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Technical Specification

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Contents

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Foreword

This Technical Specification (TS) has been produced by the Special Mobile Group (SMG) of the European Telecommunications Standards Institute (ETSI).

This TS describes the Subnetwork Dependent Convergence Protocol (SNDCP) for the General Packet Radio Service (GPRS) within the digital cellular telecommunications system.

The contents of this TS are subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of this TS it will then be released by ETSI with an identifying change of release date and an increase in version number as follows:

Version 6.x.y

where:

6 GSM Phase 2+ Release 1997

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

y the third digit is incremented when editorial only changes have been incorporated in the specification.

1 Scope

This TS provides the description of the Subnetwork Dependent Convergence Protocol (SNDCP) for the General Packet Radio Service (GPRS).

The user of the services provided by SNDCP is a packet data protocol (PDP) at the mobile Station (MS) or the Relay at the Serving GPRS Support Node (SGSN). Additionally, a control entity, e.g., AT command interpreter, may be an SNDCP user. SNDCP uses the services provided by the Logical Link Control (LLC) layer [4] and the Session Management (SM) sub-layer [2].

The main functions of SNDCP are:

- Multiplexing of several PDPs.
- Compression/decompression of user data.
- Compression/decompression of protocol control information.
- Segmentation of a network protocol data unit (N-PDU) into Logical Link Control Protocol Data Units (LL-PDUs) and re-assembly of LL-PDUs into a N-PDU.

GSM 04.65 is applicable to GPRS MS and SGSN.

2 Normative references

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

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

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

[2] GSM 02.60: “Digital cellular telecommunication system (Phase 2+); General Packet Radio Service (GPRS); Service Description, Stage 1”.

[3] GSM 03.60: “Digital cellular telecommunication system (Phase 2+); General Packet Radio Service (GPRS); Service Description, Stage 2”.

[4] GSM 04.07: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface signalling layer 3; General aspects".

[5] GSM 04.08: "Digital cellular telecommunications system (Phase 2+), Mobile radio interface layer 3 specification".

[6] GSM 04.64: “Digital cellular telecommunication system (Phase 2+); General Packet Radio Service (GPRS); Mobile Station - Serving GPRS Support Node (MS-SGSN) Logical Link Control (LLC) Layer Specification”.

[7] GSM 09.60: "Digital cellular telecommunications system (Phase 2+), General Packet Radio Service (GPRS); GPRS Tunnelling Protocol (GTP) across the Gn and Gp Interface".

[8] ITU-T, Recommendation V.42 *bis*: “Data compression procedures for data circuit- terminating equipment (DCE) using error correcting procedures”.

[9] RFC-1144, V. Jacobson: “Compressing TCP/IP Headers for Low-Speed Serial Links”.

3 Definitions and Abbreviations

3.1 Definitions

In addition to abbreviations in 01.04 [1] and 02.60 [2] the following abbreviations apply:

N201 LLC layer parameter (see GSM 04.64 for clarity). Defines maximum number of octets in the information field of LL-PDU. Separate values are applicable for I (see N201-I), U and UI (see N201-U) LL-PDUs.

N201-I LLC layer parameter (see GSM 04.64 for clarity). Defines maximum number of octets available to a SN-DATA PDU for a specific SAPI.

N201-U LLC layer parameter (see GSM 04.64 for clarity). Defines maximum number of octets available to a SN-UNITDATA PDU for a specific SAPI.

N-PDU number A sequence number assigned to N-PDUs per NSAPI in unacknowledged mode.

NSAPI For each SN-PDU the NSAPI is an index to the PDP context of the PDP that is using the services provided by the SNDCP layer.

Protection mode Identifies the transfer mode for SN-UNITDATA transfer. In the protected mode, the lower layers shall discard the erroneous data when an error in the check sequence of the received user data is noticed. The erroneous data is not delivered to SNDCP layer at the receiving entity. In the unprotected mode, the correctness of the received information is not checked. The received information is transferred transparently to the peer SNDCP layer and to the user of the peer SNDCP entity.

SAPI SAPI identifies the Service Access Point (with which a QoS profile is associated) that the SN-PDU is using at the LLC layer.

Segment number A sequence number assigned to SN-unitdata PDUs carrying segments of an N-PDU.

SNDCP entity The SNDCP entity handles the service functions provided by the SNDCP layer. The SNDCP entity is temporary logical link identity specific.

SNDCP management entity The SNDCP management entity handles communication with SM sub-layer and controls the operation of the SNDCP entity.

SNDCP user Protocol entity that is using the services provided by the SNDCP layer. PDP entities and control entities, e.g., AT command interpreter, are the SNDCP users at the MS. Relay entity is the SNDCP user at the SGSN.

SNDCP XID block The collection of SNDCP XID parameters being negotiated. It is transferred by the LL-XID and LL-ESTABLISH primitives between SNDCP and LLC.

Refer to GSM 02.60 [2] for further GPRS definitions.

3.2 Abbreviations

In addition to abbreviations in 01.04 [1] and 02.60 [2] the following abbreviations apply:

DCOMP	Identifier of the user data compression algorithm used for the N-PDU
E	Extension bit
IP	Internet Protocol
GMM	GPRS Mobility Management
LLC	Logical Link Control
M	More bit used to indicate the last segment of N-PDU

N-PDU	Network Protocol Data Unit
NSAPI	Network Layer Service Access Point Identifier
PCOMP	Identifier of the protocol control information compression algorithm used for the N-PDU
PDP	Packet Data Protocol e.g., IP or X.25
PDU	Protocol Data Unit
PTP	Point to Point
QoS	Quality of Service
SAPI	Service Access Point Identifier
SDU	Service Data Unit
SGSN	Serving GPRS Support Node
SM	Session Management
SNDCP	Subnetwork Dependent Convergence Protocol
SNSM	SNDCP-SM
TCP	Transmission Control Protocol
TLLI	Temporary Logical Link Identifier
X	Spare bit.

4 General

This document describes the functionality of the GPRS SNDCP. The overall GPRS logical architecture is defined in GSM 03.60 [3]. Location of the SNDCP in GPRS protocol stack can be seen in Figure 1.

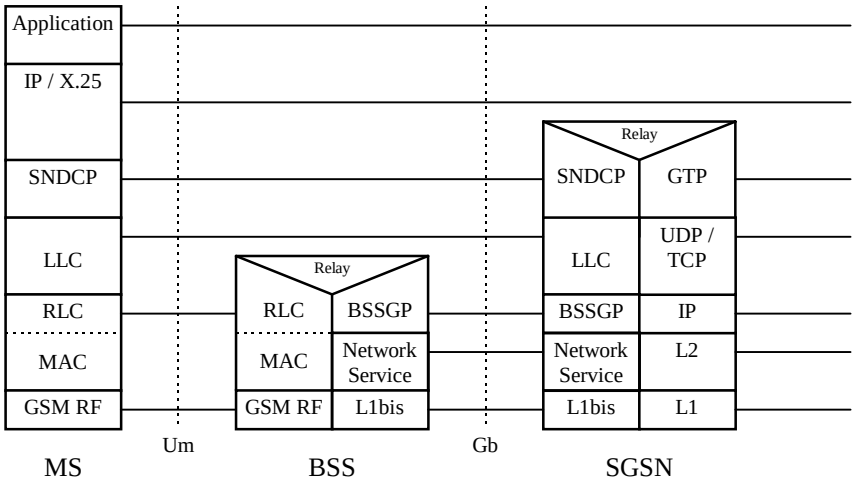


Figure 1: GPRS protocol stack

Network layer protocols are intended to be capable of operating over services derived from a wide variety of subnetworks and data links. GPRS supports several network layer protocols providing protocol transparency for the users of the service. Introduction of new network layer protocols to be transferred over GPRS shall be possible without any changes to GPRS. Therefore, all functions related to transfer of Network layer Protocol Data Units (N-PDUs) shall be carried out in a transparent way by the GPRS network entities. This is one of the requirements for GPRS SNDCP.

Another requirement for the SNDCP is to provide functions that help to improve channel efficiency. This requirement is fulfilled by means of compression techniques.

The set of protocol entities above SNDCP consists of commonly used network protocols. They all use the same SNDCP entity, which then performs multiplexing of data coming from different sources to be sent using the service provided by the LLC layer (figure 2). The Network Service Access Point Identifier (NSAPI) is an index to the PDP context (see GSM 03.60 [3]) of the PDP that is using the services provided by SNDCP. One PDP may have several PDP contexts and NSAPIs. However, it is possible that each allocated NSAPI is used by separate PDP. Each active NSAPI shall use the services provided by the Service Access Point Identifier (SAPI) in the LLC layer. Several NSAPIs may be associated with the same SAPI.

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

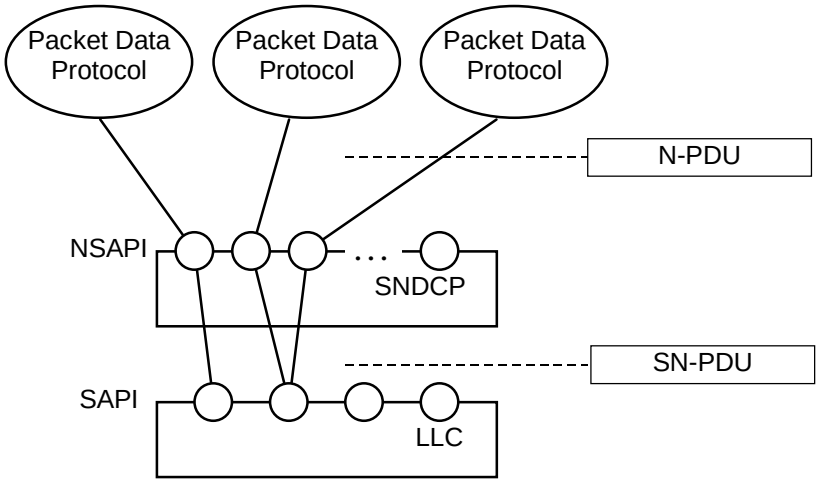


Figure 2: Example for multiplexing of different protocols

5 Service Primitives and Functions

5.1 Service Primitives

This subclause explains the service primitives used for communication between the SNDCP layer and other layers. See also GSM 04.07 [4] to get an overall picture of the service primitives. Figure 3 illustrates the service access points through which the primitives are carried out.

