INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.967.1

(06/98)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital transmission systems – Digital sections and digital line system – Digital section and digital transmission systems for customer access to ISDN

V-interfaces at the service node (SN): VB5.1 reference point specification

ITU-T Recommendation G.967.1

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION G.967.1

V-INTERFACES AT THE SERVICE NODE (SN): VB5.1 REFERENCE POINT SPECIFICATION

Summary

This Recommendation specifies the physical, procedural and protocol requirements for interfaces at the VB5.1 reference point between an Access Network (AN) and a Service Node (SN) with flexible (provisioned) Virtual Path Link (VPL) allocation and flexible (provisioned) Virtual Channel Link (VCL) allocation (controlled by the Q3 interfaces) at the VB5.1 reference point.

Keywords

VB5 reference points, Access Network, Service Node.

FOREWORD

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Introduction

The VB5 reference point concept, based on Recommendations G.902 [3] and I.414 [18], was split into two variants. The first, based on the ATM cross-connect with provisioned connectivity, called the VB5.1 reference point, is described in this Recommendation. The other, which further enables on-demand connectivity within the AN, is called the VB5.2 reference point which will be specified in a future ITU-T Recommendation.

Relationship between the VB5.1 and VB5.2 reference point concepts

The VB5.2 reference point extends the capabilities at the VB5.1 reference point to include on-demand connectivity in the AN under the control of SN.

In addition to the major difference given above, the major correspondence between the VB5.1 and VB5.2 reference point can be described as:

– both VB5 reference points support B-ISDN as well as narrow-band and other non-B-ISDN customer access types;

– both VB5 reference points support ATM multiplexing/cross-connection in the AN at the VP and/or VC level.

It is anticipated that the Real-Time Management Coordination (RTMC) protocol for the VB5.1 reference point will be a subset of the RTMC protocol for the VB5.2 reference point.

Recommendation G.967.1

V-INTERFACES AT THE SERVICE NODE (SN): VB5.1 REFERENCE
POINT SPECIFICATION

(Geneva, 1998)

1   Scope

This Recommendation specifies the physical, procedural and protocol requirements for interfaces at the VB5.1 reference point between an Access Network (AN) and a Service Node (SN) with flexible (provisioned) Virtual Path Link (VPL) allocation and flexible (provisioned) Virtual Channel Link (VCL) allocation (controlled by the Q3 interfaces) at the VB5.1 reference point.

The following B-ISDN customer access types with the general User-Network Interface (UNI) characteristics defined in Recommendation I.432.1 [19] are supported:

a)   B-ISDN accesses with a UNI at 155 520 kbit/s and 622 080 kbit/s according to Recommendation I.432.2 [20], i.e.:

    1)   SDH-based;

    2)   cell-based.

b)   B-ISDN accesses with a PDH-based UNI at 1544 kbit/s and 2048 kbit/s according to Recommendation I.432.3 [21].

c)   B-ISDN accesses with a UNI at 51 840 kbit/s according to Recommendation I.432.4 [22] and at 25 600 kbit/s according to Recommendation I.432.5 [23].

B-ISDN accesses with a UNI according to future ITU-T Recommendations may require additional functionality at the VB5.1 reference point.

In order to provide for a migration from narrow-band to broadband access network and service node arrangements, also narrow-band access types as specified for:

–   V5.1 interface according to Recommendation G.964 [4]; and/or

–   V5.2 interface according to Recommendation G.965 [5],

are supported according to the integration scenario given in III.2.2/G.902 [3], using a circuit emulation function for the transfer of circuit mode into ATM.

In addition to these B-ISDN and narrow-band customer access types, other non-B-ISDN access types are also supported.

Examples for such non-B-ISDN access types are given below:

a)   access types supporting asymmetric/multimedia services, e.g. Video-on-Demand (if not part of B-ISDN access types);

b)   access types supporting broadcast services (if not part of B-ISDN access types);

c)   access types supporting LAN interconnect functionality (if not part of B-ISDN access types);

d)   access types that can be supported via an ATM VP cross-connect.

The concept of the Virtual User Port (VUP), as described in clause 8, may be applied to enable any specific implementation.

