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New presentation - see History box

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Foreword

This European Telecommunication Standard (ETS) has been prepared by the Network Aspects (NA) Technical Committee of the European Telecommunications Standards Institute (ETSI).

The content of this ETS is derived from ITU-T Recommendation I.363 [2] and specifies the interactions between the Asynchronous Transfer Mode (ATM) Adaptation Layer (AAL) type 3/4 and the next higher layer, and the AAL type 3/4 and the ATM layer, as well as AAL type 3/4 peer-to-peer operations. This ETS is one of a set of ETSs describing different AAL types.

Transposition dates	
Date of latest announcement of this ETS (doa):	31 May 1995
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Introduction

The AAL type 3/4 enhances the service provided by the ATM layer to support functions required by the next higher layer. The AAL type 3/4 performs functions required by the user, control and management planes and supports the adaptation between the ATM layer and the next higher layer. The functions performed in the AAL type 3/4 depend upon the higher layer requirements.

The AAL supports multiple protocols (AAL types) to suit the needs of the different AAL service users. The service provided by the AAL type 3/4 to the higher layer and the functions performed are specified in this ETS.

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1 Scope

This European Telecommunication Standard (ETS) specifies the interactions between the Asynchronous Transfer Mode (ATM) Adaptation Layer (AAL) type 3/4 and the next higher layer, and the AAL type 3/4 and the ATM layer, as well as AAL type 3/4 peer-to-peer operations.

This ETS is applicable to variable bit rate sources where there exists no timing relation between the source and the destination of the data; it is applicable for both connection-oriented and connectionless type of communication.

This ETS defines the common part of AAL type 3/4 and can be complemented with standards for the service specific part of the convergence sublayer.

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.

[1] ITU-T Recommendation I.361 (1993): "B-ISDN ATM layer specification".

[2] ITU-T Recommendation I.363 (1993): "B-ISDN ATM Adaptation Layer (AAL) specification".

[3] CCITT Recommendation X.200 (1988): "Reference Model for Open Systems Interconnection for CCITT Applications".

[4] CCITT Recommendation X.210 (1988): "Open Systems Interconnection (OSI) Layer Service Definition Conventions".

[5] ISO/IEC 9646-1 (1991) | CCITT Recommendation X.290 (1991): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 1: General concepts".

[6] ISO/IEC 9646-2 (1991) | CCITT Recommendation X.291 (1991): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 2: Abstract test suite specification".

3 Definitions

For the purposes of this ETS, the definitions given in CCITT Recommendations X.200 [3] and X.210 [4] apply, in addition, the following definitions apply:

message mode: A Service data Unit (SDU) is passed across the (sub)layer interface in exactly one Interface Data Unit (IDU) (see note).

streaming mode: A SDU is passed across the (sub)layer interface in one or more IDUs. The transfer of the IDUs across the sub(layer) may occur separated in time (see note).

pipelining: The sending peer entity initiates the data transfer to the receiving peer entity before the complete SDU is available (see note).

NOTE: The implementation of these concepts is not always externally visible.

Illustration of the data unit naming convention used in this ETS can be found in annex B.

4 Abbreviations

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

AAL	ATM Adaptation Layer
AALM	AAL Management
AL	Alignment
ATM	Asynchronous Transfer Mode
BASize	Buffer Allocation Size
BOM	Beginning Of Message
Btag	Beginning tag
CEP	Connection Endpoint identifier
COM	Continuation of Message
CP-AAL	Common Part of AAL type 3/4
CPCS	Common Part CS
CPI	Common Part Indicator
CRC	Cyclic Redundancy Check
CS	Convergence Sublayer
EOM	End of Message
Etag	End tag
IDU	Interface Data Unit
LI	Length Indicator
LSB	Least Significant Bit
MID	Multiplexing Identification
MM	Message Mode
MSB	Most Significant Bit
OAM	Operation And Maintenance
PAD	Padding
PDU	Protocol Data Unit
QOS	Quality of Service
SAP	Service Access Point
SAR	Segmentation And Reassembly sublayer
SDU	Service Data Unit
SLP	Submitted Loss Priority
SM	Streaming Mode
SN	Sequence Number
SSCS	Service Specific CS
SSM	Single Segment Message
ST	Segment Type

5 AAL type 3/4

5.1 Framework of AAL type 3/4

The Convergence Sublayer (CS) has been subdivided into the Common Part CS (CPCS) and the Service Specific CS (SSCS) as shown in figure 1. Further clarification can be found in annex C.

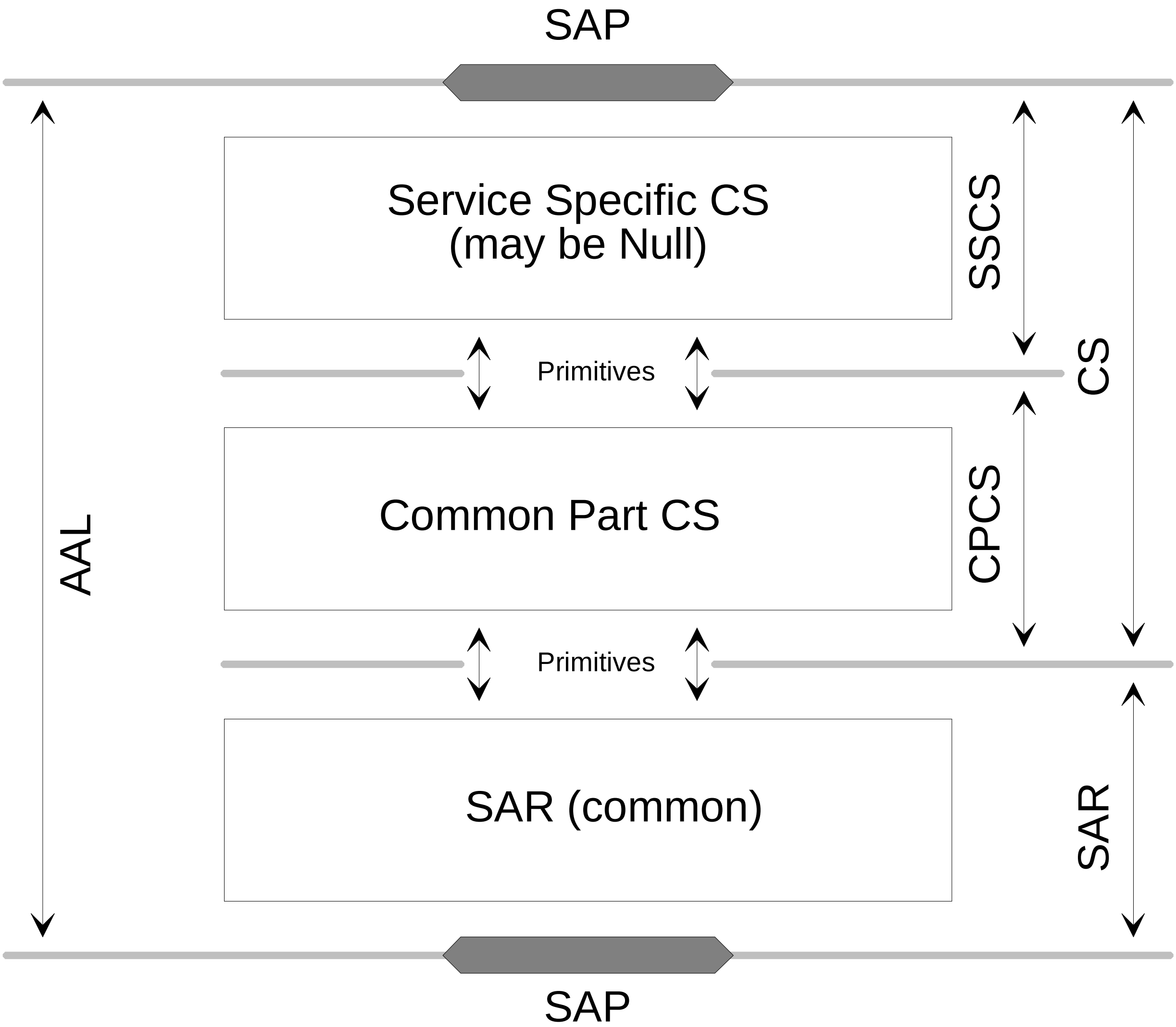


Figure 1: Structure of the AAL type 3/4

Different SSCS protocols, to support specific AAL type 3/4 user services, or groups of services, may be defined. The SSCS may also be null, in the sense that it only provides for the mapping of the equivalent primitives of the AAL type 3/4 user to CPCS and vice-versa.

The description contained in this ETS defines the functional behaviour of the AAL type 3/4 common part and does not preclude any implementation as long as the external behaviour of the implementation follows this ETS. The separation of the functionality between the SAR sublayer and CPCS is arbitrary and not visible to the outside. The allocation of function to the two sublayers was made for the sake of the ease of description.

5.2 Information flow across the ATM-AAL type 3/4 boundary

The AAL type 3/4 makes use of the ATM layer service as defined in ITU-T Recommendation I.361 [1].

5.3 Service provided by the AAL type 3/4

The AAL type 3/4 provides the capabilities to transfer the AAL-SDU from one AAL type 3/4 user to another AAL type 3/4 user through the ATM network. Two modes of service are defined, message mode and streaming mode:

a) message mode service: the AAL-SDU is passed across the AAL type 3/4 interface in exactly one AAL-IDU. This service provides the transport of fixed size or variable length AAL-SDUs:

1) in case of variable length AAL-SDUs, an internal AAL-SDU segmentation/reassembling function in the SSCS may be applied (e.g. an AAL-SDU exceeds the length limit imposed by the capability of the CPCS). In this case a single AAL-SDU is transferred in one or more SSCS-PDUs;

2) in case of short fixed size AAL-SDUs, an internal blocking/deblocking function in the SSCS may be applied; it provides the transport of one or more fixed size AAL-SDUs in one SSCS Protocol Data Unit (SSCS-PDU);

3) where the options a1) and a2) are not used, a single AAL-SDU is transferred in one SSCS-PDU. When the SSCS is null, the AAL-SDU is mapped to one CPCS-SDU;

b) streaming mode service: the AAL-SDU is passed across the AAL type 3/4 interface in one or more AAL-IDU. The transfer of these AAL-IDUs across the AAL type 3/4 interface may occur separated in time. This service provides the transport of variable length AAL-SDUs. The streaming mode service includes an abort service by which the discarding of an AAL-SDU partially transferred across the AAL type 3/4 interface can be requested:

1) an internal AAL-SDU segmentation/reassembling function in the SSCS may be applied. In this case all the AAL-IDUs belonging to a single AAL-SDU are transferred in one or more SSCS-PDU;

2) an internal pipelining function may be applied. It provides the means by which the sending AAL type 3/4 entity initiates the transfer to the receiving AAL type 3/4 entity before it has the complete AAL-SDU available;

3) where option b1) is not used, all the AAL-IDUs belonging to a single AAL-SDU are transferred in one SSCS-PDU. When the SSCS is null, the AAL-IDUs belonging to a single AAL-SDU are mapped to one CPCS-SDU.

Table 1: Combination of service mode and internal function

	AAL-SDU Message segmentation/reassembly in the SSCS	AAL-SDU blocking/deblocking in the SSCS	Pipelining
Message			
Option 1	O	N/A	N/A
Option 2	N/A	O	N/A
Streaming	O	N/A	O
Option 1: long variable size SDUs		O: Optional	
Option 2: short fixed size SDUs	N/A:	Not Applicable	

Table 2: Combination of service mode at the sending and receiving side

Receiver	Sender		
	MM/Block	MM/Seg	SM
MM/deblocking	A	N/A	N/A
MM/reassembly	N/A	A	A
SM	N/A	A	A
MM: Message Mode		A: Applicable	
SM: Streaming Mode		N/A: Not Applicable	

NOTE: An end-to-end specification of the SDU length in MM with blocking/deblocking is needed.

Both modes of service may offer the following peer-to-peer operational procedures:

- assured operations:
  every assured AAL-SDU is delivered with exactly the data content that the user sent. The assured service is provided by retransmission of missing or corrupted SSCS-PDUs. Flow control is provided as a mandatory feature. The assured operation may be restricted to point-to-point AAL type 3/4 connections;

- non-assured operations:
  integral AAL-SDUs may be lost or corrupted. Lost and corrupted AAL-SDUs will not be corrected by retransmission. An optional feature may be provided to allow corrupted AAL-SDUs to be delivered to the user (i.e. optional error discard). Flow control may be provided as an option.

5.3.1 Description of AAL type 3/4 connections

The AAL type 3/4 provides the capabilities to transfer the AAL-SDU from one AAL-SAP to one or more AAL-SAPs through the ATM network (see annex F). The AAL type 3/4 users will have the capability to select a given AAL-SAP associated with the Quality of Service (QOS) required, to transport that AAL-SDU (for example, delay and loss sensitive QOS).

AAL type 3/4 makes use of the service provided by the underlying ATM layer (see figure 2). Multiple AAL type 3/4 connections may be associated with a single ATM connection, allowing SAR-PDU multiplexing at the AAL type 3/4. The AAL type 3/4 user selects the QOS provided by the AAL type 3/4 through the choice of the AAL-SAP used for data transfer.

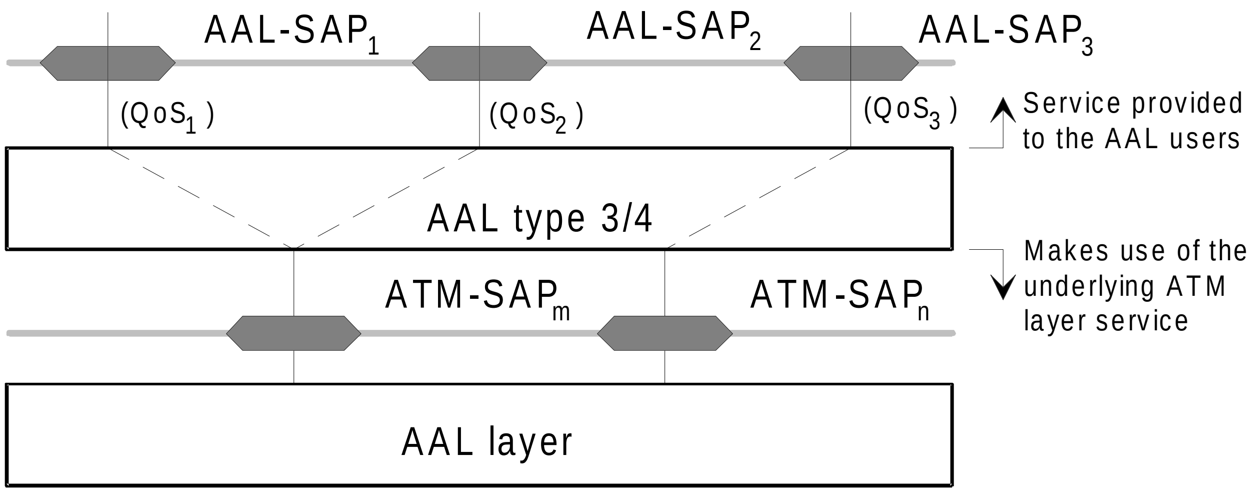


Figure 2: Relation between AAL-SAP and ATM-SAP

5.3.2 Primitives for the AAL type 3/4

These primitives depend on the SSCS protocol used; they are defined independently for each SSCS protocol.

If the SSCS is null, it only provides for the mapping of the equivalent primitives of the AAL type 3/4 to CPCS and vice-versa. In this case, the primitives for the AAL type 3/4 are equivalent to those for the CPCS (see subclause 6.1.1.1) but identified as AAL-UNITDATA-request, AAL-UNITDATA-indication, AAL-U-Abort-request, AAL-U-Abort-indication and AAL-P-Abort-indication, consistent with the primitive naming convention at a SAP.

6 The common part of the AAL type 3/4

6.1 Services provided by the common part of the AAL type 3/4

Two modes of service are defined: message and streaming:

a) message mode service: the CPCS-SDU is passed across the CPCS interface in exactly one CPCS-IDU. This service provides the transport of fixed size or variable length CPCS-SDUs. A single CPCS-SDU is transferred in one CPCS-PDU;

b) streaming mode service: the CPCS-SDU is passed across the CPCS interface in one or more CPCS-IDUs. The transfer of these CPCS-IDUs across the CPCS interface may occur separated in time. This service provides the transport of variable length CPCS-SDUs. The streaming mode service includes an abort service by which the discarding of a CPCS-SDU partially transferred across the CPCS interface can be requested.

   An internal pipelining function may be applied. It provides the means by which the sending CPCS entity initiates the transfer to the receiving CPCS entity before it has the complete CPCS-SDU available.

   All the CPCS-IDUs belonging to a single CPCS-SDU are transferred in one CPCS-PDU.

   NOTE: Figure B.2, a) and d) of annex B illustrate the message and streaming mode service.

The following peer-to-peer operational procedure is offered:

- non-assured operations:
  integral CPCS-SDUs may be lost or corrupted. Lost and corrupted CPCS-SDUs will not be corrected by retransmission. An optional feature may be provided to allow corrupted CPCS-SDUs to be delivered to the user (i.e. optional error discard).

6.1.1 Primitives

The functional model for AAL type 3/4 as contained in annex D shows the interrelation between the SAR, CPCS, and SSCS sublayers, and the SAR and CPCS primitives.

6.1.1.1 Primitives for the CPCS of the AAL type 3/4

As there exists no Service Access Point (SAP) between the sublayers of the AAL type 3/4, the primitives are called "invoke" and "signal" instead of the conventional "request" and "indication" to highlight the absence of the SAP.

CPCS connection establishment and release is performed via signalling or via management procedures. There is no provision for CPCS connection establishment and release support in the CPCS protocol.

CPCS and SAR connection establishment and release and the corresponding Multiplexing Identification (MID) allocation and deallocation can be done via signalling, management, or pre-arrangement. The CPCS connection and the corresponding SAR connection are established and released simultaneously. Annex G describes a way to establish and release CP-AAL connections, i.e. the combination of a SAR connection and the related CPCS connection via management.

6.1.1.1.1 Primitives for the data transfer service

- CPCS-UNITDATA-invoke and CPCS-UNITDATA-signal.

These primitives are used for the data transfer. The following parameters are defined:

Interface Data (ID)

This parameter specifies the IDU exchanged between the CPCS and the SSCS entity. The interface data is an integral multiple of one octet. When the corrupted data delivery option is used, the interface data may be empty. If the CPCS entity is operating in the message mode service, the interface data represents a complete CPCS-SDU; when operating in the streaming mode service, the interface data does not necessarily represent a complete CPCS-SDU.

More (M)

In the message mode service, this parameter is not used. In the streaming mode service, this parameter specifies whether the interface data communicated contains a beginning/continuation of a CPCS-SDU or the end of/complete CPCS-SDU.

Maximum Length (ML)

In the message mode service, this parameter is not used. In the streaming mode service, this parameter indicates the maximum length of the CPCS-SDU. This parameter is required with the first invoke or signal primitive related to a certain CPCS-SDU; in all other cases, this parameter is not used.

CPCS Submitted Loss Priority (CPCS-SLP)

This parameter indicates the requested loss priority for the associated CPCS-SDU. It can take only two values, one for high priority ("0") and the other for low priority ("1"). This parameter is required only with the first invoke primitive related to a certain CPCS-SDU.

Reception Status (RS)

This parameter indicates that the interface data delivered may be corrupted. This parameter is only utilized if the corrupted data delivery option is used.

Depending on the service mode (message or streaming mode service, discarding or delivery of errored information), not all parameters are required. This is summarized in table 3.

Table 3: Parameters of the CPCS-UNITDATA

Parameter	Type	MM	SM	Comments
Interface Data (ID)	invoke signal	m m	m m	whole or partial CPCS-SDU
More (M)	invoke signal	- -	m m	M = 0: end of CPCS-SDU M = 1: not end of CPCS-SDU
Maximum Length (ML)	invoke signal	- -	m* o*	Maximum length of CPCS-SDU
CPCS Submitted Loss Priority (CPCS-SLP)	invoke signal	m -	m* -	setting of the CLP bit in the ATM header
Reception Status (RS)	invoke signal	- o	- o	indication of corrupted data

MM: Message Mode service.
SM: Streaming Mode service.

m: mandatory.
o: optional.
-: not present.

m*: mandatory with the first invoke primitive related to a certain CPCS-SDU otherwise absent.

o*: optional with the first signal primitive related to a certain CPCS-SDU, otherwise absent.

6.1.1.1.2 Primitives for the abort service

These primitives are used in the streaming mode service:

a) CPCS-U-Abort-invoke and CPCS-U-Abort-signal.

   This primitive is used by the CPCS user to invoke the abort service. It is also used to signal to the CPCS user that a partially delivered CPCS-SDU is to be discarded by instruction from its peer entity. No parameters are defined.

   This primitive is not used in message mode;

b) CPCS-P-Abort-signal.

   This primitive is used by the CPCS entity to signal to its user that a partially delivered CPCS-SDU is to be discarded due to the occurrence of some error in the CPCS or below. No parameters are defined.

   This primitive is not used in message mode.

6.1.1.2 Service provided by the SAR sublayer

Two modes of service are defined, message and streaming:

a) message mode service: the SAR-SDU is passed across the SAR interface in exactly one SAR-IDU. This service provides the transport of fixed size or variable length SAR-SDUs. A single SAR-SDU is transferred in one or more SAR-PDU;

b) streaming mode service: the SAR-SDU is passed across the SAR interface in one or more SAR-IDUs. The transfer of these SAR-IDUs across the SAR interface may occur separated in time. This service provides the transport of variable length SAR-SDUs. The streaming mode service includes an abort service by which the discarding of an SAR-SDU partially transferred across the SAR interface can be requested.

   The SAR receiver always operates in streaming mode (i.e. each correctly received SAR-PDU is passed immediately to the CPCS sublayer, see subclause 6.4.1.3).

   An internal pipelining function is applied. It provides the means by which the sending SAR entity initiates the transfer to the receiving SAR entity before it has the complete SAR-SDU available.

   Figure B.2 d) of annex B illustrates the streaming mode service.

   NOTE: If the CPCS sender is operating in streaming mode, the SAR sender should also operate in streaming mode.

The following peer-to-peer operational procedure is offered:

- non-assured operations:
  integral SAR-SDUs may be lost or corrupted. Lost and corrupted SAR-SDUs will not be corrected by retransmission. An optional feature may be provided to allow corrupted SAR-SDUs to be delivered to the user (i.e. optional error discard).

6.1.1.3 Primitives for the SAR sublayer of the AAL type 3/4

These primitives model the exchange of information between the SAR sublayer and the CPCS.

As there exists no Service Access Point (SAP) between the sublayers of the AAL type 3/4, the primitives are called "invoke" and "signal" instead of the conventional "request" and "indication" to highlight the absence of the SAP.

SAR connection establishment and release is performed via signalling or via management procedures. There is no provision for SAR connection establishment and release support in the SAR protocol.

CPCS and SAR connection establishment and release and the corresponding MID allocation and deallocation can be done via signalling, management, or pre-arrangement. The CPCS connection and the corresponding SAR connection are established and released simultaneously. Annex G describes a way to establish and release CP-AAL connections, i.e. the combination of a SAR connection and the related CPCS connection via management.

6.1.1.3.1 Primitives for the data transfer service

- SAR-UNITDATA-invoke and SAR-UNITDATA-signal.

These primitives are used for the data transfer. The following parameters are defined:

Interface Data (ID)

This parameter specifies the IDU exchanged between the SAR and the CPCS entity. The interface data is an integral multiple of one octet. When the corrupted data delivery option is used, the interface data may be empty. The interface data does not necessarily represent a complete SAR-SDU;

More (M)

This parameter specifies whether the interface data communicated contains the end of the SAR-SDU.

If the More parameter is set to M = 1, the interface data parameter contains an integral multiple of 44 octets;

SAR Submitted Loss Priority (SAR-SLP)

This parameter passes the requested loss priority from the CPCS-SDU to the associated SAR-PDUs. It can take only two values, one for high priority ("0") and the other for low priority ("1").

Reception Status (RS)

This parameter indicates that the interface data delivered may be corrupted. This parameter is only utilized if the corrupted data delivery option is used.

The usage of the parameters is summarized in table 4.

Table 4: Parameters of the SAR-UNITDATA

Parameter	Type		Comments
Interface Data (ID)	invoke signal	m m	whole or partial SAR-SDU
More (M)	invoke (note) signal	m m	M = 0: end of SAR-SDU M = 1: not end of SAR-SDU
SAR Submitted Loss Priority (SAR-SLP)	invoke signal	m -	setting of the CLP bit in the ATM header
Reception Status (RS)	invoke signal	- o	indication of corrupted data
m: mandatory		o: optional	-: not present
NOTE: This parameter is always set to zero if the sender operates in message mode.			

6.1.1.3.2 Primitives for the abort service

a) SAR-U-Abort-invoke and SAR-U-Abort-signal.

The SAR-U-Abort-invoke primitive is used by the SAR user to invoke the abort service. The SAR-U-Abort-signal primitive is used by the SAR entity to signal to the SAR user that a partially delivered SAR-SDU is to be discarded by instruction from the peer SAR-user entity. The following parameter is defined:

SAR Submitted Loss Priority (SAR-SLP)

This parameter specifies, how the Submitted Loss Priority parameter in the ATM_UNITDATA.request primitive shall be set.

The usage of the parameter is summarized in table 5.

Table 5: Parameters of the SAR-U-Abort

Parameter	Type		Comments
SAR-Submitted Loss Priority (SAR-SLP)	invoke signal	m -	setting of the CLP bit in the ATM header
m: mandatory			-: not present

b) SAR-P-Abort-signal.

This primitive is used by the SAR entity to signal to its user that a partially delivered SAR-SDU is to be discarded due to the detection of some error. This primitive is only used if the corrupted data delivery option is not used. This primitive has no parameters.

6.2 Interaction with the management and control plane

Currently, no interactions with the management and control plane are standardized.

6.3 Functions, structure and coding of AAL type 3/4

6.3.1 Segmentation and Reassembly (SAR) sublayer

6.3.1.1 Functions of the SAR sublayer

The SAR sublayer functions are performed on an SAR-PDU basis. The SAR sublayer accepts variable length SAR-SDUs from the Convergence Sublayer (CS) and generates SAR-PDUs containing up to 44 octets of SAR-SDU data.

The SAR sublayer functions provide the means for the transfer of multiple variable length SAR-SDUs concurrently over a single ATM connection between AAL type 3/4 entities:

a) preservation of SAR-SDU.

This function preserves the SAR-SDU by providing for a segment type indication and a SAR-PDU payload fill indication. The SAR-PDU payload fill indication identifies the number of octets of SAR-SDU information contained within the SAR-PDU payload. The Segment Type indication identifies a SAR-PDU as a Beginning of Message (BOM), Continuation of Message (COM), End of Message (EOM), or Single Segment Message (SSM);

b) error detection and handling.

This function provides the means to detect and handle:

- bit errors in the SAR-PDU;
- lost or gained SAR-PDUs.