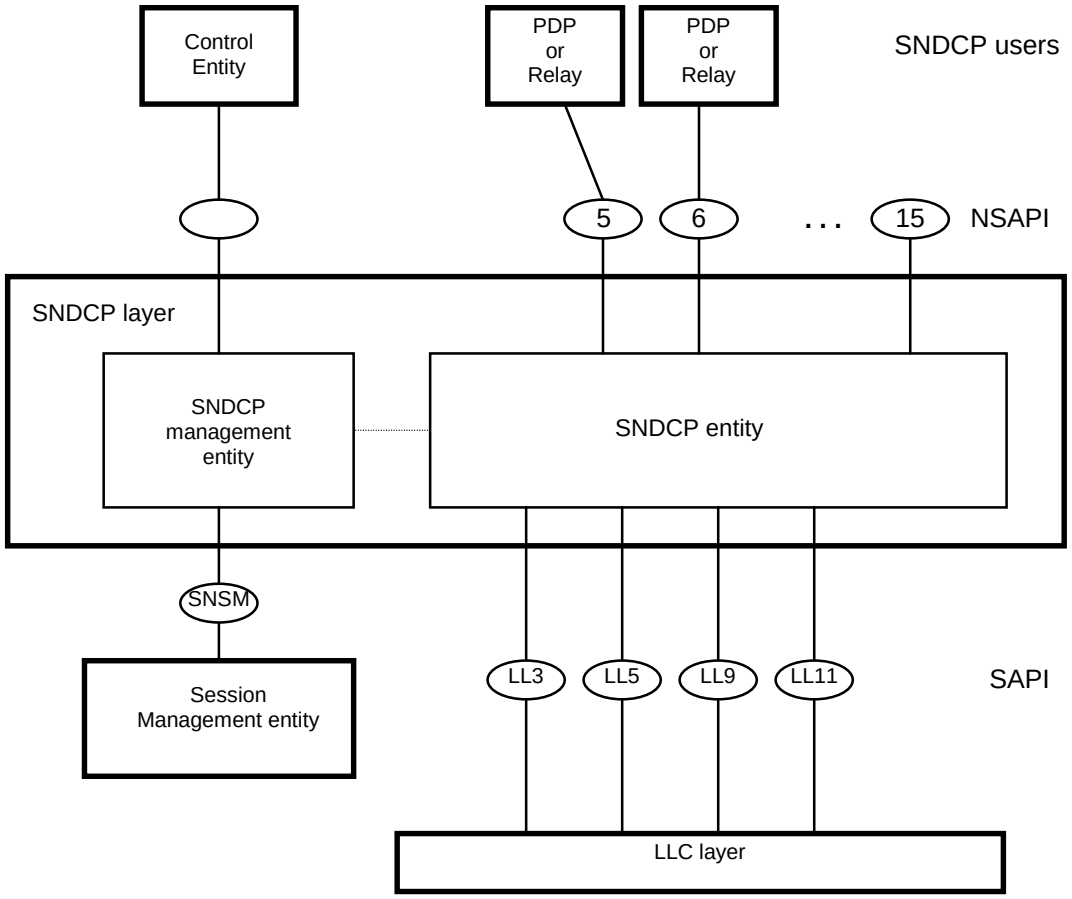


Figure 3: Service Access Points provided and used by SNDCP

5.1.1 SNDCP Service Primitives

The primitives provided by the SNDCP layer are listed in Table 1.

Table 1: SNDCP layer service primitives

Generic Name	**Type**				**Parameters**
	Request	Indication	Response	Confirm	
SNDCP User (PDP or the SGSN Relay) <---> SNDCP					
SN-DATA	X	X	-	-	N-PDU, NSAPI
SN-UNITDATA	X	X	-	-	N-PDU, NSAPI, protection mode
SN-XID	X	X	-	-	Requested SNDCP XID parameters
SN-XID	-	-	X	X	Negotiated SNDCP XID parameters

5.1.1.1 SN-DATA.request

Request used by the SNDCP user for acknowledged transmission of N-PDU. The successful transmission of SN-PDU shall be confirmed by the LLC layer. The SN-DATA.request primitive conveys NSAPI to identify the PDP using the service.

5.1.1.2 SN-DATA.indication

Indication used by the SNDCP entity to deliver the received N-PDU to the SNDCP user. Successful reception has been acknowledged by the LLC layer.

5.1.1.3 SN-UNITDATA.request

Request used by the SNDCP user for unacknowledged transmission of N-PDU. The SN-UNITDATA.request primitive conveys NSAPI to identify the PDP using the service and protection mode to identify the requested transmission mode.

5.1.1.4 SN-UNITDATA.indication

Indication used by the SNDCP entity to deliver the received N-PDU to the SNDCP user.

5.1.1.5 SN-XID.request

Request used by the SNDCP user at the initiating entity to deliver the list of requested XID parameters to the peer entity.

5.1.1.6 SN-XID.indication

Indication used by the SNDCP entity to deliver the list of requested XID parameters to the SNDCP user.

5.1.1.7 SN-XID.response

Response used by the SNDCP user to deliver the list of negotiated XID parameters to the peer entity.

5.1.1.8 SN-XID.confirm

Confirm used by the SNDCP entity to deliver the list of negotiated XID parameters to the SNDCP user.

5.1.2 Service Primitives Used by SNDCP Layer

The SNDCP layer uses the service primitives provided by the SM sublayer and the LLC layer (see Table 2). SM is specified in GSM 04.08 [5] and LLC in GSM 04.64 [6].

Table 2: Service primitives used by the SNDCP entity

Generic Name	Type				Parameters
	Request	Indication	Response	Confirm	
SNDCP <---> LLC					
LL-ESTABLISH	X	-	-	-	TLLI, XID Requested
LL-ESTABLISH	-	X	-	-	TLLI, XID Requested, N201-I, N201-U
LL-ESTABLISH	-	-	X	-	TLLI, XID Negotiated
LL-ESTABLISH	-	-	-	X	TLLI, XID Negotiated, N201-I, N201-U
LL-RELEASE	X	-	-	-	TLLI, Local
LL-RELEASE	-	X	-	-	TLLI, Cause
LL-RELEASE			-	X	TLLI
LL-XID	X	-	-	-	TLLI, XID Requested
LL-XID	-	X	-	-	TLLI, XID Requested, N201-I, N201-U
LL-XID	-	-	X	-	TLLI, XID Negotiated
LL-XID	-	-	-	X	TLLI, XID Negotiated, N201-I, N201-U
LL-DATA	X	-	-	-	TLLI, SN-PDU, Reference
LL-DATA	-	X	-	-	TLLI, SN-PDU
LL-DATA	-	-	-	X	TLLI, Reference
LL-DATASENT	-	X	-	-	TLLI, Reference, V(S)
LL-UNITDATA	X	-	-	-	TLLI, SN-PDU, Protection mode, Cipher
LL-UNITDATA	-	X	-	-	TLLI, SN-PDU
SNDCP <---> SM					
SNSM-ACTIVATE		X	-	-	TLLI, NSAPI, QoS profile, SAPI
SNSM-ACTIVATE	-	-	X		TLLI, NSAPI
SNSM-DEACTIVATE	-	X	-	-	TLLI, NSAPI(s), LLC release indicator
SNSM-DEACTIVATE	-	-	X	-	TLLI, NSAPI
SNSM-MODIFY	-	X	-	-	TLLI, NSAPI, QoS profile, SAPI
SNSM-MODIFY	-	-	X	-	TLLI, NSAPI
SNSM-STATUS	X	-	-	-	TLLI, SAPI, Cause
SNSM-WINDOW	-	X	-	-	TLLI, NSAPIs+V(R)s

5.1.2.1 LL-ESTABLISH.request

Request used by the SNDCP layer to establish or re-establish acknowledged peer-to-peer operation for a SAPI in the LLC layer.. XID Requested is used to deliver the requested SNDCP XID parameters to the LLC layer.

5.1.2.2 LL-ESTABLISH.indication

Indication used by the LLC layer to inform the SNDCP layer about establishment or re-establishment of acknowledged peer-to-peer operation for a SAPI in the LLC layer. XID Requested is used to deliver the requested SNDCP XID parameters to the SNDCP layer. In case of a link re-establishment, all buffered N-PDUs (i.e. the one whose complete reception has not been acknowledged and the ones that have not been transmitted yet) are to be transmitted starting with the oldest N-PDU when the link is re-established. Also all compression entities using acknowledged peer-to-peer LLC operation on this SAPI are reset.

5.1.2.3 LL-ESTABLISH.response

Response used by the SNDCP layer after reception of the LL-ESTABLISH.indication. XID Negotiated is used to deliver the negotiated SNDCP XID parameters to the LLC layer.

5.1.2.4 LL-ESTABLISH.confirm

Confirmation used by the LLC layer to inform the SNDCP layer about successful initiation of acknowledged peer-to-peer operation for a SAPI in the LLC layer. XID Negotiated is used to deliver the negotiated SNDCP XID parameters to the SNDCP layer. In case of a re-establishment, all buffered N-PDUs (i.e., the ones whose complete reception has not been acknowledged and the ones that have not been transmitted yet) are to be transmitted starting with the oldest N-PDU when the link is re-established. Also all compression entities using acknowledged peer-to-peer LLC operation on this SAPI are reset.

5.1.2.5 LL-RELEASE.request

Request used by the SNDCP layer to release acknowledged peer-to-peer operation for a SAPI in the LLC layer. The Local parameter indicates whether the termination shall be local (see 04.64 for details).

5.1.2.6 LL-RELEASE.indication

Indication used by the LLC layer to inform the SNDCP layer about termination of acknowledged peer-to-peer operation for a SAPI in the LLC layer. The Cause parameter indicates the cause for the termination.

On receipt of LL-RELEASE.indication, compressed N-PDUs queuing to be forwarded to the affected SAPI are deleted from the SNDCP layer. Also all compression entities using acknowledged peer-to-peer LLC operation on this SAPI are reset.

5.1.2.7 LL-RELEASE.confirm

Confirmation used by the LLC layer to inform the SNDCP layer about termination of acknowledged peer-to-peer operation for a SAPI in the LLC layer. On receipt of LL-RELEASE.confirm, compressed N-PDUs queuing to be forwarded to the affected SAPI are deleted from the SNDCP layer. Also all compression entities using acknowledged peer-to-peer LLC operation on this SAPI are reset.

5.1.2.8 LL-XID.request

Request used by the SNDCP layer to deliver the requested SNDCP XID parameters to the LLC layer.

5.1.2.9 LL-XID.indication

Indication used by the LLC layer to deliver the requested SNDCP XID parameters to the SNDCP layer.

5.1.2.10 LL-XID.response

Response used by the SNDCP layer to deliver the negotiated SNDCP XID parameters to the LLC layer.

5.1.2.11 LL-XID.confirm

Confirm used by the LLC layer to deliver the negotiated SNDCP XID parameters to the SNDCP layer.

5.1.2.12 LL-DATA.request

Request used by the SNDCP layer for acknowledged transmission of an SN-PDU. The SNDCP entity shall associate a reference parameter for each LL-DATA.request.

Acknowledged peer-to-peer LLC operation for the SAPI used shall be established using the LL-ESTABLISH primitives, before the LL-DATA.request may be used.

5.1.2.13 LL-DATA.indication

Indication used by the LLC layer to deliver the successfully received SN-PDU to the SNDCP layer.

5.1.2.14 LL-DATA.confirm

Confirm used by the LLC layer to inform SNDCP layer about successful transmission of SN-PDU. The primitive includes a reference parameter from which the SNDCP entity shall identify the LL-DATA.request this confirmation was associated with. All buffered N-PDUs whose complete reception is confirmed are deleted.

5.1.2.15 LL-DATASENT.indication

The LL-DATASENT.indication primitive is used by the LLC layer in acknowledged mode in the SGSN to inform SNDCP of the LLC send sequence number that was assigned to an LLC PDU. SNDCP uses this information to associate the LLC send sequence number with the corresponding N-PDU.

5.1.2.16 LL-UNITDATA.request

Request used by the SNDCP layer for unacknowledged transmission of a SN-PDU. Unconfirmed transmission shall be used by the LLC layer.

Acknowledged peer-to-peer LLC operation does not need to be established before unacknowledged transmission is allowed.

