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Technical Specification

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Packet Data Convergence Protocol (PDCP) Specification
(3G TS 25.323 version 2.0.0)

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Contents

Foreword

This Technical Specification has been produced by the 3GPP.

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Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 Indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document provides the description of the Packet Data Convergence Protocol (PDCP).

PDCP provides its services to the NAS at the UE or the relay at the Radio Network Controler (RNC).

PDCP uses the services provided by the Radio Link Control (RLC) sublayer.

The main functions of PDCP are:

- Compression of redundant Network PDU control information (header compression).
- Transfer of packet data protocol user data using services provided by RLC protocol.

The following function is not part of release ´99 but will be included in Release 2000:

- Multiplexing of different RBs onto the same RLC-entity.

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.

[1] 3G TS 25.401: "UTRAN Overall Description "

[2] 3G TR 25.990: "Vocabulary for the UTRAN"

[3] 3G TS 25.301: "Radio Interface Protocol Architecture"

[4] 3G TS 25.303: "Interlayer Procedures in Connected Mode"

[5] 3G TS 25.322: "RLC Protocol Specification"

[6] 3G TS 25.331: "RRC Protocol Specification"

[7] 3G TS 23.121: "Architectural Requirements for Release 1999"

[8] IETF RFC 2507: "IP Header Compression"

3 Abbreviations

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

AS Access Stratum
C-SAP Control Service Access Point
IETF Internet Engineering Task Force
L2 Layer 2 (data link layer)
L3 Layer 3 (network layer)
NAS Non Access Stratum

PDCP	Packet Data Convergence Protocol
PDU	Protocol Data Unit
PID	Packet Identifier
RB	Radio Bearer
RLC	Radio Link Control
RRC	Radio Resource Control
SDU	Service Data Unit
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

4 General

4.1 Objective

The present document describes the functionality of the UTRAN PDCP. The overall UTRAN logical architecture is defined in 3GPP TS 25.301 [3].

Network layer protocols are intended to be capable of operating over services derived from a wide variety of subnetworks and data links. UMTS supports several network layer protocols providing protocol transparency for the users of the service. At that point of view supported protocols are IPv4 and IPv6. Introduction of new network layer protocols to be transferred over UTRAN shall be possible without any changes to UTRAN protocols. Therefore, all functions related to transfer of packets from higher layers (PDCP-SDUs) shall be carried out in a transparent way by the UTRAN network entities. This is one of the requirements for UTRAN PDCP.

Another requirement for the PDCP is to provide functions that help to improve channel efficiency. This requirement is fulfilled by the possibility to implement different kinds of optimization methods. The currently known methods are standardised IETF header compression algorithms.

Multiplexing of RBs onto the same RLC entity will be included in release 2000 but is not available in release `99. Therefor, in release `99 every RB, is connected to one PDCP entity and one PDCP entity is connected to one RLC entity. The PDCP entities are located in the PDCP sublayer.

Every PDCP entity uses zero, one or several header compression algorithm types with certain parameters. Several PDCP entities may use the same algorithm type. The algorithm types and their parameters are negotiated by RRC and indicated to PDCP through the PDCP Control Service Access Point (PDCP-C-SAP).

Since the adaptation of different network layer protocols to PDCP is implementation dependent, it is not defined in the present document.

4.2 Overview on sublayer architecture

Figure 1 shows the model of the PDCP within the UTRAN protocol architecture. Every PDCP-SAP uses exactly one PDCP entity. Each PDCP entity uses none, one or several header compression algorithm types

