# 13

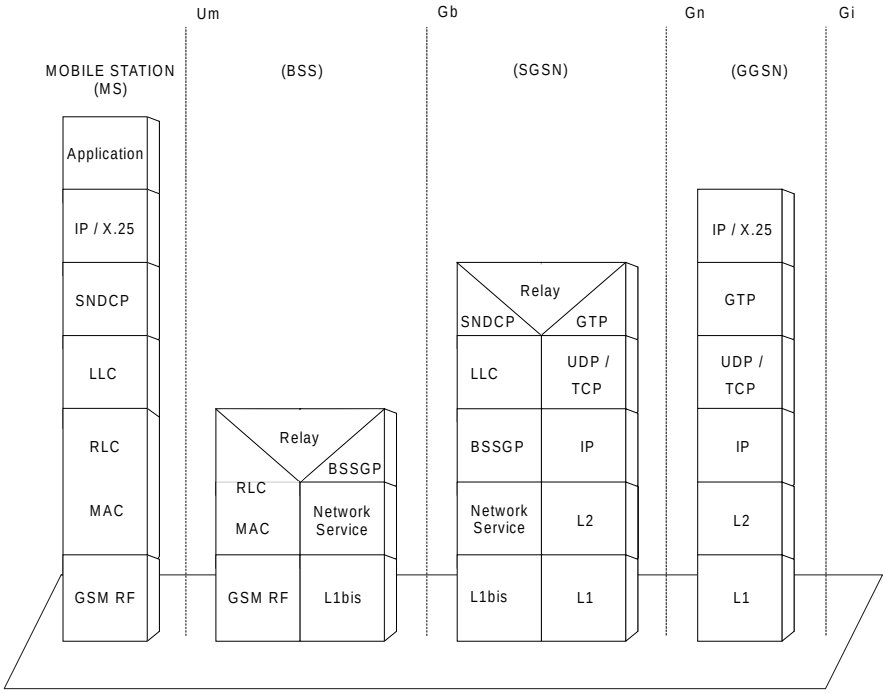
# GPRS Protocols

GPRS (General Packet Radio Service) is used as a data services upgrade to any GSM network. It allows GSM networks to be truly compatible with the Internet. GPRS uses a packet-mode technique to transfer bursty traffic in an efficient manner. It allows transmission bit rates from 9.6 Kbps to more than 150 Kbps per user.

The two key benefits of GPRS are a better use of radio and network resources and completely transparent IP support. GPRS optimizes the use of network and radio resources. It uses radio resources only when there is data to be sent or received. As a true packet technology it allows end user applications to only occupy the network when a payload is being transferred and so is well adapted to the very bursty nature of data applications.

Another important feature of the GPRS is that it provides immediate connectivity and high throughput. Applications based on standard data protocols such as IP and X.25 are supported. In GPRS four different quality of service levels are supported. To support data applications GPRS utilizes several new network nodes, in addition to the network nodes in the GSM PLMN. Those nodes are responsible for traffic routing and other interworking functions with external packet-switched data networks,

subscriber location, cell selection, roaming and many other functions that any cellular network needs for it's operation. Apart from these protocols, GPRS uses the GSM SMS protocol and the GSM MM protocol (which it calls GMM).