5.1.2.17 LL-UNITDATA.indication

Indication used by the LLC layer to deliver the received SN-PDU to the SNDCP layer.

There is no need for acknowledged-peer-to-peer LLC operation for unacknowledged transmission of SN-PDU.

5.1.2.18 SNSM-ACTIVATE.indication

Indication used by the SM entity to inform the SNDCP entity that an NSAPI has been activated for data transfer. It also informs the SNDCP entity about the negotiated QoS profile (see GSM 04.08) and the SAPI assigned for this NSAPI.

Upon reception of the SNSM-ACTIVATE.indication from the SM sublayer, the SNDCP entity shall, if necessary, establish the acknowledged peer-to-peer LLC operation for the indicated SAPI. The establishment criteria and procedure are described in subclause 6.2.2.

5.1.2.19 SNSM-ACTIVATE.response

Response used by the SNDCP layer to inform SM entity that the indicated NSAPI is now in use and that the acknowledged peer-to-peer LLC operation for the indicated SAPI is established, if necessary.

5.1.2.20 SNSM-DEACTIVATE.indication

Indication used by the SM entity to inform the SNDCP entity that an NSAPI has been deallocated and cannot be used by the SNDCP entity anymore. All buffered N-PDUs corresponding to this NSAPI are deleted.

Upon reception of the SNSM-DEACTIVATE.indication, the SNDCP entity shall, if necessary, release the acknowledged peer-to-peer LLC operation for the associated SAPI. The release criteria and procedure are described in subclause 6.2.3.

5.1.2.21 SNSM-DEACTIVATE.response

Response used by the SNDCP layer to inform SM entity that the NSAPI indicated is no longer in use and that the acknowledged peer-to-peer LLC operation for the associated SAPI is released, if necessary..

5.1.2.22 SNSM-MODIFY.indication

Indication used by the SM entity to trigger change of the QoS profile (see GSM 04.08) for an NSAPI and indication of the SAPI to be used. It is also used by the SM entity in the SGSN to inform the SNDCP entity that an NSAPI shall be created, together with the (re-)negotiated QoS profile and the SAPI assigned.

NOTE: The latter is performed in the new SGSN during an Inter-SGSN Routeing Area Update.

Upon reception of the SNSM-MODIFY.indication from the SM sublayer, the SNDCP entity shall, if necessary, establish the acknowledged peer-to-peer LLC operation for the indicated SAPI. The establishment criteria and procedure are described in subclause 6.2.2. The SNDCP entity shall also, if necessary, release the acknowledged peer-to-peer LLC operation for the originally-assigned SAPI. The release criteria and procedure are described in subclause 6.2.3.

5.1.2.23 SNSM-MODIFY.response

Response used by the SNDCP entity to inform the SM entity that the indicated NSAPI and QoS profile are now in use and the acknowledged peer-to-peer LLC operations for the appropriate SAPIs are established and/or released, if necessary.

5.1.2.24 SNSM-STATUS.request

This primitive is used by the SNDCP layer to inform the SM sub-layer that SNDCP cannot continue its operation due to errors at the LLC layer (as indicated with LL-Release.indication) or at the SNDCP layer. The Cause parameter indicates the cause of the error.

5.1.2.25 SNSM-WINDOW.indication

This primitive is only included in the SGSN and is used in the case of Inter SGSN RA Update. The primitive is used in the new SGSN by the SM entity to inform the SNDCP entity about the LLC PDU sequence number that has been correctly received by the MS. This is indicated by the V(R) value received from the MS during the Inter SGSN RA Update procedure. The SNDCP entity of the SGSN uses this information to delete all buffered N-PDUs whose complete reception is confirmed.

5.2 Service Functions

SNDCP shall perform the following functions (see figure 3):

- Mapping of SN-DATA primitives onto LL-DATA primitives.
- Mapping of SN-UNITDATA primitives onto LL-UNITDATA primitives.
- Multiplexing of N-PDUs from one or several network layer entities onto the appropriate LLC connection.
- Establishment, re-establishment and release of acknowledged peer-to-peer LLC operation.
- N-PDU buffering at SNDCP for acknowledged service.
- Management of delivery sequence for each NSAPI, independently.
- Compression of redundant protocol control information (e.g., TCP/IP header) at the transmitting entity and decompression at the receiving entity. The compression method is specific to the particular network layer or transport layer protocols in use.
- Compression of redundant user data at the transmitting entity and decompression at the receiving entity. Data compression is performed independently for each SAPI, and may be performed independently for each PDP context. Compression parameters are negotiated between the MS and the SGSN.
- Segmentation and reassembly. The output of the compressor functions is segmented to the maximum length of LL-PDU. These procedures are independent of the particular network layer protocol in use.
- Negotiation of the XID parameters between peer SNDCP entities using XID exchange.

Figure 4 shows the transmission flow through SNDCP layer. The order of functions is the following:

- Protocol control information compression.
- User data compression.
- Segmentation of compressed information into SN-DATA or SN-UNITDATA PDUs.

The order of functions is vice versa in the reception flow:

- Reassembly of SN-PDUs to SN-PDUs.
- User data decompression.
- Protocol control information decompression.

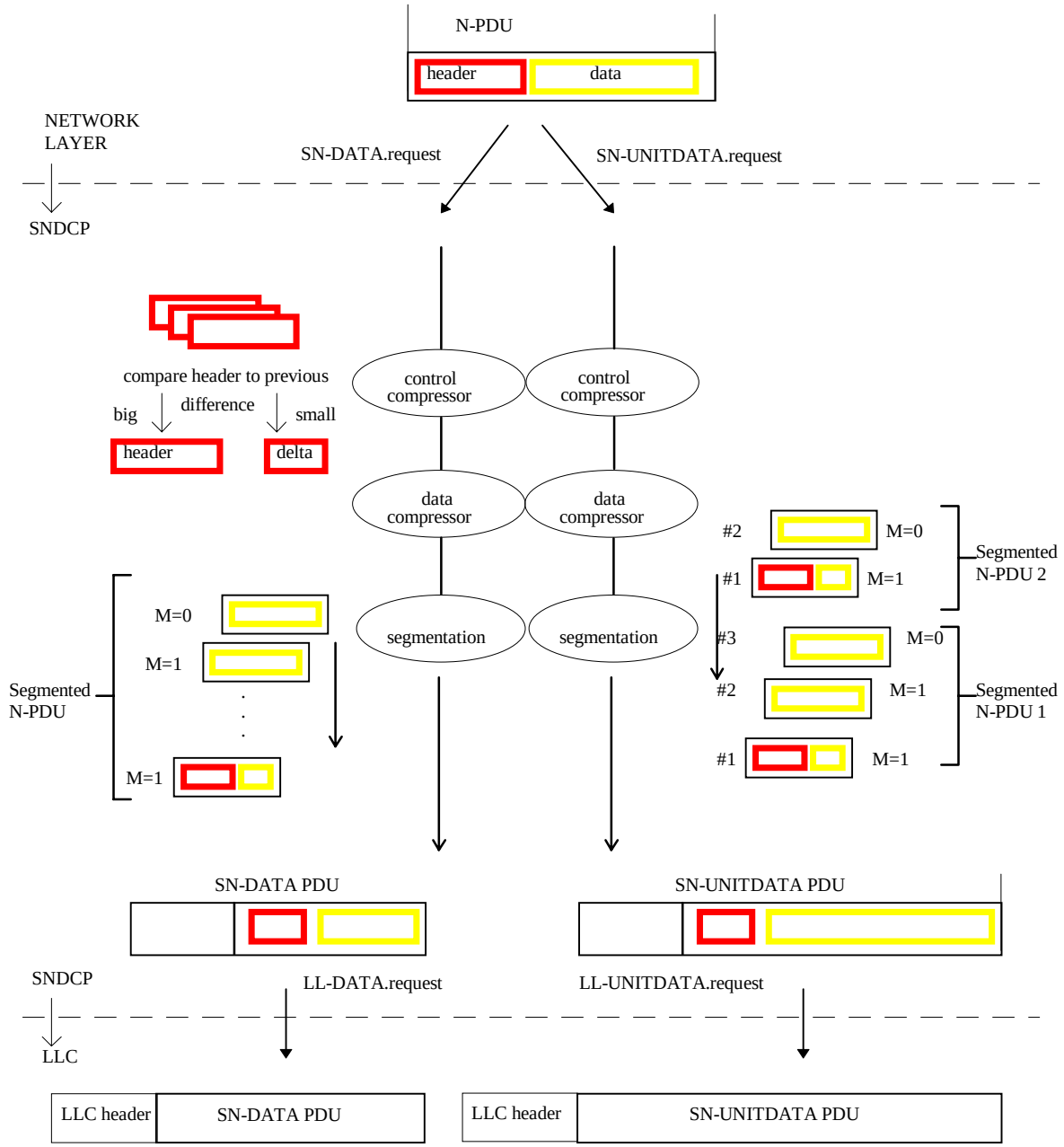


Figure 4: SNDCP model

The SNDCP layer expects the following services to be provided by the LLC layer. LLC layer functionality is defined in GSM 04.64 [6]:

- Acknowledged and unacknowledged data transfer.
- Point-to-point and point-to-multipoint data transfer.
- In-order delivery of SN-PDUs per SAPI (i.e. SN-PDUs using the same SAPI shall appear at the receiving end in the same order as transmitted). This is required only for acknowledged service.
- QoS profile-based transfer of SN-PDUs.
- Support for variable length SN-PDUs.
- Transfer of SNDCP XID parameters.

The SNDCP layer expects the following services to be provided by the SM sublayer. SM sublayer functionality is defined in GSM 04.08 [5]:

- Activation and deactivation of PDP Contexts and informing the SNDCP layer when change in PDP context has happened.
- Carrying out Inter SGSN Routing Area Update and informing the SNDCP layer in the SGSN when the N-PDUs shall be tunnelled to the new SGSN.
- Notifying the SNDCP layer when there is need to change the QoS profile parameters of the PDP contexts.

6 Protocol Functions

6.1 Multiplexing of N-PDUs

The NSAPI field shall be used for the identification of the specific PDP type and PDP address pair that is using the services provided by the SNDCP layer. The MS allocates NSAPIs dynamically at the PDP Context Activation. The NSAPI is delivered by the SM sub-layer to the SNDCP layer with the SNSM-ACTIVATE.indication primitive. The transmitting SNDCP entity shall insert the NSAPI value for each N-PDU. The peer SNDCP entity uses the NSAPI to identify the SNDCP user the N-PDU is targeted. Table 3 shows an example for the allocation of the NSAPIs.

Table 3: Example of the NSAPI allocation

PDP type	Allocated NSAPI	PDP address
IP	12	133.12.75.111
X.25	13	13254

6.2 Establishment and release of acknowledged peer-to-peer LLC operation

6.2.1 General

The SNDCP layer shall be responsible for establishing, re-establishing and releasing the acknowledged peer-to-peer LLC operation.

Re-establishment and release of the acknowledged peer-to-peer LLC operation may also be initiated by the LLC layer. The conditions under which this may happen are described in GSM 04.64.

Negotiation of SNDCP XID parameters may be carried out in conjunction with the establishment or re-establishment procedure. It is also possible to negotiate SNDCP XID parameters independently from the establishment or re-establishment procedure, by using the LL-XID primitives.