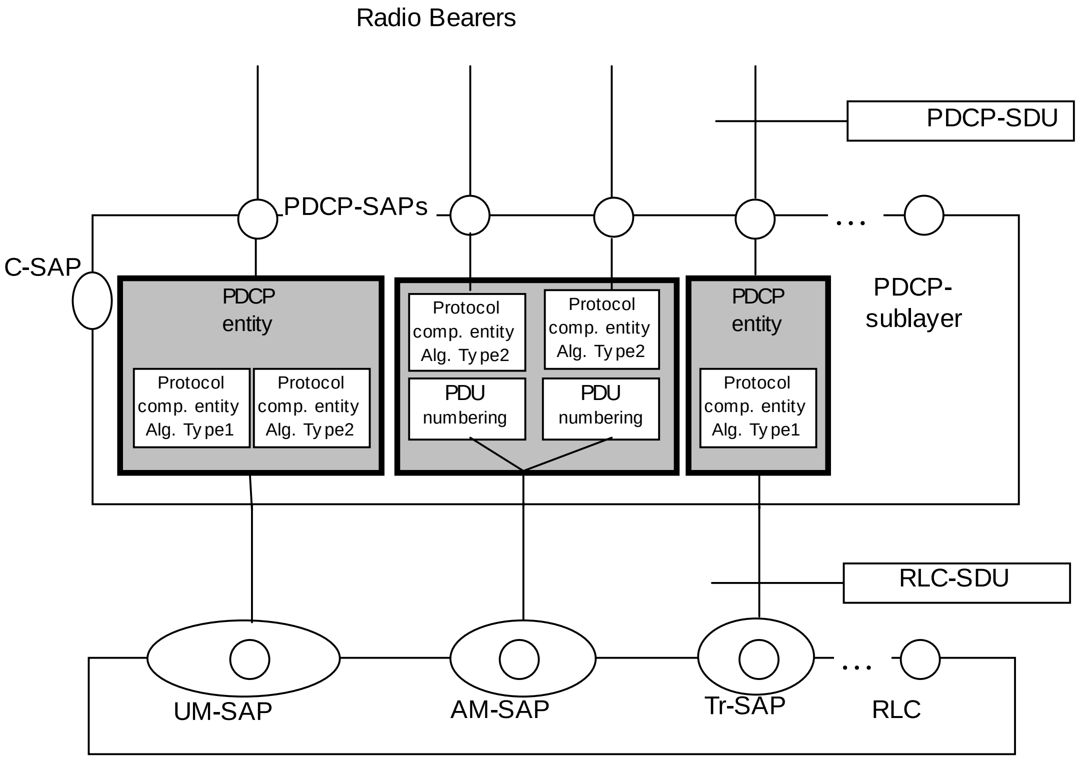

Figure 1: PDCP structure

5. Functions

Packet Data Convergence Protocol shall perform the following functions:

- Header compression and decompression of IP data streams (e.g., TCP/IP and RTP/UDP/IP headers)at the transmitting and receiving entity, respectively. The header compression method is specific to the particular network layer, transport layer or upper layer protocol combinations e.g. TCP/IP and RTP/UDP/IP.
- Transfer of user data. Transmission of user data means that PDCP receives PDCP-SDU from the NAS and forwards it to the RLC layer and vice versa.
- Buffering of transmitted PDCP SDUs and associating PDCP SDU Sequence Numbers to the transmitted and received PDCP SDUs to guarantee lossless SRNS relocation.
- Multiplexing of different RBs onto the same RLC entity. Multipexing is not part of release `99 but will be included in release 2000.

5.1 Header Compression

The header compression method is specific for each network layer protocol type. The header compression algorithms and their parameters are negotiated by RRC for each PDCP entity and indicated to PDCP through the PDCP-C-SAP. Compressor and decompressor initiated signalling between peer PDCP entities during operation is carried out in the user plane.

PDCP layer shall be able to support several header compression algorithms and it shall always be possible to extend the list of supported algorithms in the future.

The PDCP layer can have one or several PDCP entities. Each PDCP entity may use zero, one, or several header compression algorithms. It shall be possible to establish several header compression algorithms of different types related to one PDCP entity. Different PDCP entities may include header compression algorithms of the same type.

Figure 1 shows an example how PDCP may be configured.

5.1.1 Assignment of PID values

PDCP shall be able to distinguish different types of header compression packets to handle them with a correct header compression algorithm and furthermore to indicate the type of the packet within a certain algorithm. This is realized by utilizing the PID field in the PDU structure. PID values shall be assigned according to the dynamic PDCP entity specific allocation table which is configured during the configuration of the PDCP entity. The table is reconfigured every time the PDCP entity is reconfigured.