In accordance with the principles of B-ISDN (as specified in Recommendation I.121 [6]), remote access arrangements across interfaces at the VB5.1 reference point shall support switched, and

(semi-)permanent point-to-point and point-to-multipoint connections. It provides on-demand, reserved and permanent services of a mono- and/or multimedia type and of a connectionless or connection-oriented nature in a bidirectional or unidirectional configuration as supported for direct access arrangements to service nodes.

Functions to support security management (refer to Recommendation X.800 [35]) related to the customer access are out of the scope of this Recommendation. Such security management functions have no impact on the VB5.1 reference point.

This Recommendation does not specify the implementation of the requirements within the AN and does not constrain any implementation alternative as long as the functionality at the interfaces at the VB5.1 reference point as specified in this Recommendation is met. Furthermore, this Recommendation does not require that an AN shall support all the customer access types listed above.

This Recommendation is not intended to define any systems or equipment in, or connected to, a SN via interfaces at the VB5.1 reference point. Therefore, only the characteristics of the interfaces at the VB5.1 reference point are described.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-T Recommendation E.736 (1997), *Methods for cell level traffic control in B-ISDN.*

[2] ITU-T Recommendation G.704 (1995), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels.*

[3] ITU-T Recommendation G.902 (1995), *Framework Recommendation on functional access networks – Architecture and functions, access types, management and service node aspects.*

[4] ITU-T Recommendation G.964 (1994), *V-Interfaces at the digital Local Exchange (LE) – V5.1-interface (based on 2048 kbit/s) for the support of Access Network (AN).*

[5] ITU-T Recommendation G.965 (1995), *V-Interfaces at the digital Local Exchange (LE) – V5.2 Interface (based on 2048 kbit/s) for the support of Access Network (AN).*

[6] CCITT Recommendation I.121 (1991), *Broadband aspects of ISDN.*

[7] ITU-T Recommendation I.150 (1995), *B-ISDN asynchronous transfer mode functional characteristics.*

[8] ITU-T Recommendation I.311 (1996), *B-ISDN general network aspects.*

[9] CCITT Recommendation I.321 (1991), *B-ISDN protocol reference model and its application.*

[10] CCITT Recommendation I.324 (1991), *ISDN network architecture.*

[11] ITU-T Recommendation I.327 (1993), *B-ISDN functional architecture.*

[12] ITU-T Recommendation I.356 (1996), *B-ISDN ATM layer cell transfer performance.*

[13] ITU-T Recommendation I.361 (1995), *B-ISDN ATM layer specification.*

[14]   ITU-T Recommendation I.363.1 (1996), *B-ISDN ATM Adaptation Layer specification: Type 1 AAL.*

[15]   ITU-T Recommendation I.363.2 (1997), *B-ISDN ATM Adaptation Layer specification: Type 2 AAL.*

[16]   ITU-T Recommendation I.363.5 (1996), *B-ISDN ATM Adaptation Layer specification: Type 5 AAL.*

[17]   ITU-T Recommendation I.371 (1996), *Traffic control and congestion control in B-ISDN.*

[18]   ITU-T Recommendation I.414 (1997), *Overview of Recommendations on layer 1 for ISDN and B-ISDN customer accesses.*

[19]   ITU-T Recommendation I.432.1 (1996), *B-ISDN user-network interface – Physical layer specification: General characteristics.*

[20]   ITU-T Recommendation I.432.2 (1996), *B-ISDN user-network interface – Physical layer specification: 155 520 kbit/s and 622 080 kbit/s operation.*

[21]   ITU-T Recommendation I.432.3 (1996), *B-ISDN user-network interface – Physical layer specification: 1544 kbit/s and 2048 kbit/s operation.*

[22]   ITU-T Recommendation I.432.4 (1996), *B-ISDN user-network interface – Physical layer specification: 51 840 kbit/s operation.*

[23]   ITU-T Recommendation I.432.5 (1997), *B-ISDN user-network interface – Physical layer specification: Physical layer specification for 25 600 kbit/s operation.*

[24]   ITU-T Recommendation I.610 (1995), *B-ISDN operation and maintenance principles and functions.*