6.2.2 Establishment of acknowledged peer-to-peer LLC operation

6.2.2.1 Establishment criteria

If acknowledged peer-to-peer LLC operation is required by a PDP context (as indicated by the QoS profile) but is not yet established for the SAPI used by the PDP context, then the SNDCP layer shall initiate the establishment procedure.

The SNDCP layer at the MS shall initiate the establishment, using the procedure in subclause 6.2.2.3, upon receipt of the SNSM-ACTIVATE.indication primitive.

The SNDCP layer at the SGSN shall initiate the establishment, using the procedure in subclause 6.2.2.3, upon arrival of the first downlink N-PDU for the NSAPI if it has already received an SNSM-ACTIVATE.indication primitive, but the establishment procedure has not been invoked by the MS.

The SNDCP layer at the SGSN shall also initiate the establishment upon receipt of the SNSM-MODIFY.indication primitive.

6.2.2.2 Re-establishment of the acknowledged peer-to-peer LLC operation

The SNDCP layer may initiate re-establishment of the acknowledged peer-to-peer LLC operation for a SAPI under certain situations, for example when an error is detected by a V.42bis data compression entity used for acknowledged data transfer.

The LLC layer may also initiate re-establishment of the acknowledged peer-to-peer LLC operation for a SAPI under situations described in GSM 04.64. The LLC layer informs the SNDCP layers of link re-establishment using the LL-ESTABLISH.indication primitive. This is shown in Figure 5.

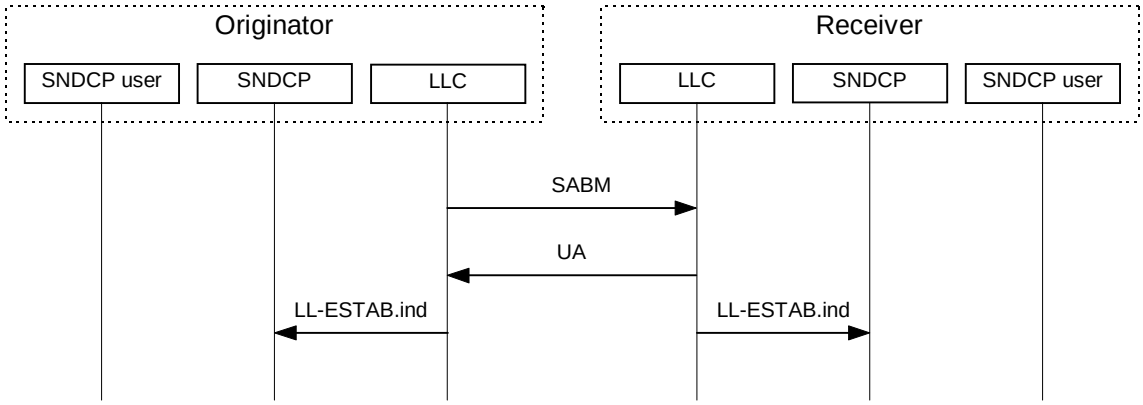


Figure 5: LLC-initiated re-establishment

6.2.2.3 Establishment procedure

The SNDCP layer shall initiate the establishment or re-establishment by sending an LL-ESTABLISH.request primitive to the relevant LLC SAP. SNDCP XID parameters may be included in an SNDCP XID block in the LL-ESTABLISH.request primitive. If no SNDCP XID parameter is to be included, an empty SNDCP XID block shall be included.

Upon receipt of an LL-ESTABLISH.indication primitive, if an SNDCP XID block is present, the peer SNDCP entity shall respond with an LL-ESTABLISH.response primitive. SNDCP XID parameters may be included in an SNDCP XID block in the LL-ESTABLISH.response primitive. If no SNDCP XID parameter is to be included, an empty SNDCP XID block shall be included. If there is no SNDCP XID block in the LL-ESTABLISH.indication primitive, the peer SNDCP entity shall not respond with an LL-ESTABLISH.response primitive.

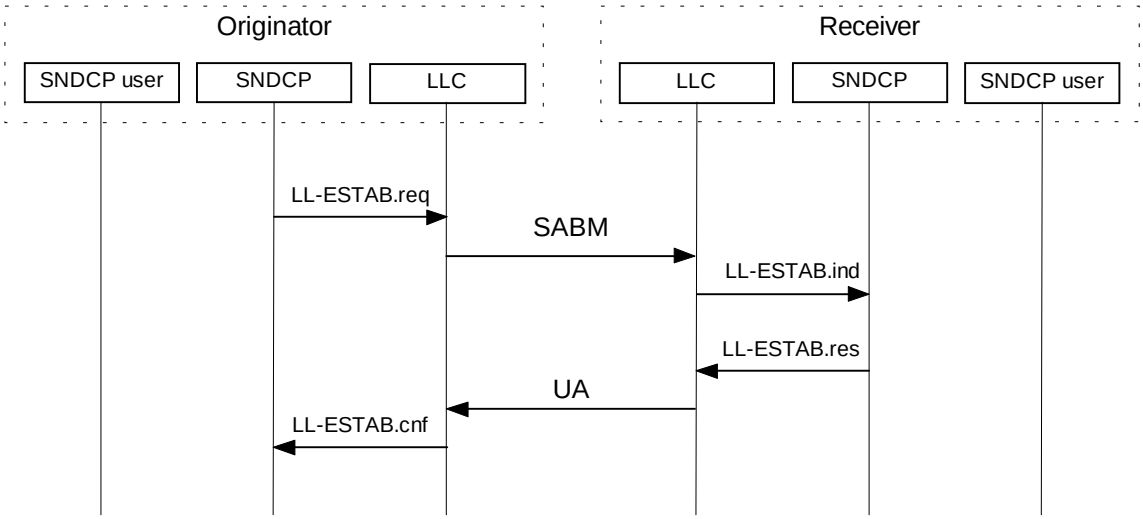


Figure 6: SNDCP-initiated establishment / re-establishment

6.2.2.4 Exceptional situations

If the originator of the establishment procedure receives an LL-RELEASE.indication with Cause “DM received”, it shall inform the SM sub-layer using the SNSM-STATUS.request primitive with Cause “DM received”. SM shall then deactivate all PDP contexts for that SAPI requiring acknowledged peer-to-peer LLC operation.

If the originator of the establishment procedure receives an LL-RELEASE.indication with Cause “invalid XID received”, it shall inform the SM sub-layer using the SNSM-STATUS.request primitive with Cause “invalid XID received”. SM shall then deactivate all PDP contexts for that SAPI.

If the originator of the establishment procedure receives an LL-RELEASE.indication with Cause “no peer response”, it shall inform the SM sub-layer using the SNSM-STATUS.request primitive with Cause “no peer response”, wait for an implementation-specific amount of time, and re-invoke the establishment procedure. Before the establishment procedure is re-invoked, N-PDUs arriving at the SNDCP layer for delivery to the LLC layer shall be buffered, if possible.

If the SNDCP layer receives an LL-RELEASE.indication with Cause “lower layer deactivation”, it shall inform the SM sub-layer using the SNSM-STATUS.request primitive with Cause “lower layer deactivation”. SM shall then deactivate all PDP contexts for that SAPI.

If the SNDCP layer receives an LL-RELEASE.indication with Cause “normal release”, it shall buffer, if possible, all downlink N-PDUs for PDP contexts using the affected SAPI that requires acknowledged peer-to-peer LLC operation. Transfer of N-PDUs for PDP contexts that do not require acknowledged peer-to-peer LLC operation shall not be affected.

If the originator of the establishment procedure detects a collision (receiving an LL-ESTABLISH.indication primitive after sending an LL-ESTABLISH.request or LL-XID.request primitive, or receiving an LL-XID.indication primitive after sending an LL-XID.request primitive), it shall treat the LL-ESTABLISH.request or LL-XID.request primitive sent as not transmitted, and process the LL-ESTABLISH.indication or LL-XID.indication primitive received. In the case of collision between an LL-XID.request and an LL-ESTABLISH.indication without an SNDCP XID block, after the LL-ESTABLISH.indication has been processed, the LL-XID.request shall be re-sent to complete the SNDCP XID negotiation.

6.2.3 Release of acknowledged peer-to-peer LLC operation

6.2.3.1 Release criteria

If acknowledged peer-to-peer LLC operation is established for the SAPI used by a PDP context that is going to be deactivated or mapped to another SAPI, and if there is no other NSAPIs that require acknowledged peer-to-peer LLC operation using the original SAPI, then the SNDCP layer shall initiate the release procedure.

The SNDCP layer shall initiate the release, using the procedure described in subclause 6.2.3.2, upon receipt of the SNSM-DEACTIVATE.indication primitive.

The SNDCP layer at the SGSN shall also initiate the release upon receipt of the SNSM-MODIFY.indication primitive if an existing NSAPI is specified.

6.2.3.2 Release procedure

The SNDCP layer shall initiate the release by sending a LL-RELEASE.request primitive to the relevant LLC SAP. The Local parameter shall be set if the release is the result of receipt of the SNSM-DEACTIVATE.indication primitive, otherwise it shall not be set.

6.2.3.3 Release initiated by the LLC layer

The LLC layer may initiate release of the acknowledged peer-to-peer LLC operation for a SAPI under situations described in GSM 04.64. The LLC layer shall inform the SNDCP layers of the release of acknowledged peer-to-peer LLC operation using the LL-RELEASE.indication primitive. SNDCP shall process the LL-RELEASE.indication primitive as described in subclause 6.2.2.4.

6.3 N-PDU buffering

The N-PDUs are buffered in the SNDCP layer before they are compressed segmented and transmitted to the LLC layer. The reception of a SNSM-DEACTIVATE.indication triggers the deletion of the buffer for the related NSAPI.

For acknowledged data transfer, an SNDCP entity shall buffer an N-PDU until successful transmission of all SN-PDUs carrying a segment of the N-PDU have been confirmed by the LLC layer. The confirmation is carried out using the LL-DATA.confirm or SNSM-WINDOW.indication primitives. At SGSN, for each LL-DATA.request sent to the LLC layer a LL-DATASENT.indication primitive is returned to SNDCP as soon as a LLC send sequence number has been assigned to the LLC PDU. This LLC send sequence number is included in the LL-DATASENT.indication primitive. At the SNDCP entities, the buffered N-PDUs which have been completely received as indicated by the acknowledgements in an LL-DATA.confirm primitive are discarded. During the Inter-SGSN RA Update, the N-PDUs whose complete reception by the MS has been confirmed in the SNSM-WINDOW.indication primitive are discarded, as defined in GSM 09.60 [7] and GSM 03.60 [3].

For unacknowledged data transfer, the SNDCP shall delete an N-PDU immediately after it has been delivered to the LLC layer.

6.4 Management of delivery sequence

The SNDCP layer shall retain the delivery sequence of N-PDUs of each NSAPI between the peer entities. The delivery sequence of N-PDUs from different NSAPIs may alter according to the QoS requirements.

6.5 Protocol Control Information Compression

Protocol control information compression is an optional SNDCP feature. Only TCP/IP header compression has been specified in this specification.

Negotiation of the supported algorithms and their parameters is carried out between MS and SGSN using the SNDCP XID parameters (see clause 8).