The following table illustrates an example of the PID value allocation table when three arbitrary header compression methods (RFC2507, Methods A and B) are configured for one PDCP entity.

Table 1: Example of the PID value allocation table

PID Value	Optimization method	Packet type
0	No header compression	-
1	RFC2507	Full header
2	RFC2507	Compressed TCP
3	RFC2507	Compressed TCP nondelta
4	RFC2507	Compressed non TCP
5	RFC2507	Context state
6	Method A	Uncompressed TCP/IP
7	Method A	Compressed TCP/IP
8	Method B	Uncompressed IP/UDP/RTP
9	Method B	Compressed IP/UDP/RTP
...	Unassigned value	-

The assignment of the PID values follow the general rules listed below:

- PID value 0 is reserved permanently for no compression.
- PID values are assigned in ascending order, starting from 1.
- PID values are assigned independently to each PDCP entity.
- PID values are reassigned for the PDCP entity after renegotiation of the header compression algorithms.
- The list of negotiated (or re-negotiated) header compression entities shall be examined, starting from the first one in the list. The number of PID values to be assigned is specified in the subclause for this algorithm.
- If there are not enough unused PID values to be assigned to a header compression algorithm, the negotiated header compression entities using this algorithm shall be ignored without error notification.
- PID values that are used and are not defined invalidate the PDCP PDU.
- For a certain algorithm in a PDCP entity the assignment of PID values starts from (n+1) where n is the number of PID values already assigned to other algorithms. The assignment is done in the order the algorithms are negotiated by RRC. In the example given in table 1 RFC 2507 was the first, method A was the second and method B was the third algorithm in the *PDCP Info* information element exchanged between peer RRC entities. The PID follows this order.

The used header compression algorithm and the packet type is unambiguously known by the basis of the PID value and shall apply to peer PDCP entities. While transferring data, the PID values are conveyed in the field of the PDCP header belonging to the PDCP-PDU. Any successfully negotiated algorithm may be used for header compression of an PDCP-SDU.

5.1.2 TCP/IP and UDP/IP header compression (RFC2507)

Detailed operation of the RFC2507 header compression is described in the chapter 3 of the IETF specification RFC 2507 [8]. Furthermore the mechanisms related to error recovery and packet reordering are described in the chapters 10 and 11 of the RFC 2507. These mechanisms shall be included in the functionality of the header compression supported by PDCP.

5.1.2.1 Assignment of PID values for RFC2507

The following PID values shall be assigned to the RFC2507 header compression in the order presented in the table where n is the number of PID values already assigned to other algorithms

Table 2: PID values assigned to RFC 2507 header compression algorithm

PID value	Optimization method	Packet type
n+1	RFC2507	Full header
n+2	RFC2507	Compressed TCP
n+3	RFC2507	Compressed TCP non-delta
n+4	RFC2507	Compressed non-TCP
n+5	RFC2507	Context state

5.2 Multiplexing

Multiplexing of different RBs onto the same RLC entity is not part of release `99 but will be included in release 2000.

NOTE: A detailed description of the multplexing function is to be added here

5.3 PDCP-SDU buffering and numbering

The PDCP-SDUs, which require reliable data transfer, shall be buffered and numbered in the PDCP layer. Numbering is carried out after header compression. The reception of an CPDCP-RELEASE.Req shall trigger the deletion of the buffer for the related PDCP entity.

If lossless SRNS relocation is required, the PDCP entity shall buffer an PDCP-SDU until information of successful transmission of PDCP-PDU has been received from RLC. The confirmation is carried out using RLC-AM-DATA.Conf primitive from the RLC layer.

For each radio bearer, an UL Send PDCP Sequence Number is associated with each sent PDCP-PDU in the UE and a DL Send PDCP Sequence Number is associated with each sent PDCP-PDU in the SRNC. For each radio bearer, an UL Receive PDCP Sequence Number is associated with each received PDCP-PDU in the SRNC and a DL Receive PDCP Sequence Number is associated with each received PDCP-PDU in the UE.