By default, SAR-PDUs with bit errors are discarded. A SAR receiver may provide the local option to deliver corrupted SAR-SDUs to the CPCS (i.e. optional error delivery). However, if the optional multiplexing and demultiplexing of SAR connections is performed, such an optional errored delivery service may deliver an errored SAR-SDU to the wrong state machine. SAR-SDUs with lost or gained SAR-PDUs are discarded or are optionally delivered to the CPCS. When delivering errored information, an appropriate indication is associated with the information. Even if the errored delivery service is used, SAR-SDUs may be lost without any notice;

c) SAR-SDU sequence integrity.

This function assures that the sequence of SAR-SDUs is maintained within one CPCS connection;

d) multiplexing/demultiplexing.

This function provides for the optional multiplexing and demultiplexing of multiple SAR connections. The number of SAR connections supported over an ATM connection is negotiated via signalling at ATM connection establishment or is prearranged (i.e. by manual management). The default number of SAR connections shall be one. Within a given SAR connection, sequence integrity is preserved;

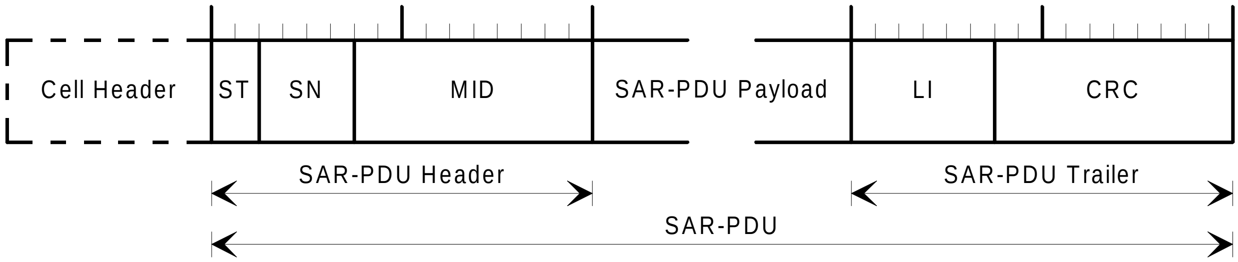
e) abort.

This function provides for the means to abort a partially transmitted SAR-SDU.

6.3.1.2 SAR-PDU structure and coding

The SAR-PDU structure and coding shall be as described in this subclause.

The SAR sublayer functions require a 2 octet SAR-PDU header and a 2 octet SAR-PDU trailer. The SAR-PDU header and trailer together with the 44 octets of SAR-PDU payload comprise the 48 octet ATM-SDU (cell payload). The sizes and positions of fields for the SAR-PDU structure are given in figure 3.



ST:	Segment Type	(2 bits)
SN:	Sequence Number	(4 bits)
MID:	Multiplexing Identification	(10 bits)
LI:	Length Indication	(6 bits)
CRC:	Cyclic Redundancy Check Code	(10 bits)

Figure 3: SAR-PDU Format for AAL type 3/4

The coding of the SAR-PDU conforms to the coding conventions specified in § 2.1 of ITU-T Recommendation I.361 [1]. There are two types of SAR-PDU:

- Data-SAR-PDUs; and
- Abort-SAR-PDUs.

6.3.1.2.1 Data-SAR-PDU coding

a) Segment Type (ST) field.

The ST indication identifies a SAR-PDU as containing a Beginning of Message (BOM), a Continuation of Message (COM), an End of Message (EOM), or a Single Segment Message (SSM). The association between the encoding and the meaning of the ST field is shown in table 6.

Table 6: Coding of the ST field

Segment Type	Encoding	Usage
BOM	10	Beginning of Message
COM	00	Continuation of Message
EOM	01	End of Message
SSM	11	Single Segment Message

b) Sequence Number (SN) field.

Four bits are allocated to the SN field allowing the stream of SAR-PDUs of a CPCS-PDU to be numbered modulo 16.

Each SAR-PDU belonging to a SAR-SDU (and hence associated with a given MID value) will have its SN incremented by one relative to the SN of the previous SAR-PDU. The receiver checks the sequence of the SN values of SAR-PDUs derived from one SAR-SDU and does not check the sequence of the SN values of the SAR-PDUs derived from successive SAR-SDUs. As the receiver does not check the SN continuity between SAR-SDUs, the sender may set the SN field to any value from 0 to 15 at the beginning of each SAR-SDU;

c) MID field.

This field is used for multiplexing. If no multiplexing is used, this field shall be set to zero.

NOTE: Any value may be used (including zero) if multiplexing is used.

In connection oriented applications it may be used to multiplex multiple SAR connections on a single ATM connection. The following restrictions apply:

- multiplexing/demultiplexing on a single ATM connection using the MID field will be on a user-to-user basis;

- a single ATM connection containing multiplexed AAL type 3/4 traffic will be administered as a single entity.

In connectionless and connection oriented applications all SAR-PDUs of a SAR-SDU will have the same MID field value. The MID field is used to identify SAR-PDUs belonging to a particular SAR-SDU. The MID field assists in the interleaving of SAR-PDUs from different SAR-SDUs and reassembly of these SAR-SDUs.

An implementation of AAL type 3/4 is not obliged to support the full range of MID field values. The range of MID field values can be restricted via signalling or prearrangement. Annex G describes one possible mechanism;

d) SAR-PDU payload field.

The SAR-SDU information is left justified within the SAR-PDU payload field. The remaining octets of the SAR-PDU payload field may be set to "0" and are ignored at the receiving end;

e) Length Indication (LI) field.

The Length Indication field is binary encoded with the number of octets of SAR-SDU information that are included in the SAR-PDU payload field. Permissible values of this field, depending on the coding of the ST field are shown in table 7. See also figure C.3.

Table 7: Permissible values of the length indication field

Segment Type	Permissible Value
BOM	44
COM	44
EOM	4 ... 44,63 (note)
SSM	8 ... 44
NOTE: The value "63" is used in the Abort-SAR-PDU (see subclause 6.3.1.2.2).	

f) CRC field.

The CRC field shall be a 10-bit sequence. It shall contain the remainder of the division (modulo 2) by the generator polynomial of the product of x^{10} and the content of the SAR-PDU (including the SAR-PDU header, SAR-PDU payload, and LI field of the SAR-PDU trailer). Each bit of the concatenated fields mentioned above is considered as a coefficient (modulo 2) of a polynomial of degree 373. The CRC-10 generator polynomial is:

$$G(x) = 1+ x+ x^4+ x^5+ x^9+ x^{10}$$

The result of the CRC calculation is placed with the least significant bit right justified in the CRC field. The CRC-10 is used to detect bit errors in the SAR-PDU.

6.3.1.2.2 Abort-SAR-PDU coding

The coding of the Abort-SAR-PDU conforms to the structure and coding specified above with the exception that:

a) the ST field shall be coded as EOM;

b) the payload field may be set to zero and is ignored at the receiving end;

c) the LI field shall be set to 63.

6.3.2 Convergence Sublayer (CS)

6.3.2.1 Functions, structure and coding for the CPCS

The CPCS has the following service characteristics:

- non-assured transfer of user data frames with any length measured in octets from 1 to 65 535 octets;

- one or more "CPCS connections" may be established between two CPCS peer entities (switching of CPCS connections is not supported). The maximum number of CPCS connections that can be established is defined by the end system with the lowest capacity;

- CPCS connection establishment by management or by the control plane;

- error detection and indication (cell loss or gain);

- CPCS-SDU sequence integrity on each CPCS connection.

The CPCS has the basic functionality to support a connectionless network layer (class D) as well as a frame relaying telecommunication service in class C. For the connectionless network access protocol layer (class D) there is no need for any service specific convergence sublayer.

6.3.2.1.1 Functions of the CPCS

The CPCS functions are performed per CPCS-PDU. The CPCS provides several functions in support of the CPCS service user. Some of the functions provided depend on whether the CPCS service user is operating in message or streaming mode:

1) message mode service: the CPCS-SDU is passed across the CPCS interface in exactly one CPCS-IDU. This service provides the transport of a single CPCS-SDU in one CPCS-PDU;

2) streaming mode service: the CPCS-SDU is passed across the CPCS interface in one or more CPCS-IDUs. The transfer of these CPCS-IDUs across the CPCS interface may occur separated in time. This service provides the transport of all the CPCS-IDUs belonging to a single CPCS-SDU into one CPCS-PDU. An internal pipelining function may be applied which provides the means by which the sending CPCS entity initiates the transfer to the receiving CPCS entity before it has the complete CPCS-PDU available. At the sending side, parts of the CPCS-PDU may have to be buffered in the CPCS entity if the restriction specified in subclause 6.1.1.3.1 (interface data being an integral number of 44 octets with the M parameter set to "1") cannot be satisfied.

   The streaming mode service includes an abort service by which the discarding of a CPCS-SDU partially transferred across the interface can be requested.

The functions implemented by the CPCS include:

a) preservation of CPCS-SDU.

This function provides for the delineation and transparency of CPCS-SDUs;

b) error detection and handling.

This function provides for the detection and handling of CPCS-PDU corruption. By default, corrupted CPCS-SDUs are discarded. A CPCS receiver may provide the local option to deliver corrupted CPCS-SDUs to the SSCS (i.e. optional error delivery). When delivering errored information to the CPCS user, an error indication is associated with the delivery. Even if the errored delivery service is used, CPCS-SDUs may be lost without notice.

Examples of detected errors would include: Btag/Etag mismatch, received length and CPCS-PDU length field mismatch, buffer overflow, improperly formatted CPCS-PDU, and errors indicated by the SAR sublayer;

c) buffer allocation size indication.

This function provides for the indication to the receiving peer entity of the maximum buffering requirements to receive the CPCS-PDU;

d) Abort.

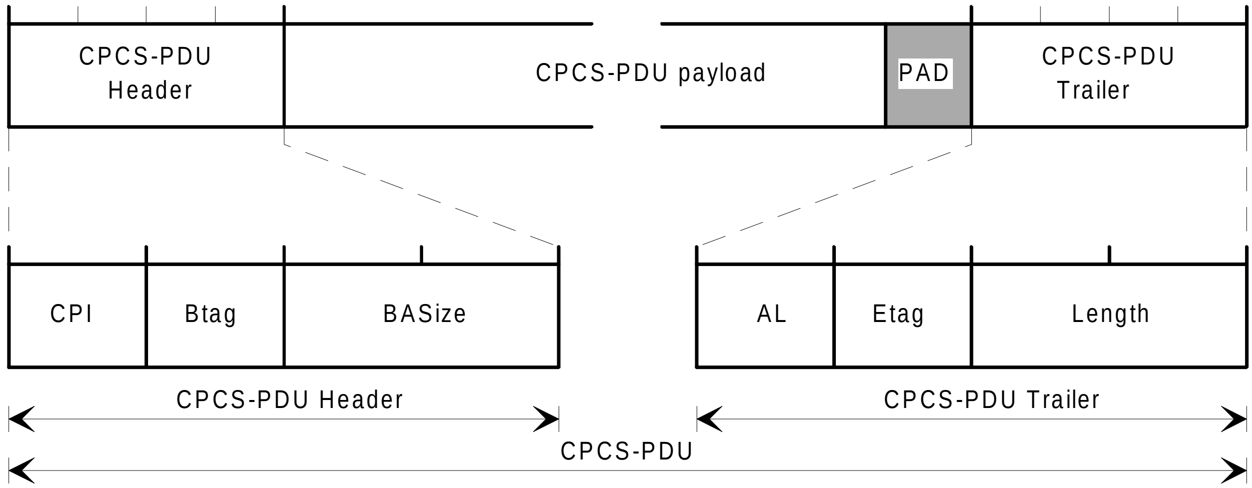
This function provides for the means to abort a partially transmitted CPCS-SDU.

6.3.2.1.2 CPCS-PDU structure and coding

The CPCS-PDU structure and coding shall be as described in this subclause.

The CPCS functions require a 4 octet CPCS-PDU header and a 4 octet CPCS-PDU trailer. In addition, a padding field provides for a 32 bit alignment of the CPCS-PDU payload. The CPCS-PDU header and trailer together with the padding field and the CPCS-PDU payload comprise the CPCS-PDU. The sizes and positions of fields for the CPCS-PDU structure are given in figure 4.

The coding of the CPCS-PDU conforms to the coding conventions specified in § 2.1 of ITU-T Recommendation I.361 [1].



CPI:	Common Part Indicator	(1 octet)
Btag:	Beginning Tag	(1 octet)
BASize:	Buffer Allocation Size	(2 octets)
PAD:	Padding	(0 .. 3 octets)
AL:	Alignment	(1 octet)
Etag:	End Tag	(1 octet)
Length:	Length of CPCS-PDU payload	(2 octets)

Figure 4: CPCS-PDU format for AAL type 3/4

a) Common Part Indicator (CPI) field.

The CPI field is used to interpret subsequent fields for the CPCS functions in the CPCS-PDU header and trailer. The default value CPI = "0" indicates that BASize and Length field values are counted in octets. The uses of the CPI field are restricted to the CPCS and SAR sublayer functions including the means to identify related AAL type 3/4 layer management messages. These messages in the future could be used to perform layer management functions which may include: performance and fault monitoring, MID allocation, and transfer of OAM messages;

b) Beginning Tag (Btag) field.

This field allows the association of the CPCS-PDU header and trailer. The sender inserts the same value in the Btag and the Etag in the trailer for a given CPCS-PDU and changes the value for each successive CPCS-PDU. The receiver checks the value of the Btag in the CPCS header with the value of the Etag in the CPCS trailer. It does not check the sequence of the Btag/Etags in successive CPCS-PDUs.

As an example, a suitable mechanism is as follows: The sender increments the value placed in the Btag and Etag fields for each successive CPCS-PDU sent over a given MID value. Btag values are cycled up to modulo 256;

c) Buffer Allocation Size indication (BASize) field.

The BASize field indicates to the receiving peer entity the maximum buffering requirements to receive the CPCS-SDU. In message mode, the BASize value is encoded equal to the CPCS-PDU payload length. In streaming mode, the BASize value is encoded equal to or greater than the CPCS-PDU payload length.

The buffer allocation size is binary encoded as number of counting units. The size of the counting units is identified by the CPI field;

NOTE: The length of the CPCS-PDU payload is limited to the maximum value of the BASize field multiplied by the value of the counting unit.

d) Padding (PAD) field.

Between the end of the CPCS-PDU payload and the 32 bit aligned CPCS-PDU trailer, there will be from 0 to 3 unused octets. These unused octets are called the PAD field; they are strictly used as filler octets and do not convey any information. The PAD field may be set to "0" and its value is ignored at the receiving end. This PAD field complements the CPCS-PDU payload to an integral multiple of 4 octets.

The function of the PAD field is shown in figure 5;

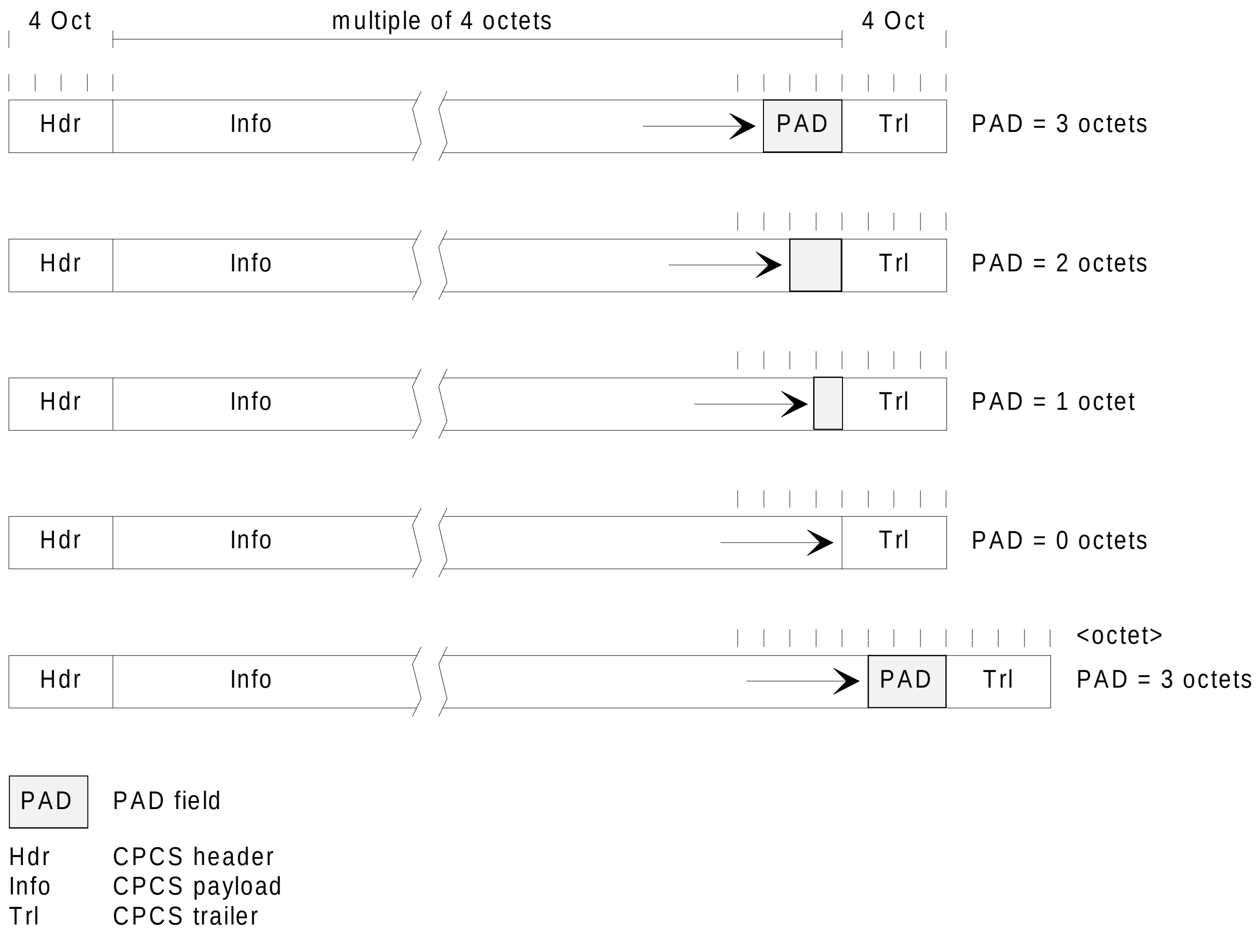


Figure 5: Function of the PAD field

e) Alignment (AL) field.

The function of the AL field is to achieve 32-bit alignment in the CPCS-PDU trailer. The AL field complements the CPCS-PDU trailer to 32 bits. This unused octet is strictly used as a filler octet and does not convey any information.

The AL field shall be set to zero.

f) End Tag (Etag) field.

For a given CPCS-PDU, the sender shall insert the same value in this field as was inserted in the Btag field in the CPCS-PDU header to allow the association of the CPCS-PDU trailer with its CPCS-PDU header;

g) Length field.

The Length field is used to encode the length of the CPCS-PDU payload field. This field is also used by the receiver to detect the loss or gain of information.

The length is binary encoded as number of counting units. The size of the counting units is identified by the CPI field.

NOTE: The length of the CPCS-PDU payload is limited to the maximum value of the Length field multiplied by the value of the counting unit.

6.4 Procedures

There exists one segmentation and one reassembly state machine per MID field value. For each such state machine, the value of this field needs to be known by the protocol state machines.

Any implementation shall produce the same externally visible results as the procedures described below.

No procedures describing the delivery of errored information are standardized.

6.4.1 Procedures of the SAR sublayer

The structure and coding of the SAR-PDU is defined in subclause 6.3.1.2.

6.4.1.1 State variables of the SAR sublayer at the sender side

The SAR sender maintains the following state variable:

- snd_SN.

  This variable is used to set the SN field of the SAR-PDU header. It is incremented modulo 16 after each SAR-PDU of a SAR-SDU has been forwarded to the ATM layer for transmission.

6.4.1.2 Procedures of the SAR sublayer at the sender side

The state machine of the SAR sender is shown in figure 6.

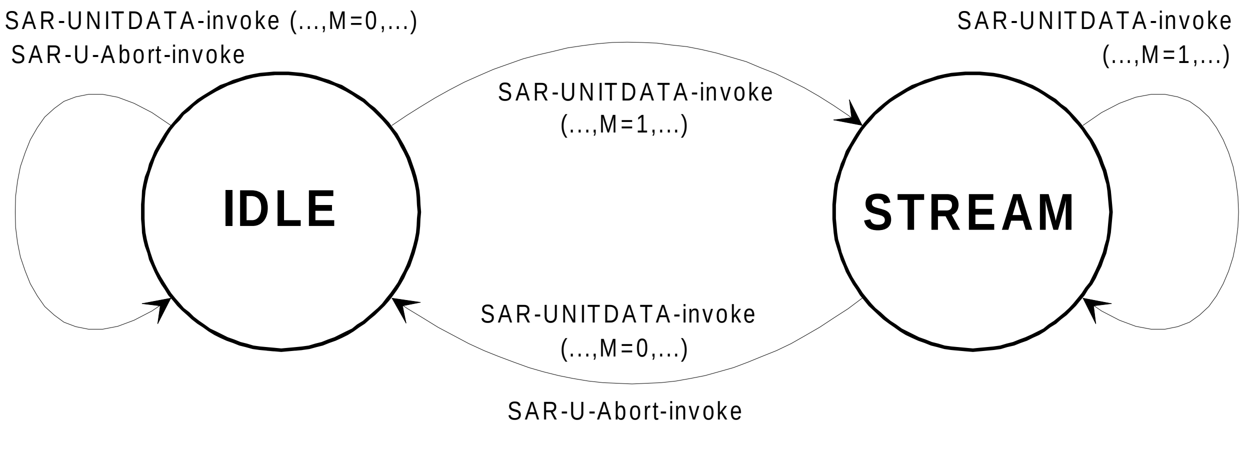


Figure 6: State transition diagram for the SAR sender

Table 8 defines the states for the SAR sender.

Table 8: State definitions for the SAR sender

State	Definition
IDLE	Waiting to begin to transmit a new SAR-SDU
STREAM	Transmitting a SAR-SDU in streaming mode

NOTE: This description of the SAR sender procedures is valid for all service modes of the CPCS. If the CPCS passes only complete CPCS-PDUs to the SAR sublayer, the state machine remains always in the IDLE state.

1) When the CPCS connection is established, the SAR sender shall proceed to the IDLE state. Whenever entering the IDLE state, the SAR sender may change its state variable snd_SN to any value from 0 to 15.

2) For each SAR-PDU, the SAR sender shall set the MID field to the value governing this state machine. The SN field is set to the value of the state variable snd_SN and the state variable snd_SN is incremented by one (modulo 16).

3) Upon receiving a SAR-UNITDATA-invoke primitive from the CPCS, the SAR sender shall start the segmenting process. If the interface data has a length of more than 44 octets, the SAR sender will generate more than one SAR-PDU. In all SAR-PDUs (except possibly the last one), the SAR-PDU payload field shall be filled with 44 octets of CPCS-PDU information.

4) In each SAR-PDU, the LI field shall be set to the number of octets of SAR-SDU data carried in the payload and the CRC field shall be computed as specified in subclause 6.3.1.2.1.

5) If the SAR sender is in the IDLE state, it shall set the most significant bit of the ST field in the first SAR-PDU to "1" ("BOM" or "SSM"); in all subsequent SAR-PDUs, this bit shall be set to "0" ("COM" or "EOM"). If the SAR sender is in the STREAM state, the most significant bit of the ST field of all SAR-PDUs shall be set to "0".

6) If the M parameter in the SAR-UNITDATA-invoke primitive has the value "0", the SAR sender shall set the least significant bit of the ST field in the last SAR-PDU to "1" ("EOM" or "SSM"); in all other cases, this bit shall be set to "0" ("BOM" or "COM").

7) Upon completion of the segmenting process, the SAR sender shall proceed either to the IDLE state or the STREAM state. If the M parameter in the SAR-UNITDATA-invoke primitive has the value "0", the SAR sender shall proceed to the IDLE state; otherwise, it shall proceed to the STREAM state.

8) The SAR sender shall ignore a SAR-U-Abort-invoke primitive when it is in the IDLE state. When in the STREAM state, the SAR sender shall generate and transmit an Abort-SAR-PDU and proceed to the IDLE state.

9) Each SAR-PDU is handed to the ATM layer with the AUU parameter set to "0". The Submitted Loss Priority is set to the value of the SAR-SLP parameter of the SAR-UNITDATA-invoke primitive.

6.4.1.3 State variables of the SAR sublayer at the receiver side

The SAR receiver maintains the following state variable:

- rcv_SN.

  This variable is used to detect loss or gain of SAR-PDUs. After the receipt of a SAR-PDU with an ST field that indicates "COM" or "EOM", the SAR receiver compares the value in the SN field with this state variable. If they are equal, the SAR-PDU is assumed to be in sequence and the rcv_SN is incremented by one modulo 16.

  If the ST field of a SAR-PDU indicates "BOM" or "SSM", the SN field is not compared with rcv_SN; however, the state variable rcv_SN is set to one greater (modulo 16) than the value in the SN field.

6.4.1.4 Procedures of the SAR sublayer at the receiver side

The state machine of the SAR receiver is shown in figure 7.

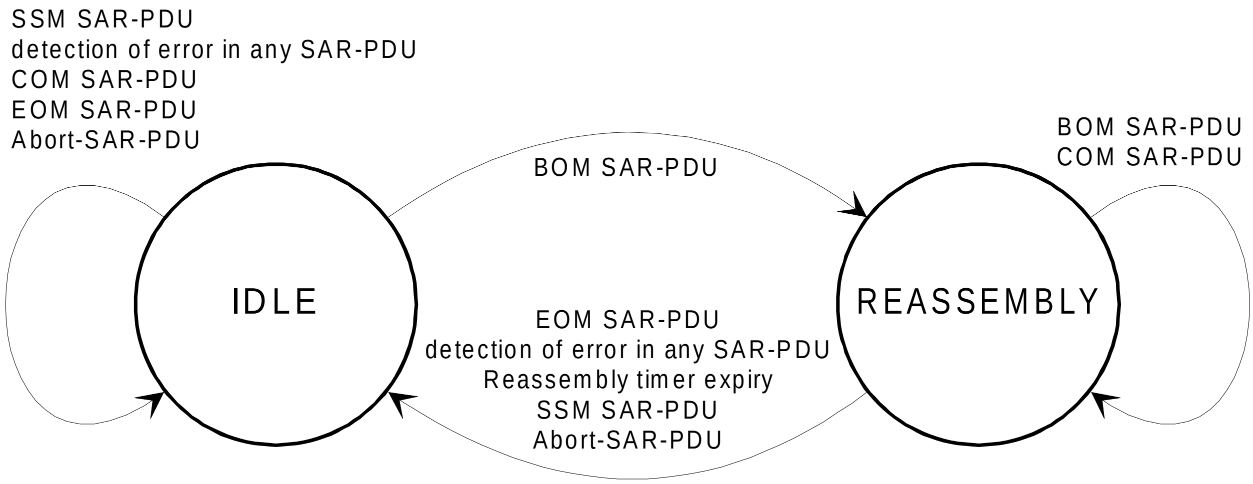


Figure 7: State transition diagram for the SAR receiver

Table 9 defines the states for the SAR receiver.