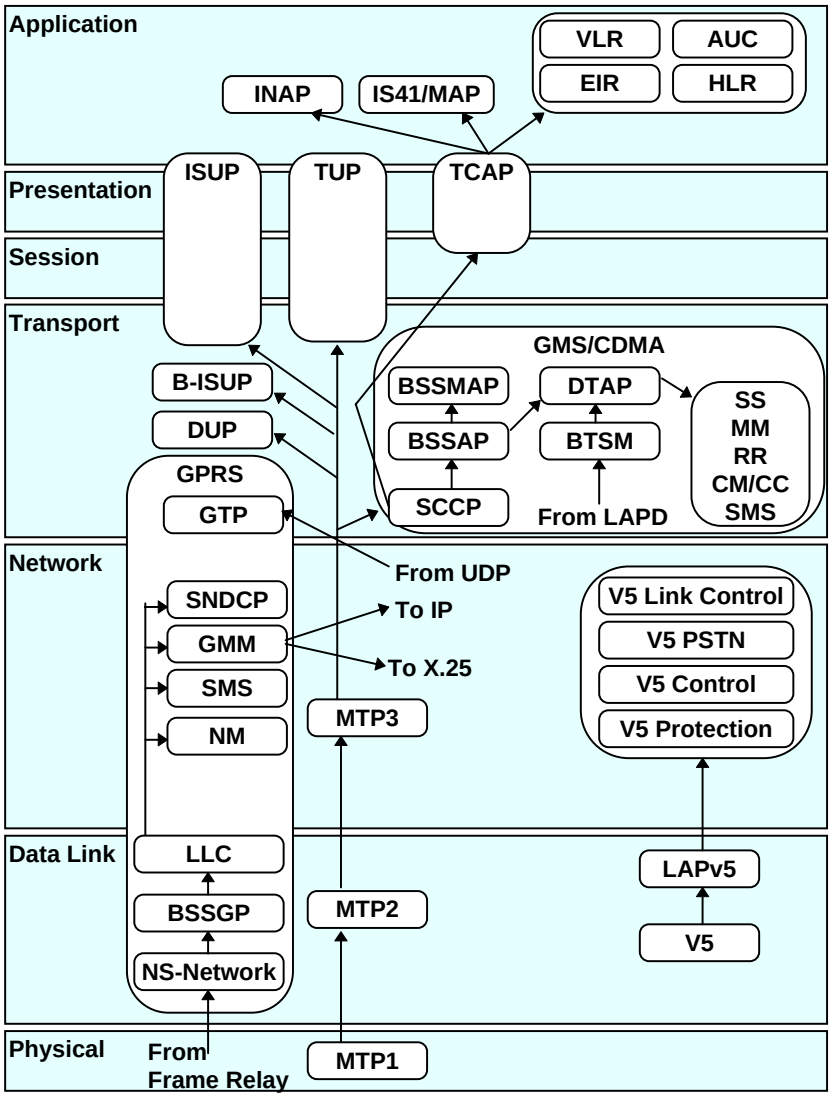



*GPRS transmission plan*

This chapter describes the following GPRS protocols:

- NS: Network Service.
- BSSGP: Base Station System GPRS Protocol.
- GTP: GPRS Tunnelling Protocol.
- LLC: Logical Link Control layer protocol for GPRS.
- SNDCP: Sub-Network Dependant Convergence Protocol.

The following diagram illustrates the GPRS protocols in relation to other telephony protocols and the OSI model:




*GPRS in relation to the OSI model*

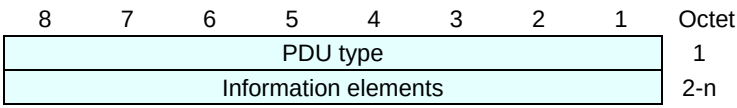
# NS

GSM 08.16 version 6.1.0 http://www.etsi.fr

The Network Service (NS) performs the transport of NS SDUs between the SGSN (serving GPRS support node) and BSS (base station system). Services provided to the NS user include:

- Network Service SDU transfer. The Network Service provides network service primitives allowing for transmission and reception of upper layer protocol data units between the BSS and SGSN. The NS SDUs are transferred in order by the Network Service, but under exceptional circumstances order may not be maintained.
- Network congestion indication. Congestion recovery control actions may be performed by the Sub-Network Service (e.g., Frame Relay). Congestion reporting mechanisms available in the Sub-Network Service implementation are used by NS to report congestion.
- Status indication. Status indication is used to inform the NS user of the NS affecting events, e.g., change in the available transmission capabilities.

The structure of the NS PDU is shown in the following illustration:



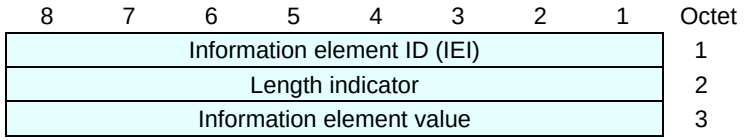

*NM header structure*

## PDU type

PDU type may be:
NS-ALIVE.
NS-ALIVE-ACK.
NS-BLOCK.
NS-BLOCK-ACK.
NS-RESET.
NS-RESET-ACK.
NS-STATUS.
NS-UNBLOCK.
NS-UNBLOCK-ACK.
NS-UNITDATA.

## Information elements

The particular IEs present in a PDU depend on the PDU type. The structure of IEs is as shown in the following illustration:




*IE structure*

## Information element ID

The first octet of an information element having the TLV format contains the IEI of the information element. If this octet does not correspond to an IEI known in the PDU, the receiver assumes that the next octet is the first octet of the length indicator field. This rule allows the receiver to skip unknown information elements and to analyze any subsequent information elements.