[25]   ITU-T Recommendation I.731 (1996), *Types and general characteristics of ATM equipment.*

[26]   ITU-T Recommendation I.732 (1996), *Functional characteristics of ATM equipment.*

[27]   ITU-T Recommendation I.751 (1996), *Asynchronous transfer mode management of the network element view.*

[28]   ITU-T Recommendation M.3610 (1996), *Principles for applying the TMN concept to the management of B-ISDN.*

[29]   ITU-T Recommendation Q.2110 (1994), *B-ISDN ATM adaptation layer – Service Specific Connection Oriented Protocol (SSCOP).*

[30]   ITU-T Recommendation Q.2120 (1995), *B-ISDN meta-signalling protocol.*

[31]   ITU-T Recommendation Q.2130 (1994), *B-ISDN signalling ATM adaptation layer – Service Specific Coordination Function for support of signalling at the User-Network Interface (SSCF at UNI).*

[32]   ITU-T Recommendation Q.2931 (1995), *Digital Subscriber Signalling System No. 2 – User-Network Interface (UNI) layer 3 specification for basic call/connection control.* (Modified by Recommendation Q.2971).

[33]   ITU-T Recommendation Q.832.1 (1998), *VB5.1 management.*

[34]   CCITT Recommendation X.731 (1992) | ISO/IEC 10164-2:1992, *Information technology – Open Systems Interconnection – Systems management: State management function.*

[35]   CCITT Recommendation X.800 (1991), *Security architecture for Open Systems Interconnection for CCITT applications.*

[36]   ITU-T Recommendation Z.100 (1993), *CCITT Specification and Description Language (SDL).*

[37]   ITU-T Recommendation Z.105 (1995), *SDL combined with ASN.1 (SDL/ASN.1).*

[38]   ITU-T Recommendation Z.120 (1993), *Message Sequence Chart (MSC).*

3   Definitions, symbols and abbreviations

3.1   Definitions

This Recommendation defines the following terms:

3.1.1   logical service port: The set of VPs at one VB5.1 reference point (i.e. associated with one and only one service node) carried on one or several transmission convergence functions.

3.1.2   logical user port: The set of VPs at the UNI or at a Virtual User Port (VUP) associated with one single VB5.1 reference point.

3.1.3   physical service port: The physical layer functions related to a single transmission convergence function at the VB5.1 interface.

3.1.4   physical user port: The physical layer functions related to a single transmission convergence function at the UNI.

3.1.5   RTMC function: The set of management plane functions providing for the coordination of time-critical management information (e.g. status information which has a direct impact on the service provision capability) between the AN and SN across the VB5.1 reference point.

3.1.6   RTMC protocol: The layer 3 protocol between AN and SN to support the RTMC function.

3.1.7   virtual user port: A Virtual User Port is an AN internal reference point and has parallels with the Physical User Port though its full functions are not specified due to the wide range of potential non-B-ISDN access types that could be supported using this concept.

A Virtual User Port concept is defined to enable the support of non-B-ISDN access types over the VB5.1 reference point in a manner consistent with B-ISDN access types.

3.1.8   VB5.1 Interface: An interface (including the physical layer) at the VB5.1 reference point.

3.2   Abbreviations

This Recommendation uses the following abbreviations:

AAF   Access Adaptation Functions

AAL   ATM Adaptation Layer

AAL-SAP   ATM Adaptation Layer – Service Access Point

AALx   ATM Adaptation Layer type x

AIS   Alarm Indication Signal

AN   Access Network

ATM   Asynchronous Transfer Mode

ATM-SAP   Asynchronous Transfer Mode – Service Access Point

AXC   ATM Cross Connect

BA   Basic (rate) Access

B-ET	Broadband Exchange Termination
B-ISDN	Broadband Integrated Services Digital Network
B-ISUP	Broadband ISDN Signalling User Part
B-LEX	Broadband Local Exchange
B-UNI	Broadband User Network Interface
CAC	Connection Admission Control
CBR	Constant Bit Rate
CCITT	International Telegraph and Telephone Consultative Committee (Superseded by the ITU-T)
CE	Connection Element
CE2	Circuit Emulation of 2048 kbit/s signal
CLP	Cell Loss Priority
CLR	Cell Loss Ratio
CLS	Connectionless Server
CPCS	Common Part Convergence Sub-layer
CPE	Customer Premises Equipment
CPN	Customer Premises Network
CRF	Connection Related Functions
DSS 2	Digital Subscriber Signalling System No. 2
DXI	(ATM) Data Exchange Interface
EFCI	Explicit Forward Congestion Indication
ET	Exchange Termination
FSM	Finite State Machine
GFC	Generic Flow Control
HEC	Header Error Control
HED	Head-End for Distribution services
ID	Identifier
IEEE	Institute of Electrical and Electronic Engineers
ISDN-BA	Integrated Services Digital Network – Basic Access
IT	Information Technology
ITU	International Telecommunication Union
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
LAN	Local Area Network
LE	Local Exchange
LME	Layer Management Entity

LSP	Logical Service Port
LT	Line Termination
LUP	Logical User Port
MIB	Management Information Base
MSC	Message Sequence Chart
NB	Narrow-band
N-ISDN	Narrow-band Integrated Services Digital Network
NNI	Network-to-Network Interface
NPC	Network Parameter Control
NT1	Network Termination type 1
OAM	Operations, Administration and Maintenance
OH	Overhead
PDH	Plesiochronous Digital Hierarchy
POH	Path overhead
PRA	Primary Rate Access
PRM	Protocol Reference Model
PSP	Physical Service Port
PSTN	Public Switched Telephone Network
PTI	Payload Type Identifier
ptm	Point-to-Multipoint
ptp	Point-to-Point
PUP	Physical User Port
Q3	"Q" Management Interface reference point as in Recommendation M.3010
QoS	Quality of Service
RDI	Remote Defect Indication
RET	Remote Entry Terminal
RTMC	Real-Time Management Coordination
SAAL	Signalling ATM Adaptation Layer
SAF	Specific Access Functions
SAP	Service Access Point
SAR	Segmentation and Reassembly
SDH	Synchronous Digital Hierarchy
SDU	Service Data Units
SN	Service Node
SNI	Service Node Interface
SOH	Section Overhead

SP	Service Port
SPF	Service Port Function
SSCF	Service Specific Coordination Function
SSCOP	Service Specific Connection Oriented Protocol
SSF	Server Signal Fail
STM	Synchronous Transport Module
TC	Transmission Convergence
TE	Terminal Equipment
TM	Transmission Media
TMN	Telecommunication Management Network
TP	Transmission Path
TP-T	Transmission Path Termination
TV	Television
UNI	User-Network Interface
UPC	Usage Parameter Control
UPF	User Port Function
VB	Broadband "V" Reference Point
VC	Virtual Channel (ATM)
VC	Virtual Container (SDH)
VC4	Virtual Container type 4
VC4c	Virtual Container type 4c
VC-AIS	Virtual Channel Alarm Indication Signal
VCC	Virtual Channel Connection
VCCT	Virtual Channel Connection Termination
VCE	Virtual Channel Entity
VCI	Virtual Channel Identifier
VCL	Virtual Channel Link
VCME	Virtual Channel Multiplex Entity
VC-RDI	Virtual Channel Remote Defect Indication
vcTTP	Virtual Channel Trail Termination Point
VoD	Video-on-Demand
VP	Virtual Path
VP-AIS	Virtual Path Alarm Indication Signal
VPC	Virtual Path Connection
VPCI	Virtual Path Connection Identifier
VPCI-CC	Virtual Path Connection Identifier – Consistency Check

VPCT	Virtual Path Connection Termination
VPE	Virtual Path Entity
VPI	Virtual Path Identifier
VPL	Virtual Path Link
VPME	Virtual Path Multiplex Entity
VP-RDI	Virtual Path Remote Defect Indication
vpTTP	Virtual Path Trail Termination Point
VUP	Virtual User Port

4 Field of application

Within the general framework of the evolution to and application of the B-ISDN, this Recommendation is intended to be applied to remote access arrangements with access networks as specified in Recommendation I.414 [18] (case of B-ISDN customer access; Remote access application of ATM multiplexing/cross-connecting in access network/VB5.1 reference point), providing customer access to various service node types as listed in 4.4.