Table 9: State definitions for the SAR receiver

State	Definition
IDLE	Waiting to begin to receive a new SAR-SDU
REASSEMBLY	Receiving a SAR-SDU

The SAR receiver ignores the value of the AUU parameter of the ATM-DATA-indication primitive.

The following procedures are specified for a SAR receiver that does not deliver errored data to the receiving CPCS.

NOTE 1: The term "delivery to the CPCS" refers to the communication across the SAR-CPCS sublayer boundary via a SAR-UNITDATA-signal primitive.

a) All illegal SAR-PDUs are ignored. An illegal SAR-PDU is a SAR-PDU with:

   - a CRC verification error; or

   - an unexpected MID field value.

   NOTE 2: The discarding of illegal SAR-PDUs actually takes place prior to assigning the SAR-PDU to a reassembly process governed by a particular MID field value.

b) For every SAR-PDU received, the SAR receiver verifies that the value of the LI field is permissible given the coding of the ST field (see table 7). If the value is outside the allowed range, the SAR-PDU is discarded. If the SAR receiver is in the REASS state, it shall issue a SAR-P-Abort-signal primitive to the receiving CPCS. In all cases, it shall proceed to the IDLE state.

c) In the absence of errors and irrespective of the state in which the SAR receiver is, the number of octets indicated in the LI field are sent from the SAR-PDU payload to the CPCS. If the ST field indicates "EOM" or "SSM", the M parameter is set to "0" and the SAR receiver proceeds to the IDLE state; otherwise, i.e. the ST field indicates "BOM" or "COM", the M parameter is set to "1" and the SAR receiver proceeds to or remains in the REASS state.

The following error conditions and recovery procedures apply.

d) If the SAR receiver is in the IDLE state and receives a SAR-PDU whose ST field indicates "COM" or "EOM", the SAR receiver shall ignore the SAR-PDU.

e) If the SAR receiver is in the REASS state and receives a SAR-PDU whose ST field indicates "BOM" or "SSM", the SAR receiver shall issue a SAR-P-Abort-signal to the receiving CPCS; the SAR-PDU shall be processed normally as described in item c) above.

f) If the SAR receiver is in the REASS state and it receives a SAR-PDU whose value in the SN field is not the same as the value of the state variable rcv_SN, it shall issue a SAR-P-Abort-signal to the receiving CPCS, in addition, if the ST field indicates "COM" or "EOM", the SAR-PDU is discarded and the SAR receiver shall proceed to the IDLE state; otherwise, the SAR-PDU shall be processed normally as described in item c) above.

g) If the SAR receiver receives an Abort-SAR-PDU and is in the IDLE state, this SAR-PDU shall be ignored; if in the REASS state, the SAR receiver shall issue a SAR-U-Abort-signal primitive and proceed to the IDLE state.

A SAR receiver may optionally implement a reassembly timer.

If a reassembly timer is supported, the following procedures apply.

NOTE 3: The initialization value of a reassembly timer is not indicated to the corresponding SAR sender(s). Neither an initialization value for the reassembly timer nor a formula to determine it from, e.g., ATM connection characteristics and/or AAL type 3/4 user requirements is standardized.

h) When after the processing of a SAR-PDU the SAR receiver reaches the REASS state, the reassembly timer shall be (re-)started.

i) If the timer is still running when the SAR receiver transitions from the REASS state to the IDLE state, the timer shall be stopped.

j) If the timer expires (the SAR receiver is in the REASS state) the SAR receiver shall issue a SAR-P-Abort-signal to the receiving CPCS and shall proceed to the IDLE state.

6.4.2 Procedures of the CPCS for the message mode service

No procedures for the CPCS operating in streaming mode are standardized.

The structure and coding of the CPCS-PDU is defined in subclause 6.3.2.1.

6.4.2.1 State variables of the CPCS at the sender side

The CPCS sender maintains the following state variable:

- snd_BEtag.

  This variable is used to set the Btag field in the CPCS-PDU header and the Etag field in the CPCS-PDU trailer.

6.4.2.2 Procedures of the CPCS at the sender side for the message mode service

The state machine of the CPCS sender is shown in figure 8.

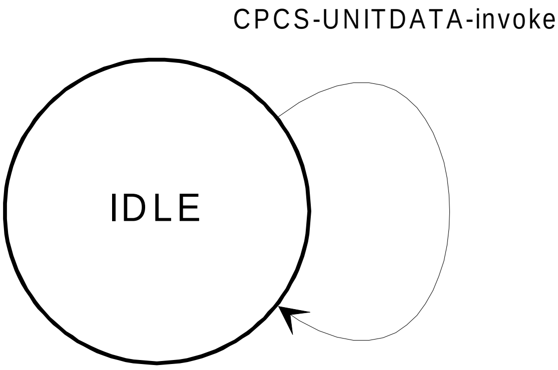


Figure 8: State transition diagram for the CPCS sender

Table 10 defines the states for the CPCS sender.

Table 10: State definitions for the CPCS sender

State	Definition
IDLE	Waiting to transmit a new CPCS-SDU

a) When the CPCS connection is established, the CPCS sender shall set its state variable snd_BEtag to any value from 0 to 255.

b) Upon receiving a CPCS-UNITDATA-invoke from the CPCS user, the CPCS sender shall construct the CPCS-PDU header, place the received CPCS-SDU into the CPCS-PDU payload, construct the PAD field and construct the CPCS-PDU trailer. The CPCS-PDU is then forwarded in its entirety (i.e. the M parameter is set to "0") to the SAR sublayer via the SAR-UNITDATA-invoke primitive for segmentation and transmission. The SAR-SLP parameter is set to the value of the CPCS-SLP parameter of the CPCS-UNITDATA-invoke primitive.

c) After forwarding the CPCS-PDU to the SAR sublayer, the CPCS sender shall modify its state variable snd_BEtag. This modification shall assure that the CPCS receiver can unambiguously associate the CPCS-PDU header and trailer of every CPCS-PDU even in the presence of loss of information (cell losses across CPCS-PDU boundaries). As the minimum, the snd_BEtag shall be set to any value different from the current one (modulo 256).

   A suitable mechanism is to increment the state variable snd_BEtag by one (modulo 256) after each CPCS-PDU.

6.4.2.3 State variables of the CPCS at the receiver side

The CPCS receiver maintains the following state variables:

a) rcv_BEtag.

   This variable is used to check if a received CPCS-PDU trailer belongs to the CPCS-PDU currently being reassembled. This is achieved by copying the Btag field value to this state variable when processing the CPCS-PDU header; when processing the associated CPCS-PDU trailer, the value in the Etag field is compared to the value in the state variable.

b) rcv_BASize.

   This variable is used to assure that attempts to assemble CPCS-PDUs that are longer than the requested BASize will fail.

6.4.2.4 Procedures of the CPCS at the receiver side

The state machine of the CPCS receiver is shown in figure 9.

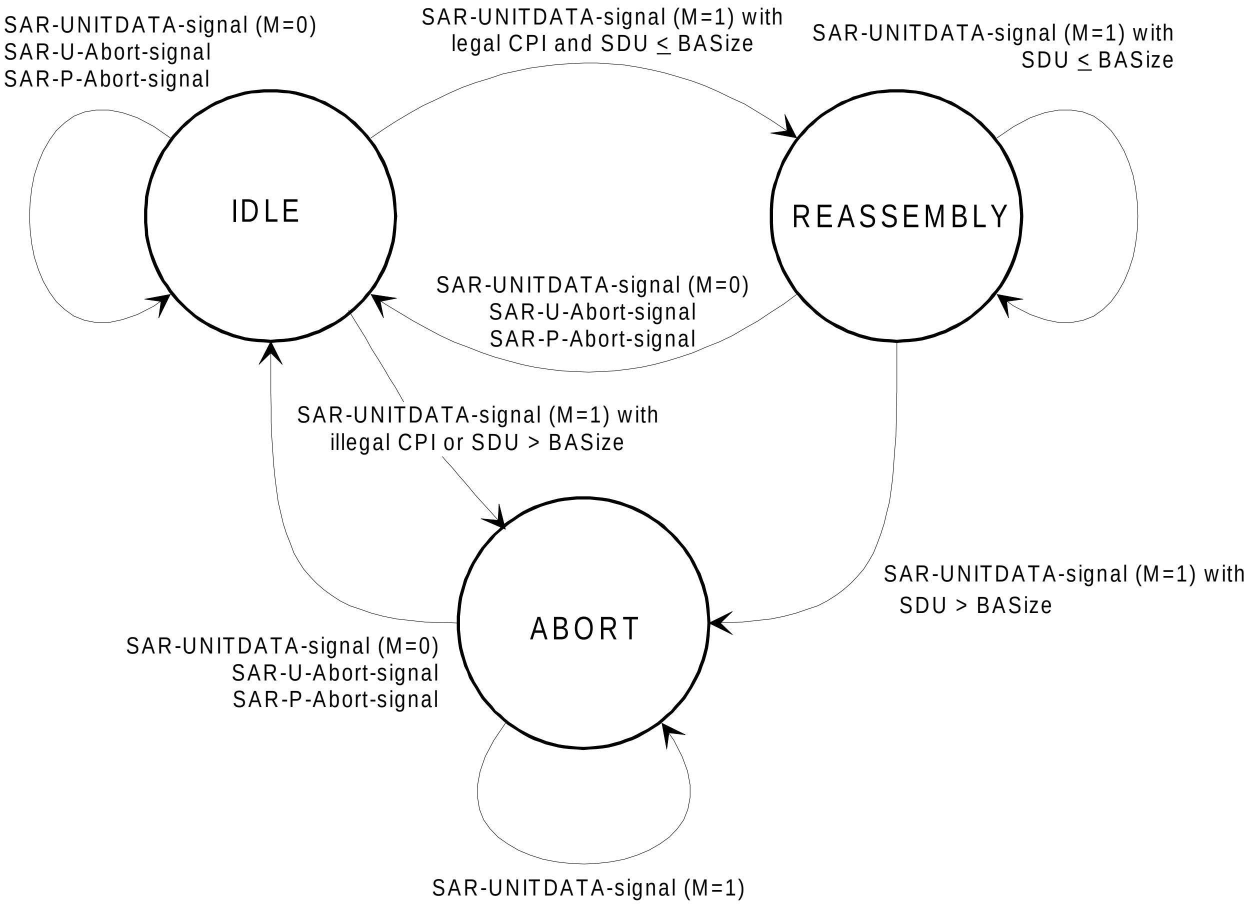


Figure 9: State transition diagram for the CPCS receiver

Table 11 defines the states for the CPCS receiver.

Table 11: State definition for the CPCS receiver

State	Definition
IDLE	Waiting to begin to reassemble a new CPCS-PDU
REASSEMBLY	Reassembling a CPCS-PDU
ABORT	Aborting an illegal CPCS-PDU

The following procedures are specified for a CPCS receiver that does not deliver errored data to the receiving CPCS user.

a) When the CPCS receiver is in the IDLE state and it receives a SAR-UNITDATA-signal primitive from the SAR sublayer, the first four octets of the information represent the CPCS-PDU header.

   If the CPI field in the CPCS-PDU header is illegal, the CPCS receiver shall proceed to the ABORT state if the M parameter is set to "1" or to the IDLE state if the M parameter is set to "0". Otherwise, the CPCS receiver shall copy the value of the Btag field into the rcv_BEtag state variable. It also shall set the state variable rcv_BASize to the value of the BASize field. The allocation of a reassembly buffer with at least the size indicated in the state variable rcv_BASize is implementation dependent.

   NOTE 1: This procedure description may copy the PAD field (which can be up to three octets) into the reassembly buffer before processing the CPCS-PDU trailer.

NOTE 2: When the CPCS receiver is in the REASS state and it receives a SAR-UNITDATA-signal primitive from the SAR sublayer, no CPCS-PDU header information is present.

b) When the CPCS receiver is in the IDLE state or the REASS state and it receives a SAR-UNITDATA-signal primitive from the SAR sublayer with the M parameter set to "0", the last 4 octets of the information represent the CPCS-PDU trailer. If the AL field in the CPCS-PDU trailer is not equal to zero, the CPCS receiver shall free the reassembly buffer and proceed to or remain in the IDLE state.

The CPCS receiver shall verify that the value of the Etag field is equal to the value in the rcv_BEtag state variable. If they are not equal, the CPCS receiver shall free the reassembly buffer and proceed to or remain in the IDLE state.
If the value of the Length field in the CPCS-PDU trailer is "0", the CPCS receiver shall free the reassembly buffer and proceed to or remain in the IDLE state.

If the value of the Length field in the CPCS-PDU trailer is greater than the already reassembled information in the reassembly buffer plus the information in the interface data of the primitive currently processed (without the CPCS-PDU trailer and possibly the CPCS-PDU header), the CPCS receiver shall free the reassembly buffer and proceed to or remain in the IDLE state.

If the value of the Length field in the CPCS-PDU trailer is less than the already reassembled information in the reassembly buffer plus the information in the interface data of the primitive currently processed (without the CPCS-PDU trailer and possibly the CPCS-PDU header) minus the maximum PAD field length (3), the CPCS receiver shall free the reassembly buffer and proceed to or remain in the IDLE state.

If the already reassembled information in the reassembly buffer plus the information in the interface data of the primitive currently processed (without the CPCS-PDU trailer and possibly the CPCS-PDU header) is greater than the state variable rcv_BASize plus the maximum PAD field length (3), the CPCS receiver shall free the reassembly buffer and proceed to or remain in the IDLE state.

If none of these error conditions applies, then the CPCS receiver shall copy the information in the interface data of the primitive currently processed (without the CPCS-PDU trailer and possibly the CPCS-PDU header) to the reassembly buffer. The CPCS receiver shall then send the reassembled CPCS-SDU to the CPCS user in the interface data of a CPCS-UNITDATA-indication primitive; the amount of information in the interface data is equal to the value of the Length field of the CPCS-PDU trailer. It shall also free the reassembly buffer, and proceed to or remain in the IDLE state.

c) When the CPCS receiver is in the IDLE state or the REASS state and it receives a SAR-UNITDATA-signal primitive from the SAR sublayer with the M parameter set to "1", no CPCS-PDU trailer is present.

If the already reassembled information in the reassembly buffer plus the information in the interface data of the primitive currently processed (without possibly the CPCS-PDU header) is greater than the state variable rcv_BASize plus the maximum PAD field length (3), the CPCS receiver shall free the reassembly buffer and proceed to the ABORT state. Otherwise, the CPCS receiver shall copy the information in the interface data of the primitive currently processed (without possibly the CPCS-PDU header) to the reassembly buffer and proceed to or remain in the REASS state.

d) If the CPCS receiver receives a SAR-U-Abort-signal or a SAR-P-Abort-signal primitive from the SAR sublayer while in the IDLE state, the primitive shall be ignored; when in the REASS state, the CPCS receiver shall free the reassembly buffer and proceed to the IDLE state.

e) If the CPCS receiver is in the ABORT state and it receives a SAR-UNITDATA-signal primitive with the M parameter set to "1", the primitive shall be ignored and the CPCS receiver shall remain in the ABORT state.

However, if in the ABORT state the CPCS receiver receives a SAR-U-Abort or SAR-P-Abort-signal primitive or a SAR-UNITDATA-signal primitive with the M parameter set to "0", the CPCS receiver shall proceed to the IDLE state.

Annex A (normative): Protocol Implementation Conformance Statement (PICS)

A.1 Introduction

To evaluate conformance of a particular implementation, it is necessary to have a statement of which capabilities and options have been implemented for a given OSI protocol. Such a statement is called a Protocol Implementation Conformance Statement (PICS).

A.2 Scope of this annex

Clause A.5 provides the PICS proforma for the SAR and CPCS protocol of AAL type 3/4 as specified in the main body of this ETS in compliance with the relevant requirements, and in accordance with the relevant guidance, given in ISO/IEC 9646-2 [6]. It is limited to the requirements resulting from the only completely defined protocol subset where the CPCS-PDU Common Part Indicator has the value "0".

A.3 Definitions

This annex uses the following terms defined in ISO/IEC 9646-1 [5]:

- PICS proforma;

- Protocol Implementation Conformance Statement (PICS).

A.4 Purpose

The supplier of a protocol implementation which is claimed to conform to the protocol subset identified in the scope is required to complete a copy of the PICS proforma provided in Clause A.5 of this annex and is required to provide the information necessary to identify both the supplier and the implementation.

A.5 PICS proforma

A.5.1 Identification of the implementation

a) Identification.

   1) implementation identification:

   2) system identification:

      - hardware:

      - software:

b) Supplier identification and/or test laboratory client identification:

c) Contact person for the PICS:

d) Date and place of statement:

e) Relationship between the PICS and the System Conformance Statement for the system:

NOTE: The information requested above is required for a complete PICS.

A.5.2 Identification of the protocol

This PICS proforma may be applied to the SAR and CPCS protocol as specified in this ETS.

A.5.3 Global statement of conformance

"Are all mandatory capabilities implemented? Yes/No"

NOTE: Answering "No" to this question indicates non-conformance to the protocol specification. Non-supported mandatory capabilities are to be identified in the PICS, with an explanation of why the implementation is non-conforming.

A.5.4 Capabilities

A.5.4.1 Initiator/responder capability

Not applicable. The establishment of the communication is out of scope of this PICS.

A.5.4.2 Major capabilities

Major capabilities implemented				
Item No.	**Major capability**	**Ref.**	**Status**	**Support**
0	CPCS-SDU transmission	6.1	o.1	
1	CPCS-SDU receipt	6.1	o.1	

o.1: At least one of these capabilities shall be implemented.

A.5.4.2.1 Transmission capabilities

The transmission capabilities apply IF (A.5.4.2/0).

Transmission capabilities implemented				
Item No.	**Capability**	**Ref.**	**Status**	**Support**
0	CPCS-SDU transmission/SAR-SDU transmission	6.3.2.1/ 6.3.1.1	m	
1	CPCS-SDU delineation and transparency preservation/ SAR-SDU delineation and transparency preservation	6.3.2.1.1 a)/ 6.3.1.1 a)	m	
2	CPCS-SDU transmission sequence preservation/ SAR-SDU transmission sequence preservation	6.3.2.1/ 6.3.1.1 c)	m	
3	CPCS-SDU bit error and information loss or gain protection	6.3.2.1.1 b)/ 6.3.1.1 b)	m	
4	CPCS-SDU streaming/ CPCS-SDU pipelining/ CPCS Abort/ SAR-SDU streaming/ SAR-SDU pipelining/ SAR Abort	6.3.2.1.1/ 6.1 b)/ 6.3.2.1.1 d)/ 6.1.1.2 b)/ 6.1.1.2 b)/ 6.3.1.1 e)	o	
5	CPCS connection multiplexing/ SAR connection multiplexing	6.3.2.1/ 6.3.1.1 d)	o	

A.5.4.2.1.1 Protocol parameters for transmission

Protocol parameters implemented						
Item No.	Timer/ Protocol Parameter	Ref.	Status	Support	Values	
					allowed	supported
0	max. CPCS-SDU length	6.3.2.1	m		o: ∈[1..65535]	
1	max. no. of concurrent CPCS connections/ SAR connections per ATM connection	6.3.2.1	m		c11	
2	range of MID values supported	6.3.1.2.1 c)	m		c12	

NOTE: "[]" denotes the interval between and including the values in the brackets.

o1: Exactly one non-empty range including at least A.5.4.2.1.1/1b values shall be established per ATM connection via signalling or prearrangement.

c11: IF (A.5.4.2.1/5) THEN o: ∈[2..1024] ELSE m: 1.

c12: IF (A.5.4.2.1/5) THEN o1: ⊆ [0..1023] ELSE m: [0..0].

A.5.4.2.1.2 PDUs for transmission

PDUs implemented				
Item No.	PDU Type	Ref.	Status	Support
0	CPCS-PDU	6.3.2.1.2	m	
1	BOM Data SAR-PDU	6.3.1.2.1	m	
2	COM Data SAR-PDU	6.3.1.2.1	m	
3	EOM Data SAR-PDU	6.3.1.2.1	m	
4	SSM Data SAR-PDU	6.3.1.2.1	m	
5	Abort SAR-PDU	6.3.1.2.2	c1	

c1: IF (A.5.4.2.1/4) THEN m.

A.5.4.2.1.2.1 CPCS-PDU parameters for transmission

Implemented parameters of CPCS-PDUs								
Item	Parameter	Ref.	Status	Support	Values			
No.	**Type**				**Length**		**Range**	
					allowed	**supported**	**allowed**	**supported**
0	Common Part Indicator	6.3.2.1 a)	m		m: 1 octet		m: 0	
1	Beginning Tag	6.3.2.1 b)	m		m: 1 octet		c1: ⊆ [0..255]	
2	Buffer Allocation Size Indication	6.3.2.1 c)	m		m: 2 octets		m: 1..A.5.4.2.1.1/0b	
3	CPCS-PDU Payload	6.3.2.1	m		m: 1..A.5.4.2.1.1/0b octets		m: all possible values	
4	Padding	6.3.2.1 d)	m		m: 0..3 octets		o.2: ⊆ [all possible values]	
5	Alignment	6.3.2.1 e)	m		m: 1 octet		m: 0	
6	End Tag	6.3.2.1 f)	m		m: 1 octet		c1: ⊆ [0..255]	
7	Length	6.3.2.1 g)	m		m: 2 octets		m: 1..A.5.4.2.1.1/0b	

NOTE: "[]" denotes the interval between and including the values in the brackets.

c1: The intersection of these two sets shall contain at least 2 elements.

o.2: Any non-empty subset may be selected.

A.5.4.2.1.2.2 BOM Data SAR-PDU parameters for transmission

Implemented transmission parameters of BOM Data SAR-PDUs								
Item No.	**Parameter Type**	**Ref.**	**Status**	**Support**	**Length**		**Value**	
					allowed	**supported**	**allowed**	**supported**
0	Segment type	6.3.1.2.1 a)	m		m: 2 bits		m: $10_{(2)}$	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: $0..1111_{(2)}$	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.1.1/2b	
3	SAR user data	6.3.1.2.1 d)	m		m: 44 octets		m: all possible values	
4	Length indication	6.3.1.2.1 e)	m		m: 6 bits		m: 44	
5	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

A.5.4.2.1.2.3 COM Data SAR-PDU parameters for transmission

Implemented transmission parameters of COM Data SAR-PDUs								
Item No.	Parameter Type	Ref.	Status	Support	Length		Value	
					allowed	supported	allowed	supported
0	Segment type	6.3.1.2.1 a)	m		m: 2 bits		m: $00_{(2)}$	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: 0..$1111_{(2)}$	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.1.1/2 b	
3	SAR user data	6.3.1.2.1 d)	m		m: 44 octets		m: all possible values	
4	Length indication	6.3.1.2.1 e)	m		m: 6 bits		m: 44	
5	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

A.5.4.2.1.2.4 EOM Data SAR-PDU parameters for transmission

Implemented transmission parameters of EOM Data SAR-PDUs								
Item No.	**Parameter Type**	**Ref.**	**Status**	**Support**	**Length**		**Value**	
					allowed	**supported**	**allowed**	**supported**
0	Segment type	6.3.1.2.1 a)	m		m: 2 bits		m: $01_{(2)}$	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: 0..$1111_{(2)}$	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.1.1/2 b	
3	SAR user data	6.3.1.2.1 d)	m		m: 4 .. 44 octets		m: all possible values	
4	Fill	6.3.1.2.1 d)	m		m: 0 .. 40 octets		o.2: ⊆ [all possible values]	
5	Length indication	6.3.1.2.1 e)	m		m: 6 bits		m: 4..44	
6	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

NOTE: "[]" denotes the interval between and including the values in the brackets.

o.2: Any non-empty subset may be selected.

A.5.4.2.1.2.5 SSM Data SAR-PDU parameters for transmission

Implemented transmission parameters of SSM Data SAR-PDUs								
Item No.	**Parameter Type**	**Ref.**	**Status**	**Support**	**Length**		**Value**	
					allowed	**supported**	**allowed**	**supported**
0	Segment type	6.3.1.2.1 a)	m		m: 2 bits		m: $11_{(2)}$	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: $0..1111_{(2)}$	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.1.1/2 b	
3	SAR user data	6.3.1.2.1 d)	m		m: 8 .. 44 octets		m: all possible values	
4	Fill	6.3.1.2.1 d)	m		m: 0 .. 36 octets		o.2: ⊆ [all possible values]	
5	Length indication	6.3.1.2.1 e)	m		m: 6 bits		m: 8 .. 44	
6	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

NOTE: “[]” denotes the interval between and including the values in the brackets.

o.2: Any non-empty subset may be selected.

A.5.4.2.1.2.6 Abort SAR-PDU parameters for transmission

Implemented transmission parameters of Abort SAR-PDUs								
Item No.	**Parameter Type**	**Ref.**	**Status**	**Support**	**Length**		**Value**	
					allowed	**supported**	**allowed**	**supported**
0	Segment type	6.3.1.2.2 a)	m		m: 2 bits		m: $01_{(2)}$	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: $0..1111_{(2)}$	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.1.1/2 b	
3	Fill	6.3.1.2.2 b)	m		m: 44 octets		o.2: ⊆ [all possible values]	
4	Length indication	6.3.1.2.2 c)	m		m: 6 bits		m: 63	
5	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

NOTE: “[]” denotes the interval between and including the values in the brackets.

o.2: Any non-empty subset may be selected.

A.5.4.2.2 Receipt capabilities

The receipt capabilities apply IF (A.5.4.2/1).

Receipt capabilities implemented				
Item No.	Capability	Ref.	Status	Support
0	CPCS-SDU receipt/ SAR-SDU receipt/ SAR-SDU receipt streaming/ CPCS abort receipt/ SAR abort receipt	6.3.2.1/ 6.3.1.1/ 6.1.1.2 b)/ 6.3.2.1.1 d)/ 6.3.1.1 e)	m	
1	CPCS-SDU delineation preservation/ SAR-SDU delineation preservation	6.3.2.1.1 a)/ 6.3.1.1 a)	m	
2	CPCS-SDU receipt sequence preservation/ SAR-SDU receipt sequence preservation	6.3.2.1/ 6.3.1.1 c)	m	
3	CPCS-SDU bit error and information loss or gain detection and handling	6.3.2.1.1 b)/ 6.3.1.1 b)	m	
4	CPCS-SDU receipt streaming/ CPCS abort indication	6.3.2.1.1/ 6.1.1.1.2 b)	o	
5	CPCS connection multiplexing/ SAR connection multiplexing	6.3.2.1/ 6.3.1.1 d)	o	

A.5.4.2.2.1 Receipt timers/protocol parameters

Receipt timers/protocol parameters implemented						
Item No.	Timer/Protocol Parameter	Ref.	Status	Support	Values	
					allowed	supported
0	max. CPCS-SDU length	6.3.2.1	m		m: 65535 octets	
1	max. no. of concurrent CPCS connections/ SAR connections per ATM connection	6.3.2.1	m		c21	
2	Range of MID values supported	6.3.1.2.1 c)	m		c22	
3	SAR reassembly timer	6.4.1.4	o		o: unspecified	

NOTE: “[]” denotes the interval between and including the values in the brackets.

o3: Exactly one non-empty range including at least A.5.4.2.2.1/1b values shall be established per ATM connection via signalling or prearrangement.

c21: IF (A.5.4.2.2/5) THEN o: $\in$ [2..1024] ELSE m: 1.

c22: IF (A.5.4.2.2/5) THEN o3: $\subseteq$ [0..1023] ELSE m: [0..0].

