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Technical Specification

Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Base Station System (BSS) - Serving GPRS Support Node (SGSN) interface; Network Service (GSM 08.16 version 6.2.0 Release 1997)

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Foreword

This Technical Specification (TS) has been produced by the Special Mobile Group (SMG).

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

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6   indicates GSM Release 1997 of Phase 2+

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

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1 Scope

The present document specifies the Network Service used on the Base Station System (BSS) to Serving GPRS Support Node (SGSN) interface (Gb interface).

The protocol stack on the Gb interface is defined in the stage 2 Technical Specification GSM 03.60 [3].

The Network Service entity provides network services to the BSSGP entity specified in GSM 08.18 [5].

The layer 1 of the Gb interface is specified in GSM 08.14 [4].

In the present document, the communication between adjacent layers and the services provided by the layers are distributed by use of abstract service primitives. But only externally observable behaviour resulting from the description is normatively prescribed by the present document.

The service primitive model used in the present document is based on the concepts developed in CCITT Recommendation X.200 [13].

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies.

- 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 telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Service description; Stage 1".

[3]   GSM 03.60: "Digital cellular telecommunications system (Phase 2+); Stage 2 Service Description of the General Packet Radio Service (GPRS)".

[4]   GSM 08.14: "Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Base Station System (BSS) - Serving GPRS Support Node (SGSN) interface; Gb interface Layer 1".

[5]   GSM 08.18: " Digital cellular telecommunications system (Phase 2+); General Packet Radio Service (GPRS); Base Station System (BSS) - Serving GPRS Support Node (SGSN) interface; BSS GPRS Protocol (BSSGP)".

[6]   FRF 1.1 (January 19, 1996): "The Frame Relay Forum User-to-Network Implementation Agreement (UNI)".

[7]   ITU-T I.233.1 (10/95): "ISDN Frame Relaying Bearer Service".

[8]   ITU-T Q.921 (10/95): "ISDN user-network interface-Data link layer specification".

[9]   ITU-T Q.922 (02/92): "ISDN data link layer specification for frame mode bearer services".

[10]   ITU-T Q.931 (10/95): " ISDN user-network interface layer 3 specification for Basic Call Control".

[11]   ITU-T revised Q.933 (10/95): "Digital Subscriber Signalling System No. 1 (DSS 1) - Signalling specification for frame mode basic call control".

[12]   ITU-T I.370 (10/95): "Congestion management for the ISDN Frame Relaying Bearer Service".

[13]   CCITT X.200 (White Book): "Reference model of open systems interconnection for CCITT applications".

3   Definitions, symbols and abbreviations

3.1   Definitions

For the purposes of the present document the following definitions apply. For additional applicable definitions refer to GSM 02.60 [2].

BSSGP Virtual Connection (BVC): An end-to-end virtual communication path between remote Network Service user entities.

BSSGP Virtual Connection Identifier (BVCI): The identifier of a BVC, having end-to-end significance across the Gb interface.

Network Service Entity Identifier (NSEI): The identifier of an NS Entity having end-to-end significance across the Gb interface.

Network Service Virtual Connection (NS-VC): An end-to-end virtual communication path between Network Service peer entities.

Network Service Virtual Connection Identifier (NS-VCI): The identifier of an NS-VC having end-to-end significance across the Gb interface.

Network Service Virtual Link (NS-VL): A virtual communication path between the BSS or the SGSN and the intermediate network, or between the BSS and the SGSN in case of direct point-to-point configuration.

Network Service Virtual Link Identifier (NS-VLI): The identifier of an NS-VL, having local significance at the BSS or SGSN.

Network Service Virtual Connection Group: Groups all NS-VCs together which provide communication between the same peer NS entities. This grouping has local significance at the BSS or SGSN.

Blocked / unblocked: When an NS-VC can not be used for NS user traffic, it is blocked. When an NS-VC can be used for NS user traffic, it is unblocked.

Dead / alive: When an NS-VC is able to provide communication between remote NS entities, it is alive. When it is not able, it is dead. These states are supervised by means of a test procedure, as further described in the present document.

3.2   Symbols

Refer to GSM 03.60 [3].

3.3   Abbreviations

For the purposes of the present document the following abbreviations apply. Additional applicable abbreviations can be found in GSM 01.04 [1]. When there is conflict between the present document and GSM 01.04 [1], the following list takes precedence.

BECN	Backward Explicit Congestion Notification
BSSGP	Base Station System GPRS Protocol
BVC	BSSGP Virtual Connection
BVCI	BSSGP Virtual Connection Identifier

CLLM	Consolidated Link Layer Management
DE	Discard Eligibility
FECN	Forward Explicit Congestion Notification
FR	Frame Relay
FRF	Frame Relay Forum
LLC	Logical Link Control
LSP	Link Selector Parameter
MAC	Medium Access Control
NS	Network Service
NSEI	Network Service Entity Identifier
NS-SAP	Network Service Service Access Point
NS-VC	Network Service Virtual Connection
NS-VCI	Network Service Virtual Connection Identifier
NS-VL	Network Service Virtual Link
NS-VLI	Network Service Virtual Link Identifier
PDU	Protocol Data Unit
PTP	Point-To-Point
PTM	Point-To-Multipoint
PVC	Permanent Virtual Connection
RLC	Radio Link Control
SGSN	Serving GPRS Support Node
UNI	User-to-Network Interface

4 Network Service general description

4.1 Overview

The position of the Network Service within the protocol stack of the Gb interface is shown in Figure 1/GSM 08.16.
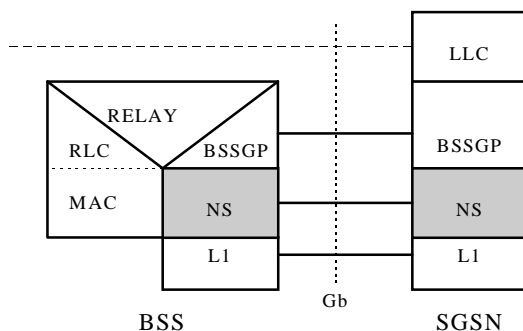
NOTE: BSSGP, L1, LLC, MAC, RELAY, RLC are outside the scope of the present document, refer to TS GSM 03.60 [3] for further details.

Figure 1/GSM 08.16: Position of the NS within the Gb interface protocol stack

The Network Service performs the transport of NS SDUs between the SGSN and BSS. The services provided to the NS user shall be:

- Network Service SDU transfer. The Network Service entity shall provide 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 shall be used by the Network Service to report congestion.

- Status indication. Status indication shall be used to inform the NS user of the NS affecting events e.g. change in the available transmission capabilities.

The Network Service entity is composed of an entity dependent on the intermediate transmission network used on the Gb interface, the Sub-Network Service, and of a control entity independent from that network, the Network Service Control. There is a hierarchical relationship between both entities. This is reflected in Figure 2/GSM 08.16. The detailed communication mechanisms between both entities is an internal matter for the Network Service and is not further standardized.

Network Service

Network Service Control /
Network Service Control protocol

Sub-Network Service /
Sub-Network Service protocol
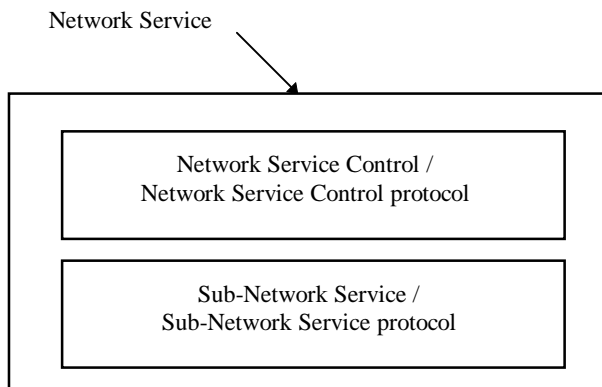
Figure 2/GSM 08.16: Internal architecture of the Network Service

The Sub-Network Service entity provides a communication service to Network Service Control peer entities. The Network Service Control peer entities use the Sub-Network Service for communication with each other. The peer-to-peer communication accross the Gb interface between remote Network Service Control entities is performed over Network Service Virtual Connections (NS-VCs). An NS-VC is a virtual communication path between Network Service Control peer entities.

The Network Service entity provides a communication service to NS user peer entities: the peer-to-peer communication between remote NS user entities is performed over BSSGP Virtual Connections (BVCs). A BVC is a virtual communication path between Network Service user peer entities. A Network Service Entity communicates with only one peer Network Service Entity.

Addressing across the Gb interface is further detailed in the rest of the present document.

The Network Service Control entity is responsible for the following functions:

- NS SDU transmission: The NS SDUs shall be transmitted on the NS-VCs. The NS SDUs are encapsulated into Network Service Control PDUs which in turn are encapsulated into Sub-Network Service PDUs.

- Load sharing: The load sharing function distributes the NS SDU traffic amongst the available (i.e. unblocked) NS-VCs of a group.

- NS-VC management: A blocking procedure is used by an NS entity to inform an NS peer entity when an NS-VC becomes unavailable for NS user traffic. An unblocking procedure is used for the reverse operation. A reset procedure is used between peer NS entities in order to set an NS-VC to a determined state, after events resulting in possibly inconsistent states of the NS-VC at both sides of the Gb interface. A test procedure is used to check that an NS-VC is operating properly between peer NS entities.

4.2   Addressing

The purpose of this clause is to describe the addressing principles on the Gb interface in a generic way, i.e. irrespective of the exact configuration of the Gb interface and of the exact nature of the intermediate transmission network, when present. Therefore, this clause provides an abstract description of the addressing principles. These principles are then applied to real networks in clause "Sub-Network Service protocol".

In this clause, addressing is considered in the general case where an SGSN is connected to several BSSs via an intermediate transmission network. Point-to-point physical connections may also be used, addressing in this special case can be derived from the general case.

Annex A provides an informative illustration of the addressing concepts when applied to the case of a Frame Relay.

4.2.1 Network Service Virtual Link (NS-VL)

An SGSN and a BSS may use different physical links for connecting to each other (e.g. because of intermediate equipment or transmission network). Each physical link is locally (i.e. at each side of the Gb interface) identified by means of a physical link identifier. The exact structure of the physical link identifier is implementation dependent.

Each physical link supports one or more Network Service Virtual Links (NS-VLs). Each NS-VL is supported by one physical link. The exact nature of the NS-VL depends on the intermediate network used on the Gb interface. In the general case of an intermediate transmission network, the NS-VL is used to access the intermediate network. Communication means internal to the intermediate network are outside the scope of the present document. The NS-VLs may alternatively be used end-to-end between the BSS and SGSN, in case of a point-to-point configuration on the Gb interface.

Each NS-VL is identified by means of a Network Service Virtual Link Identifier (NS-VLI). The significance (i.e. local or end-to-end) and the exact structure of the NS-VLI depends on the configuration of the Gb interface and on the intermediate network used. For example, in the case of a Frame Relay network, the physical link is the FR bearer channel, the NS-VL is the local link (at UNI) of the FR permanent virtual connection (PVC) and the NS-VLI is the association of the FR DLCI and bearer channel identifier.

4.2.2 Network Service Virtual Connection (NS-VC)

In order to provide end-to-end communication between the BSS and SGSN irrespective of the exact configuration of the Gb interface, the concept of Network Service Virtual Connection (NS-VC) is used.The NS-VCs are end-to-end virtual connections between the BSS and SGSN. At each side of the Gb interface there is a one-to-one correspondence between NS-VCs and NS-VLs

For example, in the case of a Frame Relay network, the NS-VC is the FR permanent virtual connection (PVC).

Figure 3/GSM08 16 shows the relationship between NS-VCs and NS-VLs.
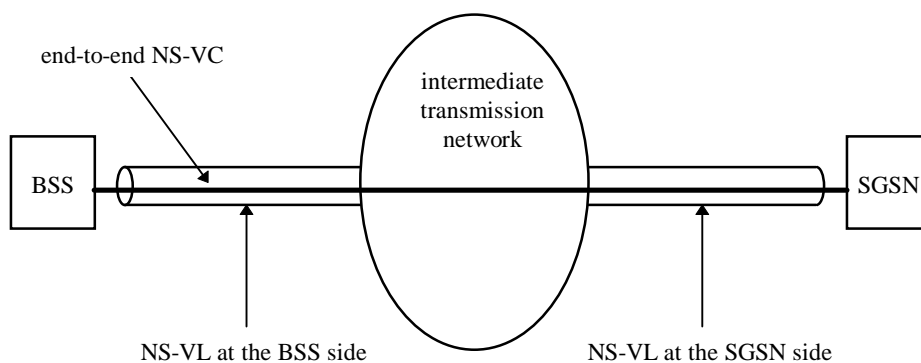
Figure 3/GSM 08.16: Relationship between NS-VCs and NS-VLs

Each NS-VC is identified by means of a Network Service Virtual Connection Identifier (NS-VCI) having end-to-end significance across the Gb interface. An NS-VCI uniquely identifies an NS-VC within an SGSN.

The establishment of an NS-VC includes the establishment of physical links, see GSM 08.14 [4], and of NS-VLs.