Reference to access types, functions, interfaces, etc. in this Recommendation does not imply that each of them has necessarily to be provided in every access network type or configuration. In general, the selection of features, functions and interfaces to be provided in an AN in a particular network application will be determined by the access network and service providers concerned.

4.1 Applications of the VB5.1 interface

Figure 1 depicts two different applications of the VB5.1 interface. It is left to the network operator to select the application required.

The physical medium of the interface is denoted with the symbol I. A subscript is added in order to indicate a physical position on the medium. I_a represents the VB5.1 interface point physically adjacent to the AN equipment (e.g. at the place of a connector, if used). I_b represents the VB5.1 interface point physically adjacent to the SN equipment. Additional interface points are introduced adjacent to the transport network equipment (I_{aa} and I_{bb}).

The physical specification of the indicated interface points (I_a, I_b, etc.) shall be compliant with the applicable physical layer standards.

The transport network includes additional equipment placed between the AN and SN equipment and is defined below.

Application 1
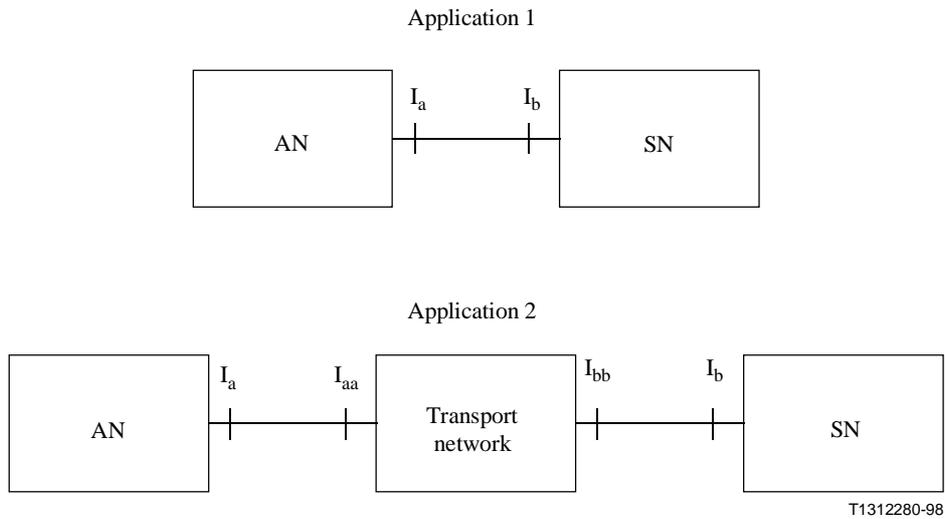
Application 2

Figure 1/G.967.1 – Basic applications of the VB5.1 interface

With respect to the physical link [e.g. (I_a, I_{aa})], two sub-application types are envisaged:

Intra-office: The physical link is constrained within a single building or can comply to a likely environment.

Inter-office: The physical link interconnects remote equipment, normally situated in different buildings.

Figure 2 gives some examples of VB5.1 applications as described above.