A.5.4.2.2.2 Support of PDUs received

PDUs supported				
Item No.	PDU Type	Ref.	Status	Support
0	CPCS-PDU	6.3.2.1.2	m	
1	BOM Data SAR-PDU	6.3.1.2.1	m	
2	COM Data SAR-PDU	6.3.1.2.1	m	
3	EOM Data SAR-PDU	6.3.1.2.1	m	
4	SSM Data SAR-PDU	6.3.1.2.1	m	
5	Abort SAR-PDU	6.3.1.2.2	m	

A.5.4.2.2.2.1 CPCS-PDU parameters at receipt

Supported parameters of received CPCS-PDUs								
Item No.	Parameter Type	Ref.	Status	Support	Values			
					Length		Range	
					allowed	supported	allowed	supported
0	Common part indicator	6.3.2.1.2 a)	m		m: 1 octet		m: 0	
1	Beginning tag	6.3.2.1.2 b)	m		m: 1 octet		m: 0..255	
2	Buffer allocation size indication	6.3.2.1.2 c)	m		m: 2 octets		m: 1..65535	
3	CPCS-PDU payload	6.3.2.1	m		m: 1..65535 octets		m: all possible values	
4	Padding	6.3.2.1.2 d)	m		m: 0 .. 3 octets		m: all possible values	
5	Alignment	6.3.2.1.2 e)	m		m: 1 octet		m: 0	
6	End tag	6.3.2.1.2 f)	m		m: 1 octet		m: 0..255	
7	Length	6.3.2.1.2 g)	m		m: 2 octets		m: 1..65535	

A.5.4.2.2.2.2 BOM Data SAR-PDU parameters at receipt

Supported parameters of received BOM Data SAR-PDUs								
Item No.	Parameter Type	Ref.	Status	Support	Length		Value	
					allowed	supported	allowed	supported
0	Segment type	6.3.1.2.1 a)	m		m: 2 bits		m: $10_{(2)}$	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: $0..1111_{(2)}$	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.2.1/2b	
3	SAR user data	6.3.1.2.1 d)	m		m: 44 octets		m: all possible values	
4	Length indication	6.3.1.2.1 e)	m		m: 6 bits		m: 44	
5	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

A.5.4.2.2.2.3 COM Data SAR-PDU parameters at receipt

Supported parameters of received COM Data SAR-PDUs								
Item No.	Parameter Type	Ref.	Status	Support	Length		Value	
					allowed	supported	allowed	supported
0	Segment type	6.3.1.2.1 a)	m		m: 2 bits		m: $00_{(2)}$	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: $0..1111_{(2)}$	
2	Multiplexing Identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.2.1/2b	
3	SAR user data	6.3.1.2.1 d)	m		m: 44 octets		m: all possible values	
4	Length indication	6.3.1.2.1 e)	m		m: 6 bits		m: 44	
5	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

A.5.4.2.2.2.4 EOM Data SAR-PDU parameters at receipt

Supported parameters of received EOM Data SAR-PDUs								
Item No.	**Parameter Type**	**Ref.**	**Status**	**Support**	**Length**		**Value**	
					allowed	**supported**	**allowed**	**supported**
0	Segment type	6.3.1.2.1 a)	m		m: 2 bits		m: 01(2)	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: 0..1111(2)	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.2.1/2b	
3	SAR user data	6.3.1.2.1 d)	m		m: 4 .. 44 octets		m: all possible values	
4	Fill	6.3.1.2.1 d)	m		m: 0 ..40 octets		m: all possible values	
5	Length indication	6.3.1.2.1 e)	m		m: 6 bits		m: 4 .. 44	
6	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

A.5.4.2.2.2.5 SSM Data SAR-PDU parameters at receipt

Supported parameters of received SSM Data SAR-PDUs								
Item No.	**Parameter Type**	**Ref.**	**Status**	**Support**	**Length**		**Value**	
					allowed	**supported**	**allowed**	**supported**
0	Segment type	6.3.1.2.1 a)	m		m: 2 bits		m: 11(2)	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: 0..1111(2)	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.2.1/2b	
3	SAR user data	6.3.1.2.1 d)	m		m: 8 .. 44 octets		m: all possible values	
4	Fill	6.3.1.2.1 d)	m		m: 0 ..36 octets		m: all possible values	
5	Length indication	6.3.1.2.1 e)	m		m: 6 bits		m: 8 .. 44	
6	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

A.5.4.2.2.2.6 Abort SAR-PDU parameters at receipt

Supported parameters of received Abort SAR-PDUs								
Item No.	**Parameter Type**	**Ref.**	**Status**	**Support**	**Length**		**Value**	
					allowed	**supported**	**allowed**	**supported**
0	Segment type	6.3.1.2.2 a)	m		m: 2 bits		m: 01(2)	
1	Sequence number	6.3.1.2.1 b)	m		m: 4 bits		m: 0..1111(2)	
2	Multiplexing identification	6.3.1.2.1 c)	m		m: 10 bits		m: A.5.4.2.2.1/2b	
3	Fill	6.3.1.2.2 b)	m		m: 44 octets		m: all possible values	
4	Length indication	6.3.1.2.2 c)	m		m: 6 bits		m: 63	
5	Cyclic redundancy check code	6.3.1.2.1 f)	m		m: 10 bits		m: 0..1023	

A.5.4.2.2.3 Protocol error handling

Error handling implemented				
Item No.	**Type of error handling**	**Ref.**	**Status**	**Support**
0	Discard of invalid CPCS-SDUs	6.3.2.1.1 b)/ 6.3.1.1 b)	m	
1	Annotated delivery of invalid CPCS-SDUs	6.3.2.1.1 b)/ 6.3.1.1 b)	o	

A.5.4.3 Negotiation capabilities

Not applicable. Any negotiation capabilities influencing the protocols concerned shall be provided by signalling or other means of prearrangement and are thus out of scope of this PICS.

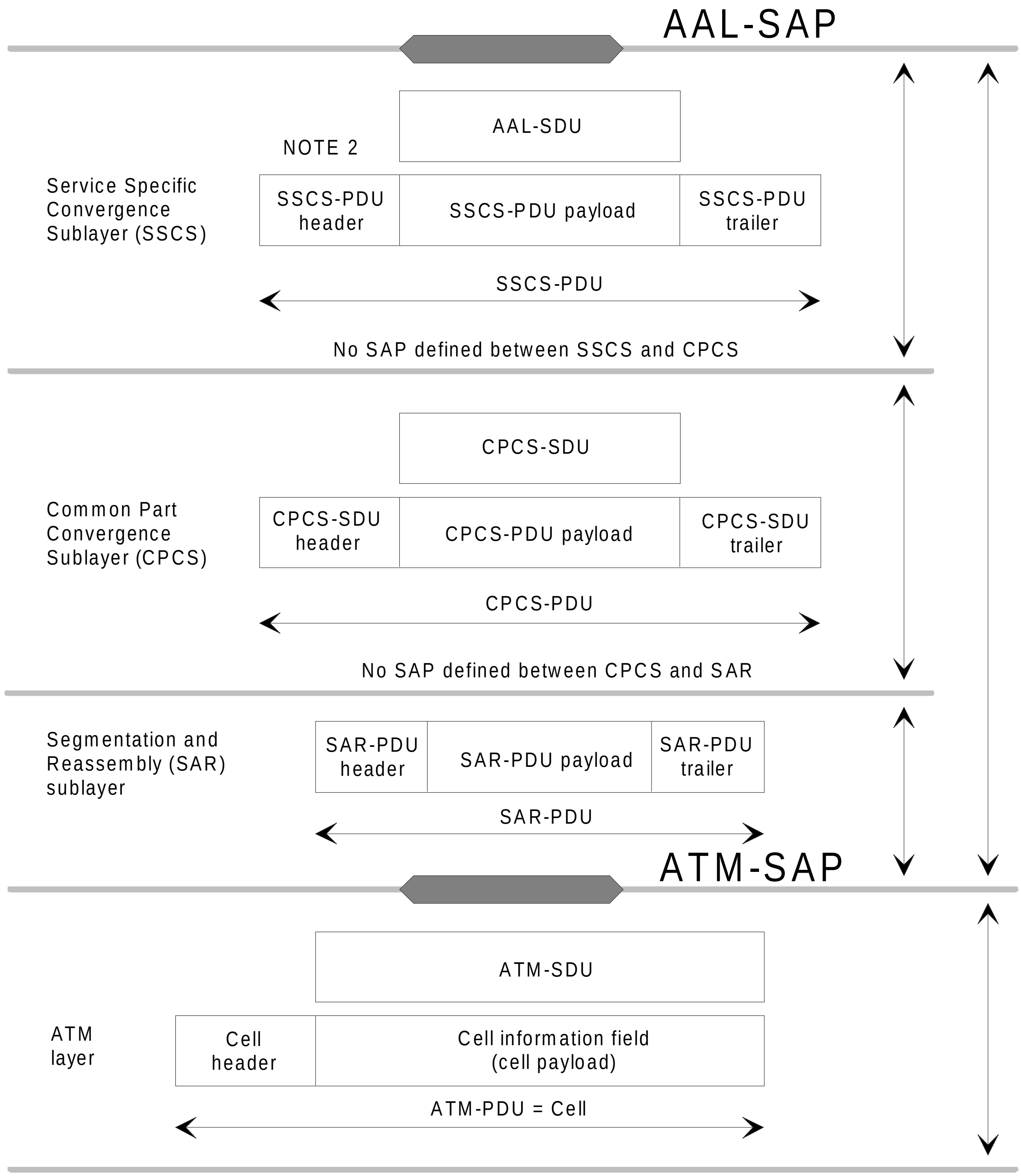
A.5.4.4 Multi-layer dependencies

No special multi-layer dependencies have been identified.

A.5.4.5 Other conditions

No relationships between options beyond those listed above have been identified.

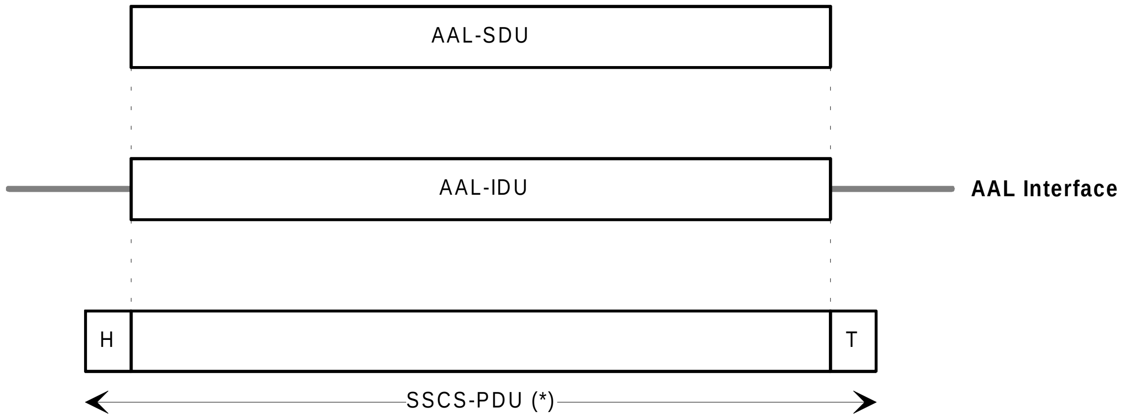
Annex B (informative): Illustration of the data unit naming convention



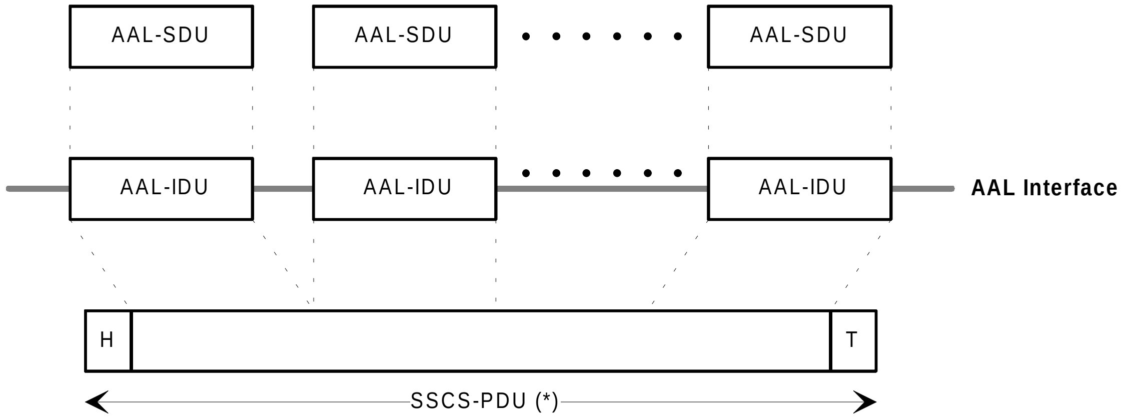
NOTE 1: This figure is to indicate the naming of the AAL data units only. It is not implied that all fields are present in all of the cases.

NOTE 2: The exact structure of the SSCS-PDU is outside the scope of this ETS.

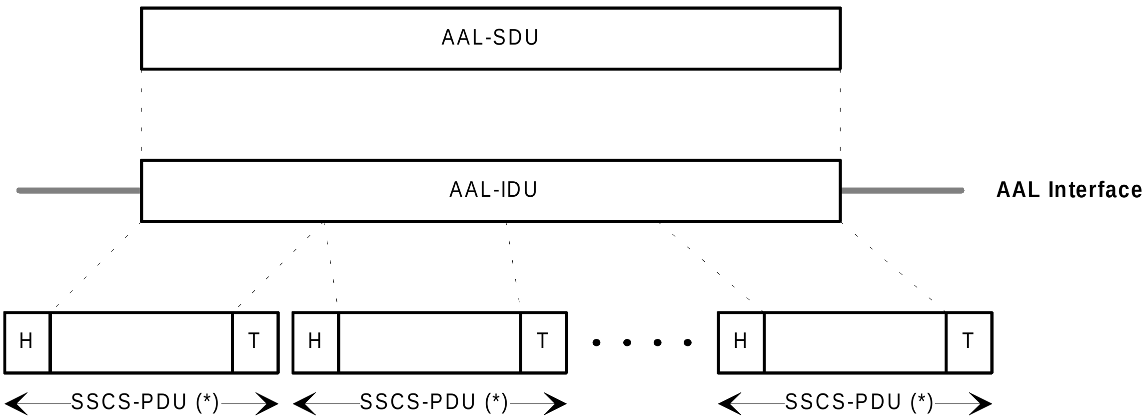
Figure B.1: Data unit naming conventions for the AAL type 3/4



a) Message mode service



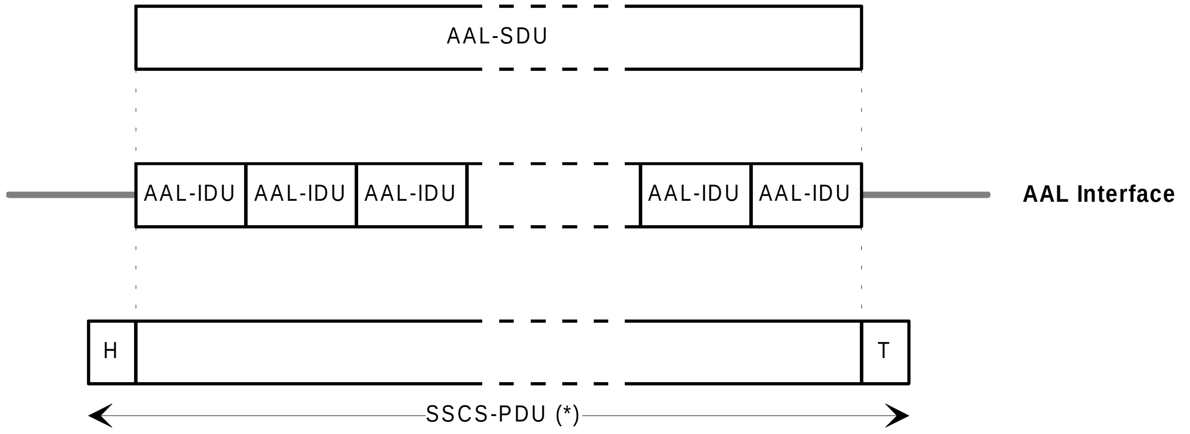
b) Message mode service plus blocking/deblocking internal function



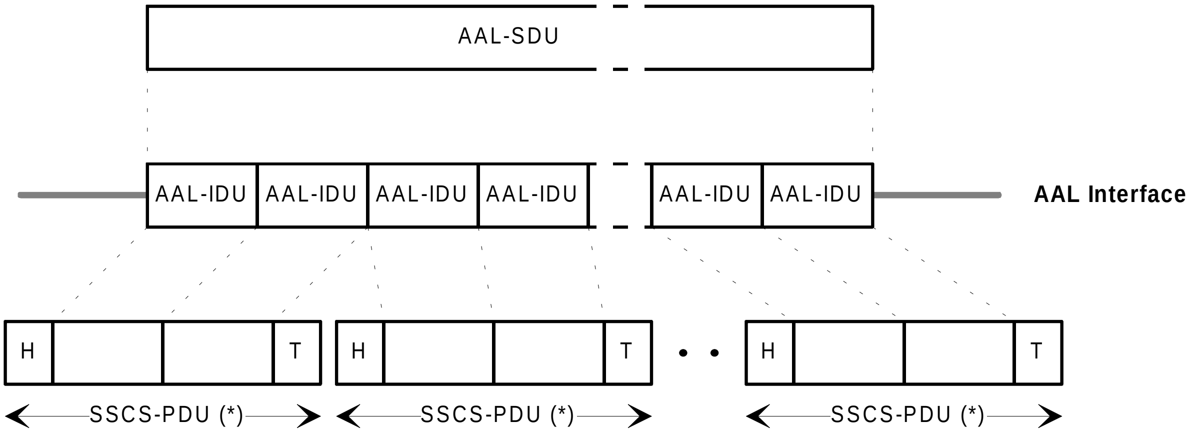
(*) The structure of the SSCS-PDU is outside the scope of this ETS.

c) Message mode service plus segmentation/reassembly internal function

Figure B.2 (sheet 1 of 2): Message and streaming mode of service at the AAL type 3/4 interface combined with blocking/deblocking or segmentation/reassembly internal function



d) Streaming mode service



(*) The structure of the SSCS-PDU is outside the scope of this ETS.

e) Streaming mode service plus segmentation/reassembly internal function

Figure B.2 (sheet 2 of 2): Message and streaming mode of service at the AAL type 3/4 interface combined with blocking/deblocking or segmentation/reassembly internal function

Annex C (informative): General framework of the AAL type 3/4

This annex provides a description of the general framework of the AAL type 3/4 including SAR and CPCS-PDU formats.

C.1 Message segmentation and reassembly

Figure C.1 provides a generic interpretation of the segmenting of a message into BOM, COM and EOM. Short messages are represented as a SSM.

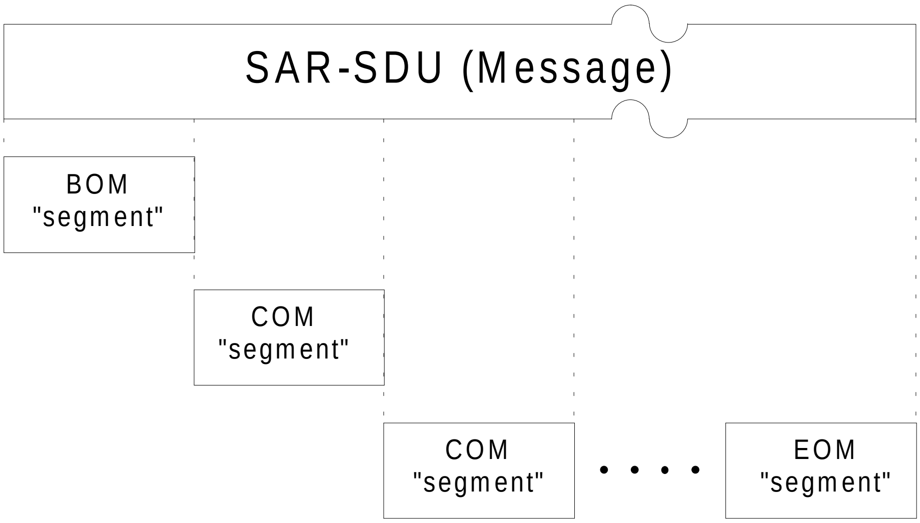


Figure C.1: Message segmentation and reassembly

C.2 PDU headers, trailers and terminology

Figure C.2 builds on the generic view of message segmentation of figure C.1 to incorporate the relevant PDU headers and trailers and appropriate terminology on the basis of BOM, COM and EOM which is of particular relevance to the combined SAR and CPCS-PDU formats of figure C.3.

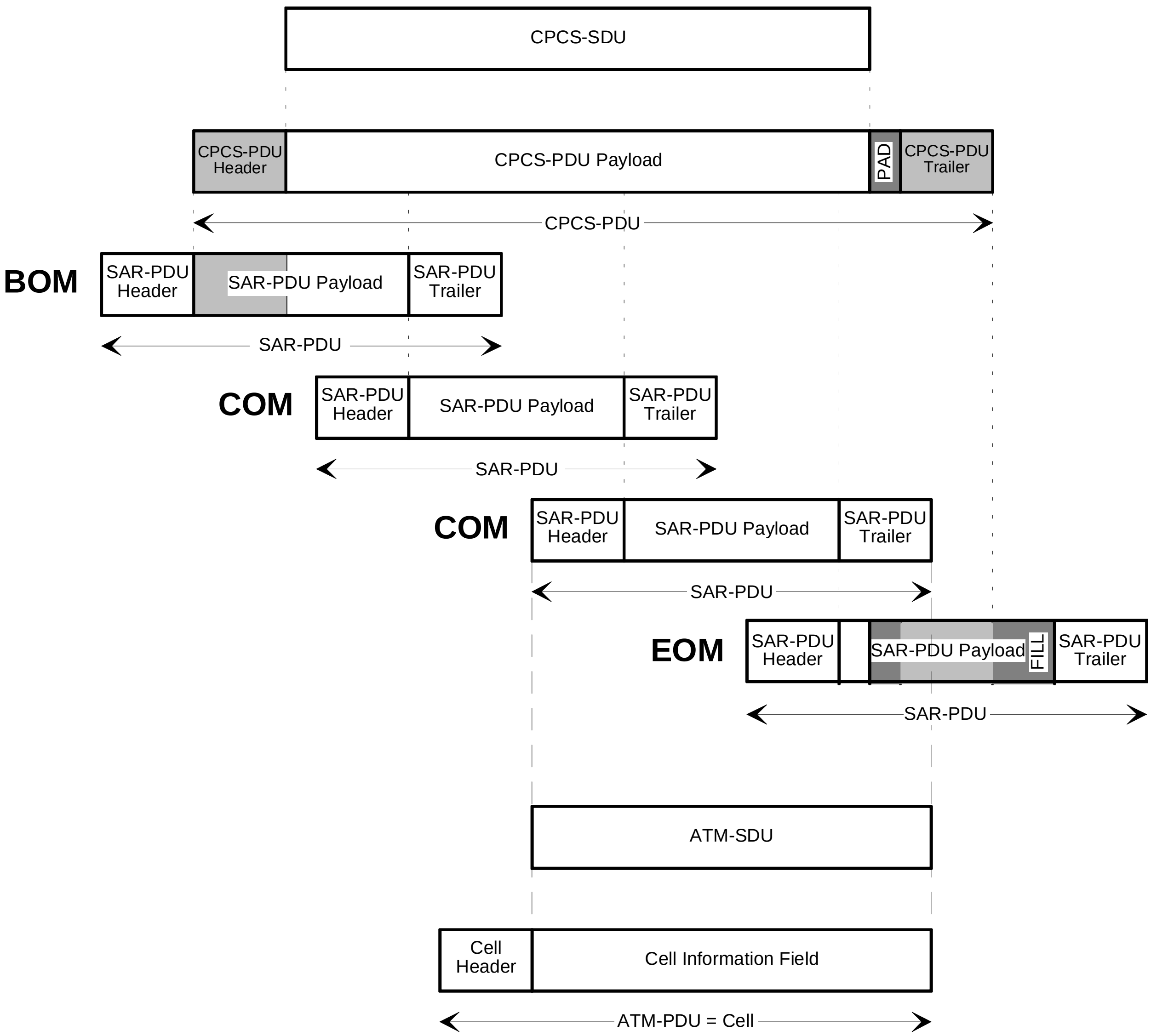


Figure C.2: PDU headers, trailers, and terminology

C.3 SAR and CPCS format

Figure C.3 illustrates the combined SAR and CPCS PDU format on a segment-by-segment basis.