NS-VCs and NS-VLs are permanently established by means of administrative procedures, NS-VCIs are allocated by administrative means as well. The mapping of NS-VCIs on NS-VLIs and on physical link identifiers is held in non-volatile memory.

4.2.3 Network Service Virtual Connection Group

The Network Service Virtual Connection Group groups together all NS-VCs providing communication between the same peer NS entities. One NS-VC group is configured between two peer NS entities. This grouping is performed by administrative means. At each side of the Gb interface, there is a one-to-one correspondence between a group of NS-VCs and an NSEI. The NSEI has an end-to-end significance across the Gb interface.

4.2.4 BSSGP Virtual Connection (BVC)

The Network Service provides communication paths between remote NS user entities. These communication paths are called BSSGP Virtual Connections (BVCs). Each BVC is used to transport NS SDUs between NS users.

A Network Service Entity provides one or more BVCs between peer NS user entities. Each BVC is supported by one group of NS-VCs. Each group of NS-VCs supports one or more BVCs. The NS entity maps between BVC and the related NS-VC group.

Each BVC is identified by means of a BSSGP Virtual Connection Identifier (BVCI) having an end-to-end significance across the Gb interface. The BVCI together with the NSEI uniquely identifies a BVC within an SGSN. The BVCI and NSEI are used on the Network Service-Service Access Point (NS-SAP) for layer-to-layer communication.

4.3 Sub-Network Service functions

The Sub-Network Service functions of the Network Service shall provide access to the intermediate network (or to the peer entity in case of direct point-to-point configuration) by means of NS-VLs and shall provide NS-VCs between NS peer entities.

On each NS-VC, data are transferred in order by the Sub-Network Service.

When the Sub-Network Service entity detects that an NS-VC becomes unavailable (e.g. upon failure detection), or when the NS-VC becomes available again (e.g. after failure recovery), the Network Service Control entity shall be informed. Failures may occur due to protocol errors, intermediate transmission network failure, equipment or link failure or other reasons.

4.4 Load sharing function

The load sharing function distributes the NS SDU traffic among the unblocked NS-VCs of the same group on the Gb interface. The use of load sharing also provides to the upper layer seamless service upon failure by re-organizing the NS SDU traffic between the unblocked NS-VCs of the same group. The re-organization may disturb the order of transferred NS SDUs. The load sharing function should be implemented in both the BSS and the SGSN.

Load sharing applies only to NS SDUs, not to NS signalling such as NS-VC management PDUs.

4.4.1 Requirements on load sharing function

All NS SDUs to be transmitted over the Gb interface are passed to the load sharing function along with the Link Selector Parameter (LSP) , the BVCI and the NSEI. LSP and BVCI are used by the NS entity to select amongst the unblocked NS-VCs within the group, addressed by means of the NSEI, where to send the NS SDU. The mapping between LSP and NS-VC is based on an implementation dependent function that meets the following requirements:

- For each BVC and NSEI, the NS entity selects the NS-VC out of the group based on the LSP. This is an internal matter for the NS entity and it is not subject to further standardization.

- For each BVC and NSEI, NS SDUs with the same Link Selector Parameter shall be sent on the same NS-VC. Thus, the load sharing function guarantees that, for each BVC, the order of all NS SDUs marked with the same LSP value is preserved. In the event of a link failure and subsequent re-organization of the NS SDU traffic between the unblocked NS-VCs, the receiver may get out of order NS SDUs. Further actions implemented to prevent this error are outside the scope of the present document.

- Load sharing functions at the BSS and the SGSN are independent. Therefore, uplink and downlink NS SDUs for a subscriber may be transferred over different NS-VCs.

- A change in NS-VCs available for NS user traffic (i.e. one or more NS-VCs become blocked or unblocked) shall result in a re-organization of the NS SDU traffic amongst the unblocked NS-VCs of the same group.

- For a BVC, when there is no unblocked NS-VC of the group left between a BSS and a SGSN, the corresponding traffic is discarded by the NS at the sending side.

The Link Selector Parameter is locally used at the BSS and at the SGSN and shall not be transmitted across the Gb interface.

4.5 NS-VC management function

The NS-VC management function is responsible for the blocking / unblocking, reset and test of NS-VCs.

4.5.1 Blocking / unblocking of an NS-VC

When a condition making an NS-VC unavailable for NS user traffic is locally detected at the BSS or at the SGSN, the NS-VC shall be marked as blocked by the local NS entity and the remote NS peer entity shall be informed by means of a blocking procedure. The remote NS entity shall then mark the NS-VC as blocked and shall consider it as unavailable for NS user traffic.

A BSS or SGSN may block an NS-VC because of:

- Operation and Maintenance intervention at the Gb interface making the NS-VC unavailable for NS user traffic;

- equipment failure at a BSS or an SGSN entity;

- equipment or link failure on a BSS or an SGSN site;

- failure in the transit network; or

- other causes.

When the NS-VC becomes available again for NS user traffic, the NS entity which initiated the blocking procedure may inform the remote NS peer entity by means of an unblocking procedure. The remote NS entity shall then mark the NS-VC as unblocked and shall consider it as available for NS user traffic.

The blocking / unblocking procedures are further detailed in the rest of the present document.

4.5.2 Reset of an NS-VC

This procedure is used to reset one NS-VC to a determined state between remote entities. This procedure is performed:

- when a new NS-VC is set-up;

- after a processor re-start;

- after a failure recovery when the state of an NS-VC must be set to blocked and alive; or

- at any local event restoring an existing NS-VC in the dead state or in an undetermined state.

When a reset procedure is initiated, data in transfer may be lost.

4.5.3 Test of an NS-VC

The test procedure is used to check that end-to-end communication exists between peer NS entities on a given NS-VC. When end-to-end communication exists, the NS-VC is in the "alive" state, otherwise it is in the "dead" state. A dead NS-VC can not be in the "unblocked" state.

5 Elements for layer-to-layer communication

This chapter presents the Network Service in a generic way, no assumptions are made regarding the real protocols providing the network services.

5.1 Service primitive model

The service primitive model shown in Figure 4/GSM 08.16 is applicable to both BSS and SGSN.
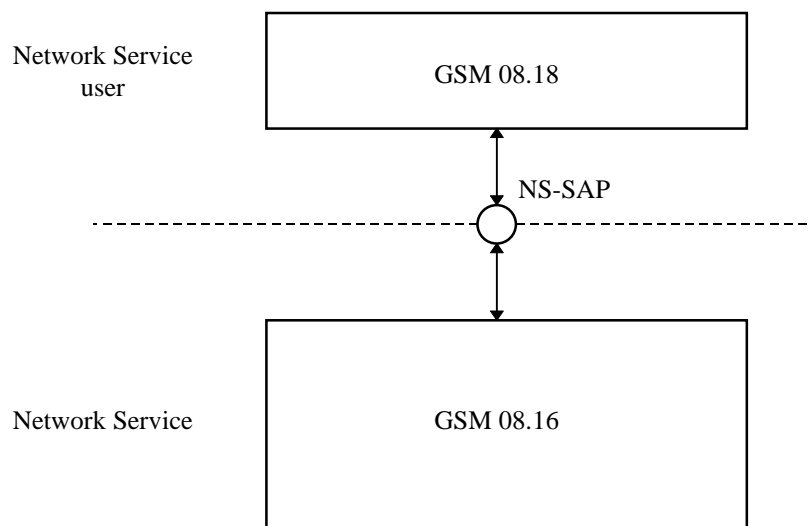
Figure 4/GSM 08.16: Network Service primitive model

The network services are provided at the Network Service-Service Access Point (NS-SAP).

5.2 Service primitives and parameters

The Network Service primitives are summarized in table 1/GSM 08.16. The general syntax of the Network Service primitives is:

NS - Generic name - Type (Parameters)

Table 1/GSM 08.16 Network Service primitives

Generic name	Type				Parameters
	Request	**Indication**	**Response**	**Confirm**	
UNITDATA	X	X			- BVCI and NSEI - NS SDU - Link Selector Parameter (in Request only)
CONGESTION		X			- BVCI and NSEI - congestion cause
STATUS		X			- BVCI and NSEI - NS affecting cause - transfer capability

5.2.1   Primitives

5.2.1.1   NS-UNITDATA-Request

This primitive is used by the NS user entity to send a NS SDU to its peer entity via a BVC. The NS entity sends the NS SDU in unacknowledged mode. The Link Selector Parameter is used to identify the NS SDUs which must be sent in order relatively to each other. The NSEI is used by the NS entity to select the group of NS-VCs corresponding to the addressed remote entity.

5.2.1.2   NS-UNITDATA-Indication

This primitive is used by the NS entity to provide the NS user entity with a NS SDU received on a virtual connection. The NS SDU are received in unacknowledged mode. BVCI together with NSEI indicate which BVC the NS SDU was received on.

5.2.1.3   NS-CONGESTION-Indication

The NS entity shall be able to detect when a congestion situation starts and ends on an NS-VC.

This primitive is used by the NS entity to report to the NS user entity that congestion is detected or that the congestion situation has disappeared. The BVCI and NSEI of the affected BVC and the congestion cause are reported to the NS user entity. Typically, the cause indicates the direction of transmission affected by the congestion.

5.2.1.4   NS-STATUS-Indication

There may be situations where an NS-VC becomes unavailable for NS user traffic. When this occurs, the NS user is informed of the degradation of the transfer capacity by means of this primitive including the "transfer capability" parameter.

When an NS-VC previously unavailable for NS user traffic becomes available again, the NS user entity is also informed by means of this service primitive, indicating the current transfer capability.

This primitive may be used in response to an NS-UNITDATA-Request primitive which the NS is unable to serve because of e.g. NS-VC failure.

This primitive may also be used upon recovery after a failure affecting the NS.

5.2.2   Parameters

5.2.2.1   NS SDU

The NS SDUs are specified in GSM 08.18 [5]. They shall never be inspected by the Network Service entity.

5.2.2.2   Link Selector Parameter

The Link Selector Parameter is included in the NS-UNITDATA-Request primitive for load sharing purposes as described in clause "Requirements on load sharing function".

5.2.2.3   BVCI I and NSEI

BVCI and NSEI parameters are included in the service primitives to identify the BVC for which the service is provided. These parameters are used by the NS entity to multiplex the NS SDUs over the NS-VCs.

5.2.2.4   Congestion cause

The congestion cause shall indicate the affected direction of transmission and may be set to the following values:

  a) congestion detected, backward

b) end of congestion, backward

c) congestion detected, forward

d) end of congestion, forward

5.2.2.5 Transfer capability

This parameter is used to report to the NS user entity the current transfer capacity available for a BVC, in terms of bandwidth. This parameter may be set to any value from "0" (zero) to the maximum bandwidth provided by the complete set of NS-VCs associated to the BVC.

5.2.2.6 NS affecting cause

This parameter is used to indicate to the NS user entity the reason which caused the NS-STATUS-Indication primitive to be used. The cause values are:

a) NS-VC failure: a failure is affecting one or more NS-VCs, the NS is still available.

b) NS-VC recovery: one or more NS-VCs which were in failure are available again.

c) NS failure: the NS can not provide data transfer services to the NS user.

d) NS recovery: the NS can provide data transfer services again.

6 Sub-Network Service protocol

6.1 Frame Relay support of the Sub-Network Service protocol

6.1.1 Overview

Frame Relay shall be the network used on the Gb interface.

The Gb interface may consist of direct point-to-point connections between the BSS and the SGSN, or an intermediate Frame Relay network may be placed between both ends of the Gb interface. Other intermediate equipments may be traversed. Several configurations are possible, the detail of which is outside the scope of the present document. For the purposes of the present document the following two types of configurations have to be considered:

-   Point-to-point physical connections.

-   Intermediate Frame Relay network.

In case of an intermediate Frame Relay network, both BSS and SGSN shall be treated as the user side of the user-to-network interface. The network-to network interface is outside the scope of the present document.

Only Frame Relay permanent virtual connections (PVCs) shall be used on the Gb interface. Therefore ITU-T Q.922 [9] Annex A and ITU-T Q.933 [11] Annex A, permanent virtual connection procedures, shall be supported. Switched virtual connection procedures in ITU-T Q.922 [9] and ITU-T Q.933 [11] shall not be supported. ITU-T Q.921 [8] and ITU-T Q.931 [10] procedures shall not be applicable.

The Frame Relay user-to-network interface (UNI) shall be implemented on the Gb interface according to the FRF 1.1 [6] agreement, unless otherwise stated in the present document. Selected options or deviations from FRF 1.1 [6] are specified in the rest of this Frame Relay chapter. Where discrepancies arise between the present document and the above mentioned recommendations, the present document takes precedence.

The rest of this Frame Relay clause applies only to PVC usage.

The Gb interface addressing principles shall be applied as follows:

-   The physical link is the Frame Relay bearer channel.

- The NS-VL is the local link in one end (at UNI) of the Frame Relay PVC.

- The NS-VLI is the Frame Relay DLCI together with the bearer channel identifier.

- The NS-VC is the Frame Relay PVC.