The following IEs may be present depending on the PDU type:
Cause.
NS-VCI.
NS PDU.
BVCI.
NSEI.

## Length indicator

Information elements may be variable in length. The length indicator is one or two octets long, the second octet may be absent. This field consists of the field extension bit, 0/1 ext, and the length of the value field which follows, expressed in octets. The field extension bit enables extension of the length indicator to two octets. Bit 8 of the first octet is reserved for the field extension bit. If the field extension bit is set to 0 (zero), then the second octet of the length indicator is present. If the field extension bit is set to 1 (one), then the first octet is the final octet of the length indicator.

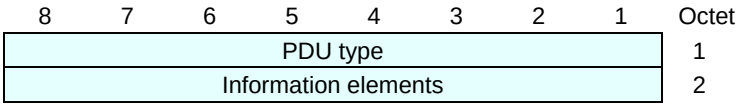
# BSSGP

GSM 08.18 version 6.1.0 http://www.etsi.fr

The NS transports BSS (base station system) GPRS protocol PDUs between a BSS and an SGSN (serving GPRS support node). The primary functions of the BSSGP include:

- Provision by an SGSN to a BSS of radio related information used by the RLC/MAC function (in the downlink).
- Provision by a BSS to an SGSN of radio related information derived from the RLC/MAC function (in the uplink).
- Provision of functionality to enable two physically distinct nodes, an SGSN and a BSS, to operate node management control functions.

The structure of BSSGP PDUs is shown in the following illustration:




*BSSGP header structure*

## PDU type

PDU type may be:
UL-UNITDATA.
RA-CAPABILITY.
PTM-UNITDATA.
PAGING PS.
PAGING CS.
RA-CAPABILITY-UPDATE.
RA-CAPABILITY-UPDATE-ACK.
RADIO-STATUS.
SUSPEND.
SUSPEND-ACK.
SUSPEND-NACK.
RESUME.
RESUME-ACK.
RESUME-NACK.
FLUSH-LL.

FLUSH-LL-ACK.
LLC-DISCARDED.
FLOW-CONTROL-BVC.
FLOW-CONTROL-BVC-ACK.
FLOW-CONTROL-MS.
FLOW-CONTROL-MS-ACK.
BVC-BLOCK.
BVC-BLOCK-ACK.
BVC-UNBLOCK.
BVC-UNBLOCK-ACK.
BVC-RESET.
BVC-RESET-ACK.
STATUS.
SGSN-INVOKE-TRACE.

### Information elements

The following IE types may be present. The hex coding is the value of the IEI field.

0x00 Alignment Octets
0x01 Bmax default MS
0x02 BSS Area Indication
0x03 Bucket Leak Rate
0x04 BVCI
0x05 BVC Bucket Size
0x06 BVC Measurement
0x07 Cause
0x08 Cell Identifier
0x09 Channel needed
0x0a DRX Parameters
0x0b eMLPP-Priority
0x0c Flush Action
0x0d IMSI
0x0e LLC-SDU
0x0f LLC Frames Discarded
0x10 Location Area
0x11 Mobile Id
0x12 MS Bucket Size
0x13 MS Radio Access Capability
0x14 OMC Id
0x15 PDU In Error
0x16 PDU Lifetime

0x17 Priority
0x18 QoS Profile
0x19 Radio Cause
0x1a RA-Cap-UPD-Cause
0x1b Routing Area
0x1c R_default_MS
0x1d Suspend Reference Number
0x1e Tag
0x1f TLLI
0x20 TMSI
0x21 Trace Reference
0x22 Trace Type
0x23 Transaction Id
0x24 Trigger Id
0x25 Number of octets effected

All values not explicitly shown are reserved for future use and are treated by the recipient as an unknown IEI.

# GTP

GSM 09.60 version 6.1.0 http://www.etsi.fr

GPRS Tunnelling Protocol (GTP) is the protocol between GSN nodes in the GPRS backbone network. GTP is defined both for the Gn interface, i.e. the interface between GSNs within a PLMN, and the Gp interface between GSNs in different PLMNs. GTP is encapsulated within UDP.

