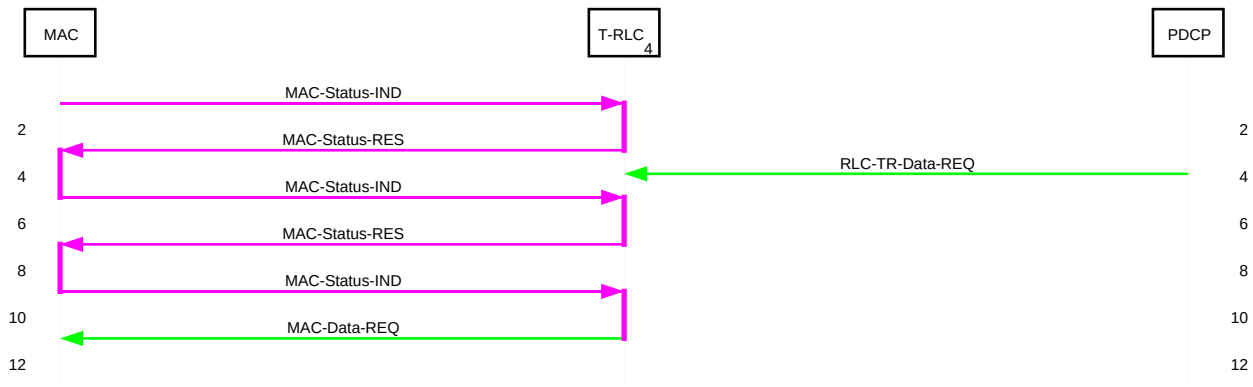
2.7.2 Transmit data

This sequence corresponds to the following system-based scenario:

- Transport voice from the microphone, located in the spaceship, to the mixer located in a concrete bunker below the planet's surface.

Figure 5 shows a GERAN T-RLC transmitting voice data to the mobile station.

Figure 5: Transmit data



Line	Description	Direction
1	MAC-Status-IND *{purpose}* MAC polls T-RLC$_4$ for data. • *Purpose* indicates *poll*.	MAC→T-RLC$_4$
3	MAC-Status-RES *{priority}* T-RLC$_4$ responds that it has no PDUs to send. • *Priority* is 0.	MAC←T-RLC$_4$
4	RLC-TR-Data-REQ *{T-RLC SDU}* PDCP requests that T-RLC$_4$ transport a PDCP PDU to the PDCP peer. • *T-RLC SDU* is the PDU received from PDCP.	T-RLC$_4$←PDCP
5	MAC-Status-IND *{purpose}* Same as line 1.	MAC→T-RLC$_4$
7	MAC-Status-RES *{priority}* T-RLC$_4$ responds that it has a PDU of priority 3 to send. T-RLC$_4$ derives its priority from the QoS established at creation. • *Priority* is 3.	MAC←T-RLC$_4$
9	MAC-Status-IND *{purpose}* MAC indicates that T-RLC$_4$, the T-RLC with the highest-priority, should send its data. • *Purpose* indicates *ready for data*.	MAC→T-RLC$_4$
11	MAC-Data-REQ *{MAC SDU}* T-RLC$_4$ requests that MAC transport data to the T-RLC$_4$ peer. • *MAC SDU* is the *T-RLC PDU* received from T-RLC$_4$.	MAC←T-RLC$_4$

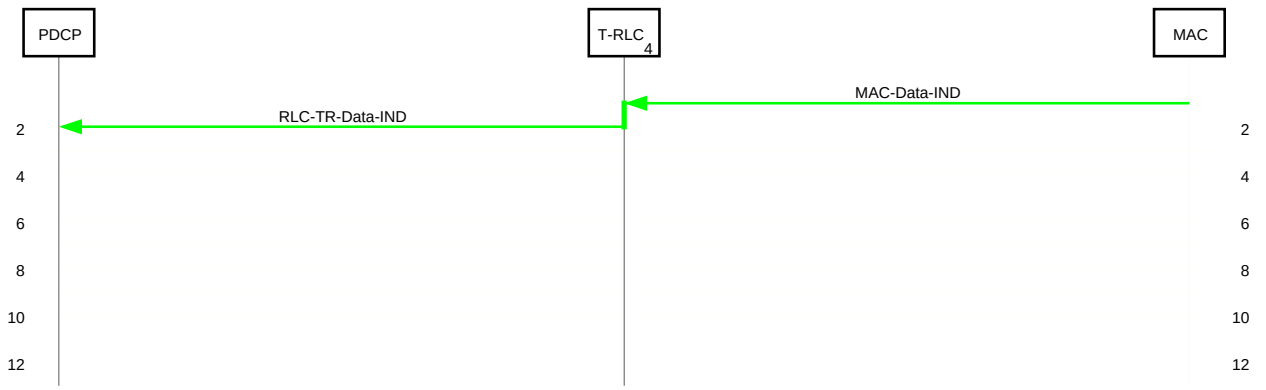
2.7.3 Receive data

This sequence corresponds to the following system-based scenario:

- Transport voice from the microphone, located in the spaceship, to the mixer located in a concrete bunker below the planet's surface.