- The Sub-Network Service entity is the Frame Relay entity.

6.1.2   Network configuration

The Gb interface is a User-to-Network (UNI) interface, as defined in FRF 1.1 [6]. Two configurations are possible, either a direct link configuration or PVC(s) via a Frame Relay network.

Annex A shows an example of each type of configuration.

In case of point-to-point connections, the BSS shall be considered as the user side of the user-to-network interface, the SGSN shall be considered as the network side, see figure 5/GSM 08.16.
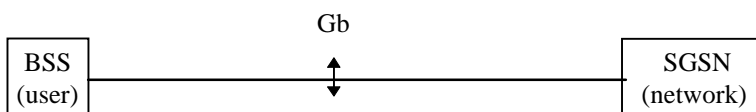
Figure 5/GSM 08.16: Direct link configuration

In case of an intermediate Frame Relay network, both BSS and SGSN shall be treated as the user side of the user-to-network interface, see figure 6/GSM 08.16. The network-to network interface is outside the scope of the present document.
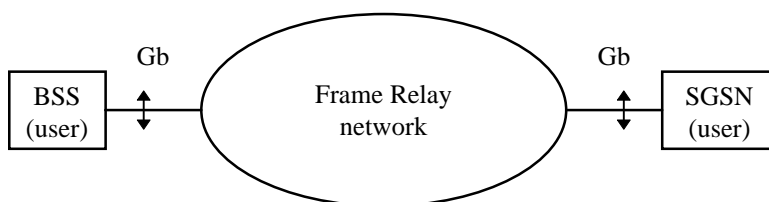
Figure 6/GSM 08.16: PVC via a Frame Relay Network

6.1.3   Services expected from layer 1

In the context of Frame Relay, the physical link is referred to as the bearer channel.

The Frame Relay protocol shall be run across permanently reserved bearer channels on the Gb interface, see GSM 08.14 [4].

6.1.4   Options selected from FRF 1.1

6.1.4.1   Support of DL-CONTROL sub-layer

No end-to-end DL-CONTROL sub-layer shall be implemented on the Gb interface.

6.1.4.2   Frame length

The default maximum information field size of 1600 octets shall be supported on the Gb interface. Maximum information field sizes greater than 1600 octets may be agreed to between Frame Relay network operators and users at subscription time.

6.1.4.3 Congestion control procedures

Congestion control is defined in FRF 1.1 [6] and consists of congestion avoidance and congestion recovery mechanisms.

Congestion control on the Gb interface consists of congestion avoidance based on the DE bit and on explicit notifications via the FECN and BECN bits within the address field of the Frame Relay frame.

Congestion avoidance based on the CLLM message (see ITU-T Q.922 [9] clause A.7 and FRF 1.1 [6] clause 2.2.5) is not required at the BSS and SGSN sides.

No congestion control mechanism based on implicit congestion detection (see ITU-T Q.922 [9] clause A.6.1) is required at the BSS and SGSN sides.

6.1.4.3.1 DE bit usage

The BSS and the SGSN shall always set the DE bit to 0 (zero).

6.1.4.3.2 FECN and BECN bit usage

Setting of the FECN and BECN bits:

The FECN and BECN bits shall be set to 0 by the BSS and the SGSN.

Reaction upon receipt of FECN or BECN marked frames:

The reaction of the BSS and the SGSN upon reception of FECN or BECN marked frames is implementation dependent.

It is recommended to implement ITU-T Q.922 [9] appendix I.2 procedures or similar procedures, so that the NS entity can reduce or increase the transmission rate, depending on the FECN or BECN bits received.

The NS entity shall be able to report the congestion situation to the upper layer. The criteria to be met for congestion being reported to the upper layer are implementation dependent. The upper layer is expected to reduce or increase its transmission rate as appropriate. It shall be up to the upper layer to perform further appropriate actions e.g. flow control with its peer entity, see ITU-T I.370 [12].

6.1.4.4 Signalling procedures

ITU-T Revised Q.933 [11] annex A procedures shall be implemented at the BSS and the SGSN sides as recommended in FRF 1.1 [6] clause 2.3.

On the Gb interface, these procedures shall be initiated by the user side of the UNI, reverse procedures shall not be used.

Only periodic polling shall be used, asynchronous status message needs not to be supported.

Switched virtual connection procedures , see FRF 1.1 [6] clause 2.3.2, shall not be implemented.

6.1.4.5 C/R bit usage

The C/R bit shall not be used and shall be set to 0 by the sending entity. It shall not be checked by the receiving entity.

6.1.5 Abnormal conditions

Upon detection of the unavailability of a PVC by the Frame Relay entity or when a PVC becomes available again, the Network Service Control entity shall be informed. Unavailability cases are described in Recommendations ITU-T Q.922 [9] and ITU-T Q.933 [11] annex A.

7 Network Service Control protocol

7.1 Procedures for the transmission of NS SDUs

NS SDUs are transmitted in unacknowledged mode across the Gb interface by means of an NS-UNITDATA PDU.

The NS-UNITDATA PDU is used in both BSS-to-SGSN and SGSN-to-BSS directions.

7.1.1 Abnormal Conditions

If the BSS receives an NS-UNITDATA PDU including a BVCI not associated to the NS-VC where the PDU was received, the BSS shall return an NS-STATUS PDU on that NS-VC, cause "BVC unknown on that NSE". Depending on the implementation, the BSS may then ignore the BVCI and treat the rest of the NS-UNITDATA PDU.

7.2 Blocking / unblocking procedures

When a BSS (or SGSN) wishes to block an NS-VC between a BSS and SGSN, the following shall be performed:

- The transmitting side at the BSS (or SGSN) shall mark the NS-VC as blocked and shall inform the load sharing function. This results in the redistribution of NS-UNIDATA PDUs to other unblocked NS-VCs of the same group, as described in the "Load sharing function" clause. The NS user entity shall also be informed of the new transfer capability by means of an NS-STATUS-Indication primitive for each affected BVC. A BSS (or SGSN) then sends an NS-BLOCK PDU to the peer entity and starts timer Tns-block.

- The NS-BLOCK PDU contains the NS-VCI and a Cause element indicating the reason for blocking (typical cause values: Transit network failure, O&M intervention, Equipment failure). The NS-BLOCK PDU may be sent in any alive (blocked or unblocked) NS-VC pertaining to the same group as the NS-VC to be blocked, unless otherwise required for particular cases which may be further described in the rest of the present document.

- At the sending side of the NS-BLOCK PDU, if no failure has occurred in the receive direction (e.g. O&M intervention), the originator of the NS-BLOCK PDU shall continue to accept NS-UNITDATA PDUs received on the NS-VC being blocked, until an NS-BLOCK-ACK PDU is received for this NS-VC. The originator of the NS-BLOCK PDU shall stop to accept NS-UNITDATA PDUs, if the number of retries of the blocking procedures is exceeded.

- Upon Receipt of an NS-BLOCK PDU at an SGSN (or BSS) the NS-VC shall be marked as blocked. The SGSN (or BSS) shall immediately inform the load sharing function. The NS user entity shall also be informed of the new transfer capability by means of an NS-STATUS-Indication primitive for each affected BVC. The SGSN (or BSS) then sends in any alive (blocked or unblocked) NS-VC of the relevant group an NS-BLOCK-ACK PDU, for the blocked NS-VC, to the BSS (or SGSN).

- On receipt of an NS-BLOCK-ACK PDU or NS-BLOCK PDU, the originator of the NS-BLOCK PDU stops timer Tns-block.

The NS-VC shall remain blocked until an NS-UNBLOCK PDU is received indicating that the NS-VC's state has been changed.

When a BSS (or SGSN) wishes to unblock an NS-VC between a BSS and SGSN, the following shall be performed:

- The BSS (or SGSN) sends an NS-UNBLOCK PDU to the peer entity and starts timer Tns-block. The NS-UNBLOCK PDU shall be sent on the NS-VC to be unblocked (the NS-VC must be alive, see check procedure in clauses "Test of an NS-VC"). The BSS or SGSN may discard any NS-UNITDATA PDU received on the concerned NS-VC until the reception of the NS-UNBLOCK-ACK PDU.

- If an NS-UNBLOCK PDU is received by an SGSN (or BSS) for an NS-VC and the SGSN (or BSS) is able to unblock the NS-VC, the SGSN (or BSS) shall return an NS-UNBLOCK-ACK PDU on the NS-VC where the NS-UNBLOCK PDU was received, then the NS-VC shall be marked as unblocked. The load sharing function shall be informed. The NS user entity shall also be informed of the new transfer capability by means of an NS-STATUS-Indication primitive for each affected BVC.

- A BSS (or SGSN) shall stop timer Tns-block on receipt of an NS-UNBLOCK-ACK or NS-UNBLOCK PDU, shall mark the NS-VC as unblocked and shall inform the load sharing function in order to allow transmission of NS-UNITDATA PDUs on this NS-VC. The NS user entity shall also be informed of the new transfer capability by means of an NS-STATUS-Indication primitive for each affected BVC. An NS-UNBLOCK PDU received while a BSS (or SGSN) is waiting for an NS-UNBLOCK-ACK PDU shall be acknowledged with an NS-UNBLOCK-ACK PDU.

- If an NS-UNBLOCK PDU is received by an SGSN (or BSS) and the SGSN (or BSS) is not able to unblock the NS-VC, the NS-VC shall remain blocked and the NS-VC blocking procedure shall be initiated by returning an NS-BLOCK PDU to the BSS (or SGSN). This NS-BLOCK PDU shall be sent on the NS-VC where the NS-UNBLOCK PDU was received.

- If a BSS (or SGSN) receives an NS-BLOCK PDU while waiting for an NS-UNBLOCK-ACK PDU, it shall stop timer Tns-block and the NS-VC shall remain blocked. An NS-BLOCK-ACK PDU shall be returned. An indication shall be issued towards the O&M system, announcing that the unblocking of the NS-VC was not possible at the peer entity. Further actions of the O&M system are out of the scope of the present document.

7.2.1 Abnormal Conditions

If an NS-BLOCK-ACK PDU is not received for an NS-BLOCK PDU within Tns-block seconds, then the NS-BLOCK PDU procedure shall be repeated a maximum of NS-BLOCK-RETRIES attempts. After NS-BLOCK-RETRIES unsuccessful retry attempts the procedure is stopped and the O&M system is informed that the blocking procedure has failed. Further actions of the O&M system are out of the scope of the present document. The NS-VC shall be marked as blocked at the originating side of the blocking procedure.

If an NS-UNBLOCK-ACK PDU is not received for an NS-UNBLOCK PDU within Tns-block seconds, the NS-UNBLOCK PDU procedure shall be repeated a maximum of NS-UNBLOCK-RETRIES attempts. After NS-UNBLOCK-RETRIES unsuccessful retry attempts the procedure is stopped and the O&M system is informed that the unblocking procedure has failed. Further actions of the O&M system are out of the scope of the present document. The NS-VC shall be marked as blocked at the originating side of the unblocking procedure.

If an NS-UNITDATA PDU is received on an NS-VC that is marked at a BSS or an SGSN as blocked and no NS-VC unblocking procedure is pending, then an NS-STATUS PDU (Cause value: NS-VC blocked) shall be returned to the peer entity.

If an NS-BLOCK PDU is received by a BSS or an SGSN for a blocked NS-VC, an NS-BLOCK-ACK PDU shall be returned.

If an NS-UNBLOCK PDU is received by a BSS or an SGSN for an unblocked NS-VC, an NS-UNBLOCK-ACK PDU shall be returned.

If an unexpected NS-BLOCK-ACK PDU is received by a BSS or an SGSN and it is related to an NS-VC that is locally blocked, the NS-BLOCK-ACK PDU is discarded. If the NS-BLOCK-ACK PDU is related to an NS-VC that is not locally blocked, then an NS-VC unblocking procedure is initiated.

If an unexpected NS-UNBLOCK-ACK PDU is received by a BSS or an SGSN and it is related to an NS-VC that is not locally blocked, the received NS-UNBLOCK-ACK PDU is discarded. If the NS-UNBLOCK-ACK PDU is related to an NS-VC that is locally blocked, then an NS-VC blocking procedure is initiated.

If the NS-VCI received in an NS-BLOCK or NS-BLOCK-ACK PDU is unknown, then the error shall be reported to the originator of the PDU by means of an NS-STATUS PDU including the unknown NS-VCI, with the Cause value set to "NS-VC unknown", the O&M system shall be informed, then the NS-BLOCK or NS-BLOCK-ACK PDU shall be ignored. Further actions of the O&M system are out of the scope of the present document.

7.3 Reset procedure

The reset procedure shall be used when a new NS-VC is set-up between a BSS and an SGSN, after processor re-start, after failure recovery or any local event restoring an existing NS-VC in the dead state or when its state is undetermined between remote NS entities. Upon completion of the reset procedure, the successfully reset NS-VC is marked as blocked and alive at both sides of the Gb interface.