GTP allows multiprotocol packets to be tunnelled through the GPRS Backbone between GPRS Support Nodes (GSNs). In the signalling plane, GTP specifies a tunnel control and management protocol which allows the SGSN to provide GPRS network access for an MS. Signalling is used to create, modify and delete tunnels. In the transmission plane, GTP uses a tunnelling mechanism to provide a service for carrying user data packets. The choice of path is dependent on whether the user data to be tunnelled requires a reliable link or not.

The GTP protocol is implemented only by SGSNs and GGSNs. No other systems need to be aware of GTP. GPRS MSs are connected to a SGSN without being aware of GTP. It is assumed that there will be a many-to-many relationship between SGSNs and GGSNs. An SGSN may provide service to many GGSNs. A single GGSN may associate with many SGSNs to deliver traffic to a large number of geographically diverse mobile stations.

The GTP header is a fixed format 16 octet header used for all GTP messages.

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Octet |
|---|---|---|---|---|---|---|---|---|
| Version | | | Reserved | | | | LFN | |
| Message type | | | | | | | | 1 |
| Length | | | | | | | | 2 |
| Sequence number | | | | | | | | 3 |
| Flow label | | | | | | | | 4 |
| LLC frame number | | | | | | | | 5 |
| x | x | x | x | x | x | x | FN | 6 |
| Reserved | | | | | | | | |
| TID | | | | | | | | |

*GTP header structure*

### Version
Set to 0 to indicate the first version of GTP.

### Reserved
Reserved bits for future use, set to 1.

### LFN
LLC frame number. Flag indicating whether the LLC frame number is included or not, set to 0 in signalling messages.

### Message type
Indicates the type of GTP message. In signalling messages it is set to the unique value that is used for each type of signalling message.

### Length
Indicates the length in octets of the GTP message (G-PDU). In signalling messages this is the length, in octets, of the signalling message including the GTP header.

### Sequence number
A transaction identity for signalling messages and an increasing sequence number for tunneled T-PDUs.

### Flow label
Identifies unambiguously a GTP flow. In signalling Path Management messages and Location Management messages, the Flow label is not used and is set to 0.

### LLC frame number
Used at the inter-SGSN routing update procedure to co-ordinate the data transmission on the link layer between the MS and SGSN. Not used for signalling, set to 225 by the sender and ignored by the receiver.

### TID
The tunnel identifier that points out MM and PDP contexts in the destination GSN. In signalling messages, it is set to 0 in all V Management messages, Location Management messages and Mobility Management messages. The format of the TID is as follows:

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Octet |
|---|---|---|---|---|---|---|---|---|
| MCC digit 2 | | | | MCC digit 1 | | | | 1 |
| MNC digit 1 | | | | MCC digit 3 | | | | 2 |
| MSIN digit 1 | | | | MNC digit 2 | | | | 3 |
| MSIN digit 3 | | | | MSIN digit 2 | | | | 4 |
| MSIN digit 5 | | | | MSIN digit 4 | | | | 5 |
| MSIN digit 7 | | | | MSIN digit 6 | | | | 6 |
| MSIN digit 9 | | | | MSIN digit 8 | | | | 7 |
| NSAPI | | | | MSIN digit 10 | | | | 8 |

*TID structure*

### MCC, MNC, MSIN digits
Parts of the IMSI (defined in GMS 04.08).

### NSAPI
Network service access point identifier.

# LLC

GSM 04.65 version 6.1.0 http://www.etsi.fr

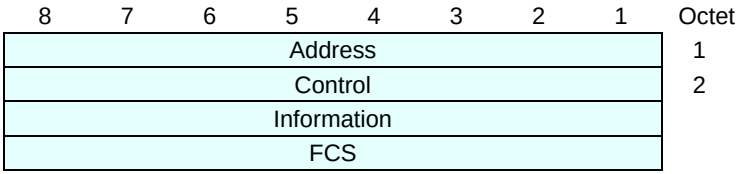
LLC defines the logical link control layer protocol to be used for packet data transfer between the mobile station (MS) and a serving GPRS support node (SGSN). LLC spans from the MS to the SGSN and is intended for use with both acknowledged and unacknowledged data transfer.

The frame formats defined for LLC are based on those defined for LAPD and RLP. However, there are important differences between LLC and other protocols, in particular with regard to frame delimitation methods and transparency mechanisms. These differences are necessary for independence from the radio path.

LLC supports two modes of operation:

- Unacknowledged peer-to-peer operation.
- Acknowledged peer-to-peer operation.