Figure 6 shows an MS T-RLC receiving voice data from GERAN.

Figure 6: Receive data



Line	Description	Direction
1	MAC-Data-IND *{MAC SDU, status}* MAC indicates it is delivering an SDU received from its peer. • *MAC SDU* contains the received MAC SDU. • *Status* indicates *OK*. If the MAC SDU was not received error-free, *status* indicates *error*.	$T\text{-}RLC_4 \leftarrow MAC$
2	RLC-TR-Data-IND *{T-RLC SDU, status}* $T\text{-}RLC_4$ indicates it is delivering an SDU received from its peer. • *T-RLC SDU* is the T-RLC PDU (MAC SDU) received from MAC. • *Status* indicates *OK*.	$PDCP \leftarrow T\text{-}RLC_4$

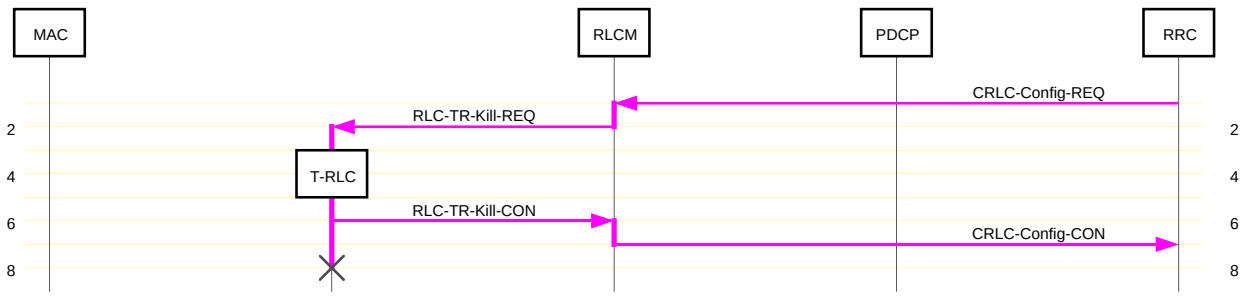
2.7.4 Release T-RLC

This sequence corresponds to the following system-based scenario:

- Release T-RLC.

Figure 7 shows RRC configuring the RLC layer to release a T-RLC. To release 4 transparent radio bears, the sequence would be repeated 4 times.

Figure 7: Release T-RLC



Line	Description	Direction
1	CRLC-Config-REQ *{action, RBid, QoS}* RRC requests that RLCM release a transparent RLC. • *action* indicates *release.* • *RBid* identifies the radio bearer. • *QoS* is *null*.	RLCM←RRC
2	RLC-TR-Kill-REQ RLCM kills the T-RLC.	T-RLC←RLCM
6	RLC-TR-Kill-CON T-RLC confirms that it is about to die.	T-RLC→RLCM
7	CRLC-Config-CON *{RBid}* RLCM confirms the transparent RLC is released.	RLCM→RRC

2.8 Processes

RLC contains two processes of interest for transparent data transport: RLCM (Radio-Link-Control Manager) and T-RLC (Transparent Radio Link Control).

