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Digitalni celiļ ni telekomunikacijski sistem (faza 2+) ï Protokol za radijsko povezovanje (RLP) podatkov in telematskih storitev o vmesniku sistema mobilna postaja-bazna postaja (MS-BSS) in vmesniku komutacijskega centra sistema bazne postaje-mobilne storitve (BSS-MSC) (GSM 04.22, razliļ ica 5.2.1)

Digital cellular telecommunications system (Phase 2+) (GSM); Radio Link Protocol (RLP) for data and telematic services on the Mobile Station - Base Station System (MS - BSS) interface and the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface (GSM 04.22 version 5.2.1)

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Digital cellular telecommunications system (Phase 2+); Radio Link Protocol (RLP) for data and telematic services on the Mobile Station - Base Station System (MS - BSS) interface and the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface (GSM 04.22 version 5.2.1)

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) of the European Telecommunications Standards Institute (ETSI).

This ETS specifies the Radio Link Protocol (RLP) for data transmission over within the digital cellular telecommunications system.

The specification from which this ETS has been derived was originally based on CEPT documentation, hence the presentation of this ETS may not be entirely in accordance with the ETSI rules.

Transposition dates	
Date of adoption of this ETS:	2 January 1998
Date of latest announcement of this ETS (doa):	30 April 1998
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 October 1998
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1 Scope

This European Telecommunication Standard (ETS) specifies the Radio Link Protocol (RLP) for data transmission over the GSM PLMN. RLP covers the Layer 2 functionality of the ISO OSI Reference Model (IS 7498). It is based on ideas contained in IS 3309, IS 4335 and IS 7809 (HDLC of ISO) as well as CCITT X.25 and Q.92x (LAP-B and LAP-D of CCITT, respectively.) RLP has been tailored to the special needs of digital radio transmission. RLP provides to its users the OSI Data Link Service (IS 8886).

RLP is intended for use with non-transparent data-transfer. Protocol conversion may be provided for a variety of protocol configurations. Those foreseen immediately are:

- Character-mode protocols using start-stop transmission (IA5);
- X.25 LAP-B.

For reasons of better presentation, material about protocol conversion has been placed within those Specifications concerned with the relevant Terminal Adaptors, i.e. GSM 07.02 for the asynchronous case and GSM 07.03 for the synchronous case. Care must be taken that that material also applies to Interworking Functions; see GSM 09.04 - 09.07.

2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

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[1] GSM 01.04 (ETR 350): "Digital cellular telecommunication system (Phase 2+); Abbreviations and acronyms".

[2] GSM 04.21 (ETS 300 945): "Digital cellular telecommunication system; Rate adaption on the Mobile Station - Base Station System (MS - BSS) interface".

[3] GSM 07.02 (ETS 300 914): "Digital cellular telecommunication system (Phase 2+); Terminal Adaptation Functions (TAF) for services using asynchronous bearer capabilities".

[4] GSM 07.03 (ETS 300 584): "Digital cellular telecommunication system (Phase 2); Terminal Adaptation Functions (TAF) for services using synchronous bearer capabilities".

[5] GSM 09.04: "Digital cellular telecommunication system; Interworking between the Public Land Mobile Network (PLMN) and the Circuit Switched Public Data Network (CSPDN)".

[6] GSM 09.05: "Digital cellular telecommunication system; Interworking between the Public Land Mobile Network (PLMN) and the Packet Switched Public Data Network (PSPDN) for Packet Assembly/Disassembly facility (PAD) access".

[7] GSM 09.06 (ETS 300 975): "Digital cellular telecommunication system (Phase 2+); Interworking between a Public Land Mobile Network (PLMN) and a Packet Switched Public Data Network/Integrated Services Digital Network (PSPDN/ISDN) for the support of packet switched data transmission services".