When a BSS (or SGSN) wishes to reset an NS-VC, the following shall be performed:

- The NS entity at the BSS (or SGSN) informs the NS user entity of the new transfer capability by means of an NS-STATUS-Indication primitive for each affected BVC. The BSS (or SGSN) then sends an NS-RESET PDU to its peer entity indicating the NS-VCI and the NSEI. The NS-RESET PDU is sent on the NS-VC being reset. The NS-RESET PDU includes a Cause information element.

- The sending entity of the NS-RESET PDU then marks the NS-VC as blocked and dead and starts timer Tns-reset.

- Receipt of an NS-RESET PDU at an SGSN (or BSS) shall be acknowledged with an NS-RESET-ACK PDU including the NS-VCI and the NSEI, provided that the receiving side is able to reset the NS-VC (i.e. no local condition prevents the receiving side from resetting the NS-VC). The NS-RESET-ACK PDU shall be sent on the NS-VC being reset.

- The entity receiving the NS-RESET PDU then marks the acknowledged NS-VC as blocked and alive and informs the NS user entity of the new transfer capability by means of an NS-STATUS-Indication primitive for each affected BVC. The test procedure is then initiated on this NS-VC.

- When the sending entity of an NS-RESET PDU receives the NS-RESET-ACK PDU, it stops timer Tns-reset, marks the NS-VC as blocked and alive and initiates the test procedure on this NS-VC. The originator of the NS-RESET PDU is then responsible for unblocking this NS-VC.

In case of collision between reset procedures initiated at both sides of the Gb interface, the following shall apply:

- When an NS entity awaiting an NS-RESET-ACK PDU in response to an NS-RESET PDU receives an NS-RESET PDU, it shall acknowledge it as described above, and in addition, it shall treat it as an NS-RESET-ACK PDU.

When an NS entity is awaiting an NS-RESET-ACK PDU, any PDU other than NS-RESET or NS-RESET-ACK received on one of the NS-VCs being reset shall be ignored.

The reset procedure overrides any other pending procedure on the affected NS-VC i.e. other pending procedures are stopped, other running timers are stopped.

7.3.1 Abnormal conditions

If the sending entity of an NS-RESET PDU receives no NS-RESET-ACK PDU before timer Tns-reset expires the corresponding NS-VCs shall remain blocked and dead and the entire reset procedure shall be repeated. If the reset procedure remains unsuccessful for a period of time established by the operator, the O&M system shall be informed, and the reset procedure shall be stopped. Further actions of the O&M system are out of the scope of the present document.

If the NS-VCI received in an NS-RESET PDU is different from the NS-VCI locally associated to this NS-VC, the O&M system shall be informed, an NS-RESET-ACK PDU shall be returned including the NS-VCI locally associated to this NS-VC, then the NS-RESET PDU shall be ignored as if not received.

If the NSEI received in an NS-RESET PDU is different from the NSEI locally associated to this NS-VC, the O&M system shall be informed, an NS-RESET-ACK PDU shall be returned including the NSEI locally associated to this NS-VC, then the NS-RESET PDU shall be ignored as if not received.

If the NS-VCI received in an NS-RESET-ACK PDU is different from the NS-VCI locally associated to this NS-VC or if the NSEI received in an NS-RESET-ACK PDU is different from the NSEI locally associated to this NS-VC, the O&M system shall be informed, then the reset procedure shall be stopped. Further actions of the O&M system are out of the scope of the present document.

If an NS-RESET-ACK PDU is received when not expected, it shall be ignored.

7.4 Test procedure

The test procedure shall be used when a BSS (or SGSN) wishes to check that end-to-end communication with its peer entity exists on an NS-VC.

Both sides of the Gb interface may initiate this procedure independently from each other. This procedure shall be initiated upon successful completion of the reset procedure (as specified in subclause "Reset procedure") and shall then be periodically repeated.

Upon successful completion of an NS-VC reset procedure, a BSS (or SGSN) shall start timer Tns-test, then:

- Upon Tns-test expiry, a BSS (or SGSN) sends an NS-ALIVE PDU on the NS-VC to be checked, starts timer Tns-alive and waits for an NS-ALIVE-ACK PDU on this NS-VC.

- Upon receipt of an NS-ALIVE PDU on an alive NS-VC, an SGSN (or BSS) shall return an NS-ALIVE-ACK PDU on the NS-VC where the NS-ALIVE PDU was received.

- Upon receipt of the NS-ALIVE-ACK PDU in response to an NS-ALIVE PDU, the originator of the NS-ALIVE PDU, shall stop timer Tns-alive and shall start again timer Tns-test.

The procedure is repeated each time Tns-test expires.

7.4.1   Abnormal conditions

If an NS-ALIVE-ACK PDU is received when not expected, it shall be ignored.

If no NS-ALIVE-ACK PDU is received before Tns-alive expires, the test procedure shall be repeated a maximum of NS-ALIVE-RETRIES attempts. After NS-ALIVE-RETRIES unsuccessful retry attempts, the procedure is stopped, the NS-VC is marked as dead and blocked, the O&M system and the load sharing function are informed, and an NS-STATUS-Indication is sent to the NS user entity. A blocking procedure is initiated using an alive NS-VC, if any. Further actions of the O&M system are out of the scope of the present document.

7.5   Procedure for error reporting

The reporting of protocol errors to the remote entity is done by means of the NS-STATUS PDU, as further described in the rest of the present document.

Upon receipt of an NS-STATUS PDU, the O&M system is informed. Further actions of the O&M system are out of the scope of the present document.

7.5.1   Abnormal conditions

If an error is detected in a received NS-STATUS PDU, then the error shall not be reported to the remote NS entity.

8   General protocol error handling

This clause is not applicable to the Sub-Network Service protocol.

The following "General case" subclause applies unless otherwise stated in the "Special cases" subclause.

8.1   General case

This clause specifies procedures for the handling of unknown, unforeseen, and erroneous protocol data by the receiving entity. These procedures are called "error handling procedures", but in addition to providing recovery mechanisms for error situations they define a compatibility mechanism for future extensions of the protocol.

Most error handling procedures are mandatory for a BSS and SGSN.

Detailed error handling procedures are implementation dependent and may vary from PLMN to PLMN. However, when extensions of this protocol are developed, networks shall be assumed to have the error handling that is indicated in this clause as mandatory ("shall") and that is indicated as strongly recommended ("should").

In this clause the following terminology is used:

- **Syntactical error:** an IE is defined to be syntactically incorrect in a PDU if it contains at least one value defined as "reserved" or "reserved for future use", or if its value part violates coding rules specified in the relevant protocol specification, e.g. a too short IE (the length indicator shall be used to determine the boundary of the IE). However, it is not a syntactical error that an IE specifies in its length indicator a greater length than defined in the relevant protocol specification; and

- **Semantic error:** a PDU is defined to have semantically incorrect contents if it contains information which, possibly dependent on the state of the receiver, is in contradiction to the resources of the receiver and/or to the procedural part of the relevant protocol specification.

To allow for the introduction of new functions the following rules shall be used to determine the actions of a receiving entity when it receives a PDU, part or all of which it is unable to understand. As the recipient is unable to tell the difference between a new, previously unspecified coding and an erroneous coding, the recipient also uses the same rules for error handling.

The robustness of a recipient in handling erroneous PDUs does not relax the requirement that the transmitter shall obey the present document. However, it is intended that functionality can be gradually added to an entity, and no obstacle to intermediate phase equipment is intended.

8.1.1   Presence requirements of Information Elements

There are three different presence requirements (M, C, or O) for an IE within a given PDU:

- **M ("Mandatory")** means that the IE shall be included by the sending side, and that the receiver diagnoses a "missing essential IE" error when detecting that the IE is not present.

- **C ("Conditional")** means:

    - that inclusion of the IE by the sender depends on conditions specified in the relevant protocol specification;

    - that there are conditions for the receiver to expect that the IE is present and/or conditions for the receiver to expect that the IE is not present; these conditions depend only on the PDU itself, and not on the state in which the PDU was received; they are known as static conditions;

    - that the receiver detecting that the IE is not present when sufficient static conditions are fulfilled for its presence, shall diagnose a "missing essential IE" error;

    - that the receiver detecting that the IE is present when sufficient static conditions are fulfilled for its non-presence, shall treat the IE as an optional one, see below.

- **O ("Optional")** means that the receiver shall never diagnose a "missing essential IE" error or shall never diagnose an error because it detects that the IE is present or that the IE is not present. There may however be conditions depending on the states, resources, etc. of the receiver to diagnose other errors.

In addition, the following definitions apply:

- **Essential Elements:** These are the conditional (C) elements when the condition for their reception is fulfilled, plus the mandatory (M) elements. Any exception to this rule is explicitly stated in the relevant protocol specification.

- **Non-Essential Elements:** Non-essential elements are all the information elements that are not defined as essential.

8.1.2   Erroneous events

The following events shall be regarded as errors by the recipient and shall be treated as specified below. Certain types of error shall be reported to the sending side, in that case the erroneous PDU and the error cause shall be returned to the sending side by means of the appropriate error reporting PDU. The following rules shall be applied in order of precedence:

1) a PDU whose type is non-existent or unrecognisable: the error shall not be reported, the PDU shall be ignored;

2) a PDU not consistent with the recipient's state: the error shall be reported with cause "PDU not compatible with the protocol state", the PDU shall be ignored;

3) a PDU sent in the wrong direction: the error shall be reported with cause "Protocol error - unspecified", the PDU shall be ignored;

4) a missing essential information element: the error shall be reported with cause "Missing essential IE", the PDU shall be ignored;

5) syntactical error in an essential IE: the error shall be reported with cause "Invalid essential IE", the PDU shall be ignored.

8.1.3   Non-erroneous events

The following events shall not be regarded as errors by the recipient:

1) spare bits with an unexpected value in any information element;

2) the use of additional octets in any information element with a length indicator, that is: when the indicated length is greater than defined in the relevant protocol specification (the length indicatorl shall be used to determine the boundary of the IE);

3) a missing non-essential information element;

4) an unknown information element identifier;

5) any unexpected information element; and

6) a syntactical error in any non-essential information element.

When the recipient detects one or more of these events the receiving entity shall ignore the information that it is unable to understand and treat the PDU on the basis of the information that remains.

Additionally, when more information elements of a particular type are received than are expected, the last one(s) shall be ignored.

If, because information was ignored, the rest of the PDU can no longer be handled then the receiving entity shall report the error to the sending side by means of the appropriate error reporting PDU including the incorrect PDU received and the cause "semantically incorrect PDU".

8.1.4   Other events

The following events should be treated on a case by case basis and the outcome may depend upon the capabilities of the recipient.

1) The recipient may accept PDUs that contain information elements that do not appear to be in the correct sequence. Elements that occur more than once in a PDU shall be assumed to have been transmitted in the correct order. Recipients that do not accept out of sequence information elements shall regard the PDU as containing unexpected and/or missing information elements and follow the procedures defined in the rest of this "General case" clause.

2) When any IE with semantically incorrect contents is received, the receiving entity shall react according to the relevant protocol specification. If however no such reactions are specified, the receiving entity shall ignore that IE and treat the rest of the PDU. If, because this IE was ignored, the rest of the PDU can no longer be handled then the receiving entity shall report the error to the sending side by means of the appropriate error reporting PDU including the incorrect PDU received and the cause "semantically incorrect PDU".

8.2   Special cases

In case of conflict between this subclause and the above "General case" subclause, this subclause takes precedence.

In case of conflict between this subclause and the specific "Abnormal conditions" subclauses in chapter "Network Service Control protocol", the "Abnormal conditions" subclauses take precedence over this "Special cases" subclause.

8.2.1 Deviations from the "General case" subclause

The Cause information element (see subclauses "General PDU definitions and contents" and "General information elements coding") shall be considered as a non-essential information element even when mandatory in a PDU.

8.2.2 Error reporting

The NS-STATUS PDU shall be used to report error to the remote NS entity, see subclause "Procedure for error reporting". The NS-STATUS PDU shall never be used to report an error detected in a received NS-STATUS PDU.

9 General PDU definitions and contents

This clause is not applicable to the Sub-Network Service protocol.

9.1 General structure of a PDU

This subclause defines the general structure of the PDUs on the Gb interface.

The general PDU structure is composed of:

   a) a PDU type information element; and

   b) other information elements, as required.

The PDU type IE occupies the first octet position in the PDU.

This general structure and the numbering convention used on the Gb interface are illustrated in figure 7/GSM 08.16. 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.

The octets shall be transmitted by increasing order of octet number. Within each octet, the bits shall be transmitted by increasing order of bit number i.e. bit 1 of octet 1 shall be transmitted first, bit 8 of octet n shall be transmitted last.

	8	7	6	5	4	3	2	1
octet 1	PDU type							
octets 2, 3, ...n	other information elements							

Figure 7/GSM 08.16 General PDU structure and numbering convention

Each PDU definition includes a table listing the information elements (IEs) known in the PDU and the order of their appearance in the PDU. Unless specified otherwise in the PDU descriptions, a particular information element shall not be present more than once in a given PDU. All information elements that may be repeated are explicitly indicated.