6.5.1 Negotiation of multiple protocol control information compression types

Each SNDCP entity that supports protocol control information compression shall be able to negotiate one or several protocol control information compression types with the SNDCP XID format shown in Figure 5. The negotiation shall be carried out using the XID parameter negotiation specified in subclause 6.8. The initiating entity defines a set of requested algorithms and their parameters. The set of algorithms and their parameters shall be transmitted to the peer

entity. The peer entity responds with the set of negotiated algorithms and their parameters. The peer entity shall select the proposed values or other appropriate values for the negotiated algorithms. No more than 15 compression algorithms (excluding the no compression alternative) shall be selected by the peer entity. If the peer entity responds with an algorithm set including more than 15 algorithms and parameters, only the 15 first algorithms shall be taken into consideration. The rest of the negotiated algorithms are ignored without error notification.

bit	8	7	6	5	4	3	2	1
octet 1	X	X	X	Algorithm Type				
octet 2	Length = n - 2							
octet 3	High-order octet							
…	…							
octet n	Low-order octet							

Figure 5: Protocol control information compression field format for SNDCP XID negotiation

Spare bit (X):

0 Shall be set to 0. If SN-PDU is received with the Spare bit set to 1, the field shall be ignored without error notification.

Table 4 show the list of protocol control information compression algorithms supported by the SNDCP layer. When new compression algorithms are needed for SNDCP, Table 4 shall be updated.

Table 4: List of protocol control information compression algorithms supported by SNDCP

Compression algorithm	Algorithm type (Range 0-31)
RFC1144 IP	0
RFC1144 Uncompressed TCP/IP	1
RFC1144 Compressed TCP/IP	2
-	Other values Reserved

The values for the PCOMP shall be defined dynamically, based on the negotiation of the XID parameters for protocol control information compression. PCOMP value 0 is reserved for no compression. Other 15 values (1-15) are derived from the set of negotiated data compression algorithms. If TCP/IP header compression shall be used for at least one NSAPI, PCOMP values must be allocated for each of the algorithm types 0, 1 and 2 in table 4. The NSAPI(s) that wish to use TCP/IP header compression must also be indicated for each of the algorithm types in the XID negotiation.

6.5.1.1 Assignment of PCOMP values

The assignment of the PCOMP values follows the following general rule:

- PCOMP value 0 is reserved permanently for no compression.
- PCOMP value 1 shall be assigned for the first algorithm on the set of the negotiated algorithms. PCOMP value n shall be assigned for the n-th algorithm on the set of the negotiated algorithms. This rule continues until the PCOMP value has been assigned for all the negotiated algorithms. However, if parameter values have been negotiated for the same algorithm in more than one field inside the XID block (applicable for different NSAPIs), the same PCOMP value shall be assigned to all instances of the same algorithm. The compression entities will be identifiable by a combination of NSAPI and PCOMP values in the SN-(UNIT)DATA frame header. If XID parameters are renegotiated during a connection, the PCOMP value of an algorithm used both before and after the renegotiation shall not be changed. Also a PCOMP value used before a renegotiation for one algorithm cannot be used for another algorithm after the renegotiation.

While transferring data, the compression algorithm type used for the SN-PDU is conveyed in the PCOMP field of the SNDCP header. Any successfully negotiated algorithm may be used for compression of N-PDU.

In case the parameters of a compression entity are renegotiated during an existing connection, the configuration is not affected if only the applicable NSAPIs are changed. However, if the other parameters change, the compression entities shall be reset.Compression entities used with acknowledged peer-to-peer LLC operation shall be reset by re-establishing the acknowledged peer-to-peer LLC operation of the SAPI used. Compression entities used with unacknowledged peer-to-peer LLC operation shall be reset locally upon completion of the SNDCP XID negotiation.

On negotiating a compression entity, not all the parameters of the entity have to be specified. If a parameter is to be included, all the preceding parameters shall also be specified, and the length field shall be set to the sum of the lengths of all the parameters specified. If any of the parameters is not specified, the rules in subclause 6.8.3 shall apply.

If the originator of the SNDCP XID re-negotiation changes the parameters of a compression entity used with acknowledged peer-to-peer LLC operation, the re-negotiation shall be performed using the LL-ESTABLISH primitives. Otherwise the LL-XID primitives shall be used. If the originator does not change the parameters of compression entities used with acknowledged peer-to-peer LLC operations (i.e. the re-negotiation is performed using the LL-XID primitives) but the responder changes the parameters, the originator shall re-establish the acknowledged peer-to-peer LLC operation, using the LL-ESTABLISH primitives, upon completion of the SNDCP XID re-negotiation.

6.5.2 TCP/IP header compression

The protocol control information compression method is specific for each network layer protocol type. TCP/IP (IPv4) header compression is specified in RFC 1144 [9].

The underlying service shall be able to distinguish three types of SN-PDUs (i.e., IP, Uncompressed TCP/IP, and Compressed TCP/IP), as defined in RFC 1144 [9]. Those three SN-PDU types are defined as three different algorithm types in Table 4. When the TCP/IP header compression is negotiated at the SNDCP XID exchange, PCOMP values for the three algorithm types shown in Table 4 shall be negotiated.

Table 5: RFC 1144 TCP/IP header compression parameters

			Parameters				
Algorithm Name	**Algorithm Type**	**Length**	**Parameter Name**	**Format**	**Range**	**Sense of Negotiation**	**Default Value**
RFC 1144 IP	0	0 or 2	Applicable NSAPIs	bbbbbbbb bbbbbbbb	0-255	down (each bit separately)	0
RFC 1144 Uncompressed TCP/IP	1	0 or 2	Applicable NSAPIs	bbbbbbbb bbbbbbbb	0-255	down (each bit separately)	0
RFC 1144 Compressed TCP/IP	2	0, 2 or 3	Applicable NSAPIs	bbbbbbbb bbbbbbbb	0-255	down (each bit separately)	0
			S_0	bbbbbbbb	0-254	down	16

Applicable NSAPIs

See subclause 7.1.3.

S_0 The Number of State Slots

The number of memory locations for saved packet headers. [9]

When TCP/IP header compression is used with unacknowledged peer-to-peer LLC operation, the decompression entity shall be notified in case an N-PDU is dropped, so that error recovery procedure (see [9] section 4.1) can be invoked.

6.6 Data compression

Data compression is an optional SNDCP feature. Data compression applies to both SN-DATA and SN-UNITDATA primitives.

Figure 6 shows an example how the SNDCP functions may be used. Several NSAPIs may use a common data compression entity, i.e., the same compression algorithm and the same dictionary. Separate data compression entities shall be used for acknowledged (SN-DATA) and unacknowledged (SN-UNITDATA) data transfer. Several NSAPIs may be associated with one SAPI, i.e., they may use the same QoS profile.

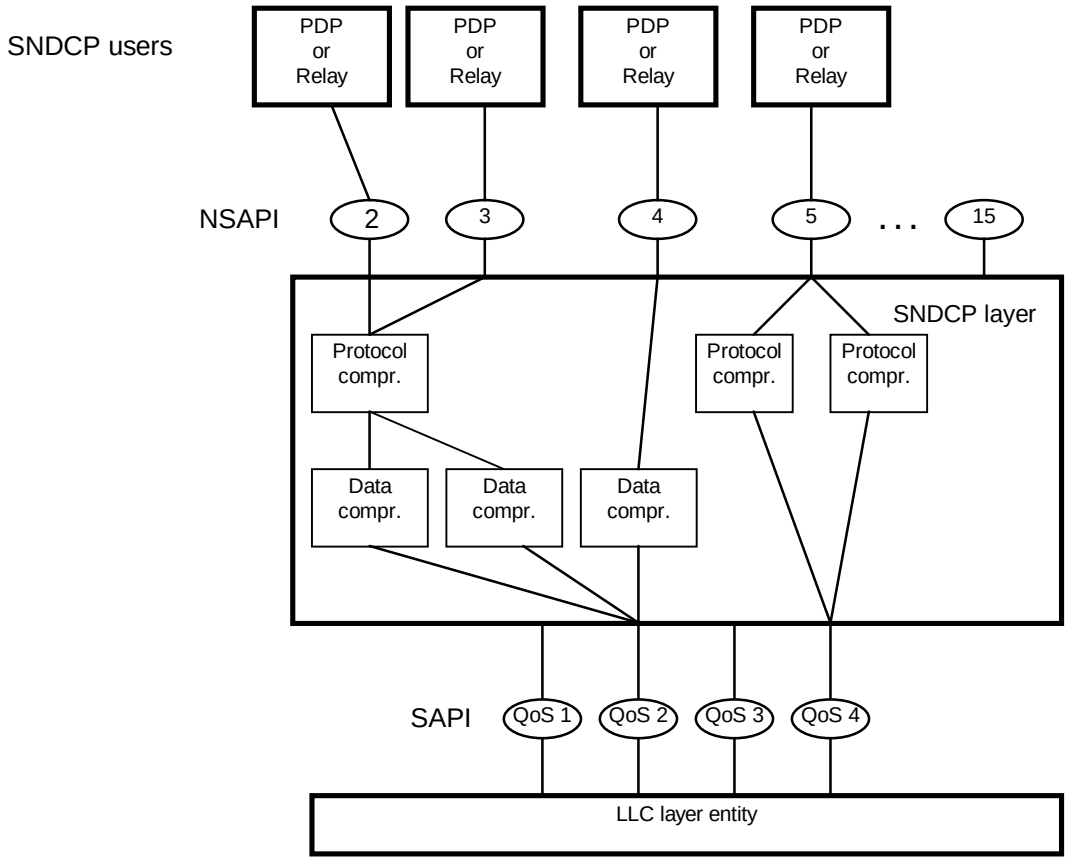


Figure 6: An example for the usage of NSAPIs, SNDCP functions, and SAPIs

6.6.1 Negotiation of multiple data compression types

Each SNDCP entity that supports data compression shall be able to negotiate one or several data compression types with the SNDCP XID format shown in Figure 7. The negotiation shall be carried out using the XID parameter negotiation specified in subclause 6.8. The initiating entity defines a set of requested algorithms and their parameters. The set of algorithms and their parameters shall be transmitted to the peer entity. The peer entity responds with the set of negotiated algorithms and their parameters. The peer entity shall select the proposed values or other appropriate values for the negotiated algorithms. No more than 15 compression algorithms (excluding the no compression alternative) shall be selected by the peer entity. If the peer entity responds with an algorithm set including more than 15 algorithms and parameters, only the 15 first algorithms shall be taken into consideration. The rest of the negotiated algorithms are ignored without error notification. For each NSAPI one or more data compression are chosen.. This choice is also indicated in the SNDCP XID. Only NSAPIs that are using the same SAPI may use the same data compression entity. If more than one compression entity is chosen for an NSAPI, these entities must use different data compression algorithms. However, only one data compression entity is used for one N-PDU; i.e. the used data compression entity may be changed from N-PDU to N-PDU.

bit	8	7	6	5	4	3	2	1
octet 1	X	X	X	Algorithm Type				
octet 2	Length = n - 2							
octet 3	High-order octet							
…	…							
octet n	Low-order octet							

Figure 7: Data compression field format for SNDCP XID negotiation

Spare bit (X):

0 Shall be set to 0. If SN-PDU is received with the Spare bit set to 1, the field shall be ignored without error notification.

Table 6 shows the list of data compression algorithms supported by the SNDCP layer. When new compression algorithms are needed for SNDCP, Table 6 shall be updated.