[8] GSM 09.07 (ETS 300 976): "Digital cellular telecommunications system (Phase 2+); General requirements on interworking between the Public Land Mobile Network (PLMN) and the Integrated Services Digital Network (ISDN) or Public Switched Telephone Network (PSTN)".

[9] CCITT Recommendation I.440 (Redbook): "ISDN user-network interface data link layer - General aspects".

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[10] CCITT Recommendation I.441 (Redbook): "ISDN user-network interface, data link".

[11] CCITT Recommendation Q.920 (Redbook): "ISDN user-network interface data link layer - General aspects".

[12] CCITT Recommendation Q.921 (Redbook): "ISDN user-network interface - data link".

[13] CCITT Recommendation Q.921bis: "Abstract test suites for LAPD conformance tests".

[14] CCITT Recommendation Q.922: "ISDN data link layer specification for frame mode bearer services".

[15] CCITT Recommendation V.42bis: "Data Compression for Data Circuit Terminating Equipment (DCE) using Error Correction Procedures".

[16] CCITT Recommendation X.25 (Redbook): "Interface between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for terminals operating in Packet Mode and connected to Public Data Networks by dedicated Circuit".

[17] ISO/IEC Recommendation 4335: "Information technology - Telecommunications and information exchange between systems - High level data link control (HDLC) procedures - Elements of procedures".

[18] ISO Recommendation 3309: "Information technology - Telecommunications and information exchange between systems - High level data link control (HDLC) procedures - Frame structure".

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[19] ISO Recommendation 7498: "Information processing systems - Open Systems Interconnection - Basic Reference Model".

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[20] ISO Recommendation 8885: "Information technology - Telecommunication and information exchange between systems - High-level data link control (HDLC) procedures - General purpose XID frame information field content and format".

[21] ISO Recommendation 8886: "Information technology - Telecommunication and information exchange between systems - Data link service definitions for Open Systems interconnection".

[22] ISO Recommendation 8509: "Information processing systems - Open Systems Interconnection - Service conventions".

[23] ISO/IEC Recommendation 7809: "Information technology - Telecommunication and information exchange between systems - High-level data link control (HDLC) procedures - Classes of procedures".

[24] ISO Recommendation 7776: "Information processing systems - High-level data link control procedures - Description of the X.25 LAPB-compatible DTE data link procedures".

2.1 Definitions and abbreviations

Abbreviations used in this ETS are listed in GSM 01.04 [1].

For the purposes of this ETS, the following definitions apply:

backwards compatibility: RLP defines several backwards-compatible versions. That means that a newer version can interwork with an older one without changing the older one. This is realized by a fall back mechanism during XID exchange.

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command: An instruction represented in the RLP header, causing the receiving RLP entity to execute a specific function.

frame check sequence: A field of redundant information based on a cyclic code, used for error detection.

I + S frame: An RLP frame that is used for user information transfer, carrying supervisory information piggyback.

improper frame: An RLP frame having an FCS error or having a header the contents of which is inconsistent with this Specification.

non-transparent: In PLMN data transmission, a configuration where at layer 2, protocol information of the fixed network is mapped on RLP elements, and vice versa.

piggybacking: Means by which one and the same frame can carry both user information and RLP related supervisory information.

response: A reply represented in the RLP-header, by which the sending RLP entity reports back about its status.

RLP frame: A sequence of contiguous bits, representing an RLP procedural element.

RLP header: That part of an RLP frame that encodes either a command or a response, located at the beginning of the RLP frame.

S frame: An RLP frame that contains supervisory information in the absence of user information.

transparent: In PLMN data transmission, a configuration where at layer 2 (and also at the layers above) no protocol conversion takes place.

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U frame: An RLP frame that contains unnumbered protocol control information.

3 Introduction

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Three versions of RLP are defined:

- RLP version 0: single-link basic version;
- RLP version 1: single-link extended version (e.g. extended by data compression);
- RLP version 2: multi-link version

RLP uses one (single-link) or from 1 up to 4 (multi-link) physical links. However, the RLP multi-link version is designed to be able to support up to 8 physical links. If, in the call setup signalling, either end indicates that it cannot support multilink operation, neither end shall require usage of RLP-versions higher than 1.