As the VB5.1 interface can consist of different physical media, in principle different applications for the different physical media are not excluded. For example, the active link of the VB5.1 interface is intra-office and the standby link for protection is inter-office.
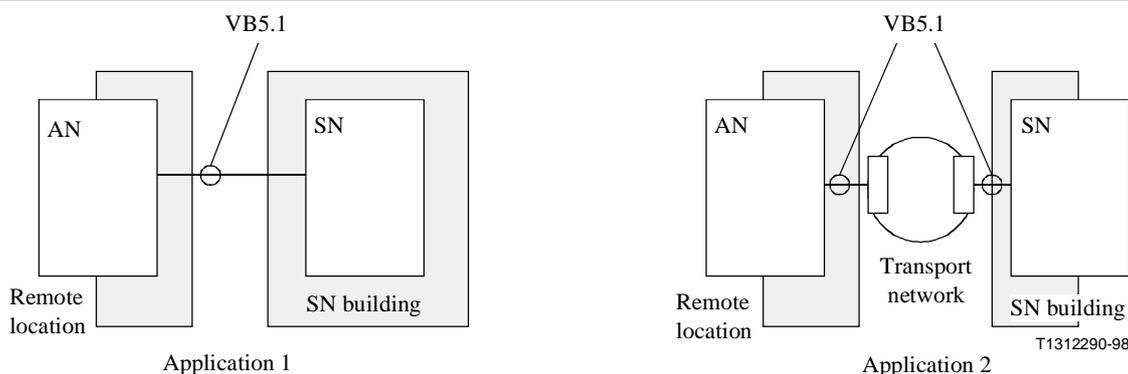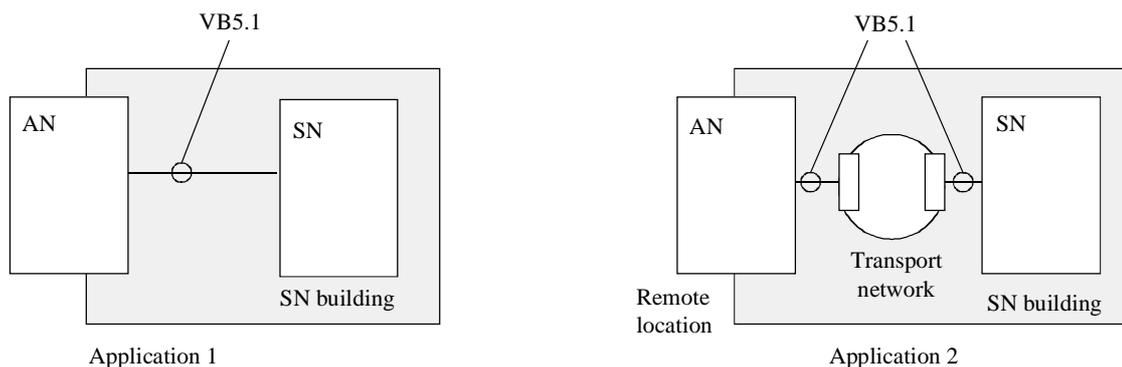
Figure 2/G.967.1 – Example applications of the VB5.1 interface

4.1.1 Transport network

The VB5.1 reference point concept provides high flexibility with respect to the physical interface applied at the SNI and the interconnection between the AN and the SN.

If the AN side and the SN side of the SNI are not at the same location (see case of inter-office application 2 in Figure 2) the remote connection of an AN and an SN shall be provided by a transport network. A transport network between an AN and an SN shall not change the structure and the content of the information at the VB5.1 reference point, i.e. it is considered as transparent to the information structure and content at the VB5.1 reference point. The transport network may include VP connecting point functions (for point-to-point connections) as specified in the relevant ITU-Recommendations for the ATM VP cross-connect, but is not allowed to perform VC connecting point functions (translation of VCI values).

From a management point of view a transport network between AN and SN is separate from the AN and the SN and is managed via a separate interface to the TMN. However, a coordinated management of the transport network and the AN (and SN) may be required. The definition of these management functions is outside the scope of this Recommendation.