When the PDCP entity is setup for the first time for the PDCP user the PDCP Sequence Numbers are initialised to zero. The corresponding values are incremented by one at each transmission and reception of a PDCP-PDU. The value of the PDCP sequence number ranges from 0 to 255.

For unacknowledged mode RLC data transfer, the PDCP entity shall delete an PDCP-SDU immediately after the corresponding PDCP-PDU has been delivered to RLC.

NOTE: The technique of PDCP-SDU buffering is described only to provide a model for PDCP functions in case of lossless SRNS relocation. It shall not restrict implementation.

5.4 Data Transfer

5.4.1 Data transfer over acknowledged mode RLC

If header compression is negotiated the PDCP entity shall perform header compression upon reception of a PDCP-DATA.Req. The PDCP-PDU is then forwarded in RLC-AM-DATA.Req to the RLC . The PDCP-SDU shall be stored into the buffer of the PDCP entity if lossless SRNS relocation is required. Buffered PDCP-SDU shall be deleted when the PDCP-SDU is confirmed to be transmitted by an RLC-AM-DATA.Conf.

During operation, when the peer PDCP entity receives the PDCP-PDU in a RLC-AM-DATA.Ind primitive, the PDCP entity shall perform the header decompression (if negotiated) of PDCP-PDU to obtain the PDCP-SDU and forward the PDCP-SDU to the PDCP user with the PDCP-DATA.Ind. The following figure illustrates data transfer over acknowledged mode RLC.

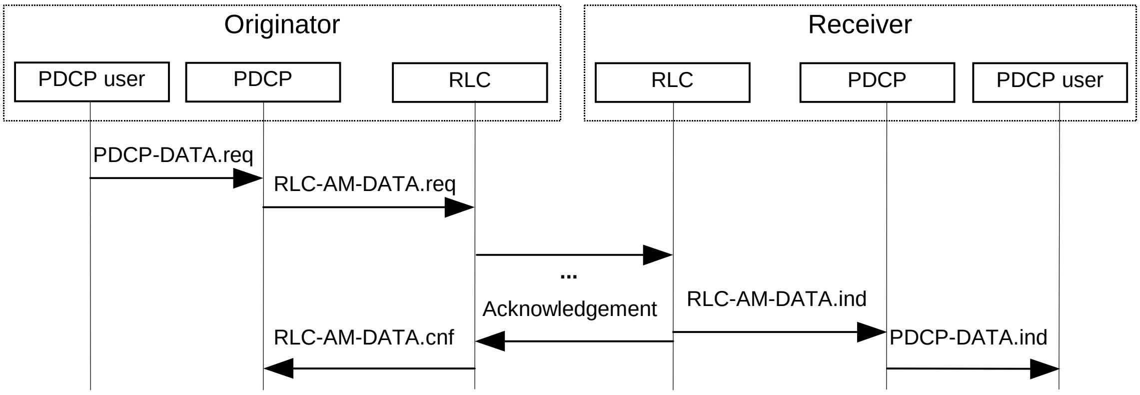

Figure 2: PDCP data transfer over acknowledged mode RLC

5.4.2 Data transfer over unacknowledged and transparent mode RLC

If header compression is negotiated the PDCP entity shall perform header compression upon reception of a PDCP-DATA.Req. The PDCP-PDU is then forwarded in RLC-UM-DATA.Req or RLC-Tr-DATA.Req to the RLC layer. The PDCP-SDU shall be deleted immediately after the data has been delivered to the RLC layer.

When the peer PDCP entity receives the PDCP-PDU in the RLC-UM-DATA.Ind or RLC-Tr-DATA.Ind primitive, the PDCP entity shall perform the header decompression (if negotiated) of PDCP-PDU to obtain the PDCP-SDU and forward the PDCP-SDU to the PDCP user with the PDCP-DATA.Ind. The following figure illustrates data transfer over unacknowledged and transparent mode RLC.