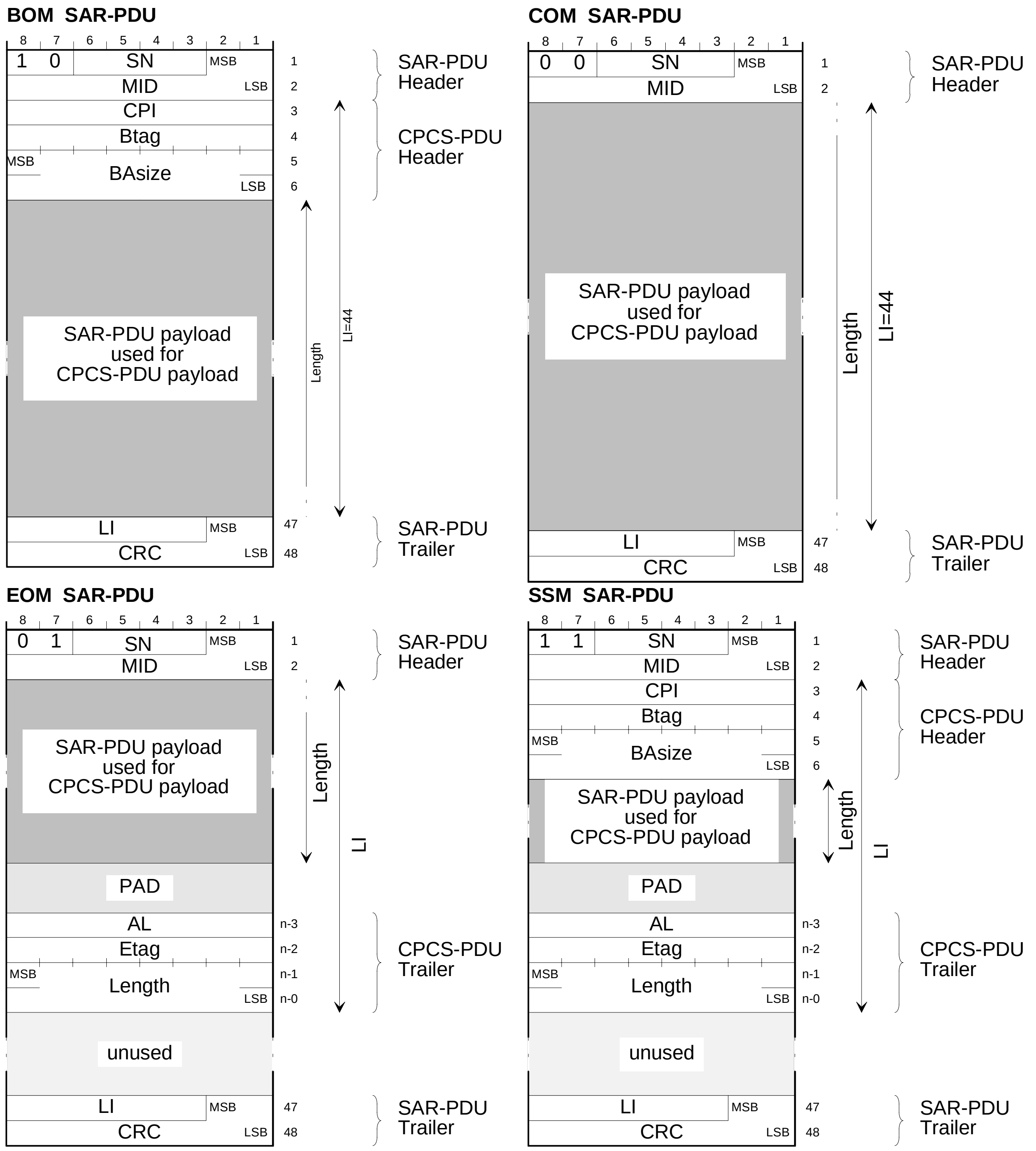


Figure C.3: Combined SAR and CPCS PDU format

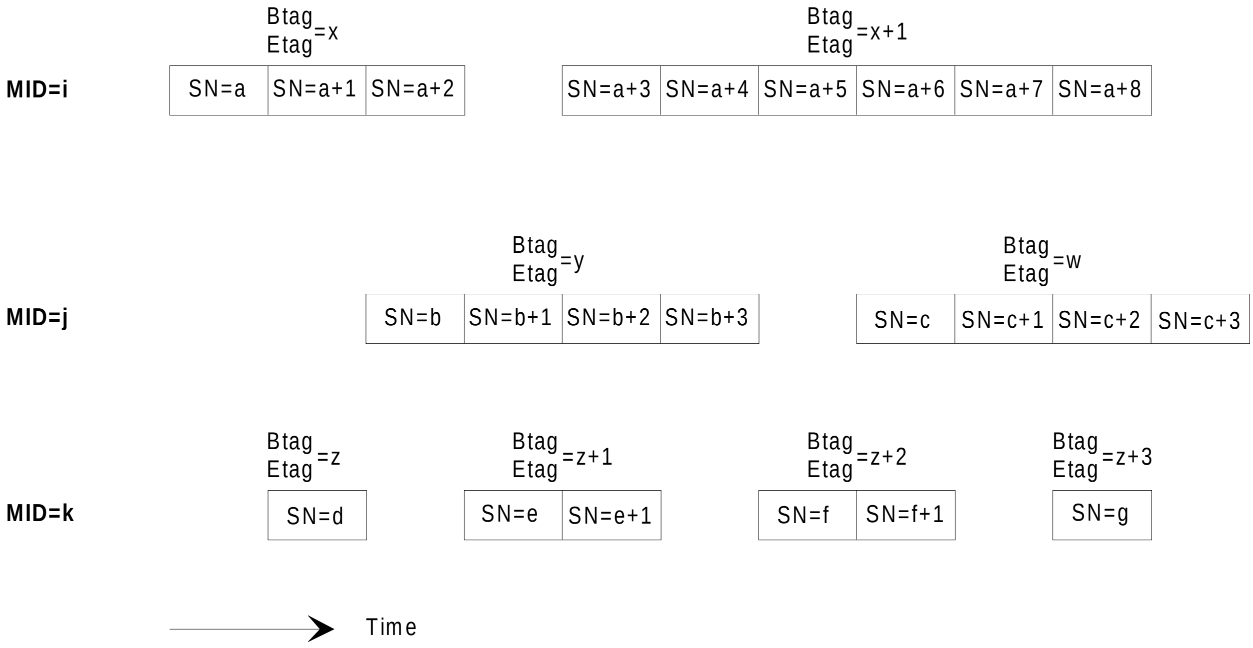
Key to figure C.3:

ST	=	Segment Type
SN	=	Sequence Number
MID	=	Multiplexing Identification
LI	=	Length Indicator
CRC	=	Cyclic Redundancy Check
CPI	=	Common Part Indicator
Btag	=	Begin Tag
Etag	=	End Tag
BASize	=	Buffer Allocation Size
AL	=	Alignment
Length	=	CPCS-PDU Payload Length

The definition of the encoding and functions associated with the fields is described in subclauses 6.3.1.2 and 6.3.2.1.2.

C.4 Relation of the MID field to the SN field and Btag/Etag fields

As an example, figure C.4 illustrates the possible relation of the MID field values to the SN field and Btag/Etag field values for the AAL type 3/4.



NOTE: Modulo 16 and modulo 256 apply to determine the SN field and the Btag/Etag fields.

Figure C.4: The relation of MID field values to the SN field and Btag/Etag field values for AAL type 3/4

C.5 Examples of the segmentation and reassembly process

Figure C.5 shows schematically a successful segmentation and reassembly of a CPCS user PDU in message mode. In figure C.6, a SAR-PDU is assumed lost due a transmission error; hence, the reassembly cannot be completed.

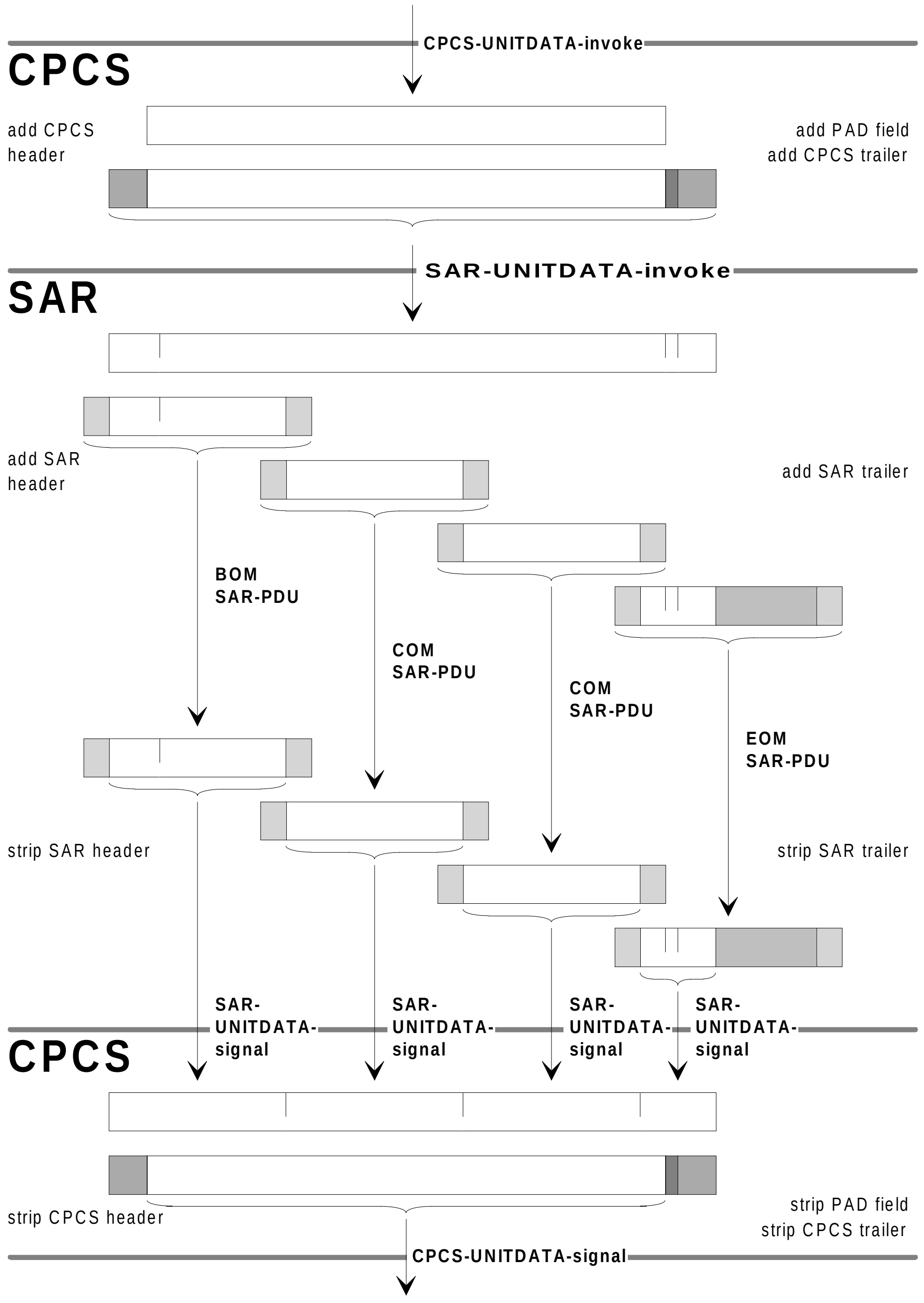


Figure C.5: Successful segmentation and reassembly of a CPCS user PDU

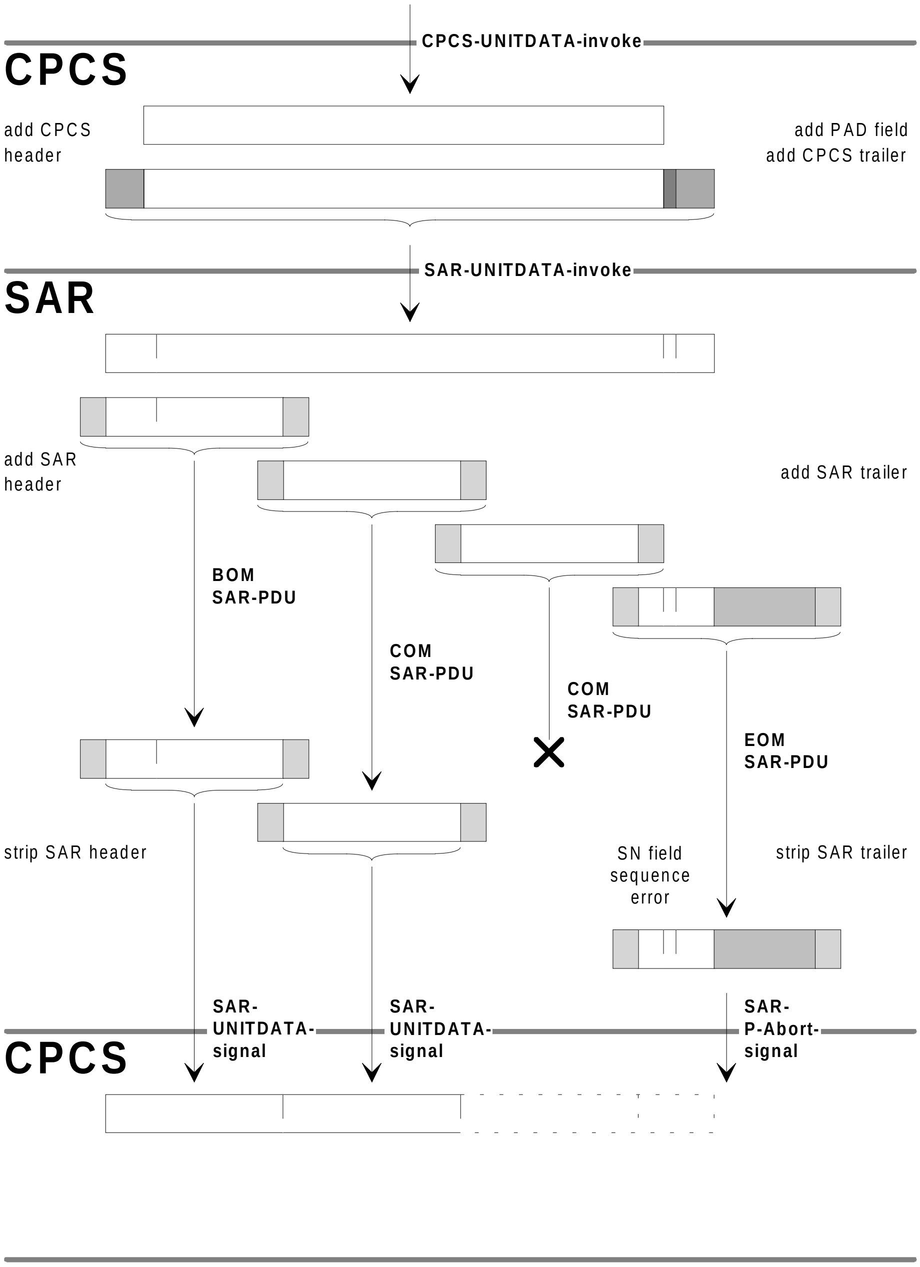


Figure C.6: Segmentation and unsuccessful reassembly of a CPCS user PDU

Annex D (informative): Functional model for the common part of the AAL type 3/4

For the AAL type 3/4, the functionality of the SSCS may provide only for the mapping of the equivalent primitives of the AAL type 3/4 to the CPCS and vice versa. The SSCS may also implement functions such as assured data transfer, multiplexing/demultiplexing, etc. Such functions, however, are not shown in the following figures.

The functional model of the AAL type 3/4 at the sender side is shown in figure D.1.

The model consists of several blocks that co-operate to provide the AAL type 3/4 services. Each SAR and CPCS block that are paired represent one segmentation state machine.

The interleaver allocates the available bit rate of the ATM connection to the SAR-PDUs generated by the segmentation state machines according to some internal policy.

The functional model of the AAL type 3/4 at the receiver side is shown in figure D.2.

The model consists of several blocks that co-operate to provide the AAL type 3/4 services. Each SAR and CPCS block that are paired represent one reassembly state machine. The dispatcher (R_DSP) routes the primitives from the ATM layer to the appropriate reassembly state machine based on the value of the MID field within the SAR-PDU.

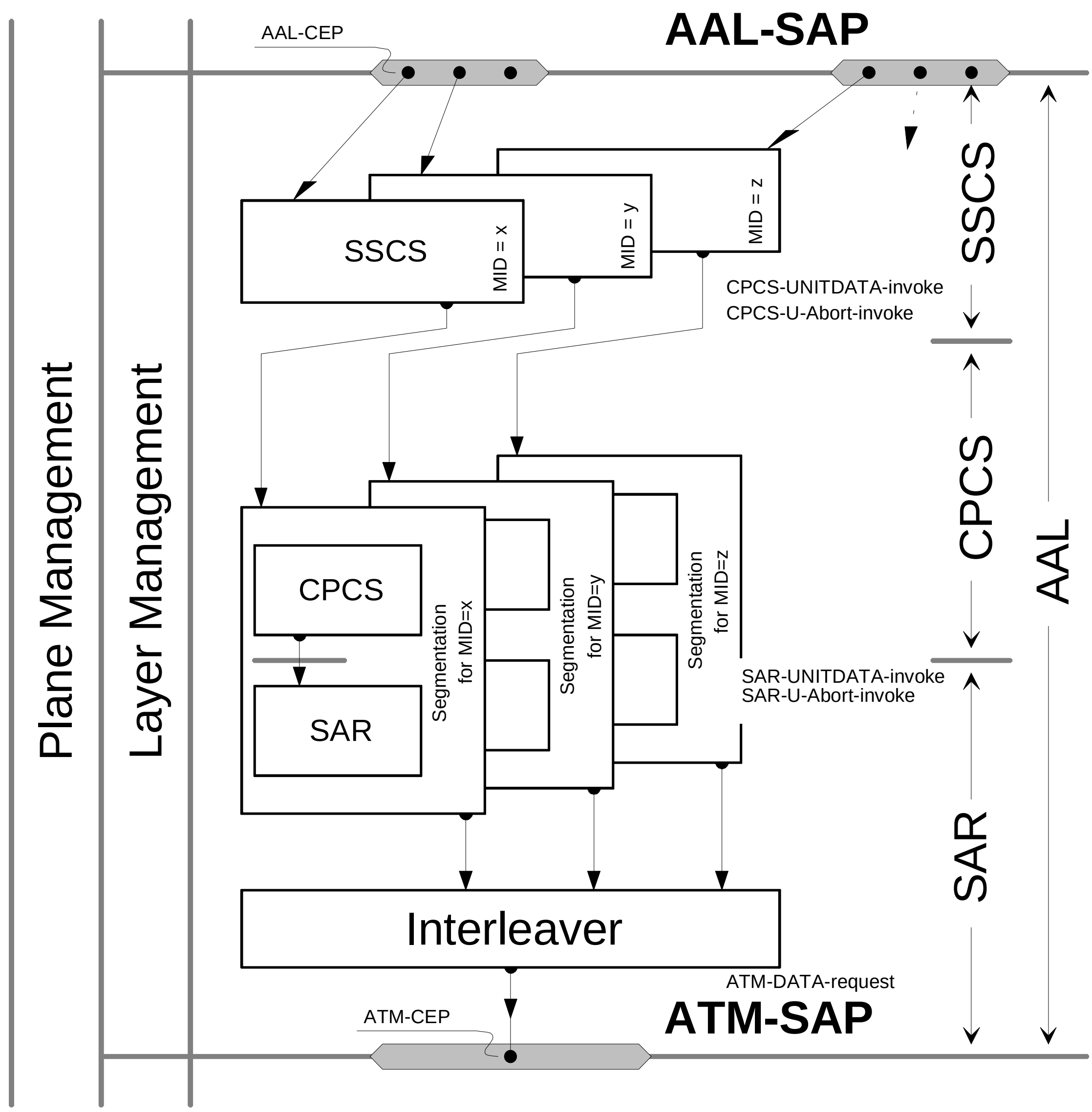


Figure D.1: Functional model for the AAL type 3/4 (sender side)

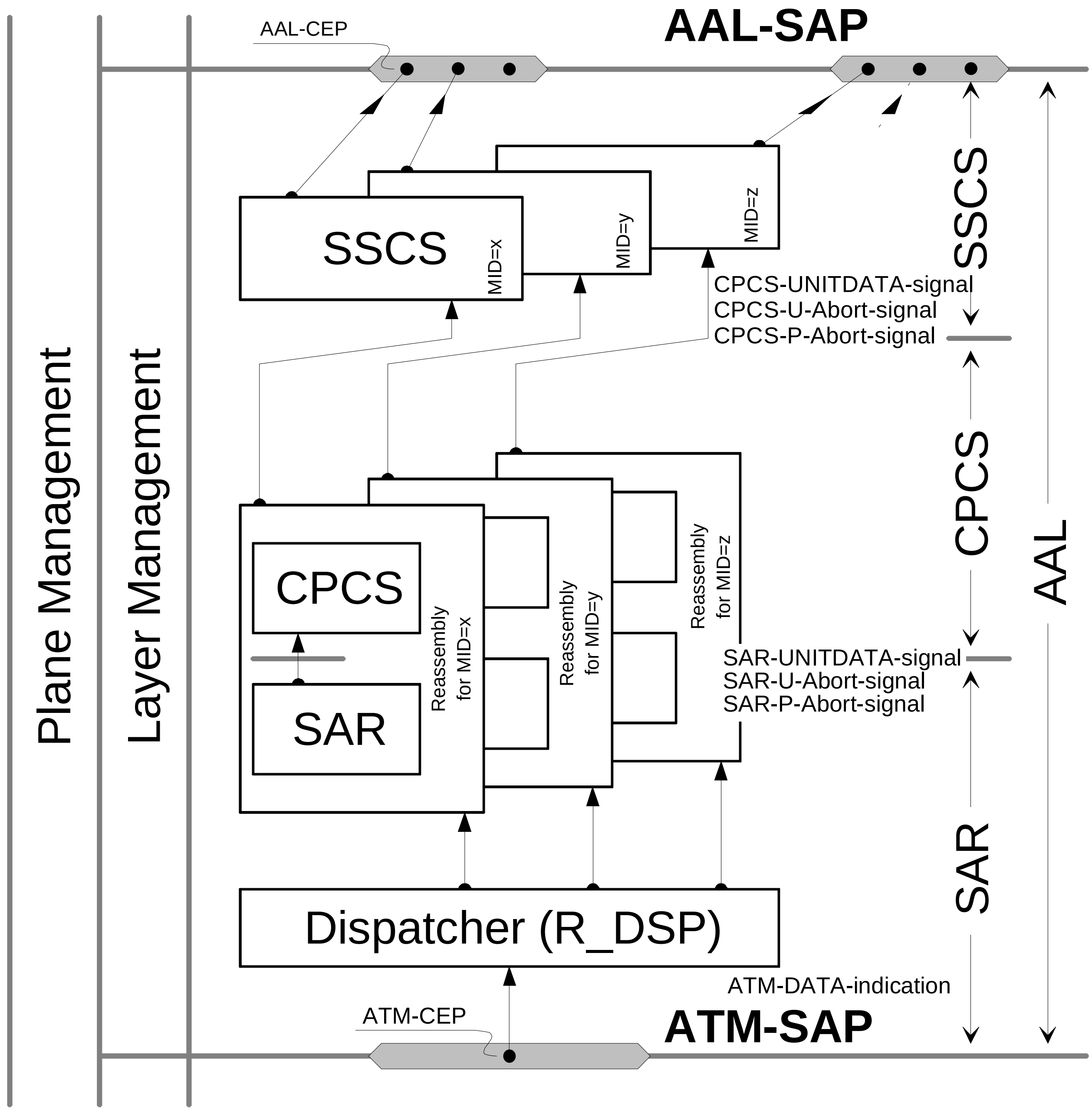


Figure D.2: Functional model for the AAL type 3/4 (receiver side)

Annex E (informative): SDL diagrams for the SAR and the CPCS of the AAL type 3/4

E.1 SDL for the SAR sublayer and the CPCS

The purpose of this annex is to provide one example of an SDL representation of the SAR and CPCS procedures and with it to assist in the understanding of this ETS. This representation does not describe all of the possible actions of the SAR sublayer and CPCS entity as a non-partitioned representation (i.e. the state machine is shown for one MID field value) was chosen in order to minimize its complexity. In particular, neither delivery of errored data nor CPCS streaming mode procedures are included.

Therefore, the SDL representation does not constrain implementations from exploiting the full potential inherent in this highly parallel and fast environment. The text description of the procedures in the main part of this ETS is definitive.

NOTE: These SDL diagrams represent the SAR and the CPCS for one MID field value.

E.1.1 The SAR sender

The SAR sender makes use of the state variable snd_SN (as defined in subclause 6.4.1.1).

In addition, it utilizes four further variables:

a) ptrPDU.

This is a temporary variable that points into the (partial) CPCS-PDU received via the SAR-UNITDATA-invoke primitive. As successive parts of the CPCS-PDU are filled into SAR-PDU payloads, this pointer keeps pointing at the first octet within the CPCS-PDU that has not yet been sent within a SAR-PDU;

b) len.

This temporary variable is set to the length of the (partial) CPCS-PDU received via the SAR-UNITDATA-invoke primitive;

c) count.

This temporary variable keeps track of the number of octets still awaiting segmentation and transmission within a SAR-PDU;

d) snd_ST.

This temporary variable is used to set the ST field of the SAR-PDU header. It can take the values: "BOM", "COM", "EOM" or "SSM";

e) snd_MID.

This variable contains the value of the MID field that is put into every SAR-PDU.

The primitive MAAL-ID is used in the SAR sender. Its only parameter communicates a MID field value from Layer Management to the SAR sender. The mechanism is used for descriptive purposes here and, thus, no further details are specified.

E.1.2 The SAR receiver

The SAR receiver makes use of the state variable rcv_SN (as defined in subclause 6.4.1.3). It utilizes no further variables.

All illegal SAR-PDUs are ignored. An illegal SAR-PDU is a SAR-PDU with:

- a CRC verification error; or
- an unexpected MID field value.

NOTE: The discarding of illegal SAR-PDUs actually takes place prior to assigning the SAR-PDU to a reassembly process governed by a particular MID field value, hence, this is not shown in the following SDL diagrams.