Some simple examples of possible implementation cases of the interconnection between the AN and the SN are given in Figure 3.
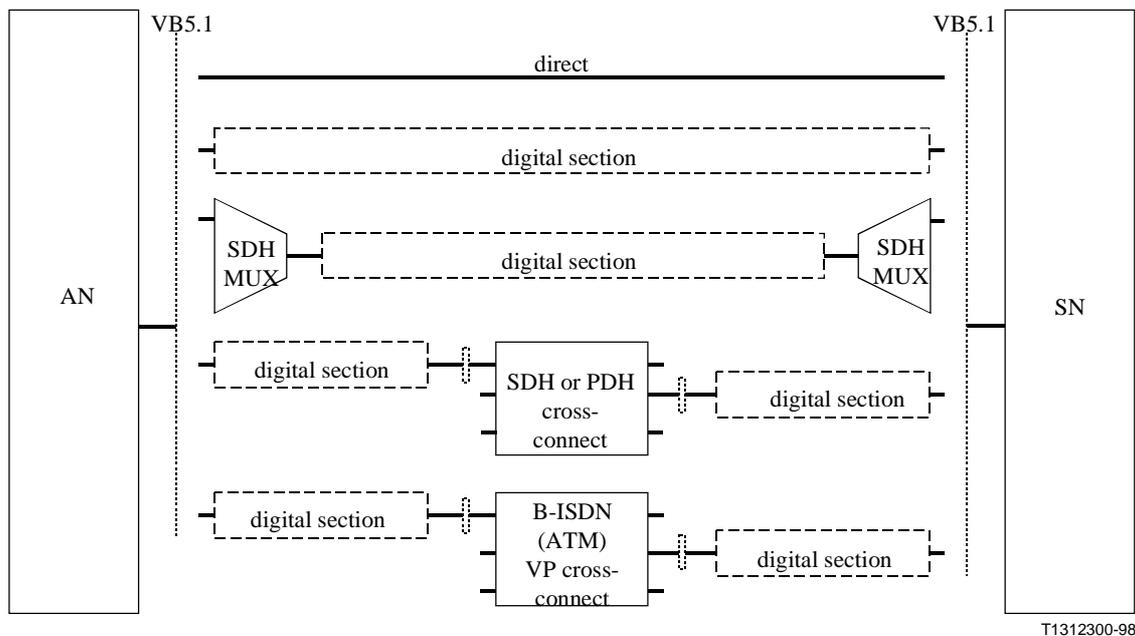
**Figure 3/G.967.1 – Examples for transport network
implementation between AN and SN**

4.2 Integration of narrow-band customer access types

A key feature of VB5.1 reference point concept is the integration of narrow-band customer access types.

The VB5.1 reference point concept allows the integration of narrow-band (i.e. PSTN and N-ISDN) accesses with B-ISDN accesses into one access network. Thus, the VB5.1 reference point concept provides for a step-by-step migration from circuit based (access) networks to the ATM-based B-ISDN.

Figure 4 shows the integration of narrow-band accesses (using circuit mode) and B-ISDN accesses applying multiplexing at the ATM layer and using a circuit emulation function to transfer the circuit mode into ATM and vice versa. The aggregate ATM-based information stream is conveyed through the interface(s) at the VB5.1 reference point. At the SN side the information stream is demultiplexed and the narrow-band local exchange is accessed using a circuit emulation function.

The functional architecture in Figure 4 illustrates the applicability of existing narrow-band access network functions and circuit mode based SNIs at the narrow-band local exchange, i.e. the standardized V5.1 and V5.2 reference points as specified in Recommendations G.964 [4] and G.965 [5].
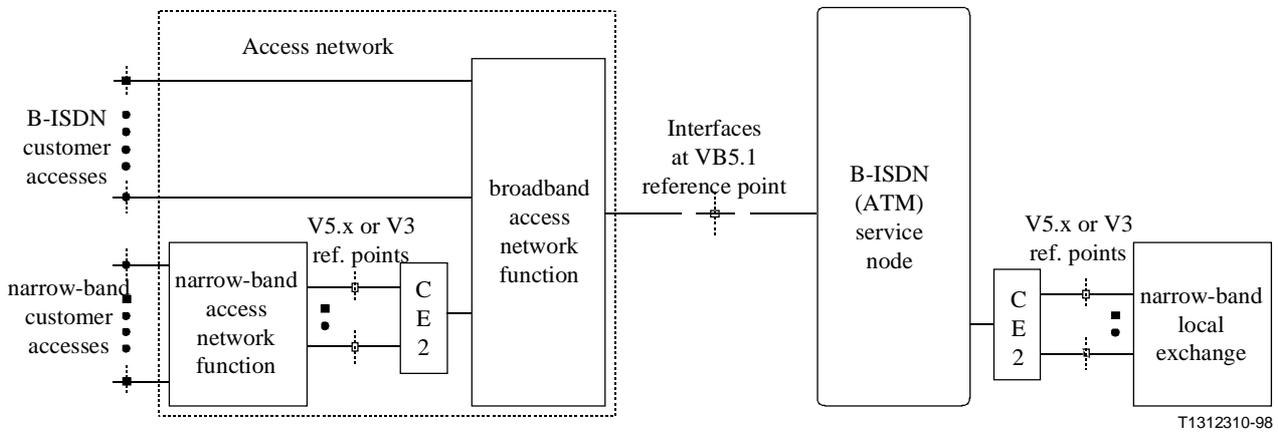
**Figure 4/G.967.1 – Service architecture for the case
of separate broadband and narrow-band SNs**