Table 6: List of data compression algorithms supported by SNDCP

Data compression algorithm	Algorithm type (Range 0-31)
V.42 bis	0
-	Other values Reserved

6.6.1.1 Assignment of DCOMP values

The assignment of the DCOMP values follows the following general rule:

- DCOMP value 0 is reserved permanently for no compression.
- DCOMP value 1 shall be assigned for the first algorithm on the set of the negotiated algorithms. DCOMP value n shall be assigned for the n-th algorithm on the set of the negotiated algorithms. This rule continues until the DCOMP value has been assigned for all the negotiated algorithms. However, if parameter values have been negotiated for the same algorithm in more than one field inside the XID block (applicable for different NSAPIs), the same DCOMP value shall be assigned to all instances of the same algorithm. The compression entities will be identifiable by a combination of NSAPI and DCOMP values in the SN-(UNIT)DATA frame header. If XID parameters are renegotiated during a connection, the DCOMP value of an algorithm used both before and after the renegotiation shall not be changed. Also a DCOMP value used before a renegotiation for one algorithm cannot be used for another algorithm after the renegotiation.

While transferring data, the compression algorithm type used for the SN-PDU is conveyed in the DCOMP field of the SNDCP header. Any successfully negotiated algorithm may be used for compression of N-PDU.

In case the compression parameters are renegotiated during an existing connection and only the applicable NSAPI(s) change, the configuration of the compression entity is not affected. However, if the other parameters change, the compression entities shall be reset. Compression entities used with acknowledged peer-to-peer LLC operation shall be reset by re-establishing the acknowledged peer-to-peer LLC operation of the SAPI used. Compression entities used with unacknowledged peer-to-peer LLC operation shall be reset locally upon completion of the SNDCP XID negotiation.

If the originator of the SNDCP XID re-negotiation changes the parameters of a compression entity used with acknowledged peer-to-peer LLC operation, the re-negotiation shall be performed using the LL-ESTABLISH primitives. Otherwise the LL-XID primitives shall be used. If the originator does not change the parameters of compression entities used with acknowledged peer-to-peer LLC operations (i.e. the re-negotiation is performed using the LL-XID primitives) but the responder changes the parameters, the originator shall re-establish the acknowledged peer-to-peer LLC operation, using the LL-ESTABLISH primitives, upon completion of the SNDCP XID re-negotiation.

On negotiating a compression entity, not all the parameters of the entity have to be specified. If a parameter is to be included, all the preceding parameters shall also be specified, and the length field shall be set to the sum of the lengths of all the parameters specified. If any of the parameters is not specified, the rules in subclause 6.8.3 shall apply.

6.6.2 Management of V.42 *bis* data compression

V.42 *bis* data compression may be used with SN-DATA primitives and SN-UNITDATA primitives.

ITU-T V.42 *bis* is specified in [8]. The use of data compression function and associated parameters shall be negotiated at initial connection establishment.

Table7: V.42 *bis* data compression parameters

			Parameters				
Algorithm Name	**Algorithm Type**	**Length**	**Parameter Name**	**Format**	**Range**	**Sense of Negotiation**	**Default Value**
V.42 bis	0	0, 2, 3, 5 or 6	Applicable NSAPIs	bbbbbbbb bbbbbbbb	0-255	down (each bit separately)	0
			P_0	000000bb	0-3	down (each direction separately)	3
			P_1	bbbbbbbb bbbbbbbb	512-65535	down	2048
			P_2	bbbbbbbb	6-250	down	20

Applicable NSAPIs

See subclause 7.1.3.

P_0 V.42bis compression request

Two bits are used to indicate the usage of compression, one bit for each direction.

00 compress neither direction

01 compress MS-to-SGSN direction only

10 compress SGSN-to-MS direction only

11 compress both directions

P_1 V.42bis number of codewords

Maximum number of codewords in the compressor dictionary.

P_2 V.42bis maximum string length

Maximum number of characters in an uncompressed data string that is accepted to be encoded.

When V.42 bis is used with SN-DATA primitives, the data in the compression entity shall be flushed (using the C-FLUSH primitive defined in [8] section 7.9) after an N-PDU is sent.

When V.42 bis is used with SN-UNITDATA primitives, the data in the compression entity shall be flushed (using the C-FLUSH primitive defined in [8] section 7.9), and then the compression entity shall be reset, after an N-PDU is sent. The LLC protocol shall operate in the protected mode of operation.

When V.42 bis is used with SN-DATA primitives and an error is detected by the decoder, the SNDCP entity shall use LL-ESTABLISH.request primitive to reset the acknowledged peer-to-peer LLC operation for the SAPI used.

6.7 Segmentation and reassembly

Any (possibly compressed) N-PDU + SNDCP header shall be segmented by SNDCP if it is longer than N201 (see GSM 04.64 [6]). In the segmentation, the SN-PDU is divided into multiple SN-PDUs. The M bit of the last SN-PDU is set to 0 while the M bit of the other segments is set to 1. The receiving SNDCP entity shall reassemble the segments back to the original N-PDU format. The segmentation and reassembly procedures are different for acknowledged and unacknowledged mode of operation.

The PCOMP and DCOMP parameters shall only be included in the first segment. If PCOMP and DCOMP are not present in a received SN-PDU corresponding to the first segment, their values shall be treated as zero. If PCOMP and DCOMP are present in a received SN-PDU which is not the first segment, their values shall be ignored without error notification.

6.7.1 Segmentation in acknowledged mode

The transmitting SNDCP entity shall segment an N-PDU into an ordered sequence of one or more SN-PDUs. The More bit (M) is used to identify the last segment. This procedure is illustrated in figure 4.

6.7.2 Segmentation in unacknowledged mode

The More bit is used to indicate N-PDU boundaries in the same way as specified for the acknowledged transmission mode. See figure 4 for illustration.

The Segment number is a sequence number given to each SN-UNITDATA PDU carrying a segment of an N-PDU The sequence number shall be set to 0 in the first SN-UNITDATA PDU of an N-PDU, and incremented by 1 for each subsequent SN-UNITDATA PDU. Modulo 16 operation is applied.

The received segments belonging to the same N-PDU shall be buffered. If a timer (implementation dependent) elapses before all segments are received, the N-PDU shall be ignored.

N-PDU number for PTP shall be inserted by the SNDCP entity. The N-PDU numbering starts from 0. For each of the following N-PDUs, the N-PDU number shall be increased by one. Modulo 524287 operation is applied. N-PDUs are numbered per NSAPI. Numbering cycles are reset at PDP context activation.

6.8 XID parameter negotiation

6.8.1 General

Negotiation of XID parameters between peer SNDCP entities may be carried out to ensure optimal information transfer. The parameters are called SNDCP exchange identity (XID) parameters.

SNDCP XID parameter negotiation may be initiated by the SNDCP entity at the MS or at the SGSN. If SNDCP XID parameters are to be changed, SNDCP XID negotiation shall be initiated prior to data transfer - the MS shall initiate SNDCP XID negotiation upon receipt of SNSM-ACTIVATE.indication; the SGSN shall initiate SNDCP XID negotiation upon receipt of the first downlink N-PDU if it has received the SNSM-ACTIVATE.indication primitive, but SNDCP XID negotiation has not been performed and no uplink SN-PDU has been received. Upon receipt of the SNSM-MODIFY.indication primitive, the SGSN shall also initiate SNDCP XID negotiation if a PDP context has been created (in the case of an Inter-SGSN Routeing Area Update), or the change in QoS profile to an existing PDP context results in a change in compressor(s) used by the PDP context.

The XID negotiation is a one-step procedure; i.e. the initiating end proposes parameter values, and the responding end either accepts these or offers different values in their place according to the XID negotiation rules described in this document; the rules limit the range of parameter values as well as the sense of negotiation. The initiating end accepts (or rejects) the values in the response; this concludes the negotiation.

The block format for the SNDCP XID parameter negotiation is shown in figure 8. Not all parameters have to be included in the XID block, only parameters that are negotiated. Also it shall be possible to negotiate parameters for more than one NSAPI in one XID block since more than one NSAPI can use the same SAPI.

Bit	8	7	6	5	4	3	2	1
Octet 1	Parameter type=0							
Octet 2	Version number							
Octet 3	Parameter type=1							
Octet 4	Length=n-4							
Octet 5	X	X	X	Algorithm type				
Octet 6	Length=k-6							
Octet 7	High-order octet							
…	…							
Octet k	Low-order octet							
Octet k+1	X	X	X	Algorithm type				
Octet k+2	Length=m-(k+2)							
Octet k+3	High-order octet							
…	…							
Octet m	Low-order octet							
…	…							
Octet n	Low-order octet							
Octet n+1	Parameter type=2							
Octet n+2	Length=r-(n+2)							
Octet n+3	X	X	X	Algorithm type				
Octet n+4	Length=p-(n+4)							
Octet n+5	High-order octet							
…	…							
Octet p	Low-order octet							
Octet p+1	X	X	X	Algorithm type				
Octet p+2	Length=q-(p+2)							
Octet p+3	High-order octet							
…	…							
Octet q	Low-order octet							
…	…							
Octet r	Low-order octet							

Figure 8: Example of SNDCP XID block format

The SNDCP user uses SN-XID.request to initiate the negotiation of the XID parameters. The SNDCP entity sends the proposed SNDCP XID parameters to the LLC SAP with the LL-XID.request or LL-ESTABLISH.request. The LLC SAP shall issue an XID command containing the SNDCP XID parameters (see GSM 04.64). The peer LLC SAP shall, upon receipt of the XID command, indicate the SNDCP XID parameters to SNDCP entity using LL-XID.indication or LL-ESTABLISH.indication. The peer SNDCP entity shall select appropriate values for the proposed parameters or negotiate the appropriate values with the SNDCP user entity with the SN-XID.indication and SN-XID.response primitives. When the appropriate parameter values are known by the peer SNDCP entity, it shall use the LL-XID.response or LL-ESTABLISH.response primitive to continue negotiation. Upon reception of the response, the LLC SAP shall send the received parameters to the SNDCP entity using the LL-XID.confirm or LL-ESTABLISH.confirm primitive. The SNDCP entity delivers the negotiated parameters to the SNDCP user. This is illustrated in Figure 9. The originator of the negotiation shall apply the new parameter values after it has received the ’confirm’ primitive. The responding end of the negotiation shall apply the new parameter values after it has sent the replying ’response’ primitive.

LLC may also initiate LLC XID negotiation, in which case LLC may send an LL-XID.indication to inform SNDCP the values of N201-I and N201-U. This is illustrated in Figure 10. If the SNDCP entity receives an LL-XID.indication without an SNDCP XID block, it shall not respond with the LL-XID.response primitive. Negotiation of SNDCP version number is always between the peer SNDCP entities. The version number is not known by the SNDCP user. However, negotiation of the parameters for compression algorithms may be carried out between the SNDCP user entities.

Negotiation of SNDCP XID parameters for an NSAPI shall be carried out in the SAPI to which the NSAPI is mapped.