For each information element the table indicates:

   a) The name of the information element (which may give an idea of the semantics of the element).

   b) Possibly a reference to another GSM Technical Specification where the information element is described.

   c) The presence requirement indication (M, C, or O) for the IE as defined in clause "General protocol error handling".

   d) The format (T, L, V) of the information element. See further description of the type (T), length (L) and V (value) fields in subclause "General structure of the information elements".

e) The length of the information element (or permissible range of lengths), in octets, in the PDU, where "?" means that the maximum length of the IE is only constrained by the lower layer protocol. This indication is non-normative. The indicated length includes all the T, L, V fields present in the IE.

f) Subclauses specifying, where appropriate, conditions for IEs with presence requirement C or O in the relevant PDU which together with other conditions specified in GSM 08.16 define when the information elements shall be included or not, what non-presence of such IEs means, and - for IEs with presence requirement C - the static conditions for presence and/or non-presence of the IEs, see clause "General protocol error handling".

9.2 Network Service Control PDUs

The Network Service Control PDUs are also referred to as NS PDUs in the rest of the present document.

9.2.1 NS-ALIVE

This PDU is used to test an NS-VC.

PDU type: NS-ALIVE

Direction: BSS to SGSN, SGSN to BSS

Table 1/GSM 08.16 NS-ALIVE PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1

9.2.2 NS-ALIVE-ACK

This PDU acknowledges a received NS-ALIVE PDU and is sent on the NS-VC where the NS-ALIVE PDU was received.

PDU type: NS-ALIVE-ACK

Direction: SGSN to BSS, BSS to SGSN

Table 2/GSM 08.16 NS-ALIVE-ACK PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1

9.2.3 NS-BLOCK

This PDU indicates that an NS-VC shall be blocked at the recipient entity.

PDU type: NS-BLOCK

Direction: BSS to SGSN, SGSN to BSS

Table 3/GSM 08.16 NS-BLOCK PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1
Cause		M	TLV	3
NS-VCI		M	TLV	4

9.2.4   NS-BLOCK-ACK

This PDU acknowledges that an NS-VC has been blocked for use.

PDU type: NS-BLOCK-ACK

Direction: SGSN to BSS, BSS to SGSN

Table 4/GSM 08.16 NS-BLOCK-ACK PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1
NS-VCI		M	TLV	4

9.2.5   NS-RESET

This PDU indicates that the NS peer entity is trying to reset one NS-VCs.

PDU type: NS-RESET

Direction: BSS to SGSN, SGSN to BSS

Table 5/GSM 08.16 NS-RESET PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1
Cause		M	TLV	3
NS-VCI		M	TLV	4
NSEI		M	TLV	4

Typical cause values are: O&M intervention, Equipment failure.

9.2.6   NS-RESET-ACK

This PDU acknowledges the reset of the indicated NS-VCs.

PDU type: NS-RESET-ACK

Direction: BSS to SGSN, SGSN to BSS

Table 6/GSM 08.16 NS-RESET-ACK PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1
NS-VCI		M	TLV	4
NSEI		M	TLV	4

9.2.7   NS-STATUS

This PDU is used to report error conditions.

PDU type: NS-STATUS

Direction: SGSN to BSS, BSS to SGSN

Table 7/GSM 08.16 NS-STATUS PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1
Cause		M	TLV	3
NS-VCI		C	TLV	4
NS PDU		C	TLV	3-?
BVCI		C	TLV	4

9.2.7.1 Static conditions for NS-VCI

The "NS-VCI" IE shall be included when the "Cause" IE is set to one of the following values:

   a) "NS-VC blocked",

   b) "NS-VC unknown",

and shall not be included otherwise.

9.2.7.2 Static conditions for NS PDU

The "NS PDU" IE shall be included if the NS-STATUS message is sent in response to a received NS PDU within which an error was detected i.e. when the "Cause" IE is set to one of the following values:

   a) - "Semantically incorrect PDU",

   b) - "PDU not compatible with the protocol state",

   c) - "Protocol error - unspecified",

   d) - "Invalid essential IE",

   e) - "Missing essential IE",

and shall not be included otherwise.

This is the whole PDU received with error. This PDU may be truncated if it exceeds the information carrying capacity of the NS.

9.2.7.3 Static conditions for BVCI

The "BVCI" IE shall be included when the "Cause" IE is set to one of the following values:

   a) " BVCI unknown on that NSE",

and shall not be included otherwise.

9.2.8 NS-UNBLOCK

This PDU indicates that an NS-VC shall be unblocked at the recipient entity.

PDU type: NS-UNBLOCK

Direction: BSS to SGSN, SGSN to BSS

Table 8/GSM 08.16 NS-UNBLOCK PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1

9.2.9   NS-UNBLOCK-ACK

This PDU acknowledges that an NS-VC has been unblocked.

PDU type: NS-UNBLOCK-ACK

Direction: SGSN to BSS, BSS to SGSN

Table 9/GSM 08.16 NS-UNBLOCK-ACK PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1

9.2.10   NS-UNITDATA

This PDU transfers one NS SDU between the BSS and SGSN.

PDU type: NS-UNITDATA

Direction: BSS to SGSN, SGSN to BSS

Table 10/GSM 08.16 NS-UNITDATA PDU contents

Information element	Reference	Presence	Format	Length
PDU type		M	V	1
spare octet		M	V	1
BVCI		M	V	2
NS SDU		M	V	1-?

The length of the "NS SDU" information element shall be derived by the Network Service Control entity from the length of the complete NS-UNITDATA PDU provided by the Sub-Network Service entity to the Network Service Control entity.

10   General information elements coding

This clause is not applicable to the Sub-Network Service protocol.

10.1   General structure of the information elements

The general information element structure is composed of (see Figure 8/GSM 08.16):

   a) an Information Element Identifier (also referred to as the T field),

   b) a length indicator (also referred to as the L field),

   c) the information element value (also referred to as the V field).

Information elements have the TLV or the V format, as specified in the relevant protocol specification. The format of any given information element may depend on the context e.g. on the message type.

	8	7	6	5	4	3	2	1
octet 1				Information Element Identifier (IEI)				
octets 2, 2a				length indicator				
octet 3 ... octet ... n				information element value				

Figure 8/GSM 08.16 Information element structure, TLV format

	8	7	6	5	4	3	2	1
octet 1 ... octet ... n				information element value				

Figure 9/GSM 08.16 Information element structure, V format

When a field extends over more than one octet, the order of bit values progressively decreases as the octet number increases. The least significant bit of the field is represented by the lowest numbered bit of the highest numbered octet of the field.

10.1.1   Information Element Identifier

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 shall assume that the next octet is the first octet of the length indicator field and shall interpret it as described in the "Length indicator" clause.

This rule allows the receiver to skip unknown information elements and to analyse any following information elements.

10.1.2   Length indicator

The length indicator shall be included in all information elements having the TLV format.

Information elements may be variable in length. The length indicator is one or two octet 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.

The length of the value field of the IE occupies the rest of the bits in the length indicator.

	8	7	6	5	4	3	2	1
octet 2	0/1 ext				length			
octet 2a				length				

Figure 10/GSM 08.16 Length indicator structure

The BSS or SGSN shall not consider the presence of octet 2a in a received IE as an error when the IE is short enough for the length to be coded in octet 2 only.

10.2 Information element description

The descriptions of the information elements are organized in alphabetical order of the IE name. Each IE is described in one subclause.

A figure of the subclause defines the structure of the IE indicating:

- the position of the IEI, when present;

- the fields the IE value part is composed of;

- the position of the length indicator, when present;

- possibly octet numbers of the octets that compose the IE.

Finally, the subclause may contain figures defining the structure and value range of the fields that compose the IE value part.

Where the description of information elements in the present document contains bits defined to be "spare bits", these bits shall set to zero by the sending side, and their value shall be ignored by the receiving side.

The term "default" may be used, implying that the value defined shall be used in the absence of any assignment, or that this value allows negotiation of alternative values in between the two peer entities.

10.3 Network Service Control information element description

The IEI values defined for the Network Service Control protocol are indicated in table 11/GSM 08.16:

Table 11/GSM 08.16 IEI coding

IEI coding								Information element name
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Cause
0	0	0	0	0	0	0	1	NS-VCI
0	0	0	0	0	0	1	0	NS PDU
0	0	0	0	0	0	1	1	BVCI
0	0	0	0	0	1	0	0	NSEI
other values								reserved for future use

10.3.1 BVCI

This IE is used for multiplexing BVCs on NS-VCs.

	8	7	6	5	4	3	2	1
octet 1	IEI							
octets 2, 2a	length indicator							
octet 3	most significant octet of BVCI							
octet 4	least significant octet of BVCI							

Figure 11/GSM 08.16 BVCI information element

10.3.2 Cause

This IE may be used to indicate to the peer NS entity the reason which triggered a procedure, or the reason of an abnormal condition.

	8	7	6	5	4	3	2	1
octet 1	IEI							
octets 2, 2a	length indicator							
octet 3	cause value							

Figure 12/GSM 08.16 Cause information element

The cause values are indicated in Table 12/GSM 08.16:

Table 12/GSM 08.16 Cause values

Cause value coding								Cause name
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Transit network failure
0	0	0	0	0	0	0	1	O&M intervention
0	0	0	0	0	0	1	0	Equipment failure
0	0	0	0	0	0	1	1	NS-VC blocked
0	0	0	0	0	1	0	0	NS-VC unknown
0	0	0	0	0	1	0	1	BVCI unknown on that NSE
0	0	0	0	1	0	0	0	Semantically incorrect PDU
0	0	0	0	1	0	1	0	PDU not compatible with the protocol state
0	0	0	0	1	0	1	1	Protocol error - unspecified
0	0	0	0	1	1	0	0	Invalid essential IE
0	0	0	0	1	1	0	1	Missing essential IE
other values								reserved for future use

10.3.3　NS PDU

This IE is included in the NS-STATUS PDU sent in answer to an erroneous NS PDU. This IE contains the erroneous PDU received. The erroneous PDU may be truncated in order to fit in the maximum size of the NS-STATUS PDU.

	8	7	6	5	4	3	2	1
octet 1	IEI							
octets 2, 2a	length indicator							
octet 3	NS PDU							
...								
octet n								

Figure 13/GSM 08.16 NS PDU information element

10.3.4　NS SDU

This IE contains one and only one NS SDU transmitted across the Gb interface. This IE has the V format.

	8	7	6	5	4	3	2	1
octet 1	NS SDU							
...								
octet n								

Figure 14/GSM 08.16 NS SDU information element

In this "NS SDU" information element, bit i of octet j is equal to bit i of octet j of the NS SDU, as defined in the NS user protocol specification.

10.3.5   NS-VCI

This IE unambiguously identifies one NS-VC amongst all the NS-VCs used between one SGSN and the connected BSSs.

	8	7	6	5	4	3	2	1
octet 1				IEI				
octets 2, 2a				length indicator				
octet 3				most significant octet of NS-VCI				
octet 4				least significant octet of NS-VCI				

Figure 15/GSM 08.16 NS-VCI information element

10.3.6   NSEI

This IE unambiguously identifies one NSE

	8	7	6	5	4	3	2	1
octet 1				IEI				
octets 2, 2a				length indicator				
octet 3				most significant octet of NSEI				
octet 4				least significant octet of NSEI				

Figure 16/GSM 08.16 NSEI information element

10.3.7   PDU type

The PDU type has the V format.

Table 13/GSM 08.16 PDU type coding

PDU type coding								PDU name
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	NS-UNITDATA
0	0	0	0	0	0	1	0	NS-RESET
0	0	0	0	0	0	1	1	NS-RESET-ACK
0	0	0	0	0	1	0	0	NS-BLOCK
0	0	0	0	0	1	0	1	NS-BLOCK-ACK
0	0	0	0	0	1	1	0	NS-UNBLOCK
0	0	0	0	0	1	1	1	NS-UNBLOCK-ACK
0	0	0	0	1	0	0	0	NS-STATUS
0	0	0	0	1	0	1	0	NS-ALIVE
0	0	0	0	1	0	1	1	NS-ALIVE-ACK
other values								reserved for future use

10.3.8   Spare octet

This IE is included in a PDU e.g. when it is needed to align another IE on a 32 bit boundary. This IE has the V format. All bits are spare.

	8	7	6	5	4	3	2	1
octet 1				spare				

Figure 17/GSM 08.16 NS-VCI information element

11 List of system variables

Table 14/ GSM 08.16 System timers

timer name	timer value	notes	relation to other timers
Tns-block	1s to 120s	Guards the blocking and unblocking procedures	none
Tns-reset	1s to 120s	Guards the reset procedure	none
Tns-test	1s to 60s	Periodicity of the NS-VC test procedure	none
Tns-alive	3s	Guards the NS-VC test procedure	none

Table 15/ GSM 08.16 System counters

counter name	value	notes
NS-BLOCK-RETRIES	3	recommended value
NS-UNBLOCK-RETRIES	3	recommended value
NS-ALIVE-RETRIES	10	recommended value

Annex A (informative):
Illustration of the addressing scheme on the Gb interface

This annex provides illustrative examples of the addressing scheme on the Gb interface.