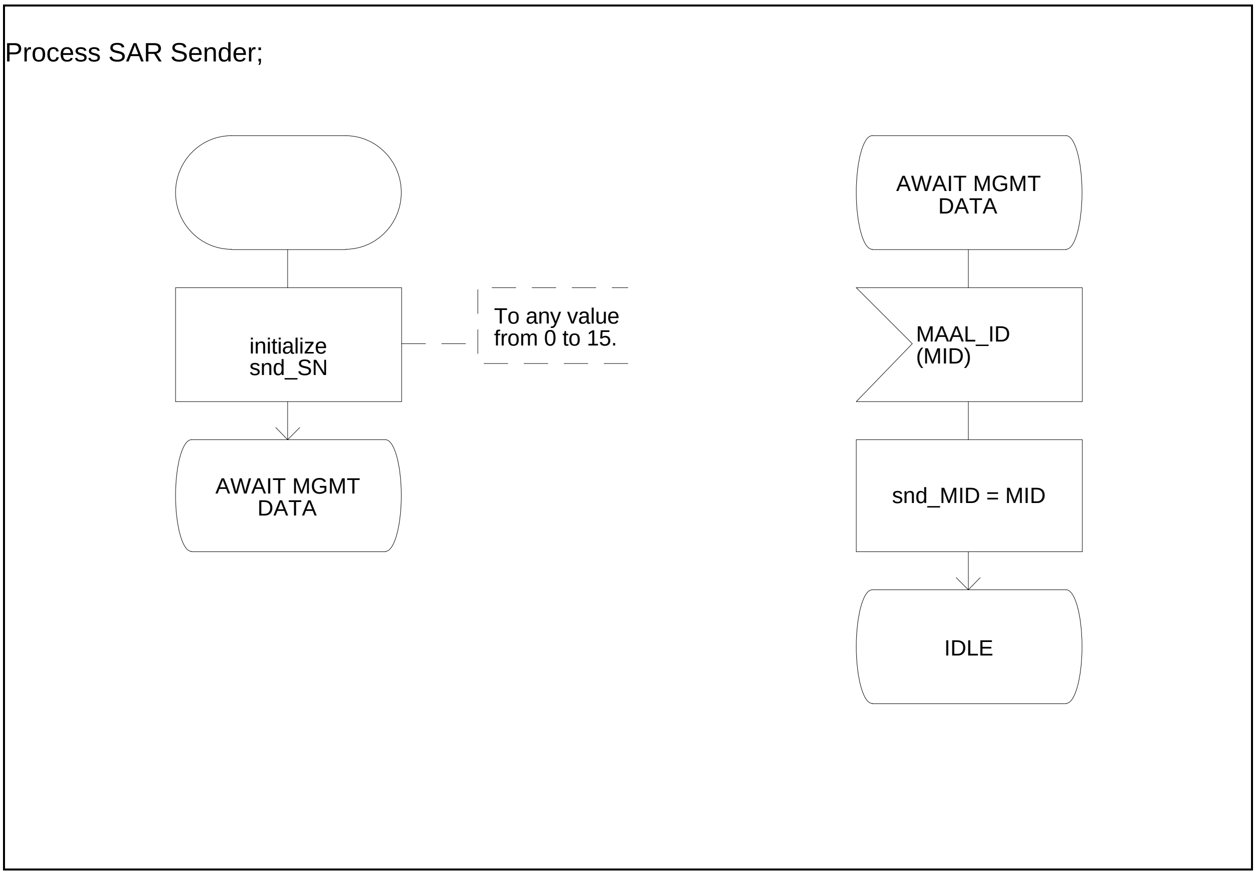


Figure E.1 (sheet 1 of 5): SDL diagrams for the SAR sender

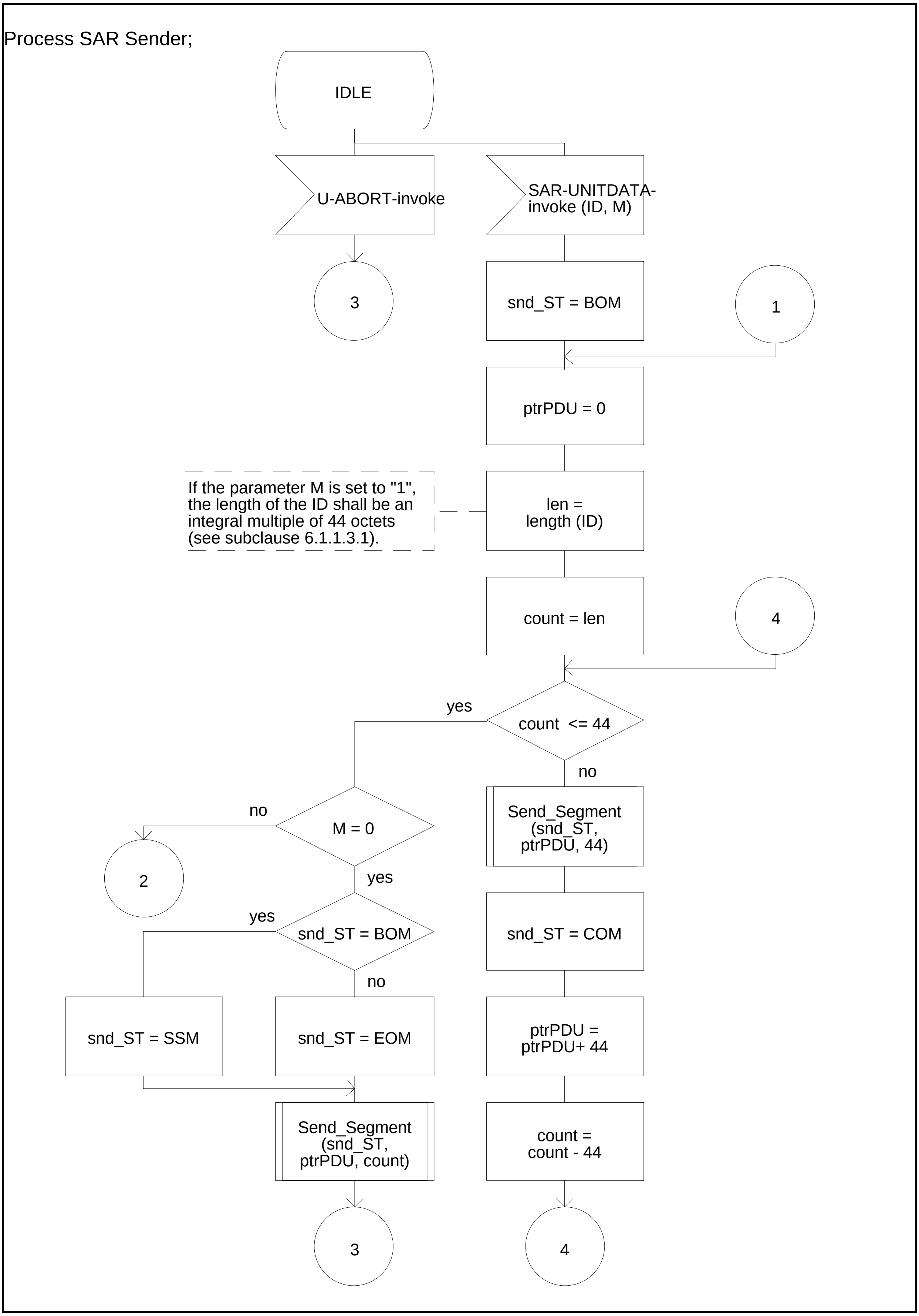


Figure E.1 (sheet 2 of 5): SDL diagrams for the SAR sender

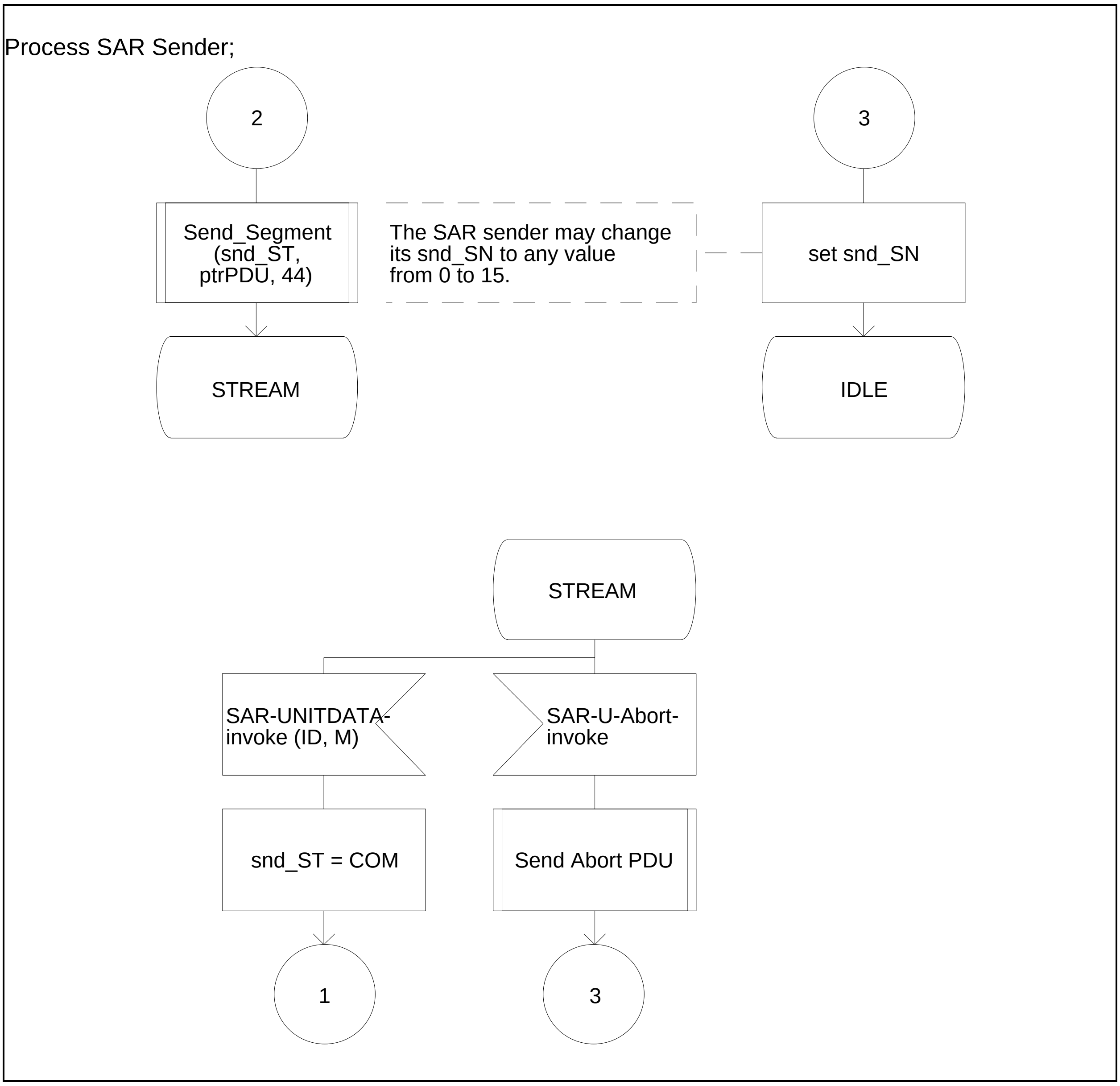


Figure E.1 (sheet 3 of 5): SDL diagrams for the SAR sender

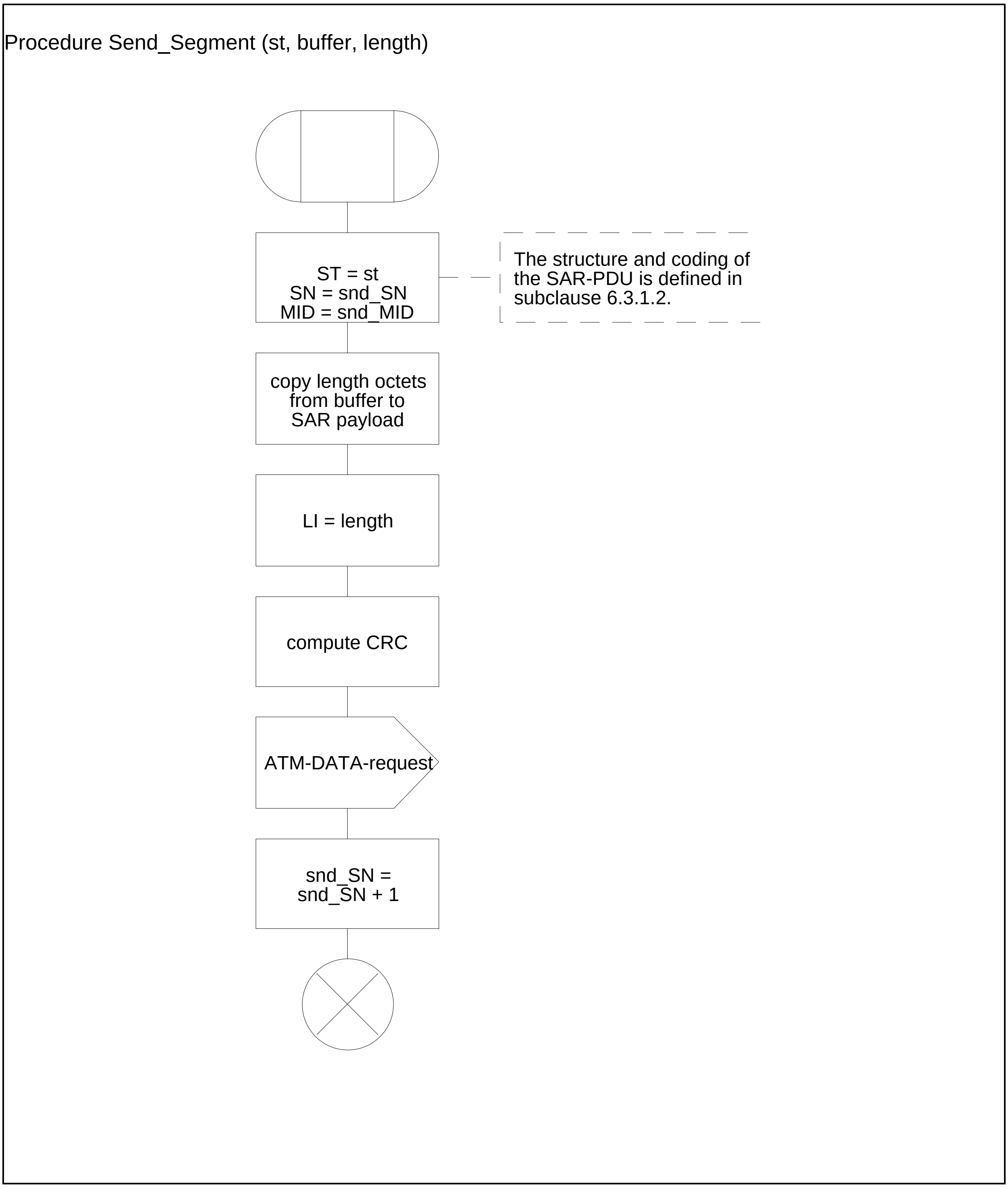


Figure E.1 (sheet 4 of 5): SDL diagrams for the SAR sender

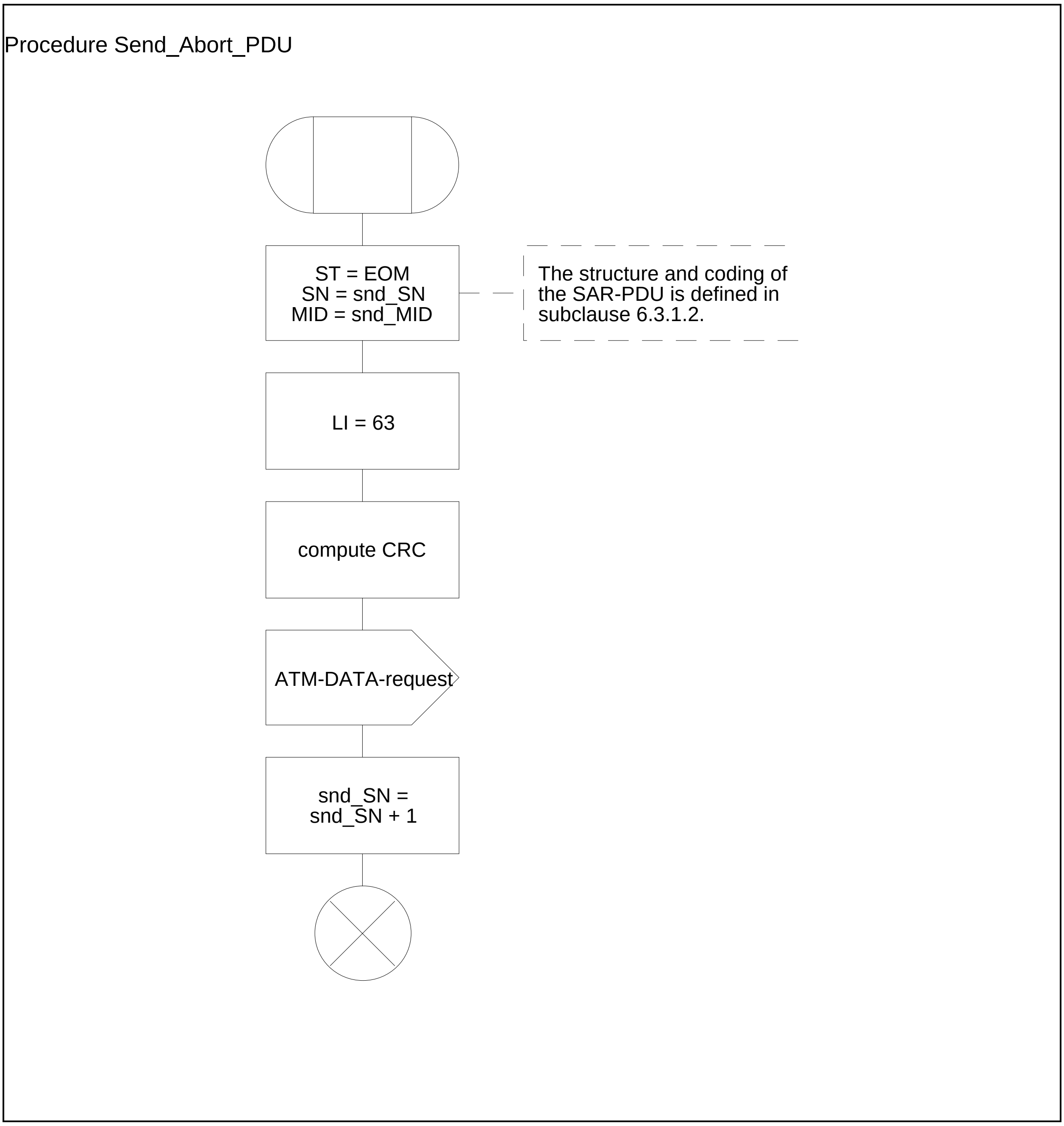


Figure E.1 (sheet 5 of 5): SDL diagrams for the SAR sender

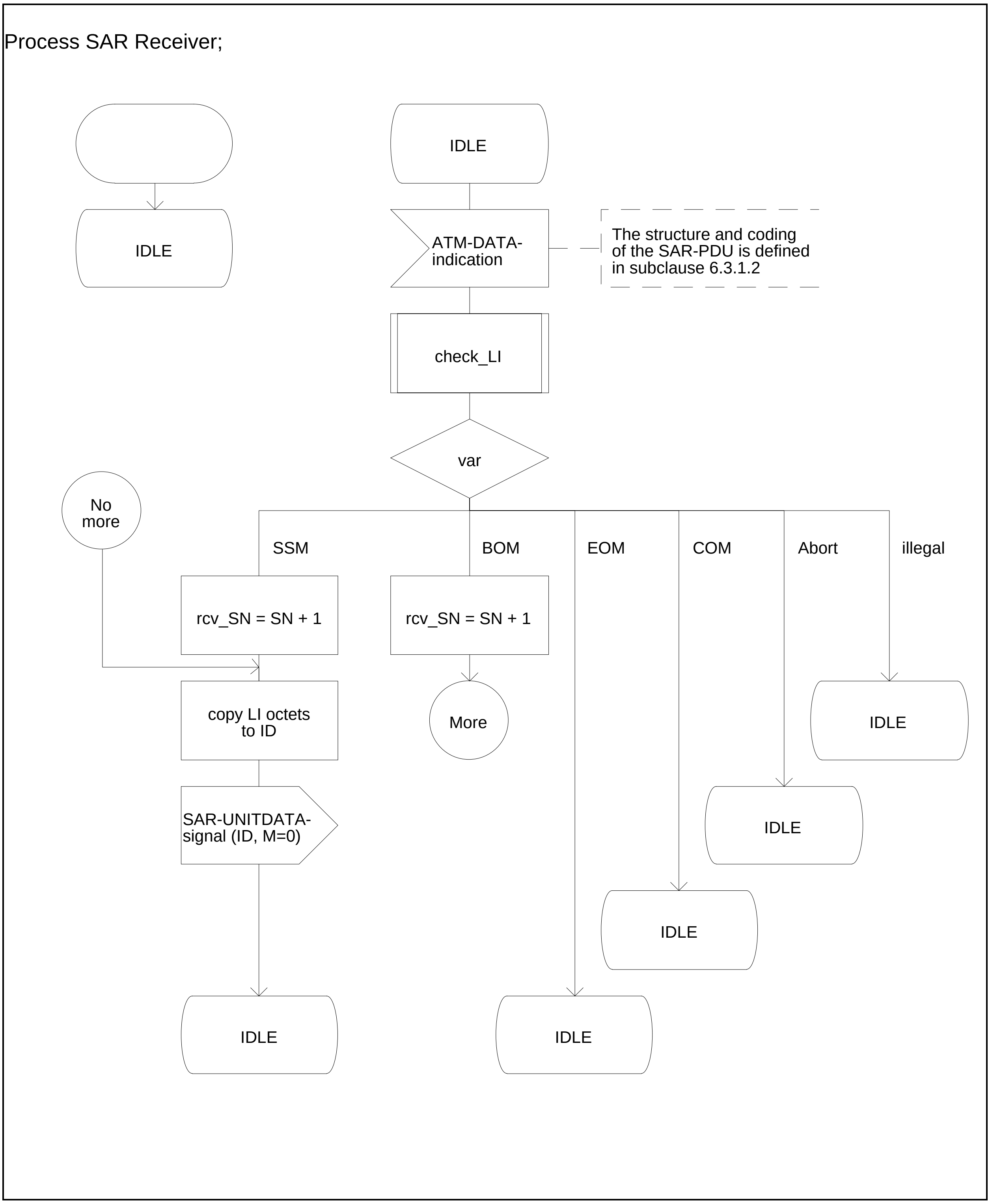


Figure E.2 (sheet 1 of 4): SDL diagrams for the SAR receiver

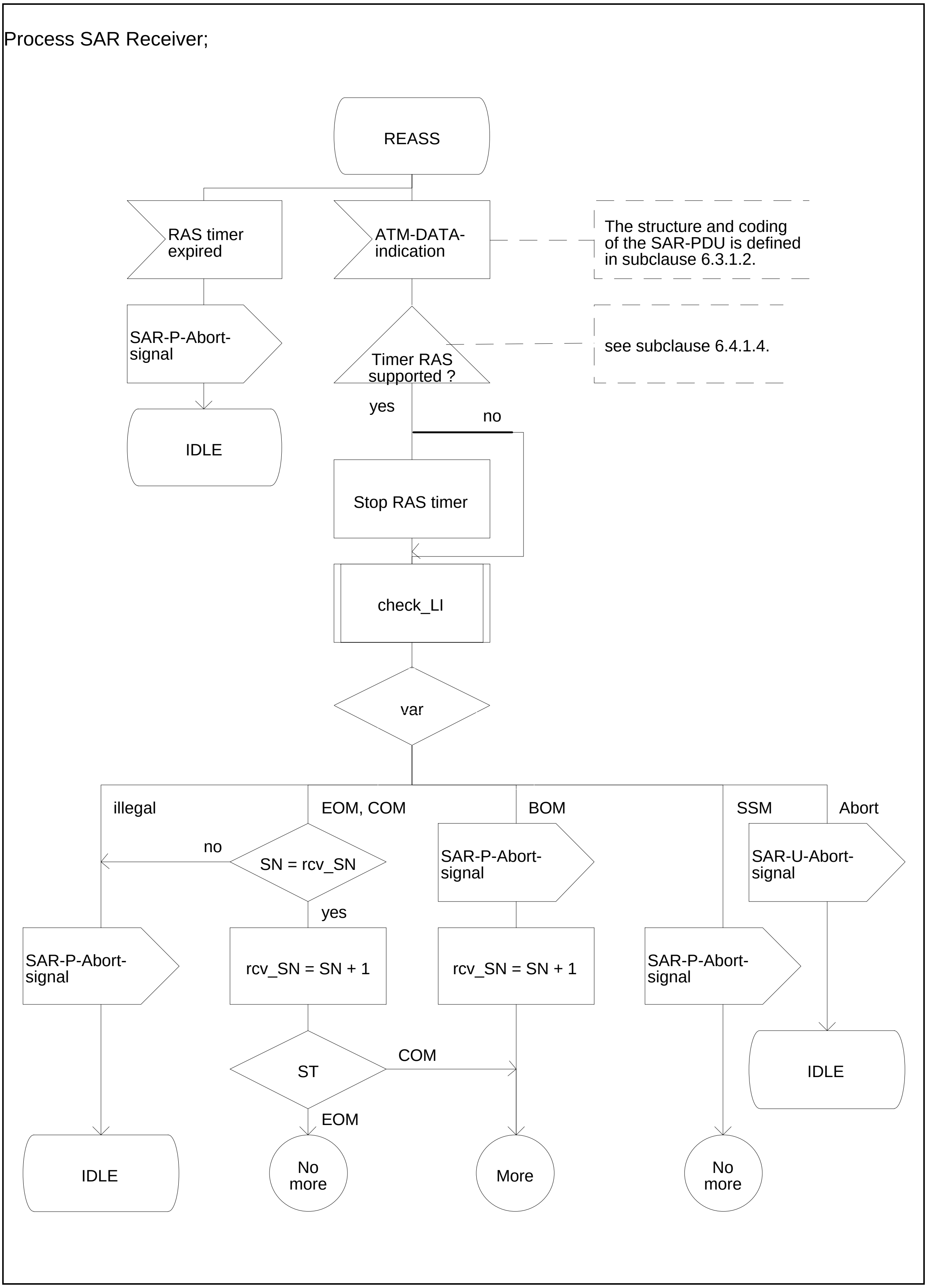


Figure E.2 (sheet 2 of 4): SDL diagrams for the SAR receiver

Process SAR Receiver;

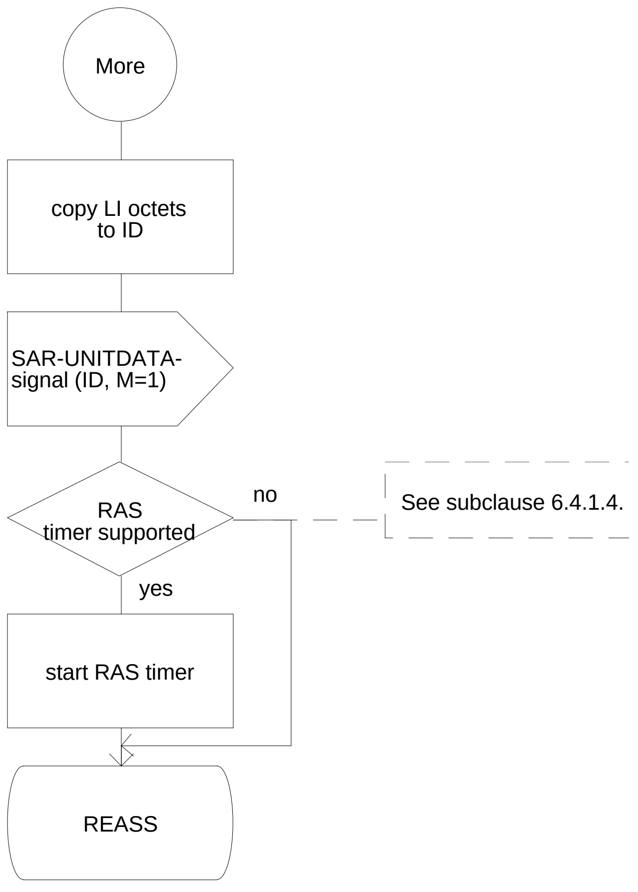


Figure E.2 (sheet 3 of 4): SDL diagrams for the SAR receiver

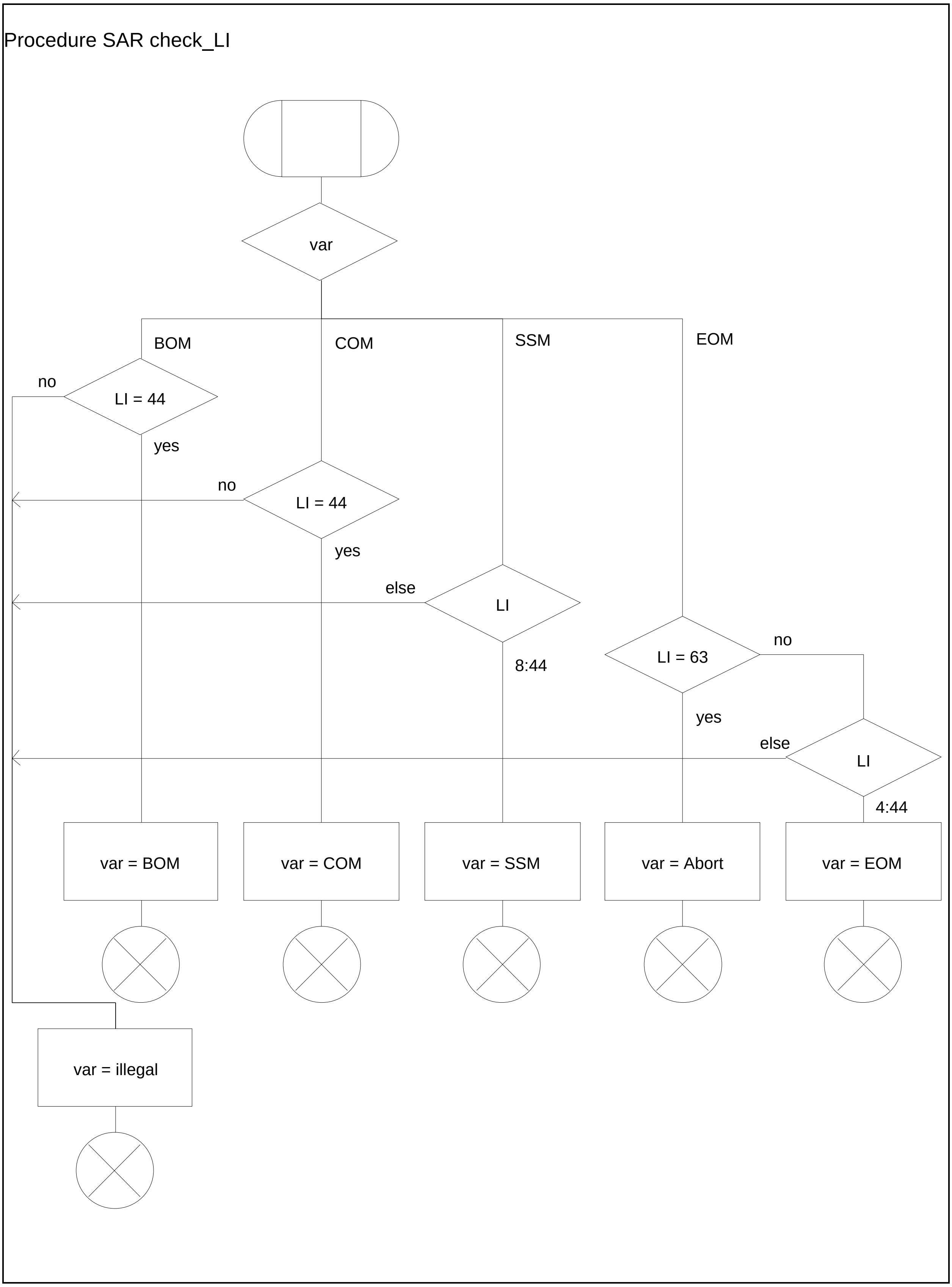


Figure E.2 (sheet 4 of 4): SDL diagrams for the SAR receiver

E.1.3 The CPCS sender

The CPCS sender makes use of the state variable snd_BEtag (as defined in subclause 6.4.2.1). In addition, it utilizes one further variable:

- len.