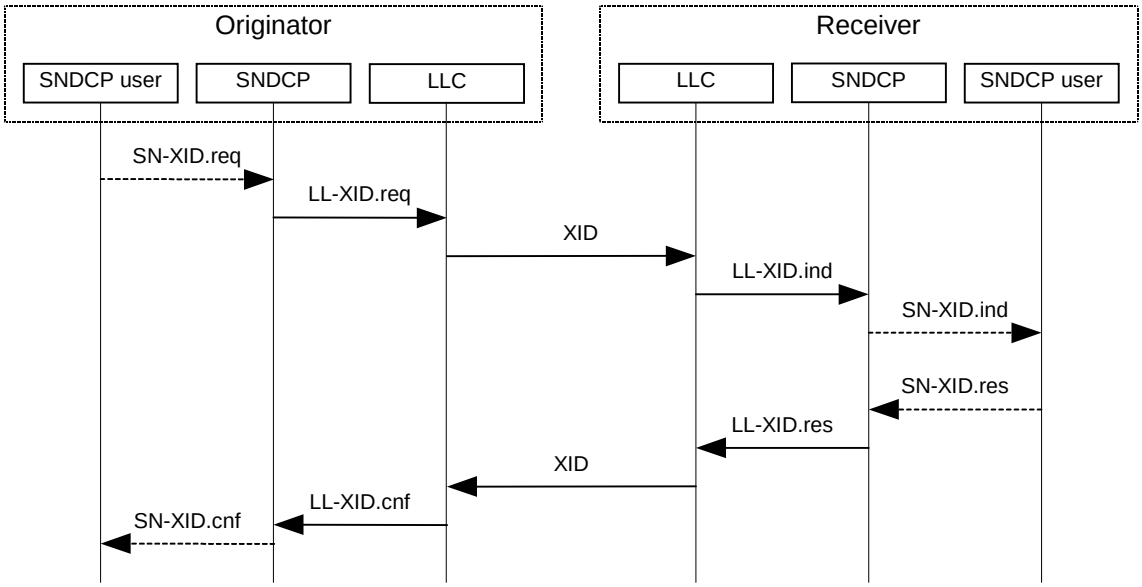


Figure 9: SNDCP XID negotiation procedure

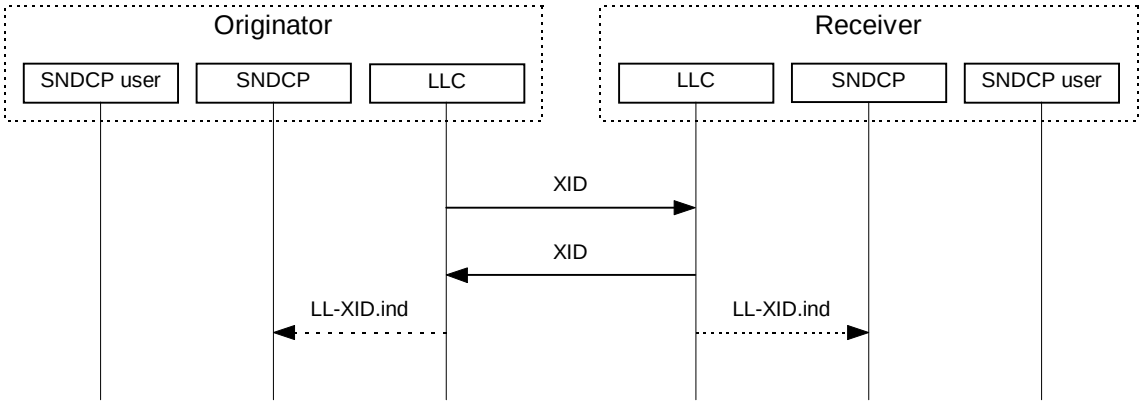


Figure 10: LLC XID negotiation procedure

6.8.2 Negotiation of compression entities

For parameter type 1 and 2, multiple compression fields (as shown in Figure 5 and Figure 7) may be specified. Each compression field corresponds to a compression entity.

In each compression field, the "Applicable NSAPIs" parameter indicates the NSAPIs that uses the compression entity. The parameter, if included, shall consist of 2 octets. Multiple NSAPIs may share the same compression entity by setting multiple bits in the parameter. NSAPIs requiring acknowledged peer-to-peer LLC operation and unacknowledged peer-to-peer LLC operation shall not share the same compressor (see subclause 6.10).

During SNDCP XID negotiation or re-negotiation, if a parameter type is specified in the SNDCP XID block, compression entities currently in use and compression entities proposed to be added may be included in the SNDCP XID block. Compression entities shall be arranged in an ordered list. The originator shall arrange the entities currently in use in the order in which they are created, followed by entities proposed to be created (if any). The responder shall arrange the entities currently in use in the order in which they are created, followed by entities proposed to be created by the originator (if any) in the order in which they are included by the originator. Not all entities in the list need to be included in the SNDCP XID block. However, if an entity is to be included, all preceding entities in the list shall be included. If a compression entity is not included, the value of its parameters shall be determined by the rules defined in subclause 6.8.3.

If, implicitly or explicitly (see subclause 6.8.3), a compression entity is specified in the responding SNDCP XID block with one or more bits set to 1 in the "Applicable NSAPIs" parameter, the compression entity shall be created (if it does not exist yet).

If, implicitly or explicitly, a compression entity is specified in the responding SNDCP XID block with no bit set to 1 in the "Applicable NSAPIs" parameter, the compression entity shall be deleted (if it currently exists).

If, implicitly or explicitly, one or more additional bits are set to 1 in the "Applicable NSAPIs" parameter of a compression entity in the responding SNDCP XID block, the NSAPIs corresponding to the additional bits shall be added to the compression entity.

If, implicitly or explicitly, one or more bits are set to 0 in the "Applicable NSAPIs" parameter of a compression entity in the responding SNDCP XID block, the NSAPIs corresponding to the bits set to 0 shall release the compression entity.

6.8.3 Values of SNDCP XID parameters

In this subclause, the term "parameter" refers to an SNDCP XID parameter, a compression field (for parameter type 1 or 2), or a parameter for a compression field.

If an SNDCP XID parameter has not been negotiated, default values shall apply. The default value for a compression field (entity) is "non-existing".

If the originating SNDCP XID block does not include a parameter (implicit command), it shall be treated as equivalent to requesting for the current value for the parameter. The responder may explicitly include this parameter in its response.

If a parameter is included in the originating SNDCP XID block and the responder does not include the parameter in its response (implicit response), it shall be treated as equivalent to responding with the value proposed by the originator.

If both the originator and the responder do not include a parameter in the negotiation, the value of the parameter is not changed.

6.8.4 Exception handling

In this subclause, the term "parameter" may refer, wherever applicable, to an SNDCP XID parameter, a compression field (for parameter type 1 or 2), or a parameter for a compression field.

If the originating SNDCP XID block includes a parameter with unrecognised Type field, the parameter shall be ignored by the responder.

If the originating SNDCP XID block includes a parameter with unsupported length or an out-of-range value, then the responder shall respond to the parameter with lengths and values set according to the responder’s preference.

If the originating SNDCP XID block includes parameter type 1 or 2 which violates the rules in subclause 6.8.2, the responder shall treat the parameter as not transmitted by the originator, and responds according to subclause 6.8.3.

If the originating SNDCP XID block includes a parameter with duplicated instances, the subsequent instances of the duplicated parameter shall be ignored.

If the responding SNDCP XID block includes a parameter with unrecognised Type field, unsupported length, an out-of-range value or a value violating the sense of negotiation, a parameter type 1 or 2 which violates the rules in subclause 6.8.2, or a parameter with duplicated instances, then the originator shall ignore the block and reinitiate the negotiation. If the renegotiation fails for an implementation-specific number of times, the originating SNDCP layer shall send an SNSM-STATUS.request primitive with Cause "invalid XID response" to the SM sub-layer. SM shall then deactivate all PDP contexts for this SAPI.

6.9 Data transfer

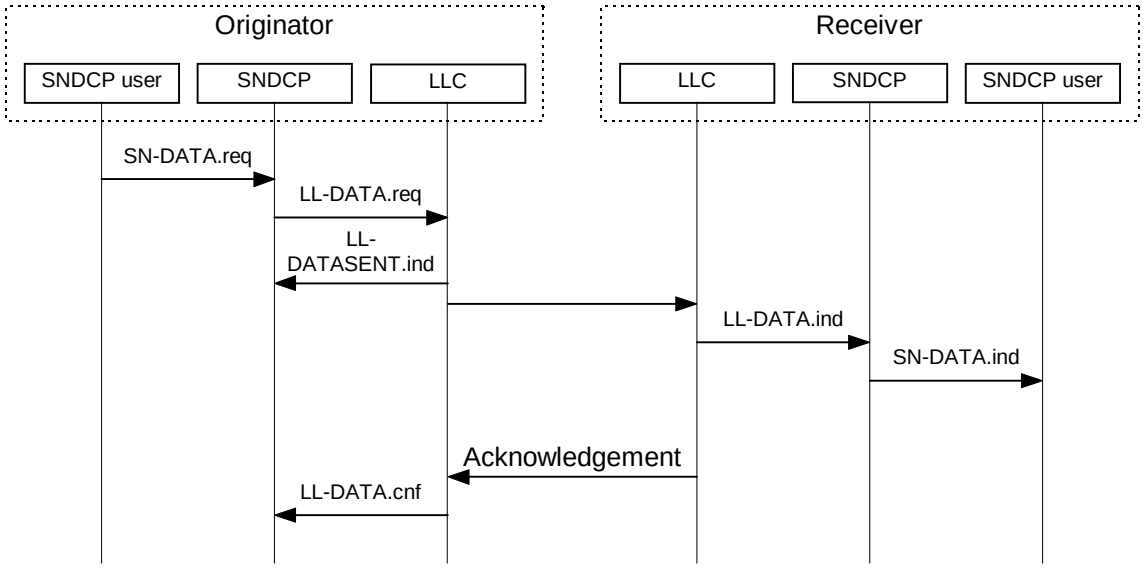
6.9.1 Acknowledged mode

The SNDCP entity shall initiate acknowledged data transmission only if the PDP context for the NSAPI identified in the SN-DATA.request has been activated and if acknowledged LLC operation has been established. Upon reception of the SN-DATA.request, the SNDCP entity shall perform the compression and segmentation functions, then forward the SN-PDU in LL-DATA.request to the LLC layer. The N-PDU shall be stored into a buffer in the SNDCP entity.

When the peer SNDCP entity receives the SN-PDU in the LL-DATA.indication primitive, the SNDCP entity extracts the N-PDU from the SN-PDU, reassembles and decompresses the information, and forwards it to the SNDCP user with the SN-DATA.indication. The correct SNDCP user is identified by the NSAPI field in the SN-PDU.

If an SN-UNITDATA PDU (T bit set to 1) is received by an NSAPI using acknowledged mode, the PDU shall be ignored without error notification.

The SNDCP entity that has originated the transmission shall wait until the transmission of the SN-PDU is confirmed by an LL-DATA.confirm. After the confirmation of the last SN-PDU carrying a segment of an N-PDU, the N-PDU may be deleted from buffer.



NOTE: LL-DATASENT.ind is returned to the SNDCP layer in the originating side if Originator is a SGSN.

Figure 11: SNDCP acknowledged data transfer

6.9.2 Unacknowledged mode

The SNDCP entity shall initiate unacknowledged data transmission only if the PDP context for the NSAPI identified in the SN-DATA.request has been activated. The SNDCP entity may initiate unacknowledged data transmission even if the acknowledged peer-to-peer operation is not established for that NSAPI. Upon reception of the SN-UNITDATA.request, the SNDCP entity shall compress and segment the information, then forward the SN-PDU in LL-UNITDATA.request to the LLC layer. The N-PDU shall be deleted immediately after the data has been delivered to LLC layer.