2.8.1 RLC Manager

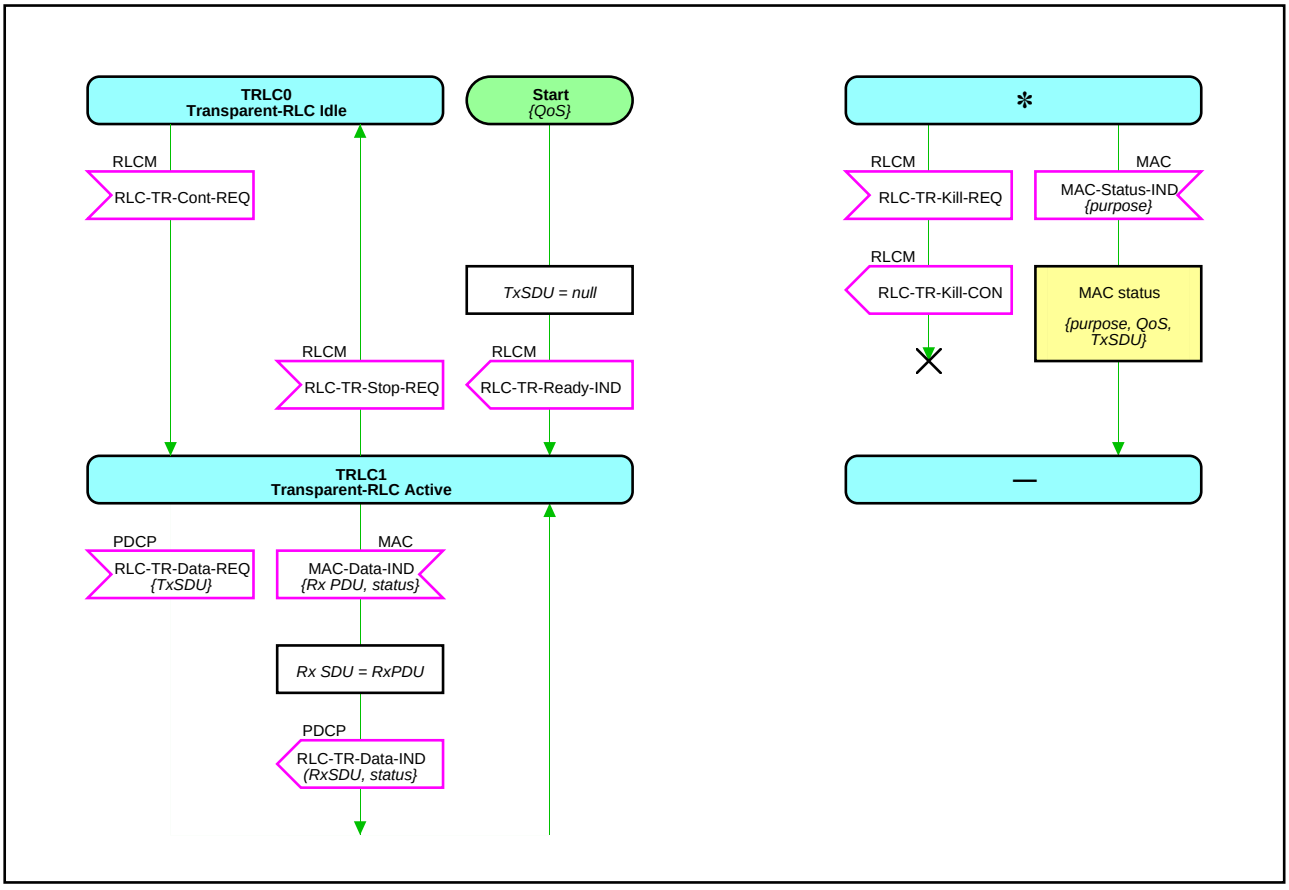
Although this process desperately needs to be specified, it is presently beyond the scope of this document.

2.8.2 Transparent RLC

T-RLC shall perform the process shown in Figure 8. The process uses the following variables:

Variable	Values	Description
purpose	poll, RFD	The purpose for which MAC provides status to T-RLC.
QoS	1, 2 … 8	The quality of service passed from RLCM at T-RLC creation.
RxPDU	bit string	The PDU T-RLC received from its peer.
RxSDU	bit string	The SDU T-RLC will deliver to a higher layer.
status	OK, error	The quality of data T-RLC receives from MAC.
TxSDU	bit string	The SDU T-RLC received from a higher layer.