  This temporary variable is set to the length of the interface data parameter received via the CPCS-UNITDATA-invoke primitive. It is used to set the BASize field, the Length field, and to calculate the length of the PAD field.

E.1.4 The CPCS receiver

The CPCS receiver makes use of the state variable rcv_BEtag and rcv_BASize (as defined in subclause 6.4.2.3). In addition, it utilizes three further variables:

a) len.

   This temporary variable is set to the length of the CPCS-PDU information received from the SAR sublayer for reassembly;

b) reassembly buffer.

   The reassembly buffer is allocated while processing the CPCS-PDU header and freed once the reassembly of a CPCS-PDU is complete (or abandoned due to errors);

c) ptrRAB.

   This variable points into the reassembly buffer to the octet where the next information received from the SAR sublayer is to be stored.

Figure E.3 illustrates the use of the reassembly buffer during the reassembly of a CPCS-SDU.

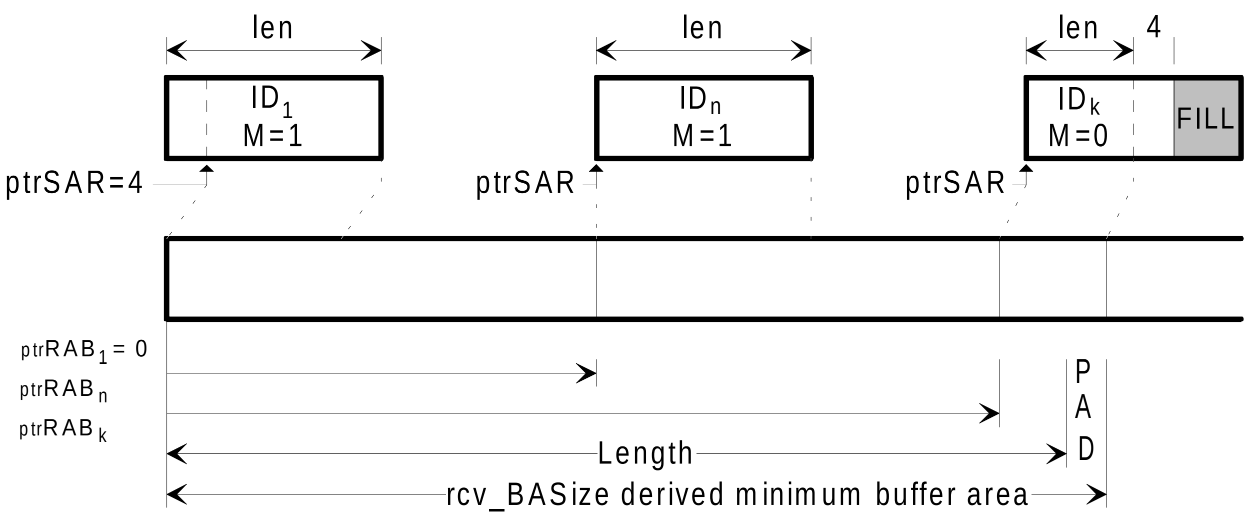


Figure E.3: The mechanism of the reassembly buffer

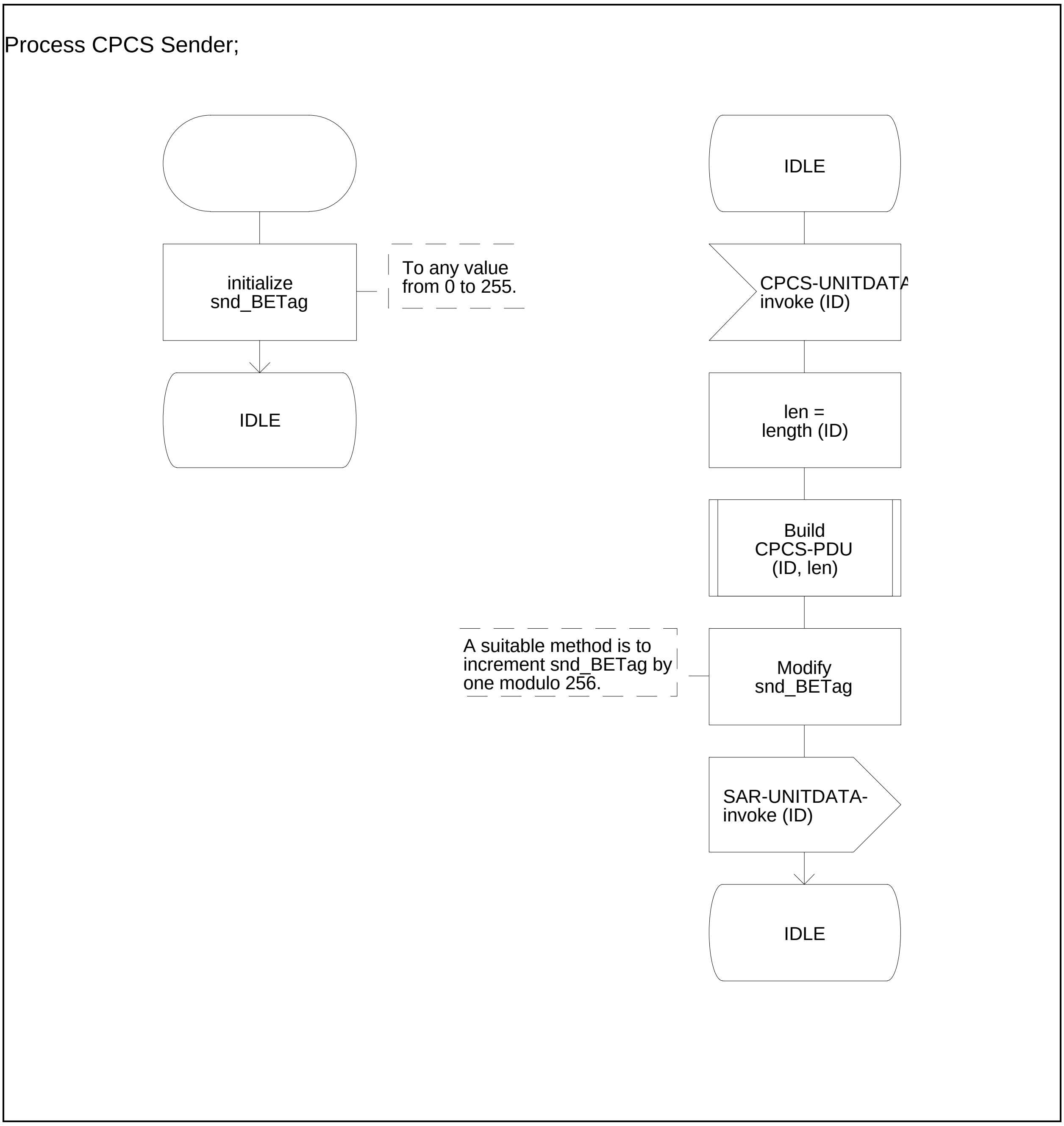


Figure E.4 (sheet 1 of 2): SDL diagrams for the CPCS sender

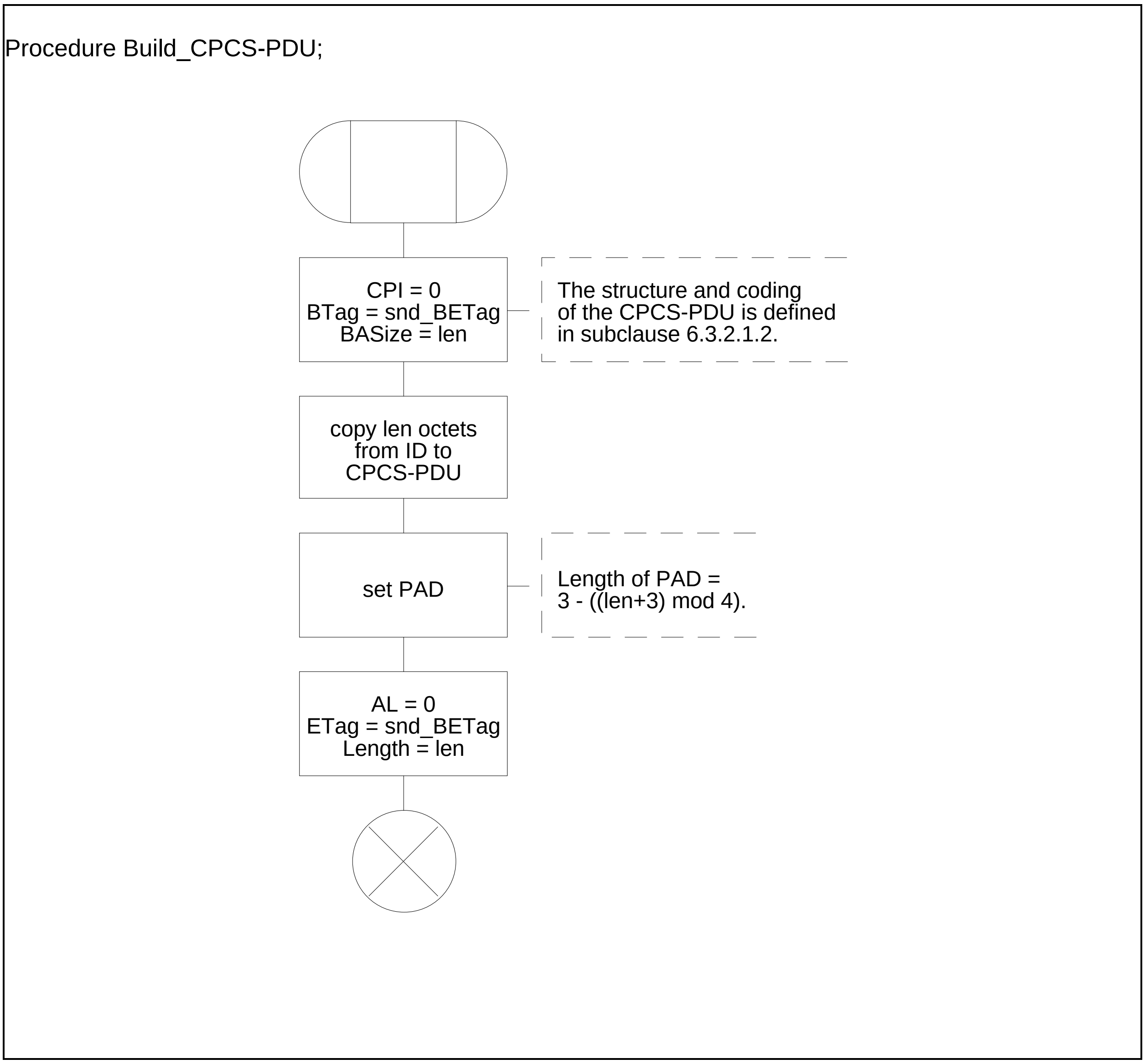


Figure E.4 (sheet 2 of 2): SDL diagrams for the CPCS sender

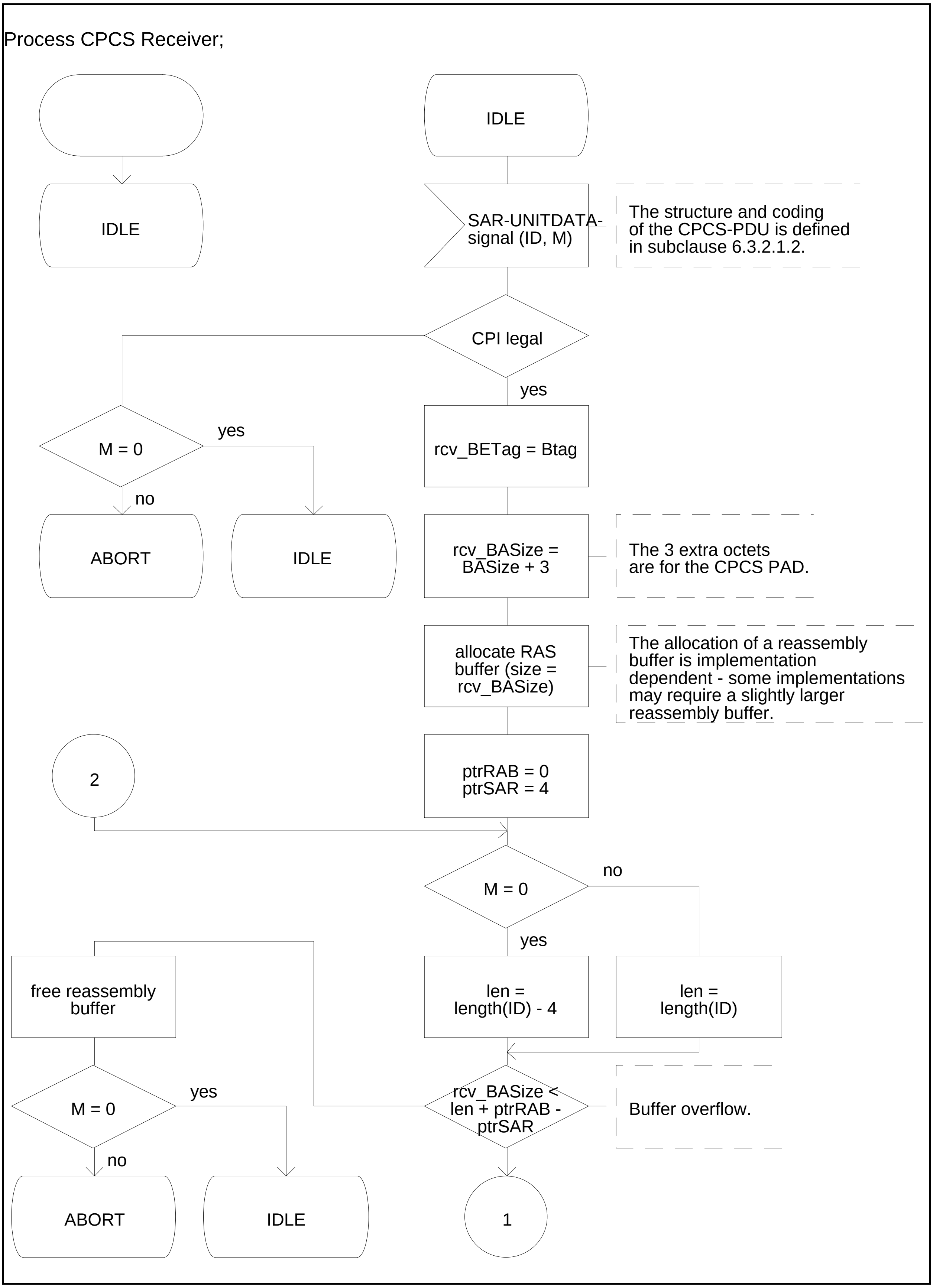


Figure E.5 (sheet 1 of 4): SDL diagrams for the CPCS receiver

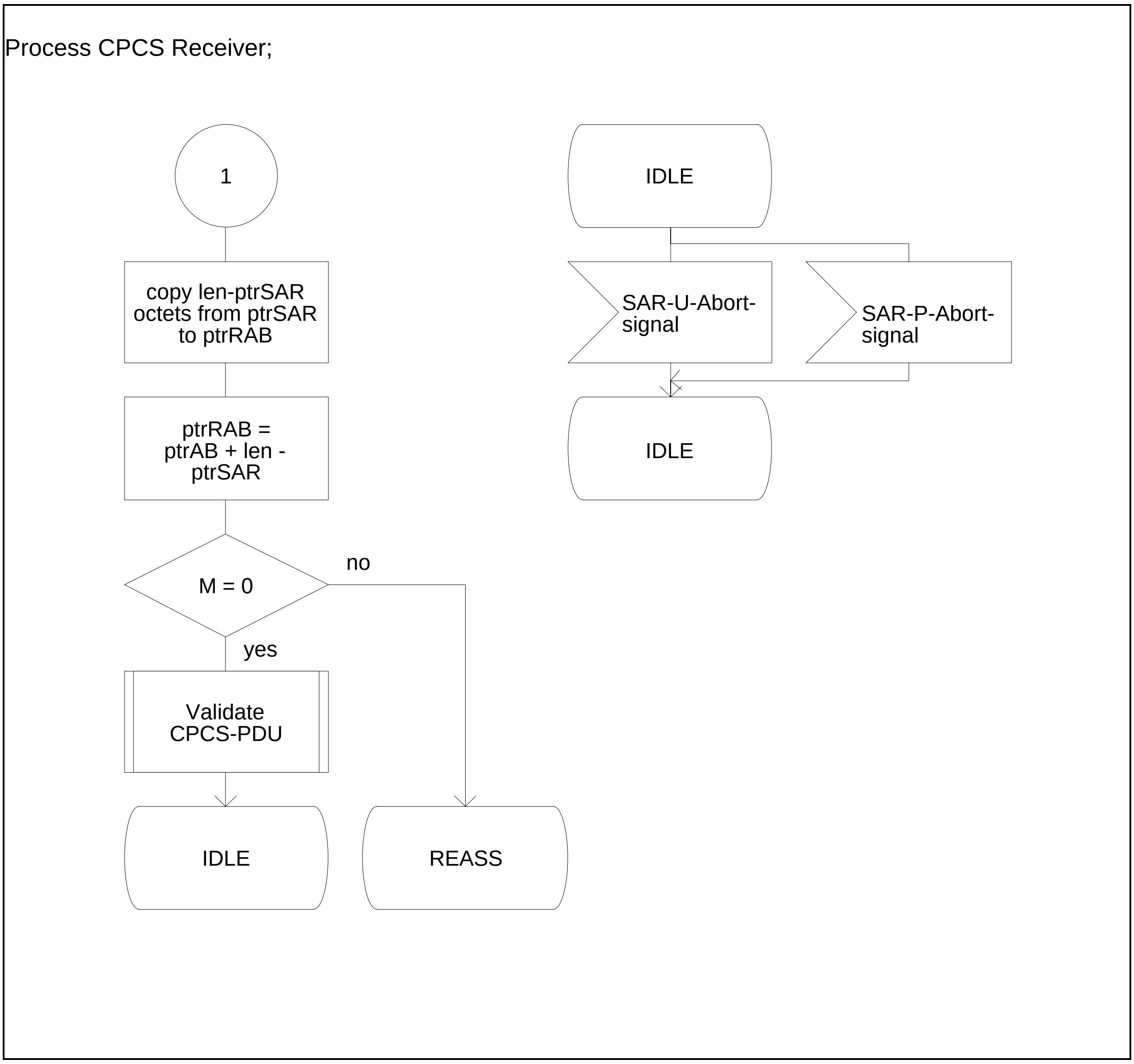


Figure E.5 (sheet 2 of 4): SDL diagrams for the CPCS receiver

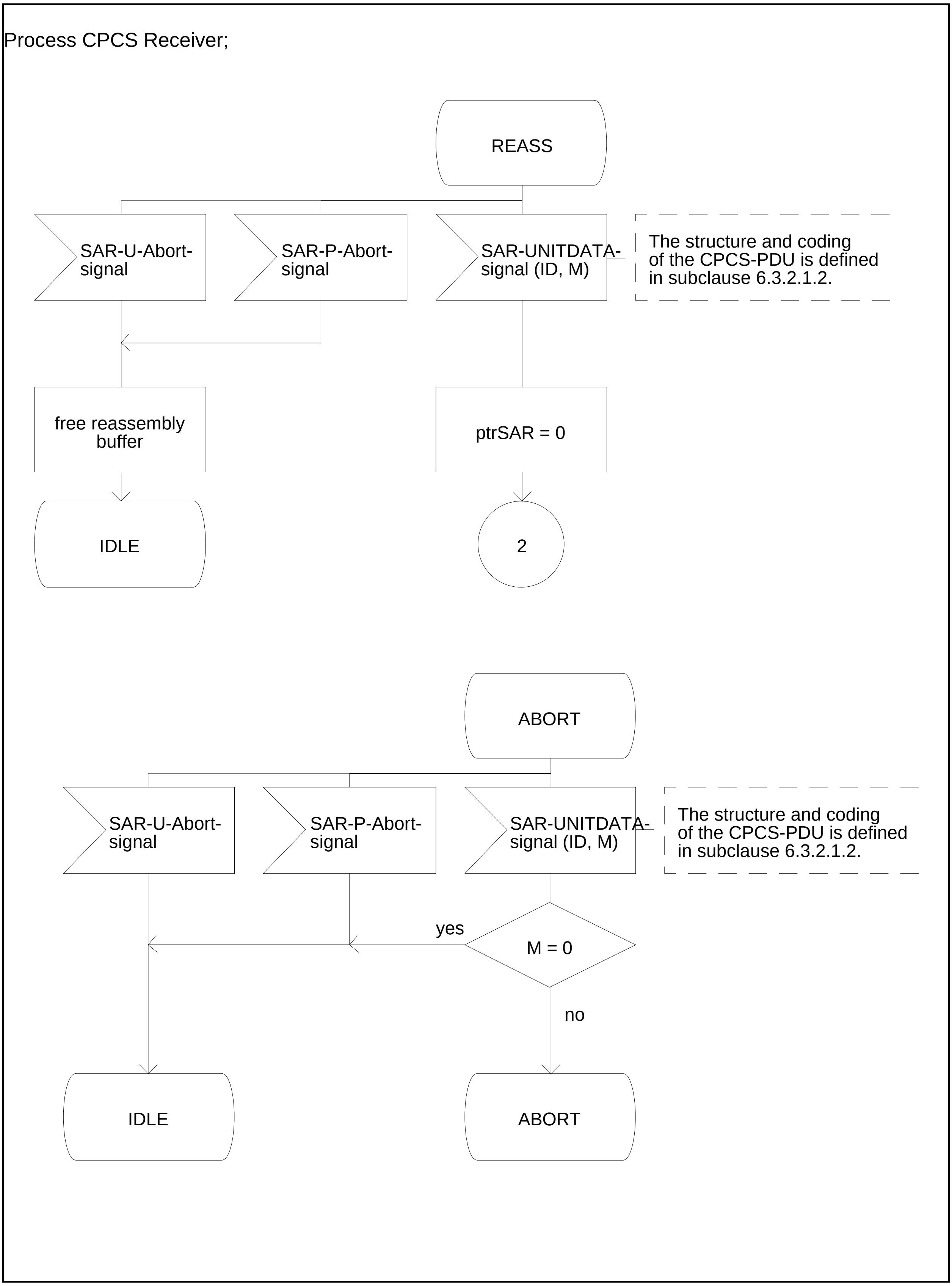


Figure E.5 (sheet 3 of 4): SDL diagrams for the CPCS receiver

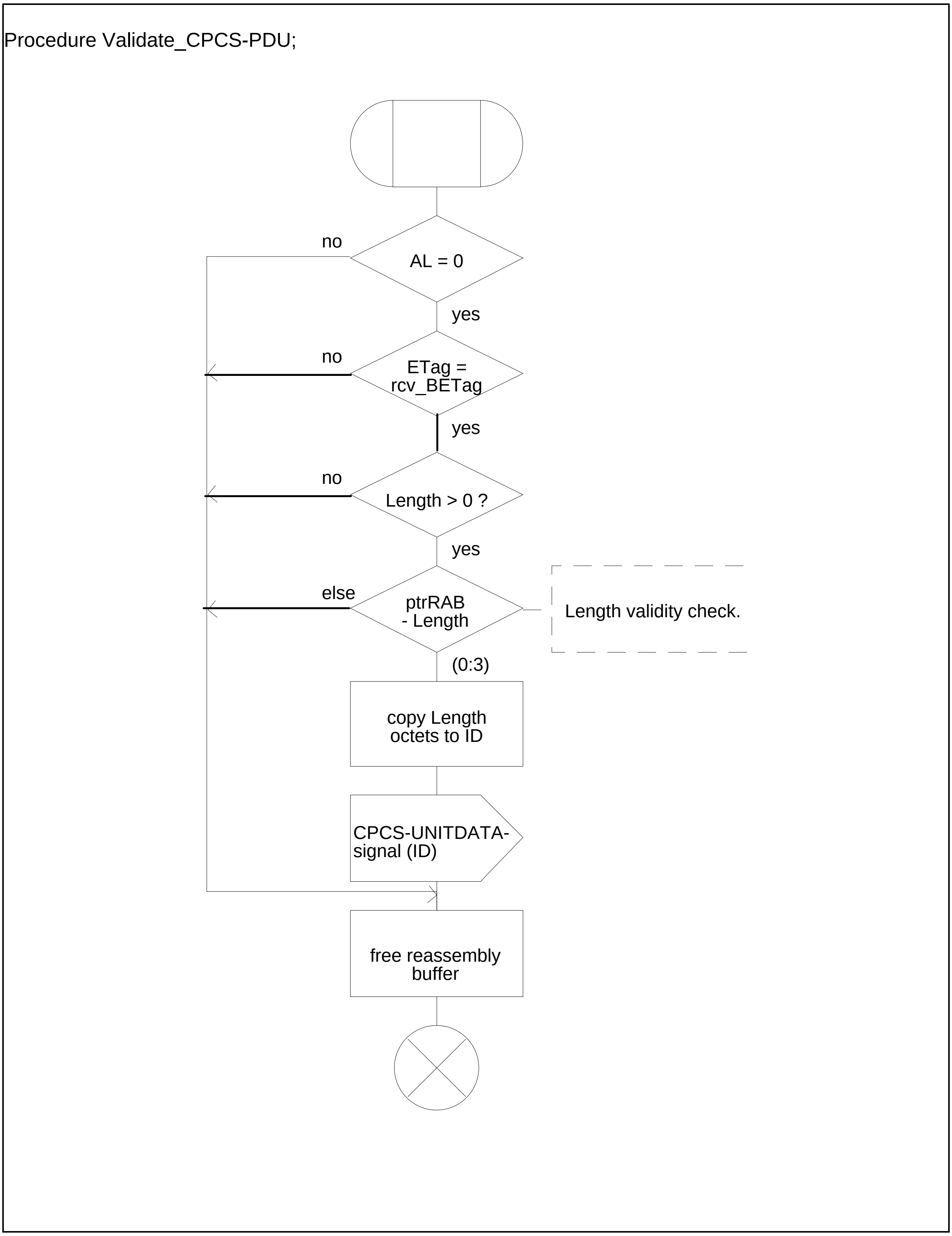


Figure E.5 (sheet 4 of 4): SDL diagrams for the CPCS receiver

Annex F (informative): Multiplexing AAL type 3/4 connections on an ATM connection using the MID field

F.1 Introduction

This annex illustrates the multiplexing of AAL type 3/4 connections on an ATM connection using the MID field within the common part of the AAL type 3/4. It also identifies some of the requirements on the MID value allocation scheme.