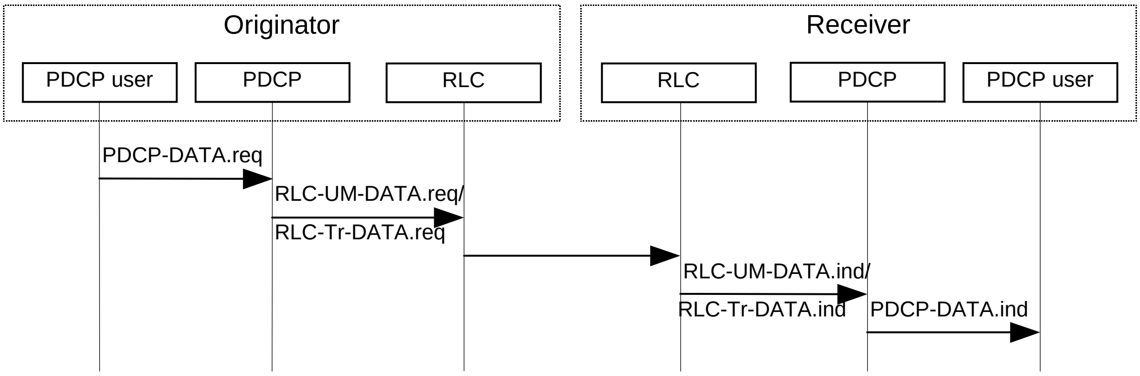

Figure 3: PDCP data transfer over unacknowledged or transparent mode RLC

5.5 SRNS Relocation

The PDCP layer shall carry out following functions during lossless SRNS relocation:

- transmission of all PDCP-SDUs to target SRNC that have not been received correctly,
- forwarding of PDCP-SDUs and associated sequence numbering from old SRNC to target SRNC;
- transfer of next expected PDCP SDU sequence number from UE to target SRNC and vice versa and
- either reset of PDCP entities (when negotiated for the entity).
- or forwarding of internal protocol information from source to target SRNC (when negotiated for the entity).

These procedures are started by CPDCP-RELOC.Req primitive from the RRC layer. For each radio bearer, the Receive PDCP Sequence Number of the next PDCP SDU expected to be received is transferred from the source to target SRNC. For each radio bearer the source SRNC forwards to the target SRNC the downlink PDCP-SDUs stored in its buffer. Source SRNC provides the Send PDCP SDU Sequence Number of the PDCP-SDU which is first in the buffer to the target SRNC.

The target SRNC shall send to the UE the next expected UL Receive PDCP Sequence Number., The UE shall send to the target SRNC the DL Receive PDCP Sequence Number of the next expected PDCP SDU.. The succesfully transmitted PDCP-SDUs are thus confirmed.

During the relocation the PDCP Sequence Numbers are either reset to zero (if PDCP reset is negotiated by RRC for the PDCP entity in case of SRNS relocation) or the PDCP contexts are transfered from the source to the target SRNC and the PDCP Sequence Numbers continue from their previous value (if PDCP reset is not negotiated by RRC for the PDCP entity in case of SRNS relocation).

The reset of all compression entities shall be made during SRNS relocation, when negotiated by RRC in the *Reconfiguration reset* parameter for that PDCP entity. Negotiated comression parameters remain valid during reset, but all state information is initialized, e.g. header compression contexts. Therefore, in header compresssion case, the first 'compressed' packet is a full header. Otherwise, when RRC negotiated in the *Reconfiguratio reset* parameter not to reset the PDCP entity, internal propocol information, i.e. states and header compression contexts, shall be forwarded from source SRNC to target SRNC in the network side. In header compression case, the header compression can then continue from the status it had directly before SRNS relocation.

In the case where lossless SRNS relocation is not required, the PDCP layer shall carry out following functions:

- reset of compression entities (if indicated by RRC in the *Reconfiguration reset* parameter).
- if *Reconfiguration reset* parameter indicates not to reset the PDCP entity (in RRC signalling), internal protocol information, i.e. states and header compression contexts, shall be forwarded from source SRNC to target SRNC.

6 Services

6.1 Services provided to upper layers

The following services are provided by PDCP to upper layers:

- PDCP-SDU delivering.

6.2 Services provided to RRC layer

The following services are provided by PDCP to RRC layer:

- The configuration of PDCP.

6.3 Services expected from RLC layer

For a detailed description of the following functions see [5].