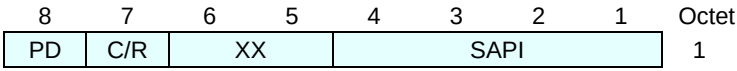
All LLC layer peer-to-peer exchanges are in frames of the following format:




*LLC header structure*

## Address field

The address field contains the SAPI and identifies the DLCI for which a downlink frame is intended and the DLCI transmitting an uplink frame. The length of the address field is 1 byte and it has the following format:




*LLC address field structure*

## PD

Protocol discriminator bit indicates whether a frame is an LLC frame or belongs to a different protocol. LLC frames have the PD bit set to 0. If a

frame with the PD bit set to 1 is received, then it is treated as an invalid frame.

### C/R

Identifies a frame as either a command or a response. The MS side sends commands with the C/R bit set to 0, and responses with the C/R bit set to 1. The SGSN side does the opposite; i.e., commands are sent with C/R set to 1 and responses are sent with C/R set to 0. The combinations for the SGSN side and MS side are as follows.

| *Type* | *Direction* | *C/R value* |
|---|---|---|
| Command | SGSN side to MS side | 1 |
| Command | MS side to SGSN side | 0 |
| Response | SGSN side to MS side | 0 |
| Response | MS side to SGSN side | 1 |

### XX

Reserved (2 bits).

### SAPI

Service Access Point Identifier identifies a point at which LLC services are provided by an LLE to a layer-3 entity.

### Control

Identifies the type of frame. Four types of control field formats are specified:

- Confirmed information transfer (I format)
- Supervisory functions (S format)
- Unconfirmed information transfer (UI format)
- Control functions (U format)

### Information

Contains the various commands and responses.

### FCS

Frame check sequence consists of a 24 bit CRC code which is used to detect bit errors in the frame header and information fields.

# SNDCP

GSM 04.65 version 6.1.0 http://www.etsi.fr

Sub-Network Dependant Convergence Protocol (SNDCP) uses the services provided by the Logical Link Control (LLC) layer and the Session Management (SM) sub-layer. SNDCP splits into either IP or X.25.

The main functions of SNDCP are:

- Multiplexing of several PDPs (packet data protocol).
- 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.

The SN-DATA PDU is used for acknowledged data transfer. Its format is as follows:

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Octet |
|---|---|---|---|---|---|---|---|---|
| X | C | T | M | NSAPI | | | | 1 |
| DCOMP | | | | PCOMP | | | | 2 |
| Data | | | | | | | | 3-n |

*SN-DATA PDU structure*

The SN-UNITDATA PDU is used for unacknowledged data transfer. Its format is as follows:

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Octet |
|---|---|---|---|---|---|---|---|---|
| X | C | T | M | NSAPI | | | | 1 |
| DCOMP | | | | PCOMP | | | | 2 |
| Segment offset | | | | N-PDU number | | | | 3 |
| E | N-PDU number (continued) | | | | | | | 4 |
| N-PDU number (extended) | | | | | | | | 5 |
| Data | | | | | | | | 6-n |

*SN-UNITDATA PDU structure*

### NSAPI

Network service access point identifier. Values may be:

0 Escape mechanisms for future extensions.
1 Point-to-mutlipoint multicast (PTM-M) information.
2-4 Reserved for future use.
5-15 Dynamically allocated NSAPI value.

### M

More bit. Values may be:

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

### T

SN-PDU type specifies whether the PDU is SN-DATA (0) or SN-UNITDATA (1).

### C

Compression indicator. A value of 0 indicates that compression fields, DCOMP and PCOMP, are not included. A value of 1 indicates that these fields are included.

### X

Spare bit is set to 0.

### DCOMP

Data compression coding, included if C-bit set. Values are as follows:

0 No compression.
1-14 Points to the data compression identifier negotiated dynamically.
15 Reserved for future extensions.

### PCOMP

Protocol control information compression coding, included if C-bit set. Values are as follows:

0 No compression.
1-14 Points to the protocol control information compression identifier negotiated dynamically.
15 Reserved for future extensions.

### Segment offset

Segment offset from the beginning of the N-PDU in units of 128 octets.

### N-PDU number

0-2047 when the extension bit is set to 0.
2048-524287 if the extension bit is set to 1.

### E

Extension bit for N-PDU number.

0 Next octet is used for data.

1 Next octet is used for N-PDU number extensions.