Refer to GSM 08.18 [5] for the definition of PTP functional entities, PTM functional entities and signalling entities.

Figure A.1/GSM 08.16 shows an example of the addressing scheme when an intermediate Frame Relay network is used on the Gb interface.
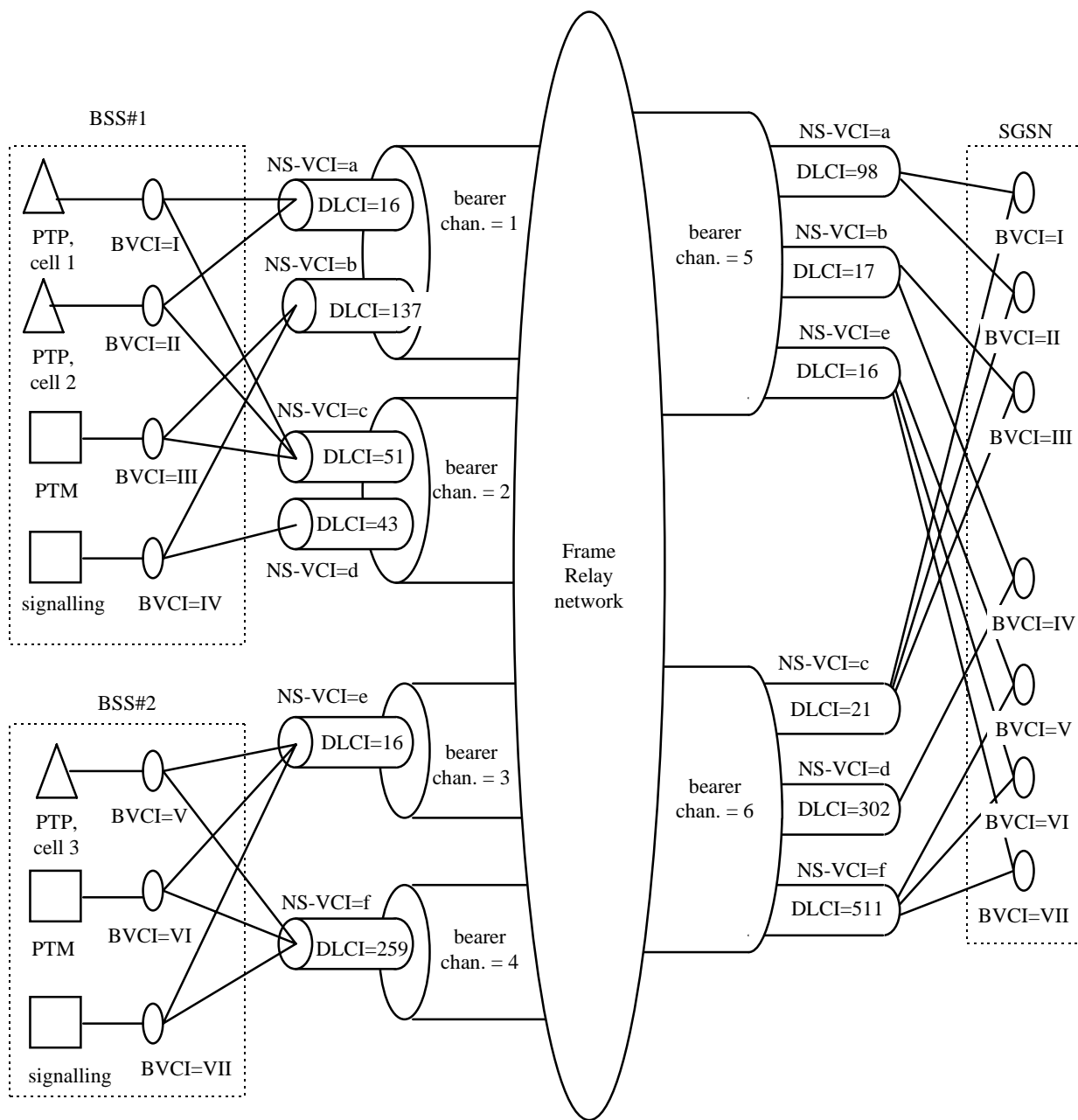
Figure A.1/GSM 08.16: Example of the Gb interface with an intermediate Frame Relay network

In this example, it is assumed that each BVC is supported by two NS-VCs. The two sides of the Gb interface use different physical links.

BVCI=I, II and V are used to address the PTP functional entities responsible for cells 1, 2 and 3 respectively.

BVCI=III and VI are used to address PTM functional entities in BSS#1 and #2 respectively (in this example, it is assumed there is one PTM functional entity per BSS).

BVCI=IV and VII are used to address signalling entities in BSS#1 and #2 respectively (in this example, it is assumed there is one signalling entity per BSS).

The following mapping tables correspond to the above example:

Table A.1/GSM 08.16: Mapping table of the NS entity, SGSN side

NSEI	NS-VCI	DLCI	bearer channel	Comments
α	a	98	5	Load sharing of BVCIs I, II, II and IV between NS-VCs a, b, c and d.
	b	17	5	
	c	21	6	
	d	302	6	
β	e	16	5	Load sharing of BVCIs V, VI and VII between NS-VCs e and f.
	f	511	6	

Table A.2/GSM 08.16: Mapping table of the NS entity, BSS#1 side

NSEI	BVCI	NS-VCI	DLCI	bearer channel	Comments
α	all (I, II, III and IV)	a	16	1	Load sharing between all NS-VCs.
		b	137	1	
		c	51	2	
		d	43	2	

Table A.3/GSM 08.16: Mapping table of the NS entity, BSS#2 side

NSEI	BVCI	NS-VCI	DLCI	bearer channel	Comments
	all (V, VI and VII)	e	16	3	Load sharing between all NS-VCs.
		f	259	4	

Table A.4/GSM 08.16: Mapping table of the NS user entity, SGSN side

Cell / BSC	BVCI	NSEI
PTP, cell 1	I	α
PTP, cell 2	II	α
PTP, cell 3	V	β
PTM, BSS#1	III	α
PTM, BSS#2	VI	β
signalling, BSS#1	IV	α
signalling, BSS#2	VII	β

Table A.5/GSM 08.16: Mapping table of the NS user entity, BSS#1 side

Cell / BSC	BVCI	NSEI
PTP, cell 1	I	α
PTP, cell 2	II	α
PTM	III	α
signalling	IV	α

Table A.6/GSM 08.16: Mapping table of the NS user entity, BSS#2 side

Cell / BSC	BVCI	NSEI
PTP, cell 3	V	β
PTM	VI	β
signalling	VII	β

Figure A.2 /GSM 08.16 shows an example of the addressing scheme when point-to-point Frame Relay connections are used on the Gb interface. The BSS configuration is the same as in figure A.1/GSM 08.16.

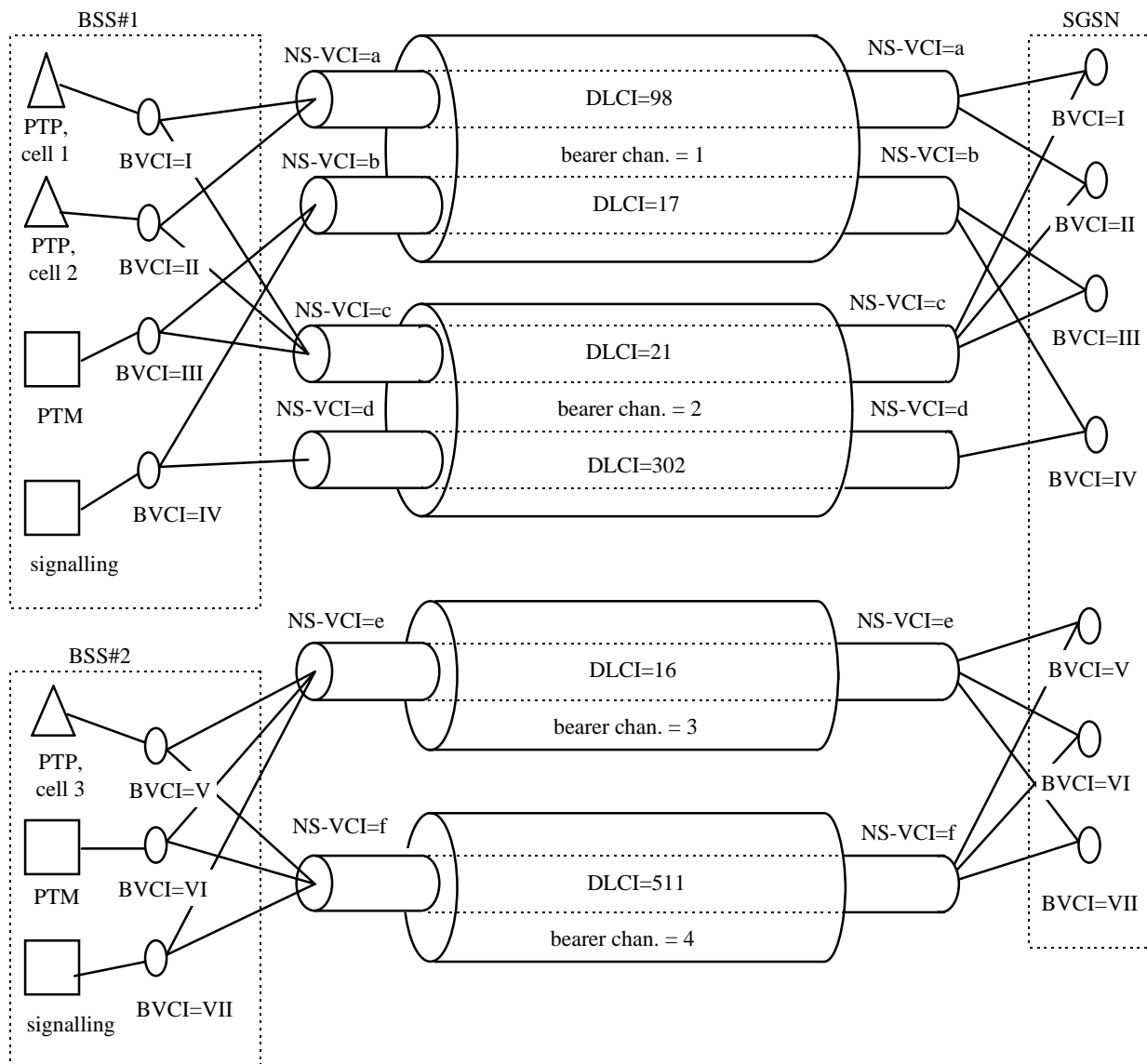**Figure A.2 /GSM 08.16: Example of the the Gb interface, with point-to-point Frame Relay connections**

The two sides of the Gb interface use the same physical links. In figure A.2/GSM 08.16, it is assumed that, for each bearer channel, the bearer channel identifiers are set to the same value at both sides of the Gb interface. Alternatively, they could also have different values.

The corresponding mapping tables are:

Table A.7/GSM 08.16: Mapping table of the NS entity, SGSN side

NSEI	NS-VCI	DLCI	bearer channel	Comments
α	a	98	1	Load sharing of BVCIs I, II, II and IV
	b	17	1	between NS-VCs a, b, c and d.
	c	21	2	
	d	302	2	
β	e	16	3	Load sharing of BVCIs V, VI and VII
	f	511	4	between NS-VCs e and f.

Table A.8/GSM 08.16: Mapping table of the NS entity, BSS#1 side

NSEI	BVCI	NS-VCI	DLCI	bearer channel	Comments
α	all	a	98	1	Load sharing
	(I, II, III and IV)	b	17	1	between all NS-VCs.
		c	21	2	
		d	302	2	

Table A.9/GSM 08.16: Mapping table of the NS entity, BSS#2 side

NSEI	BVCI	NS-VCI	DLCI	bearer channel	Comments
β	all	e	16	3	Load sharing
	(V, VI and VII)	f	511	4	between all NS-VCs.

Table A.10/GSM 08.16: Mapping table of the NS user entity, SGSN side

Cell / BSC	BVCI	NSEI
PTP, cell 1	I	α
PTP, cell 2	II	α
PTP, cell 3	V	β
PTM, BSS#1	III	α
PTM, BSS#2	VI	β
signalling, BSS#1	IV	α
signalling, BSS#2	VII	β

Table A.11/GSM 08.16: Mapping table of the NS user entity, BSS#1 side

Cell / BSC	BVCI	NSEI
PTP, cell 1	I	α
PTP, cell 2	II	α
PTM	III	α
signalling	IV	α

Table A.12/GSM 08.16: Mapping table of the NS user entity, BSS#2 side

Cell / BSC	BVCI	NSEI
PTP, cell 3	V	β
PTM	VI	β
signalling	VII	β

Annex B (informative):
Illustration of the Load Sharing Function on the Gb interface

This annex provides illustrative examples of the Load Sharing function on the Gb interface based on the notion of BVC pool. The notion of pool is only defined in that informative annex to describe a possible implementation, and has no impact or normative value in the rest of the specification.