When the peer SNDCP entity receives the SN-PDU in the LL-UNITDATA.indication primitive, the SNDCP entity extracts the N-PDU from the SN-PDU, reassembles and decompresses the information, then forwards it to the SNDCP user with the SN-UNITDATA.indication. The correct SNDCP user is identified by the NSAPI field in the SN-PDU.

If an SN-DATA PDU (T bit set to 0) is received by an NSAPI using unacknowledged mode, the PDU shall be ignored without error notification.

The SNDCP entity shall detect lost SN-PDUs. The SNDCP entity shall discard duplicate SN-PDUs and re-order out-of-sequence SN-PDUs, if possible.

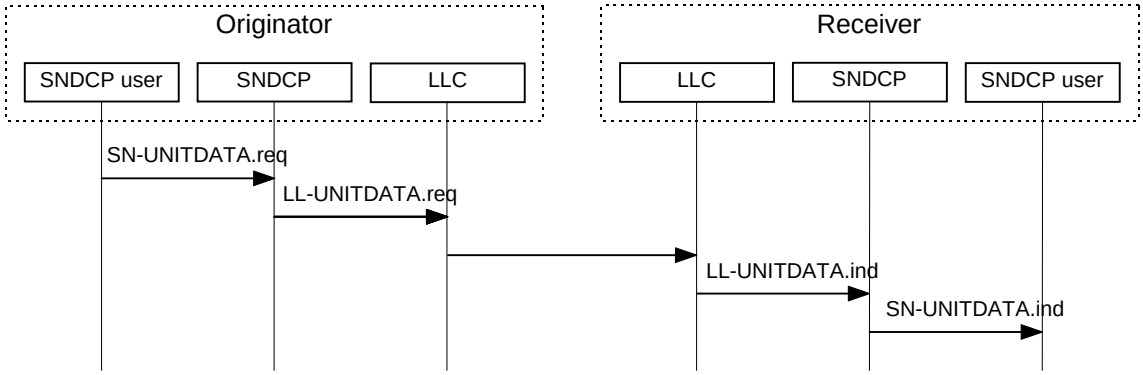


Figure 12: SNDCP unacknowledged data transfer

6.10 Possible combinations of SNDCP Protocol Functions and their connection to service access points

The following combinations of SNDCP protocol functions are allowed:

- One or several NSAPIs may use one SAPI
- Only one SAPI shall be used by one NSAPI
- One or several NSAPIs may use the same protocol control information compression entity
- One NSAPI may use zero, one, or several protocol control information compression entities
- One or several NSAPIs may use the same data compression entity
- One NSAPI may use zero, one, or several data compression entities
- Separate data compression entities shall be used for SN-DATA and SN-UNITDATA PDUs
- Separate protocol control information compression entities shall be used for SN-DATA and SN-UNITDATA PDUs
- One data compression entity shall be connected to one SAPI.
- One protocol control information compression entity shall be connected to one SAPI.
- One or several protocol control information compression entities may be connected to the same data compression entity.
- One protocol control information compression entity shall be connected to zero, one, or several data compression entities

7 Definition of SN-PDU

7.1 Format convention

7.1.1 Numbering convention

The convention used in this specification is illustrated in figure 13. The bits are grouped into octets. The bits of an octet are shown horizontally and are numbered from 1 to 8. Multiple octets are shown vertically and are numbered from 1 to N.

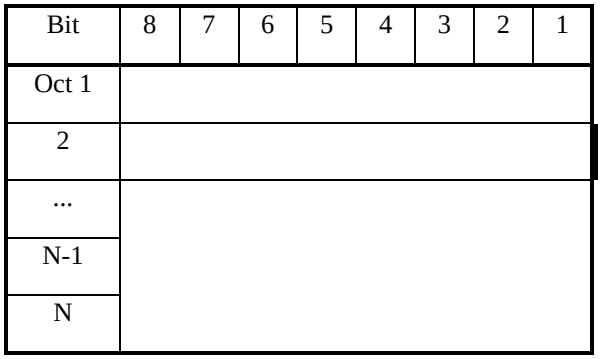


Figure 13: Format convention

7.1.2 Order of transmission

SN-PDUs are transferred between the SNDCP layer and LLC layer in units of octets, in ascending numerical octet order (i.e., octet 1, 2, …, N-1, N). The order of bit transmission is specific to the underlying protocols used across the Um interface and the Gb interface.

7.1.3 Field mapping convention

When a field is contained within a single octet, the lowest bit number of the field represents the lowest order value. When a field spans more than one octet, the order of bit values within each octet progressively decreases as the octet number increases. In that part of the field contained in a given octet the lowest bit number represents the lowest order value.

For example, a bit number can be identified as a couple (o, b) where o is the octet number and b is the relative bit number within the octet. Figure 14 illustrates a field that spans from bit (1, 3) to bit (2, 7). The high order bit of the field is mapped on bit (1, 3) and the low order bit is mapped on bit (2, 7).

Bit	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1st octet of field						2^4	2^3	2^2
2nd octet of field	2^1	2^0						

Figure 14: Field mapping convention

Figure 15 illustrates an NSAPI field that spans from bit (1,8) to bit (2,1). NSAPI 15 is mapped to bit (1,8) and the other NSAPIs are mapped in decreasingly order until NSAPI 0 that is mapped to bit (2,1). A bit set to 0 means that the compression entity is not applicable to the corresponding NSAPI. A bit set to 1 means that the compression entity is applicable to the corresponding NSAPI.

Bit	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1st octet of field	15	14	13	12	11	10	9	8
2nd octet of field	7	6	5	4	3	2	1	0

Figure 15: NSAPI mapping convention

7.2 SN-PDU Formats

Each SN-PDU shall contain an integral number of octets, and shall comprise a header part and a data part. An SN-PDU shall contain data from a single N-PDU only. Two different SN-PDU formats are defined. The SN-DATA PDU shall be used for acknowledged data transfer and SN-UNITDATA PDU for unacknowledged data transfer.

Bit	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Oct 1	X	C	T	M	NSAPI			
2	DCOMP				PCOMP			
...	Data segment							
N								

Figure 16: SN-Data PDU format

Bit	8	7	6	5	4	3	2	1
Oct 1	X	C	T	M	NSAPI			
2	DCOMP				PCOMP			
3	Segment number				N-PDU number			
4	E	N-PDU number (continued)						
5	N-PDU number (extended)							
...	Data segment							
N								

Figure 17: SN-Unitdata PDU format

More bit (M):

0 Last segment of N-PDU

1 Not the last segment of N-PDU, more segments to follow

SN-PDU Type (T):

0 SN-DATA PDU

1 SN-UNITDATA PDU

Compression indicator (C):

0 Compression fields are not included.

The octet including DCOMP and PCOMP is not included in the SN-Data PDU or SN-Unitdata PDU format.

1 Compression fields are included.

The values of the DCOMP and PCOMP fields are applicable.

Spare bit (X):

0 Shall be set to 0. If SN-PDU is received with the Spare bit set to 1, the field shall be ignored without error notification.

NSAPI:

0 Escape mechanism for future extensions

1 Point-to-Multipoint Multicast (PTM-M) information

2-4 Reserved for future use

5-15 dynamically allocated NSAPI value (see subclause 6.1)

SN-PDU with an unallocated NSAPI value shall be ignored by the receiving SNDCP entity without error notification.

Data compression coding (DCOMP):

0 no compression

1-14 Points to the data compression identifier negotiated dynamically (see subclause 6.6)

15 Reserved for future extensions

SN-PDU with an unallocated DCOMP value shall be ignored by the receiving SNDCP entity without error notification.

Protocol control information compression coding (PCOMP):

0 no compression

1-14 Points to the protocol control information compression identifier negotiated dynamically (see subclause 6.5)

15 Reserved for future extensions

SN-PDU with an unallocated PCOMP value shall be ignored by the receiving SNDCP entity without error notification.

Segment number:

0-15 Sequence number for segments carrying an N-PDU.

N-PDU number:

0-2047 Range used if Extension bit is set to 0

2048-524287 Range used if Extension bit is set to 1

The higher range is used only when the N-PDU number is such that more than 11 bits are needed to present the number in binary format. SN-PDU with an N-PDU number that is out of range shall be ignored by the receiving SNDCP entity without error notification.

In the N-PDU number field bit in position (3, 4) is the MSB and the bit in position (5, 1) is the LSB. The extension bit E in position (4, 8) is skipped, i.e. Bit 2^{14} in position (4, 7) is followed by bit 2^{15} in position (3, 1).

Extension bit for N-PDU number (E):

0 Next octet is used for data

1 Next octet is used for N-PDU number extension

8 SNDCP XID parameters

The SNDCP XID parameters are shown in Table 8:

Table 8: SNDCP XID parameters

Parameter name	Parameter Type	Length	Format	Range	Default value	Units	Sense of negotiation
SN-VER (SNDCP version number)	0	1	0000bbbb	0-15	0	-	down
Data Compressions	1	variable	see subclause 6.6.1				
Protocol Control Information Compressions	2	variable	see subclause 6.5.1				

NOTE: The current version of SNDCP is 0. This is also the default value for the version number. It is assumed that the future versions are backward compatible with former ones.

Annex A (informative): Change history

SPEC	SMG#	CR	VERS	NEW_VERS	SUBJECT
04.65	s23	new	2.0.0	5.0.0	GSM 04.65 GPRS; Subnetwork Dependent Convergence Protocol
04.65	s24	A001	5.0.0	5.1.0	Introduction of new primitive
04.65	s24	A003	5.0.0	5.1.0	Introduction of header compression for SN-UNITDATA
04.65	s24	A004	5.0.0	5.1.0	Introduction of data compression for SN-UNITDATA
04.65	s24	A005	5.0.0	5.1.0	SNDCP XID negotiation
04.65	s24	A007	5.0.0	5.1.0	Update of service primitives
04.65	s24	A008	5.0.0	5.1.0	Separation of N201-I and N201-U
04.65	s24	A010	5.0.0	5.1.0	1st editorial changes
04.65	s24	A011	5.0.0	5.1.0	2nd editorial changes
04.65	s24	A012	5.0.0	5.1.0	Various corrections
04.65	s25	A013	5.1.0	6.0.0	N-PDU buffering
04.65	s25	A014	5.1.0	6.0.0	Possible combinations of SNDCP functions
04.65	s25	A015	5.1.0	6.0.0	Minor modifications
04.65	s25	A016	5.1.0	6.0.0	Improvements to XID-negotiation procedures
04.65	s26	A017	6.0.0	6.1.0	Various improvements and editorial corrections
04.65	s26	A018	6.0.0	6.1.0	Modifications/improvements
04.65	s27	A020	6.1.0	6.2.0	Acknowledged LLC operation establishment and release procedure
04.65	s27	A019	6.1.0	6.2.0	Corrections and clarifications
04.65	s27	A022	6.1.0	6.2.0	TCP/IP header compression and Data compression
04.65	s27	A024	6.1.0	6.2.0	Data transfer
04.65	s27	A025	6.1.0	6.2.0	Replacement of "Segment offset" with "Segment number"
04.65	s27	A021	6.1.0	6.2.0	XID negotiation
04.65	editorial		6.2.0	6.2.1	Editorial changes, missed references, spell errors

History

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