RLP makes use of an underlying FEC (Forward Error Correction) mechanism. For RLP to perform adequately it is assumed that the basic radio channel together with FEC provides for a block error rate of less than 10 %, where a block consists of 240 or 576 bits (Further study on the BLER for 576-bit blocks is needed). Furthermore, it is assumed that in case of multi-link RLP the difference of the delay between all physical links is less than timer T4.

RLP frames are sent in strict alignment with the radio transmission. (For details, see GSM 04.21). RLP frames are of a fixed size of 240 (TCH/F9.6 channel coding) or 576 bits (TCH/F14.4 channel coding).. Whenever a frame is to be sent, the RLP entity has to provide the necessary protocol information to be contained in it. Provision is made for discontinuous transmission (DTX).

RLP spans from the Mobile Station (MS) to the interworking function (IWF), located at the nearest Mobile Switching Centre (MSC), or beyond. Depending on the exact location of the IWF, handover of the MS may result in link-reset or even total loss of the connection.

In the terminology of HDLC, RLP is used in a balanced configuration, employing asynchronous operation, i.e. either station has the right to set-up, reset, or disconnect a link at any time. Procedural means are provided for to deal with contentious situations, should they ever occur.

RLP is full-duplex in the sense that it allows for information to be transferred in both directions simultaneously.

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4 Frame structure

4.1 Basic frame structure

An RLP-frame has a fixed length of either 240 or 576 bits consisting of a header, an information field, and an FCS (frame check sequence) field. The size of the components depends on the RLP version and on the RLP frame. As a benefit of using strict alignment with underlying radio transmission there is no need for frame delimiters (like flags etc.) in RLP. In consequence, there is no "bit-stuffing" necessary in order to achieve code transparency. Frames cannot be aborted while being transmitted.

	Header	Information	FCS
version 0 and 1, version 2 (U frames only)	16/24 bit	200/192 bit	24 bit
version 2 (S and I+S frames only)	24 bit	192 bit	24 bit

b) 576 bit frame size

	Header	Information	FCS
version 0, 1, and version 2 (U frames only)	16 bit	536 bit	24 bit
version 2 (S and I+S frames only)	24 bit	528 bit	24 bit

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Figure 1: Frame structure

4.2 RLP header

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An RLP-header carries one of three types of control information, the first being unnumbered protocol control information (U frames), the second being supervisory information (S frames), the third being user information carrying supervisory information piggybacked (I + S frames).

4.3 Order of transmission

The header, as defined in clause 5.2, shall be transmitted from left to right. The FCS shall be transmitted commencing with the highest order term. The order of bit transmission for the information field is from left to right.

4.4 Frame check sequence

The FCS shall be the ones complement of the modulo 2 sum of:

a) the remainder of:

For 9.6/4.8 kbit/s channel coding:

$$x^{216} (x^{23} + x^{22} + x^{21} + x^{20} + x^{19} + x^{18} + x^{17} + x^{16} + x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^{9} + x^{8} + x^{7} + x^{6} + x^{5} + x^{4} + x^{3} + x^{2} + x + 1)$$

For 14.4kbit/s channel coding:

$$x^{552} (x^{23} + x^{22} + x^{21} + x^{20} + x^{19} + x^{18} + x^{17} + x^{16} + x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^{9} + x^{8} + x^{7} + x^{6} + x^{5} + x^{4} + x^{3} + x^{2} + x + 1$$

divided modulo 2 by the generator polynomial:

$$x^{24} + x^{23} + x^{21} + x^{20} + x^{19} + x^{17} + x^{16} + x^{15} + x^{13} + x^{8} + x^{7} + x^{5} + x^{4} + x^{2} + 1$$

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and

b) the remainder of the division modulo 2 by the generator polynomial:

$x^{24} + x^{23} + x^{21} + x^{20} + x^{19} + x^{17} + x^{16} + x^{15} + x^{13} + x^{8} + x^{7} + x^{5} + x^{4} + x^{2} + 1$

of the product of x^{24} by the content of the frame, excluding the FCS field. (The first bit transmitted corresponds to the highest order term.)