The notion of pool allows to define locally in each sending entity (BSS or SGSN) a preferential order of use of the NS-VCs that carry a BVC. Several use can be envisaged for that mechanism e.g. use NS-VCs with different QoS or cost for the operator, or to optimise the receiving end of a Gb interface by loading preferentially a given route which would minimise internal re-routing functions.

The Load Sharing function uses, for each BVC, a ranked list of NS-VCs. Within that list, there is a number N of NS-VCs which belong to the pool level 1, the rest belonging to the pool level 2. Both the ranked list and the parameter N are configuration parameters for each BVC.

The list of NS-VCs belonging to the pool level 1 is comprised of the N first NS-VCs in the list which are available (i.e. UNBLOCKED). This means that depending on the BLOCK/UNBLOCK status of the NS-VCs in the list, some NS-VCs shall change of level dynamically.

The NS SDUs for a BVC shall be sent preferentially by the load sharing function on the level 1 NS-VCs. The level 2 NS-VCs shall only be used whenever the level 1 NS-VCs are overloaded.

The available bandwidth for a BVC is the sum of its 2 pools.

Refer to GSM 08.18 [5] for the definition of PTP functional entities, PTM functional entities and signalling entities.

Figure B.1/GSM 08.16 shows an example of the addressing scheme when an intermediate Frame Relay network is used on the Gb interface. The plain lines represent the NS-VCs belonging to the first level pool. The dotted lines represent the NS-VCs belonging to the second level pool
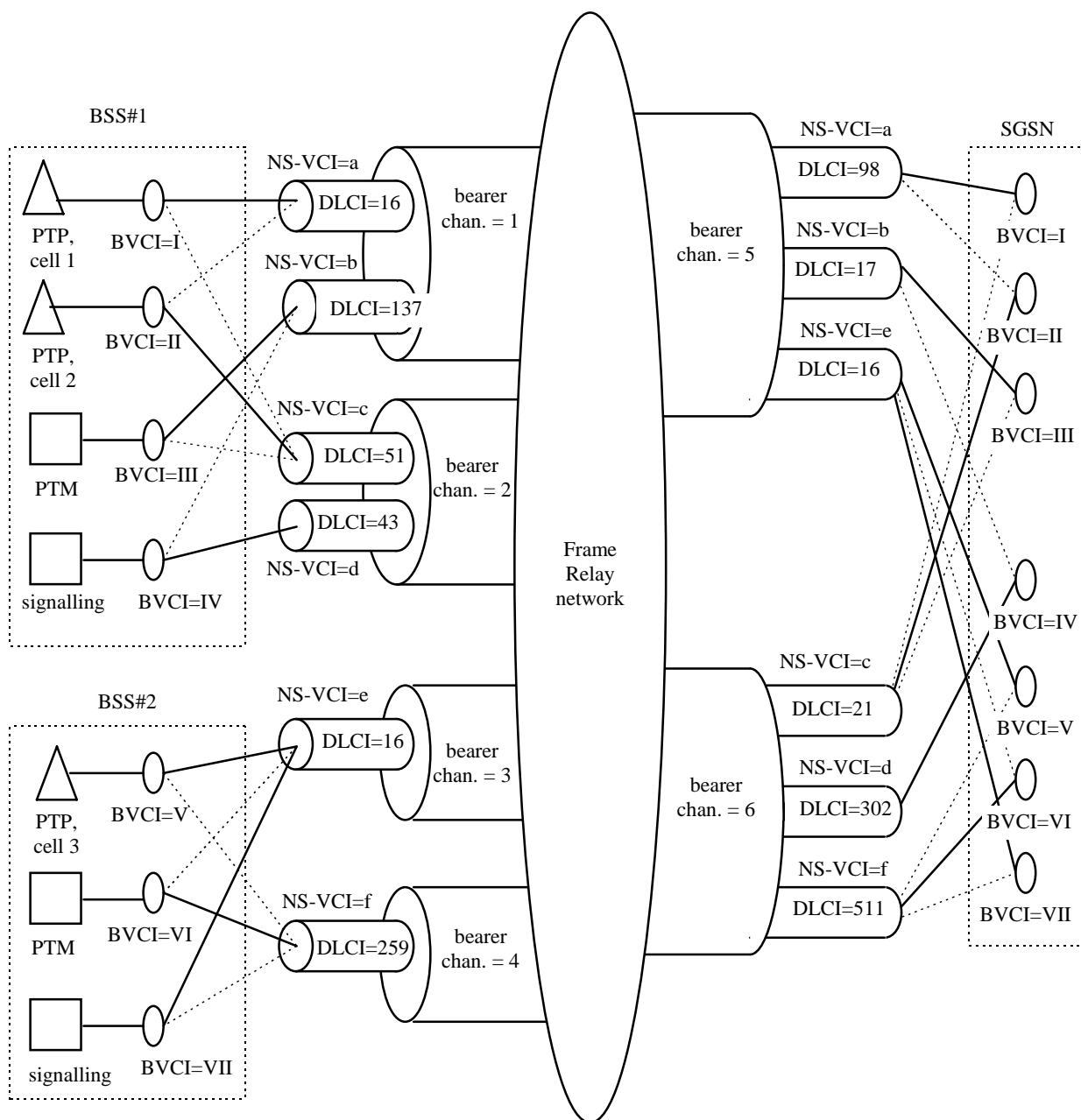
Figure B.1/GSM 08.16: Example of the Gb interface with an intermediate Frame Relay network

In this example, it is assumed that each BVC is supported by two NS-VCs, one in the level 1 pool, one in the level 2 pool. The two sides of the Gb interface use different physical links.

BVCI=I, II and V are used to address the PTP functional entities responsible for cells 1, 2 and 3 respectively.

BVCI=III and VI are used to address PTM functional entities in BSS#1 and #2 respectively (in this example, it is assumed there is one PTM functional entity per BSS).

BVCI=IV and VII are used to address signalling entities in BSS#1 and #2 respectively (in this example, it is assumed there is one signalling entity per BSS).

The following mapping tables correspond to the above example:

Table B.1/GSM 08.16: Mapping table of the NS entity, SGSN side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
I	1	a	98	5	load sharing between both NS-VCs
	2	c	21	6	
II	2	a	98	5	load sharing between both NS-VCs
	1	c	21	6	
III	1	b	17	5	load sharing between both NS-VCs
	2	c	21	6	
IV	2	b	17	5	load sharing between both NS-VCs
	1	d	302	6	
V	1	e	16	5	load sharing between both NS-VCs
	2	f	511	6	
VI	2	e	16	5	load sharing between both NS-VCs
	1	f	511	6	
VII	1	e	16	5	load sharing between both NS-VCs
	2	f	511	6	

Table B.2/GSM 08.16: Mapping table of the NS entity, BSS#1 side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
I	1	a	16	1	load sharing between both NS-VCs
	2	c	51	2	
II	2	a	16	1	load sharing between both NS-VCs
	1	c	51	2	
III	1	b	137	1	load sharing between both NS-VCs
	2	c	51	2	
IV	2	b	137	1	load sharing between both NS-VCs
	1	d	43	2	

Table B.3/GSM 08.16: Mapping table of the NS entity, BSS#2 side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
V	1	e	16	3	load sharing between both NS-VCs
	2	f	259	4	
VI	2	e	16	3	load sharing between both NS-VCs
	1	f	259	4	
VII	1	e	16	3	load sharing between both NS-VCs
	2	f	259	4	

Table B.4/GSM 08.16: Mapping table of the NS user entity, SGSN side

Cell / BSC	BVCI
PTP, cell 1	I
PTP, cell 2	II
PTP, cell 3	V
PTM, BSS#1	III
PTM, BSS#2	VI
signalling, BSS#1	IV
signalling, BSS#2	VII

Table B.5/GSM 08.16: Mapping table of the NS user entity, BSS#1 side

Cell / BSC	BVCI
PTP, cell 1	I
PTP, cell 2	II
PTM	III
signalling	IV

Table B.6/GSM 08.16: Mapping table of the NS user entity, BSS#2 side

Cell / BSC	BVCI
PTP, cell 3	V
PTM	VI
signalling	VII

Figure B.2/GSM 08.16 shows an example of the addressing scheme when point-to-point Frame Relay connections are used on the Gb interface. The BSS configuration is the same as in figure B.1/GSM 08.16. The plain lines represent the NS-VCs belonging to the first level pool. The dotted lines represent the NS-VCs belonging to the second level pool.

Figure B.2/GSM 08.16: Example of the the Gb interface, with point-to-point Frame Relay connections

The two sides of the Gb interface use the same physical links. In figure B.2/GSM 08.16, it is assumed that, for each bearer channel, the bearer channel identifiers are set to the same value at both sides of the Gb interface. Alternatively, they could also have different values.

The corresponding mapping tables are:

Table B.7/GSM 08.16: Mapping table of the NS entity, SGSN side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
I	1	a	98	1	load sharing between both NS-VCs
	2	c	21	2	
II	2	a	98	1	load sharing between both NS-VCs
	1	c	21	2	
III	1	b	17	1	load sharing between both NS-VCs
	2	c	21	2	
IV	2	b	17	1	load sharing between both NS-VCs
	1	d	302	2	
V	1	e	16	3	load sharing between both NS-VCs
	2	f	511	4	
VI	2	e	16	3	load sharing between both NS-VCs
	1	f	511	4	
VII	1	e	16	3	load sharing between both NS-VCs
	2	f	511	4	

Table B.8/GSM 08.16: Mapping table of the NS entity, BSS#1 side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
I	1	a	98	1	load sharing between both NS-VCs
	2	c	21	2	
II	2	a	98	1	load sharing between both NS-VCs
	1	c	21	2	
III	1	b	17	1	load sharing between both NS-VCs
	2	c	21	2	
IV	2	b	17	1	load sharing between both NS-VCs
	1	d	302	2	

Table B.9/GSM 08.16: Mapping table of the NS entity, BSS#2 side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
V	1	e	16	3	load sharing between both NS-VCs
	2	f	511	4	
VI	2	e	16	3	load sharing between both NS-VCs
	1	f	511	4	
VII	1	e	16	3	load sharing between both NS-VCs
	2	f	511	4	

Table B.10/GSM 08.16: Mapping table of the NS user entity, SGSN side

Cell / BSC	BVCI
PTP, cell 1	I
PTP, cell 2	II
PTP, cell 3	V
PTM, BSS#1	III
PTM, BSS#2	VI
signalling, BSS#1	IV
signalling, BSS#2	VII