AAL type 3/4 connections can be:

a) unidirectional point-to-point (pt-pt), e.g. for retrieval services;

b) bidirectional point-to-point (pt-pt), e.g. used for class C services;

c) unidirectional point-to-multipoint (pt-mpt), e.g., used for class D services and by the local exchange to broadcast an incoming call to the terminals;

d) multipoint-to-multipoint (mpt-mpt);

e) multipoint-to-point (mpt-pt).

The ATM-connection can either be a point-to-point, a point-to-multipoint, or a multipoint-to-multipoint connection.

Both for class C and class D services, the AAL type 3/4 protocol will use the MID field to identify an "AAL type 3/4 connection". The correlation between Connection Endpoint identifier (CEP) and MID values is defined by control or management plane functions.

An AAL type 3/4 CEP is defined according to the OSI model and is represented in the AAL type 3/4 protocol by a single MID value. With a given AAL type 3/4 connection, the sequence integrity will be preserved.

Without changing the functionality within an AAL type 3/4 entity, it will also be possible to define a point-to-multipoint AAL type 3/4 connection by assigning more than two CEPs in two different AAL type 3/4 entities to the same MID value. A point-to-multipoint connection has however to be assigned unidirectionally.

F.2 Multiplexing configurations

F.2.1 Point-to-point AAL type 3/4 connection on a point-to-point ATM connection

This subclause applies to both unidirectional and bi-directional point-to-point AAL type 3/4 connections.

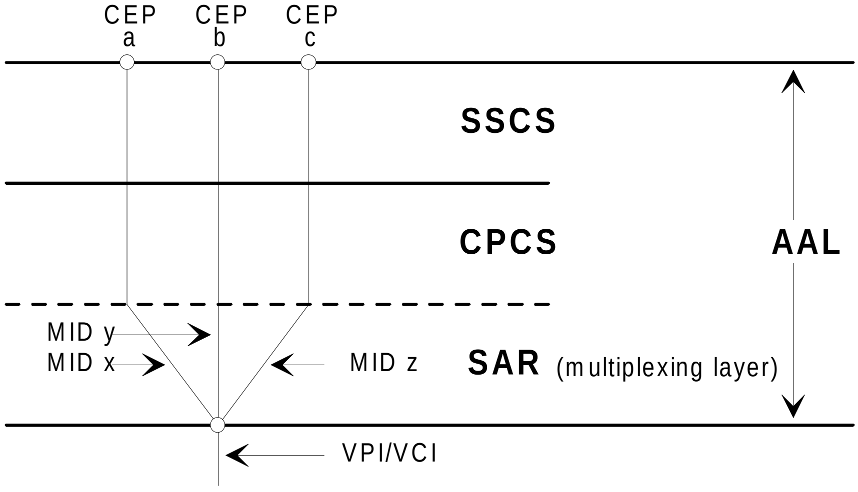


Figure F.1: Simplified model of the AAL type 3/4 to illustrate the multiplexing

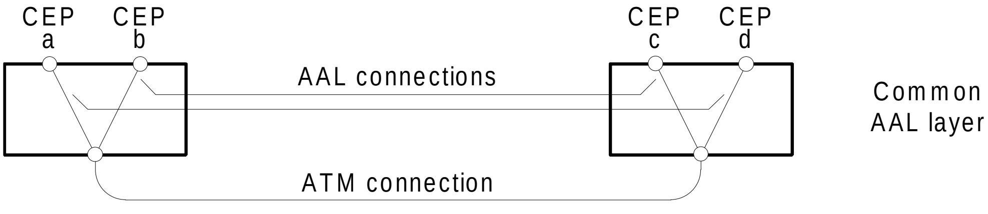


Figure F.2: Point-to-point AAL type 3/4 connection on a point-to-point ATM connection

Figure F.2 shows the case of a point-to-point AAL type 3/4 connection on a point-to-point ATM connection. Only two AAL type 3/4 entities are involved in the negotiation of the MID value to be used for each AAL type 3/4 connection.

The first MID value to be used can be either default or negotiated in the call establishment phase. Additional MID values (thus the establishment of additional AAL type 3/4 connections on the same ATM connection) can be negotiated via the M-plane or the C-plane ("inband" or "outband" signalling). As an example, since only two AAL type 3/4 entities are involved, the AAL type 3/4 entity at either end can take a free MID value (e.g. SAR entity A starting from the low end of the range, SAR entity B from the high end of the range).

Demultiplexing is handled in only one SAR entity. It shall discard all received SAR-PDUs with an unknown MID value and shall report the occurrence to the M-plane.

The AAL type 3/4 user will be guaranteed sequence integrity as long as the same CEP is selected.

F.2.2 Point-to-point AAL type 3/4 connection on a point-to-multipoint ATM connection

This section applies to both unidirectional and bi-directional point-to-point AAL type 3/4 connections.

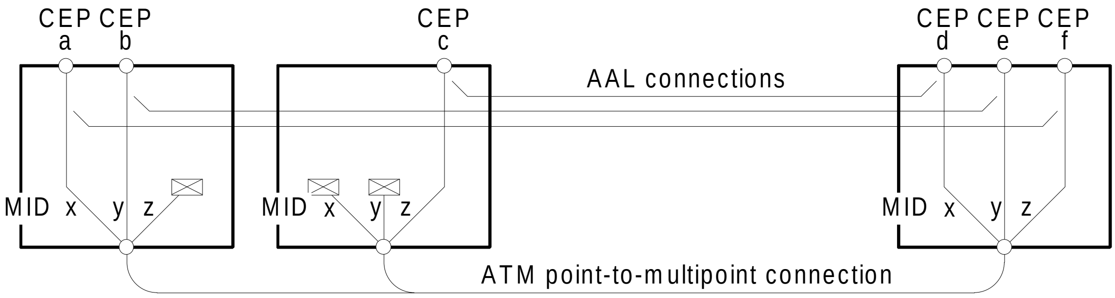


Figure F.3: Point-to-point AAL type 3/4 connection on a point-to-multipoint ATM connection

Figure F.3 shows the configuration of a point-to-point AAL type 3/4 connection on a point-to-multipoint ATM connection.

In this case the range of possible MID values needs to be distributed among all the AAL type 3/4 entities on the point-to-multipoint ATM connection. No MID value shall be allocated to two or more distinct AAL type 3/4 entities (on the multipoint side of the ATM connection).

The SAR entities can not use the same balanced example procedure for MID value allocation procedure as in the configuration of subclause 2.1 of this annex. The AAL type 3/4 entities at the multipoint side need not be aware of all the MID values allocated to the other AAL type 3/4 entities. A different MID value allocation procedure needs to be used since this is a Master-Slave configuration. One possible mechanism is described in annex G.

The demultiplexing will be handled the following way: the SAR entities at the multipoint side, on receiving a SAR-PDU with an unknown MID value, shall discard this SAR-PDU (this is represented with a crossed box in figure F.3), but need not necessarily send an error indication to the M-plane.

The AAL type 3/4 user will be guaranteed sequence integrity as long as the same CEP is selected.

F.2.3 Point-to-multipoint AAL type 3/4 connection on a point-to-multipoint ATM-connection

Without changing the functionality within an end system, it will also be possible to define a point-to-multipoint AAL type 3/4 connection by assigning more than two CEPs in two different AAL type 3/4 entities to the same MID value. A point-to-multipoint connection has however to be assigned unidirectionally.

NOTE: Other configurations, e.g. point-to-point and point-to-multipoint AAL type 3/4 connections on a multipoint-to-multipoint ATM-connection have not been studied.

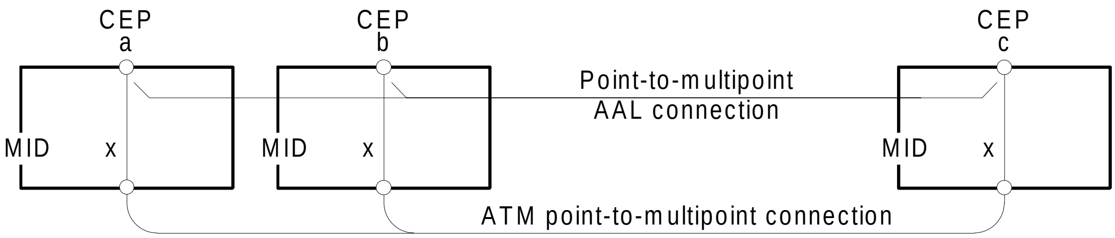


Figure F.4: Point-to-multipoint AAL type 3/4 connection on a point-to-multipoint ATM connection

Annex G (informative): MID allocation procedures

G.1 Introduction

The following procedures are one alternative to provide MID allocation. Other possible methods include signalling and management.

The common part of the AAL type 3/4 gives the possibility to multiplex/demultiplex CP-AAL connections on a single ATM connection using the MID field provided by the SAR sublayer. The number of CP-AAL connections supported over an ATM connection shall be negotiated between two CP-AAL entities. The default number of CP-AAL connection is one and has the default MID value "0". To assign and remove MID values to and from an ATM connection when multiplexing is used, MID allocation procedures are used. This management function is carried out by AAL Management (AALM) and is located in the management plane.

It may be possible to establish CP-AAL connections during the ATM connection establishment, e.g., by negotiating MID values using additional information elements. This is for further study.

In this annex, however, the MID allocation procedures will take place in the communication phase, i.e. the ATM connection is already established. The MID allocation procedures apply to the following configurations mentioned in annex F:

- point-to-point AAL type 3/4 connection on a point-to-point ATM connection;

- point-to-point AAL type 3/4 connection on a point-to-multipoint ATM connection;

- point-to-multipoint AAL type 3/4 connection on a point-to-multipoint ATM connection.

G.2 MID allocation functional architecture

The MID allocation functional architecture is depicted in figure G.1. There are two parties involved: two CP-AAL entities. The first party has the role of the one who is requesting the MID: the MID user and the second is the party who is assigning the MID values: the MID manager. Before any MID allocation procedure can be initiated, the role of the MID user and the MID manager needs to be agreed. This can be done via signalling in case of an on-demand ATM connection or via OAM in case of a (semi-)permanent ATM connection. In a point-to-multipoint ATM connection, the role of the MID users shall be located at the multipoint side.

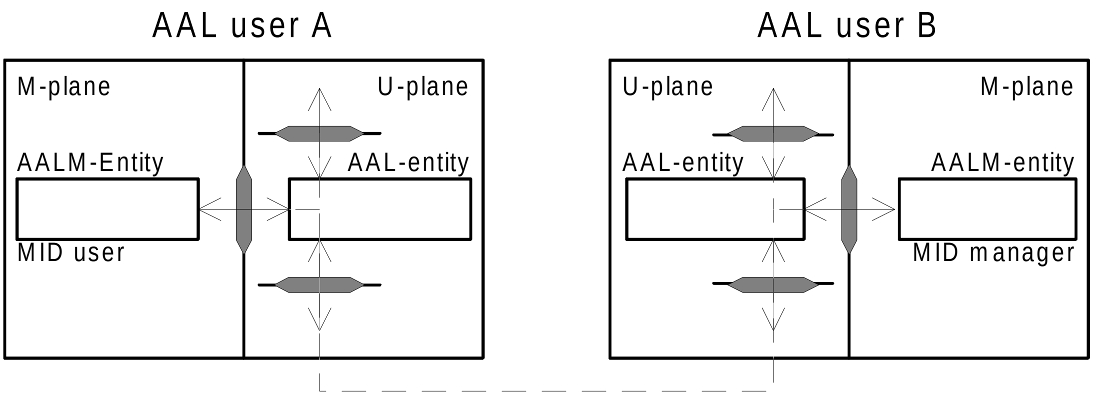


Figure G.1: MID allocation functional architecture

G.2.1 Functions of the MID user and the MID manager

The functions of MID user and MID manager are allocated in the management plane (see figure G.1).

The functions performed by a MID user are:

- requesting the allocation of one or more MID values;
- returning MID values;
- reporting what MID values it wishes to retain.

The functions performed by the MID manager are:

- allocating MID values to MID users;
- auditing MID values in order to retrieve MID values that were allocated but no longer needed or to detect any MID values that are not uniquely allocated;
- retrieving any MID values that are not or may not be uniquely allocated; and
- assigning and removing MID values from its associated AAL-entity.

G.2.2 Interaction between M-plane and U-plane

Primitives are needed to exchange the information across the boundary between the AALM-entity in the management plane and AAL-entity in the User plane. The primitives are for further study.

G.3 MID allocation PDUs and parameters

G.3.1 AALM-PDU types and parameters

An AALM-entity uses AALM-PDUs to communicate with its peer AALM-entities. Seven AALM-PDU types are used by the AALM-entities as part of the MID allocation process. All AALM-PDUs are sent over the same ATM connection as the AAL-PDUs. The AALM-PDUs will be sent by the AAL-entity in the user plane on behalf of the AALM-entity. Each AALM-PDU will be carried in a CPCS-PDU which in turn will be carried in a single segment type SAR-PDU (SSM), allowing 36 octets to be used for structure and coding of the MID allocation. The CPI field of the CPCS-PDU header is used to identify the type of AALM-PDU. The AALM-PDU types and their related parameters used for the MID allocation procedures are given in table G.1.

Table G.1: AALM-PDU types and parameters

AALM-PDU TYPE	Parameter used	Description
CP-AAL ESTABLISH REQUEST	N, RI	This message is sent from the MID user to the MID manager to request allocation of one or more MID values.
CP-AAL ESTABLISH RESPONSE	N, RI, MID values	This message is sent from the MID manager to the MID user in response to the CP-AAL ESTABLISH REQUEST message when the MID manager is able to allocate MID value(s).
CP-AAL ESTABLISH DENIED	RI, cause (note 2)	This message is sent from the MID manager to the MID user in response to the CP-AAL ESTABLISH REQUEST message when the MID manager is not able to allocate MID value(s).
CP-AAL RELEASE	MID values	This message is sent from the MID manager to the MID user to indicate the removal either of a set of MID values, or of all MID values from the MID user(s).
CP-AAL RETURN	MID values	This message is sent from the MID user to return one or more MID values to the MID manager for future allocation.
CP-AAL POLL		This message is sent by the MID manager to determine which MID values are being used by MID users.
CP-AAL STATUS	MID values	This message is sent from the MID user to the MID manager in response to the CP-AAL POLL message to indicate MID values the MID user wishes to retain.

NOTE 1: The used parameters are:
- N (the number of MID values);
- RI (Random reference Identifier); and
- cause.

Future editions of this ETS may contain additional parameters, e.g. the information element containing the AAL type 3/4 connection user (i.e. which SSCS and/or Higher Layer) may be used in combination with the CP-AAL ESTABLISHMENT REQUEST.

NOTE 2: The need for this parameter has to be clarified.

G.3.2 Structure and coding

In this subclause, structure and coding of the SAR-PCI, CPCS-PCI and AALM-PDU are given.

G.3.2.1 Structure and coding of the SAR-PCI

See subclause 6.3.1.2 for the general structure and coding of a SAR-PDU. The MID value of the SSM shall be a fixed value for management purposes. This fixed value will also be used by all MID users in case of multi-user configuration. The value is "0".

G.3.2.2 Structure and coding of the CPCS-PCI

The general structure and coding of a CPCS-PDU is described in subclause 6.3.2.1.2. The CPI (Common Part Indicator) field in the CPCS-PDU header is used to interpret subsequent fields for the CPCS functions in the CPCS-PDU header and trailer. For the MID allocation purposes, this field will be used to identify the AALM-PDU types. The AALM-PDU types in the CPI field and the encoding are given in table G.2.

Table G.2: CPI encoding of he AALM-PDU type

CPI encoding	AALM-PDU type
00001000	CP-AAL ESTABLISH DENIED
00001001	CP-AAL POLL
00001010	CP-AAL ESTABLISH RESPONSE
00001011	CP-AAL RELEASE
00001100	CP-AAL STATUS
00001110	CP-AAL RETURN
00001111	CP-AAL ESTABLISH REQUEST

G.3.2.3 Structure and coding of the AALM-PDU

35 octets are needed to allocate 16 MID values. The structure of the AALM-PDU is illustrated in figure G.2.

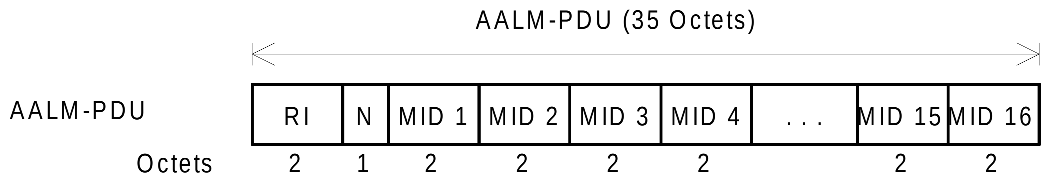


Figure G.2: Structure of the AALM-PDU

The AALM-PDU contains the following fields:

a) RI (Random reference Identifier).

This 2-octet field contains the value of the random number associated with the AALM-PDU. This field is used to correlate a CP-ESTABLISH-REQUEST-PDU with a CP-AAL-ESTABLISH-RESPONSE/DENIED-PDU. This field is set to zero for all PDUs that are not a CP-AAL-ESTABLISH-REQUEST-PDU or a CP-AAL-ESTABLISH-RESPONSE/DENIED-PDU;

b) N (Number of MID values).

This 1-octet field indicates the number of MID values that are referenced by the AALM-PDU. Valid values for this field are 1 to 16 ("00000001" to "00010000");

c) MIDn.

Each of these 2-octet fields contains an MID value referenced by the AALM-PDU. Exactly 16 of these fields are included in an AALM-PDU (the index "n" has the range from 1 to 16). A MIDn field is considered referenced if its index "n" is less than or equal to the value of the N field. All non-referenced MIDn fields are coded with zeros. Valid coding for the referenced MIDn fields include the values 1 to 1 023.

G.3.2.4 Relationship between PDUs

The relationship between AALM-PDU, CPCS-PDU and SAR-PDU is illustrated in figure G.3.

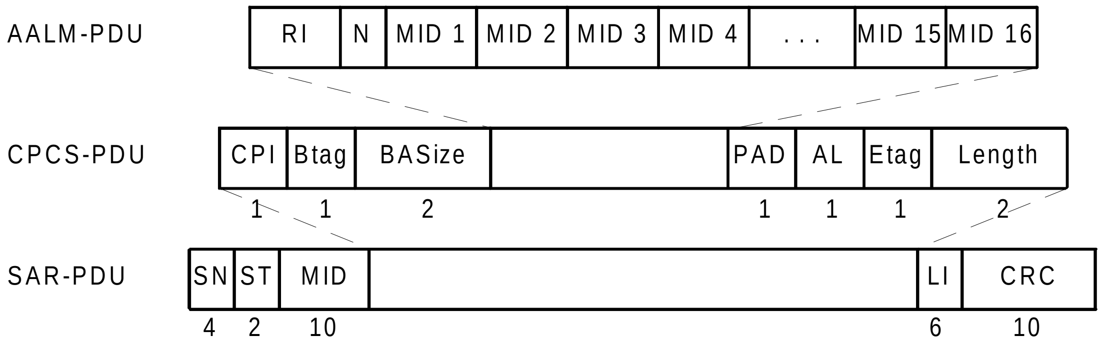


Figure G.3: Relationship between PDUs

G.4 MID allocation procedures

The MID allocation procedures are divided into three sets:

- to establish CP-AAL connection(s);
- to check the existence of CP-AAL connection(s);
- to release CP-AAL connection(s).

G.4.1 Procedures to establish CP-AAL connections

The procedures for the establishment of AAL type 3/4 connections are depicted in figures G.4 and G.5 for two situations respectively: successful and unsuccessful.

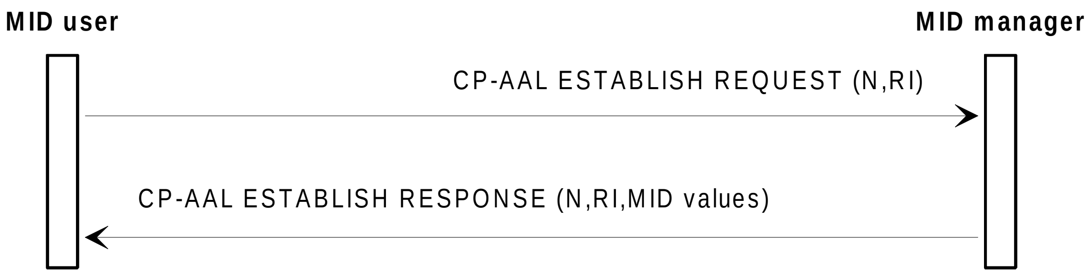


Figure G.4: Successful MID allocation

The first message is generated by a MID user and is a request for a MID value containing a randomly generated reference identifier RI value. The second message is generated by the MID manager and is a response to the request message that includes a unique MID value and the RI value (see figure G.4). The RI value is needed as an identifier for a MID user for the case when two or more MID users simultaneously want to request MID value(s). These procedures can be invoked if the MID user wants to set up new CP-AAL connections.

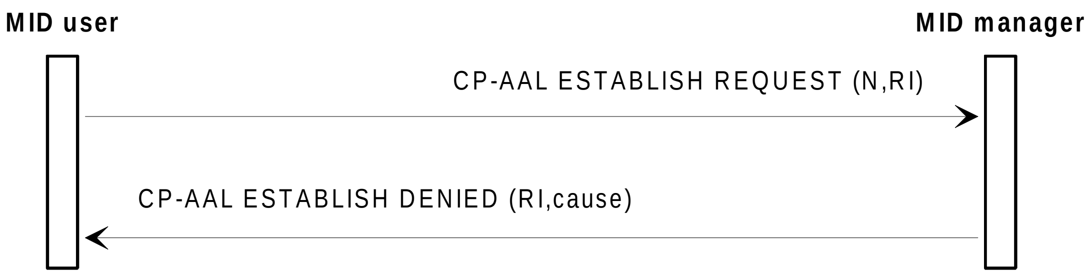


Figure G.5: Unsuccessful MID allocation

Figure G.5 gives the situation that no MID can be assigned to the MID user.

G.4.2 Procedure to check the CP-AAL connections

This procedure gives the MID manager the possibilities to check the allocated MID values.

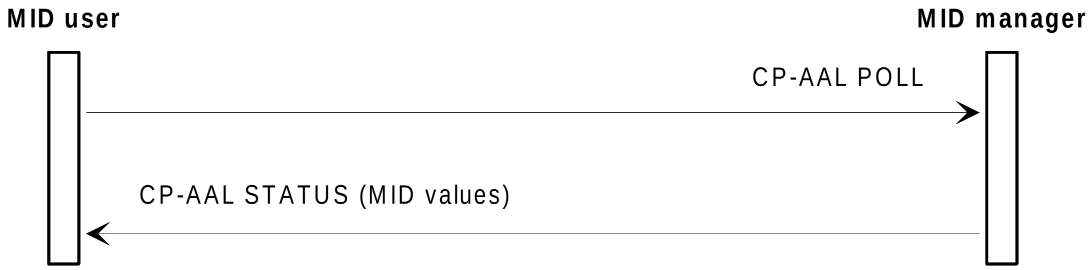


Figure G.6: Check MID values

On receiving a CP-AAL POLL from the MID manager, the MID user shall respond with a CP-AAL STATUS containing the MID values he would like to retain.

G.4.3 Procedures to release CP-AAL connections

Both sides of the CP-AAL connection can release the CP-AAL connection:

- by the MID manager;
- by the MID user.

G.4.3.1 Procedure to release CP-AAL connections, initiated by the MID manager

In some circumstances (e.g., system failure) the MID manager has to remove the MID values that have been assigned. In this case, it shall send a message to the MID user (see figure G.7).

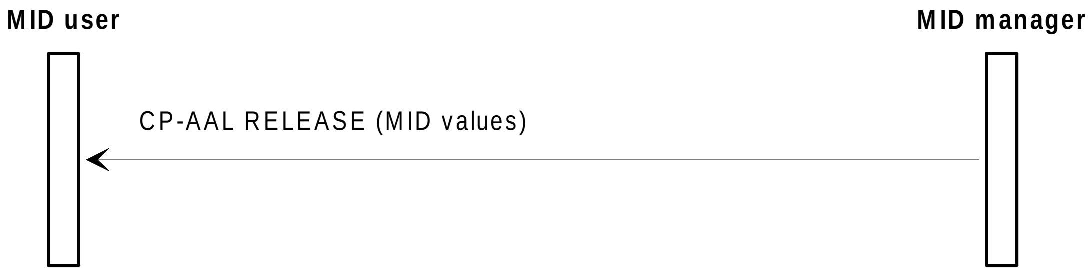


Figure G.7: Remove MID values

G.4.3.2 Procedure to release CP-AAL connections, initiated by the MID user

A method to release the AAL type 3/4 connections is by returning the MID values. This can be done by sending a message to the MID manager (see figure G.8).

Figure G.8: Return MID values

Annex H (informative): Bibliography

The following references are given for informative purposes.

1) ITU-T Recommendation I.362 (1993): "B-ISDN ATM Adaptation Layer (AAL) functional description".

2) ITU-T Recommendation Z.100 (1993): "Specification and Description Language (SDL)".

History

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