Implementation note: As a typical implementation, at the transmitter, the initial content of the register of the device computing the remainder of the division is pre-set to all ones and is then modified by division by the generator polynomial (as described above) of the header and information field; the ones complement of the resulting remainder is transmitted as the 24 bit FCS sequence.

At the receiver, the initial content of the register of the device computing the remainder is pre-set to all ones. The final remainder after multiplication by x^{24} and then division (modulo 2) by the generator polynomial:

$x^{24} + x^{23} + x^{21} + x^{20} + x^{19} + x^{17} + x^{16} + x^{15} + x^{13} + x^{8} + x^{7} + x^{5} + x^{4} + x^{2} + 1$

of the serial incoming protected bits and the FCS will be:

0 1 1 0 1 1 0 1 1 0 0 0 1 0 0 1 0 0 1 1 0 0 0 0 (x^{23} to x^{0}, resp.)

in the absence of transmission errors.

5 Elements and procedure

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5.1 Modes

An RLP entity can be in one of two modes:

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- Asynchronous Balanced Mode (ABM)
- Asynchronous Disconnected Mode (ADM)

5.1.1 Asynchronous Balanced Mode (ABM)

In ABM, which is the data link operational mode, either RLP entity may send commands at any time and may initiate response frame transmission without receiving explicit permission to do so from the other RLP-station. In ABM, frames shall be used for information field transfer and/or to indicate status changes in the RLP-station.

5.1.2 Asynchronous Disconnected Mode (ADM)

In ADM, which is the data-link non-operational mode, the RLP entity shall be logically disconnected from the data link and shall, therefore, neither transmit nor accept numbered information frames.

The RLP entity shall, however, be permitted to transmit and accept NULL, DM, UI, TEST and XID frames. Either RLP entity can issue an SABM command at any time, in order to terminate the ADM state. In that case, entrance of the ABM state will be indicated by a UA response from the opposite station. If the opposite station is not able to enter ABM, it will indicate this by a DM response. All commands other than those mentioned above and any unsolicited response will be ignored in ADM under all circumstances.

5.2 Header and parameters

The formats defined for the header are listed in figure 2.

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5.2.1 Generally used bits

NOTES:
- C/R = COMMAND/RESPONSE BIT
- P/F = POLL/FINAL BIT
- X = DON'T CARES

S_1	S_2	
0	0	R R
0	1	R E J
1	0	R N R
1	1	S R E J

$M_1M_2M_3M_4M_5$	
1 1 1 0 0	S A B M
0 0 1 1 0	U A
0 0 0 1 0	D I S C
1 1 0 0 0	D M
1 1 1 1 0	NULL
0 0 0 0 0	U I
1 1 1 0 1	X I D
0 0 1 1 1	T E S T
1 0 0 0 1	REMAP

Versions 0 and 1:

NOTES:
- N(S) : Bit 4 low order bit
- N(R) : Bit 11 low order bit

U	C/R	X	X	1	1	1	1	1	1	P/F	M1	M2	M3	M4	M5	X
S	C/R	S1	S2	0	1	1	1	1	1	P/F	N(R)					
I+S	C/R	S1	S2	N(S)						P/F	N(R)					
bit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

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Version 2:

NOTES:
- S = L2R Status Bit
- N(S) : Bit 1 low order bit
- N(R) : Bit 14 low order bit

U	C/R	X	X	1	1	1	1	1	1	P/F	M1	M2	M3	M4	M5	X								
S	X	X	X	0	1	1	1	1	1	P/F	C/R	S1	S2	N(R)									X	X
I+S	N(S)									P/F	C/R	S1	S2	N(R)									S	X
bit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Figure 2: Header formats

5.2.1.1 Command/response bit, C/R

The C/R-bit is used to indicate whether the frame is a command or response frame and whether the P/F-bit is to be interpreted as a poll or final bit, resp. For commands, the C/R bit shall be set to "1", for responses it shall be set to "0".