Figure 8: T-RLC process



2.9 Procedures

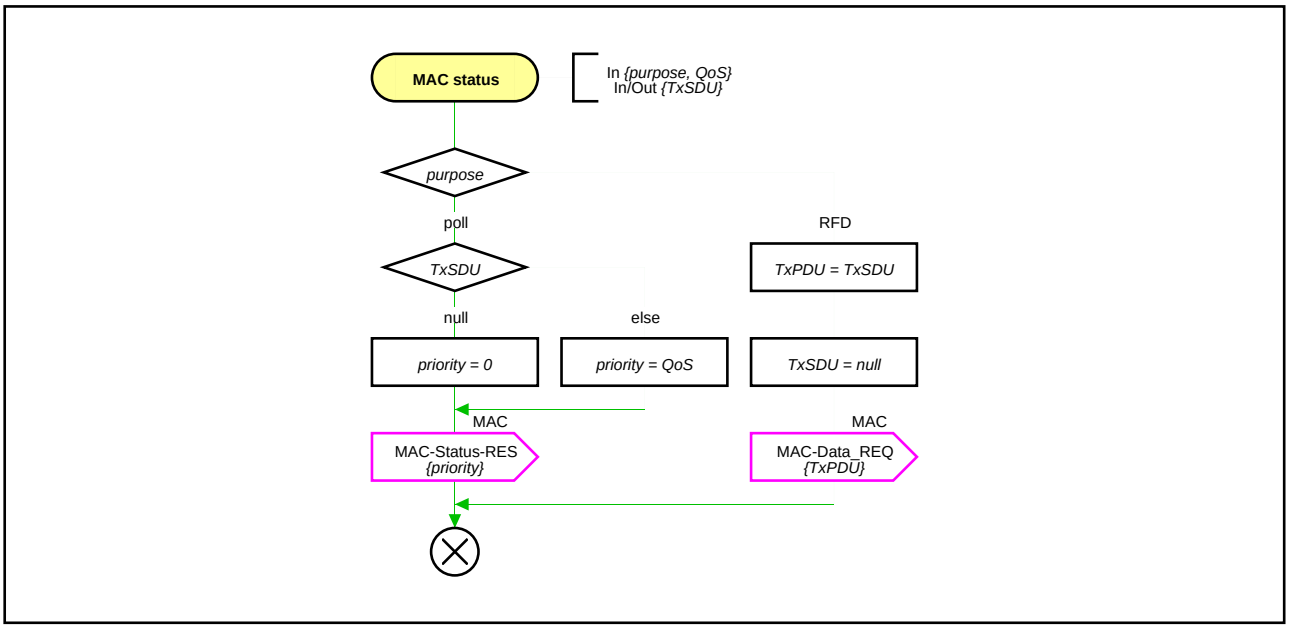
This section specifies each of the procedures called in the processes of § 2.8.

2.9.1 MAC status

T-RLC shall perform the procedure shown in Figure 9. The procedure uses the following variables:

Variable	Type	Values	Description
priority	Internal	0, 1 … 8	The priority of the SDU that T-RLC wants to transmit to its peer.
purpose	In	poll, RFD	The purpose for which MAC provides status to T-RLC.
QoS	In	1, 2 … 8	The quality of service passed from RLCM at T-RLC creation.
TxPDU	Internal	bit string	The PDU T-RLC will transport to its peer.
TxSDU	In / Out	bit string	The SDU T-RLC received from a higher layer.

Figure 9: MAC status procedure



3. Impact on specifications

This section is incomplete.

3.1 Changes to 23.060 (GPRS stage 2)

Section	Description

3.2 Changes to 44.060 (GERAN RLC/MAC)

Section	Description

3.3 Changes to 45.002 (L1 Multiplexing)

Section	Description

4. References

1. Cooper, Alan. *The Inmates are Running the Asylum – Why High-Tech Products Drive Us Crazy and How to Restore the Sanity.* Indianapolis: SAMS, 1999.

2. 3GPP TS 23.060. *3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS); Service description; Stage 2.*

3. 3GPP TS 24.008. *3rd Generation Partnership Project; Technical Specification Group Core Network; Mobile radio interface layer 3 specification; Core Network Protocols - Stage 3.*

4 3GPP TS 25.322. *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; RLC Protocol Specification.*

5 3GPP TS 25.323. *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Packet Data Convergence Protocol (PDCP) Specification.*

6. 3GPP TS 44.060. *3rd Generation Partnership Project; Technical Specification Group GSM EDGE Radio Access Network; General Packet Radio Service (GPRS); Mobile Station (MS) – Base Station System (BSS) interface; Radio Link Control / Medium Access Control (RLC/MAC) protocol.*

7. 3GPP TS 45.002. *3rd Generation Partnership Project; Technical Specification Group GERAN; Digital cellular telecommunications system (Phase 2+); Multiplexing and multiple access on the radio path.*

8. GAHW-010241. *Results of RLC/MAC drafting meeting.* Bellevue: GERAN Ad Hoc, 07 May 01.

9 *Hitchhiker's Guide to the Galaxy.* Ursa Minor Beta: Megadodo Publications.
<Apologies to the late Douglas Adams.>

10. ITU-T X.200. *Information Technology – Open Systems Interconnection – Basic Reference Model: The Basic Model.* Geneva: International Telecommunication Union, July 1994.

11. ITU-T X.210. *Information Technology – Open Systems Interconnection – Basic Reference Model: Conventions for the Definition of OSI Services.* Geneva: International Telecommunication Union, November 1993.

12. ITU-T Z.100. *Languages and general software aspects for telecommunication systems; Formal description techniques (FDT) – Specification and Description Language (SDL).* Geneva: International Telecommunication Union, November 1999.

13. ITU-T Z.120. *Message Sequence Chart (MSC).* Geneva: International Telecommunication Union, March 1993.