Table B.11/GSM 08.16: Mapping table of the NS user entity, BSS#1 side

Cell / BSC	BVCI
PTP, cell 1	I
PTP, cell 2	II
PTM	III
signalling	IV

Table B.12/GSM 08.16: Mapping table of the NS user entity, BSS#2 side

Cell / BSC	BVCI
PTP, cell 3	V
PTM	VI
signalling	VII

Figure B.3/GSM 08.16 shows an example of the addressing scheme when a mixed intermediate and point-to-point Frame Relay network is used on the Gb interface. The plain lines represent the NS-VCs belonging to the first level pool. The dotted lines represent the NS-VCs belonging to the second level pool.
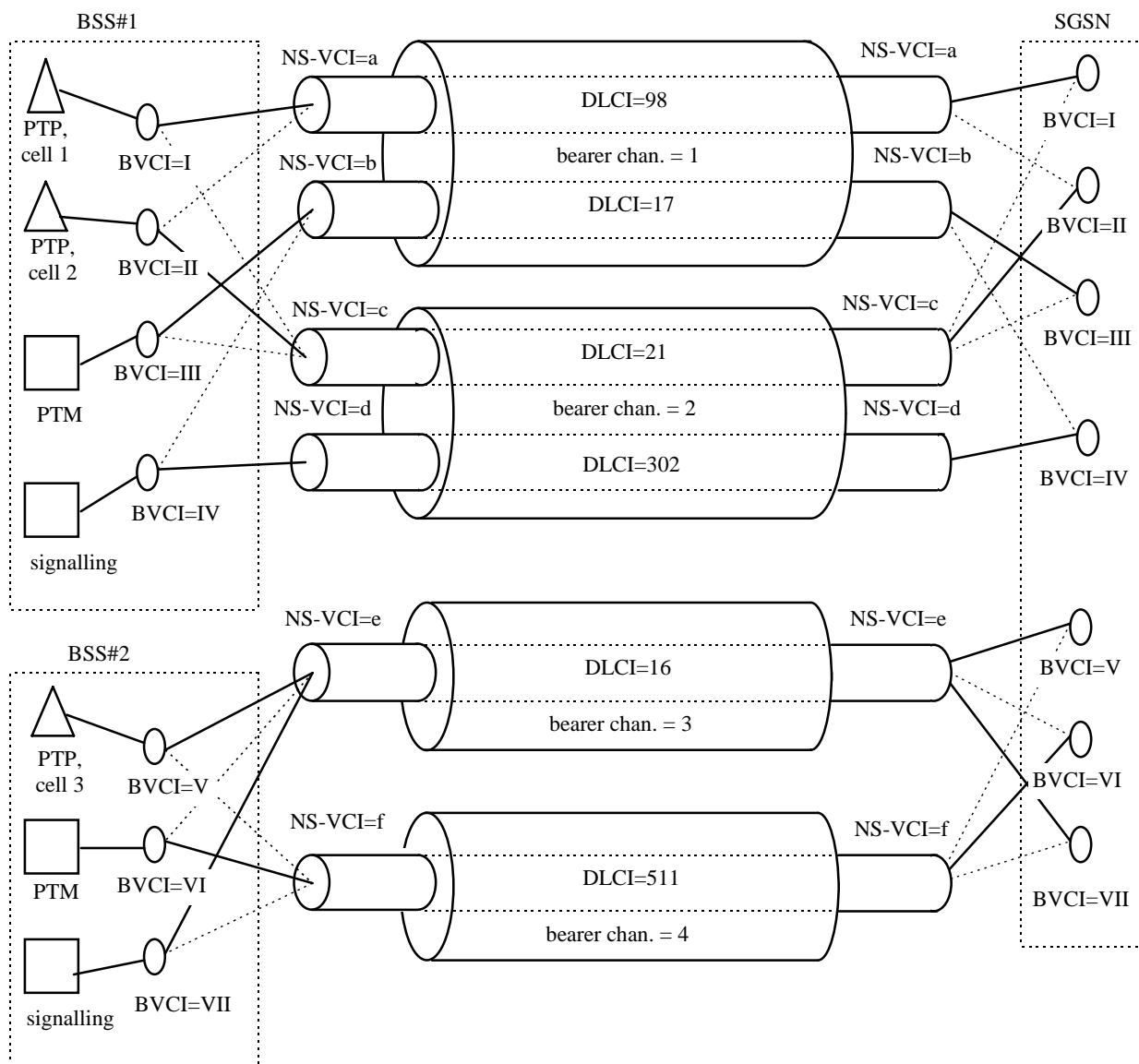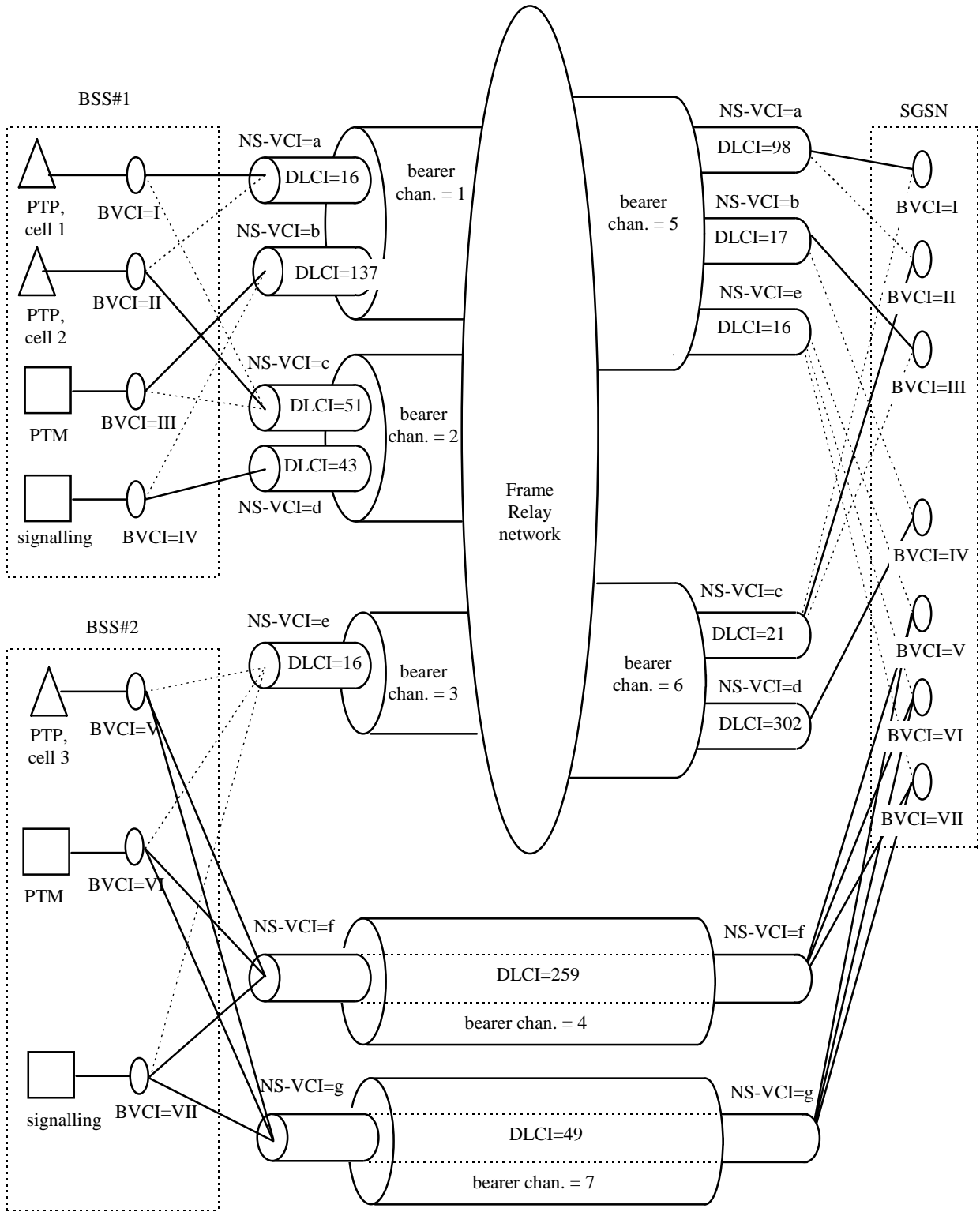
Figure B.3/GSM 08.16: Example of the Gb interface with a mix intermediate and point-to-point Frame Relay network

In this example, it is assumed the following configuration :

> For BSS#1, each BVC is supported by two NS-VCs, one in the level 1 pool, one in the level 2 pool.

> For BSS#2, each BVC is supported by three NS-VCs, two in the level 1 pool, one in the level 2 pool.

The two sides of the Gb interface use different physical links but the 2 pools system allows to put a priority on the point-to-point FR connection instead of the external one.

BVCI=I, II and V are used to address the PTP functional entities responsible for cells 1, 2 and 3 respectively.

BVCI=III and VI are used to address PTM functional entities in BSS#1 and #2 respectively (in this example, it is assumed there is one PTM functional entity per BSS).

BVCI=IV and VII are used to address signalling entities in BSS#1 and #2 respectively (in this example, it is assumed there is one signalling entity per BSS).

The following mapping tables correspond to the above example:

Table B.13/GSM 08.16: Mapping table of the NS entity, SGSN side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
I	1	a	98	5	load sharing between both NS-VCs
	2	c	21	6	
II	2	a	98	5	load sharing between both NS-VCs
	1	c	21	6	
III	1	b	17	5	load sharing between both NS-VCs
	2	c	21	6	
IV	2	b	17	5	load sharing between both NS-VCs
	1	d	302	6	
V	2	e	16	5	load sharing between NS-VCs
	1	f	259	4	
	1	g	49	7	
VI	2	e	16	5	load sharing between NS-VCs
	1	f	259	4	
	1	g	49	7	
VII	2	e	16	5	load sharing between NS-VCs
	1	f	259	4	
	1	g	49	7	

Table B.14/GSM 08.16: Mapping table of the NS entity, BSS#1 side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
I	1	a	16	1	load sharing between both NS-VCs
	2	c	51	2	
II	2	a	16	1	load sharing between both NS-VCs
	1	c	51	2	
III	1	b	137	1	load sharing between both NS-VCs
	2	c	51	2	
IV	2	b	137	1	load sharing between both NS-VCs
	1	d	43	2	

Table B.15/GSM 08.16: Mapping table of the NS entity, BSS#2 side

BVCI	NS-VC Pool	NS-VCI	DLCI	bearer channel	Comments
V	2	e	16	3	load sharing between NS-VCs
	1	f	259	4	
	1	g	49	7	
VI	2	e	16	3	load sharing between NS-VCs
	1	f	259	4	
	1	g	49	7	
VII	2	e	16	3	load sharing between NS-VCs
	1	f	259	4	
	1	g	49	7	

Table B.16/GSM 08.16: Mapping table of the NS user entity, SGSN side

Cell / BSC	BVCI
PTP, cell 1	I
PTP, cell 2	II
PTP, cell 3	V
PTM, BSS#1	III
PTM, BSS#2	VI
signalling, BSS#1	IV
signalling, BSS#2	VII

Table B.17/GSM 08.16: Mapping table of the NS user entity, BSS#1 side

Cell / BSC	BVCI
PTP, cell 1	I
PTP, cell 2	II
PTM	III
signalling	IV

Table B.18/GSM 08.16: Mapping table of the NS user entity, BSS#2 side

Cell / BSC	BVCI
PTP, cell 3	V
PTM	VI
signalling	VII

Annex C (informative):
Recommended usage of BVCI and NSEI

This annex recommends a way to use BVCIs and NSEIs, avoiding huge and unflexible configuration data at the SGSN. This annex uses concepts defined in GSM 08.18 [5].

The key points are:

- A BVCI needs not to be unique within an SGSN, a BVCI is unique within an NS Entity. BVCI together with NSEI uniquely identify a BVC within an SGSN (the global identifier within an SGSN is BVCI+NSEI).

- BVCIs corresponding to PTP functional entities need not to be statically configured at the SGSN side: no fixed, permanent relationship is required in the SGSN between PTP BVCIs and NS-VCs.

With the NSEI, the SGSN needs not to be updated when a new cell (BVCI) is added to a BSS (NSEI). The pre-configuration of a cell in the SGSN and the constraint in the number of BVCs in an SGSN are not needed:

- The SGSN keeps detailed MM information about an MS while the MS is in the READY state, i.e. the SGSN knows the BVCI and NSEI which can be used to contact the MS for downlink transmission. The BVCI and NSEI are passed from NS to BSSGP and from BSSGP to the upper layers as a primitive parameter in every uplink packet received by the SGSN. Subsequent downlink LLC frames to this MS shall be transmitted by the SGSN over the BVC identified by this BVCI+NSEI.

- An SGSN in STANDBY state will page an MS before sending downlink traffic. The MS will respond with an LLC packet that will put the MM context in READY state and will deliver the BVCI and NSEI to the user of BSSGP.

For paging purposes, the SGSN only needs to know the correspondence between each Routeing Area and one or more NSEI(s) where to send the corresponding paging messages. Paging messages shall always be sent over BVCI=0. There may be NSEI(s) where BVCI=0 is not used.

Annex D (informative):
Change control history

Document history		
<Version>	<Date>	<Milestone>
proposed 0.0.0	01/08/1997	Document creation. First draft.
proposed 0.1.0	11/09/1997	Updated after drafting session, Berlin, and SMG2/3 WPA meeting, Kista, August 1997: - Editorial improvements. - Removal of text redundant with FRF 1.1. - Introduction of "Addressing" clause. - Introduction of load sharing function. - Introduction of blocking / unblocking procedure. - Introduction of NS protocol.
1.0.0	2/10/1997	Agreed by SMG2 to submit to SMG#23 for information. Updated after drafting session, Berlin, September 1997: - Editorial improvements. - Terminology improved. - Abbreviation list updated. - "Addressing" clause made more abstract. - Introduction of BVC. - Creation of informative annex "Illustration of the addressing scheme on the Gb interface". - Introduction of the reset procedure. - Clarification to the load sharing function. - Re-ordering of clauses describing PDUs and IEs in order to respect the alphabetical order.
1.1.0	10/11/1997	Updated after drafting sessions, Swindon, October 1997 & Paris, November 1997: - Editorial improvements and corrections. - Miscellaneous clarifications. - Definitions improved. - Re-definition of the BVC. - Service primitives updated. - Description of Frame Relay support improved. - Blocking / unblocking procedures improved. - Re-definition of the reset procedure. - Introduction of the test procedure. - Protocol error handling re-written and made common to 08.16 and 08.18.

1.2.0	18/11/1997	Updated after SMG2/3 WPA meeting, Sophia Antipolis, November 1997: - Editorial corrections and improvements, clarifications, removal of useless text. - Editorial improvements to clauses 9 and 10 concerning all issues common to 08.16 and 08.18. - Improvements to protocol error handling: "reserved for future use" and "reserved" are the same. - Removal of the T and L fields from the BVCI and NS SDU IEs, and clarification to the mapping of NS SDUs onto the "NS SDU" IE.
proposed 2.0.0	26/11/1997	Presented to SMG2#24 for agreement.
5.0.0	12/1/1998	Approved at SMG#24
preliminary 6.0.0	17/3/1998	Inclusion of CRs approved at SMG#25: - CRs A001, A002, A003r1, A004, A005, A006r1, A008r1
6.1.0	23/6/98	Inclusion of CRs approved at SMG#26: A007r3, A011, A012
6.2.0	12/2/99	Inclusion of CRs approved at SMG#28: A014, A015

History

Document history		
V6.1.0	July 1998	Publication
V6.2.0	April 1999	Publication