5.2.1.2 Poll/Final bit, P/F

The P/F-bit is used to mark a special instance of command/response exchange. With a command, it is called the P-bit, with a response, it is called the F-bit. In any one direction, only one P/F-bit exchange may be outstanding at any time. A response with the F-bit set to "1" shall always reflect the latest receive status of the RLP entity.

A P/F-bit exchange always starts with a command frame with the P-bit set to "1", which shall be answered by a response frame with the F-bit set to "1" at the earliest response opportunity.

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No unsolicited F-bit = "1" is allowed. Such a frame shall be considered "improper" (see subclause 5.3.1). In ABM, the use of the P/F-bit with numbered information exchange is only allowed for checkpoint-recovery (see subclause 5.3.3).

5.2.2 Unnumbered frames, U

5.2.2.1 Set asynchronous balanced mode SABM (11100)

The SABM encoding is used as a command only. It is always used with the P-bit set to "1".

The SABM command is used either to initiate a link for numbered information transfer, i.e. to go from ADM to ABM, or to reset a link already established for numbered information transfer. With an SABM command, no information transfer is allowed.

When issuing an SABM, the RLP entity has set to zero its internal variables for sending and receiving numbered information. The other RLP entity, on receiving an SABM command, will either confirm it by setting to zero its internal variables for sending and receiving numbered information and then issuing an UA (unnumbered acknowledgement) response or reject it by sending a DM (disconnected mode) response. In the former case, both entities have entered ABM and numbered information transfer may commence. In the latter case, both entities are in ADM.

When an SABM command is issued, a loss of information may occur. Appropriate action is in the responsibility of the layers above.

5.2.2.2 Unnumbered Acknowledge. UA (00110)

The UA encoding is used as a response only. It is used to positively acknowledge an SABM or DISC command. With the UA response, no information transfer is allowed.

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5.2.2.3 Disconnect, DISC (00010)

The DISC encoding is used as a command only. It is used to disestablish a link, previously established for numbered information transfer, i.e. to terminate ABM and go into ADM. With the DISC command, no information transfer is allowed.

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The other RLP-entity shall answer with a UA response before actioning the DISC command. When a DISC command is actioned, loss of information may occur. It is the responsibility of the layers above, to provide for a "graceful" disconnect.

5.2.2.4 Disconnected Mode, DM (11000)

The DM encoding is used as a response only. It is used by RLP entity to report that it is in ADM and, as an answer to SABM, that it is (possibly temporary) unable to action a mode setting command. With the DM response, no information transfer is allowed.

5.2.2.5 Unnumbered Information, UI (00000)

The information field is to be interpreted as unnumbered information. Unnumbered Information (UI) frames can be sent in both ADM and ABM. There is no acknowledgement of receipt of UI-frames within RLP.

5.2.2.6 Exchange Identification, XID (11101)

The information field is to be interpreted as exchange identification. This frame is used to negotiate and renegotiate parameters of RLP and layer 2 Relay function. XID frames can be sent in both ADM and ABM.

The negotiation procedure is one step i.e. one side will start the process by sending an XID command, offering a certain set of parameters from the applicable parameter repertoire (see table 1) the sending entity wants to negotiate proposing values within the allowed range. In return, the other side will send an XID response, either confirming these parameter values by returning the requested values, or offering higher or lower ones in their place (see table 1 for sense of negotiation), except when the indicated RLP version is a lower one where a limited set of those parameters presented in the XID command may be