- Data transfer in acknowledged mode,
- Data transfer in unacknowledged mode,
- Data transfer in transparent mode,
- Segmentation and reassembly,
- In-Sequence delivery.

7 Elements for layer-to-layer communication

7.1 Primitives between PDCP and upper layers

The primitives between PDCP and upper layers are shown in Table 3.

Table 3: Primitives between PDCP and upper layers

Generic Name	Parameter			
	Req.	Ind.	Resp.	Conf.
PDCP-DATA	Data	Data	Not Defined	Not Defined
CPDCP-CONFIG	PDCP-Info, RLC-SAP	Not defined	Not Defined	Not Defined
CPDCP-RELEASE	FFS	Not defined	Not Defined	Not Defined
CPDCP-RELOC	FFS	FFS	Not Defined	Not Defined

Each Primitive is defined as follows:

a) PDCP-DATA-Req./Ind.

PDCP-DATA-Req is used by higher user-plane protocol layers to request a transmission of higher layer PDU. PDCP-DATA-Ind is used to deliver PDCP SDU that has been received to upper user plane protocol layers.

b) CPDCP-CONFIG-Req.

CPDCP-CONFIG Req is used to to configure and – in case of already existing PDCP entity – to reconfigure a PDCP entity and to assign it to the radio bearer associated with that entity.

c) PDCP-RELEASE-Req.

CPDCP-RELEASE-Req is used by RRC to release a PDCP entity.

d) CPDCP- RELOC-Req./Ind.

See chapter 5.5.

The following parameters are used in the primitives:

1) PDCP info
Contains the parameters for each of the header compression algorithms configured to be used by one PDCP entity.

2) RLC-SAP
The RLC-SAP (Tr/Um/Am) used by PDCP entity when communicating with RLC sublayer.

8 Elements for peer-to-peer communication

8.1 Protocol data units

Currently two different protocol data unit formats are defined in PDCP. A configuration parameter provided by RRC with CPDCP-CONFIG primitive for every PDCP entity selects whether PDCP shall introduce a PDCP PDU header or not.

8.2 Formats

8.2.1 PDCP-No-Header PDU

The PDCP-No-Header PDU does not introduce any overhead to the PDCP-SDU.

The format of the PDCP-No-Header-PDU is shown in Table 4.

Table 4: PDCP-No-Header PDU

Bit	8	7	6	5	4	3	2	1
Oct 1	Data segment							
...								
N								

8.2.2 PDCP Data PDU

The data PDU is used to convey a payload unit containing a PDCP-SDU, header compression related control signalling or data that has been obtained from PDCP-SDU after header compression. The format of the PDCP-Data-PDU is shown in Table 5.

Table 5: PDCP-Data-PDU format

Bit	8	7	6	5	4	3	2	1
Oct 1	PDU type			PID				
...	Data segment							
N								

8.3 Parameters

8.3.1 PDCP-No-Header-PDU

The PDCP-No-Header-PDU does not contain any parameters.

8.3.2 PDCP-data-PDU

The PDCP-data-PDU parameters are defined as follows:

- PDU type
  000 PID field used for header compression information (PDCP-PDU format described in table 5)
  001 Not defined in release '99
  : :
  : :
  111 Not defined in release '99

- PID:
  0 No header compression
  1-31 Dynamically negotiated header compression identifier

PID field value defines used header compression type and packet type. One compression algorithm may reserve a certain amount of values from PID field value space for different packet types. Receiving PDCP makes reverse operation (e.g. header decompression) according to PID field value. There is not fixed relation between PID field value and used optimization / packet type, but PID field values are defined dynamically at the PDCP parameter negotiation.

9 Handling of unknown, unforeseen and erroneous protocol data

History

Document history		
0.0.1	September 1999	version based on agreed changes to Tdoc 99c25
0.1.0	September 1999	version based on agreed changes to Tdoc 99c73
0.1.1	November 1999	version based on agreed changes to Tdoc 99d48
0.2.0	December 1999	version based on agreed changes to Tdoc 99j54
0.2.1	December 1999	version based on agreed changes to Tdoc 99k03
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