Figure 5 shows the same access network architecture as in Figure 4, but for the support of an integrated SN providing both broadband and narrow-band services. In this case, the SN is demultiplexing the aggregate information stream internally and handles both types of information transfer modes internally.
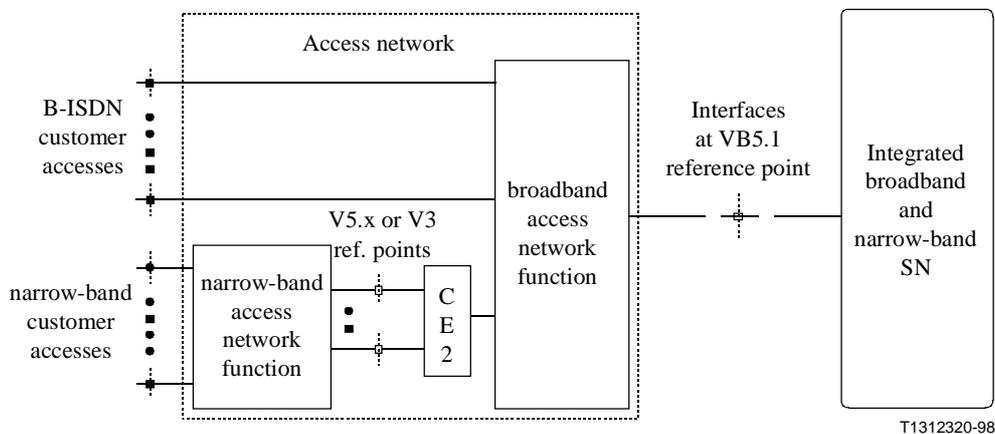
**Figure 5/G.967.1 – Service architecture for the case
of integrated broadband and narrow-band SN**

4.3   Support of other non-B-ISDN access types

A key feature of VB5.1 reference point concept is the support of other non-B-ISDN customer access types.

In addition to the integration of narrow-band customer access types, remote access arrangements with VB5.1 reference point may integrate further non-B-ISDN access types (e.g. access types supporting asymmetric/multimedia services, access types supporting broadcast services).

However, this requires additional access type specific access adaptation functions in order to adapt the specific non-B-ISDN UNI to the requirements and capabilities of the broadband access network. Further details of this concept are described in clause 8. The specification of access adaptation functions is outside the scope of this Recommendation.

4.4   Support of various service node types

The VB5.1 reference point concept is independent from the specific service(s) provided by the SN as long as the SNI meets the functional requirements at the VB5.1 reference point. One of the essential requirements is the support of the Real-Time Management Coordination (RTMC) function as specified in clause 11. Further functional requirements are identified in clause 6.

Remote access arrangements with VB5.1 reference point can therefore be applied to provide access to various types of SNs. An SN may be either a service specific SN (i.e. providing one specific service), as for example:

– Broadband Local Exchange (B-LEX);

– Connectionless Server (CLS) providing broadband connectionless data services;

– Head-End for Distribution services (HED);

– SNs providing digital video and audio on-demand services;

– SNs providing leased line services, i.e. ATM VP (and/or VC) cross-connect,

or a modular SN providing more than one type of service.

Furthermore, remote access arrangements with VB5.1 reference point support access configurations which allow that a customer can access more than one SN through a single UNI at the same time. This is a feature which can not be supported within direct access arrangements by definition.

The customer access to several SNs via a single AN may be realized:

– either by applying individual transmission paths at the VB5.1 reference points as illustrated in Figure 6. This does not preclude the application of any multiplexing or cross-connecting function at the transmission layer (e.g. SDH or PDH cross-connect); or

– with the help of ATM VP cross-connect functions between the ANs and the SNs as illustrated in Figure 7.

Transmission path

Virtual path
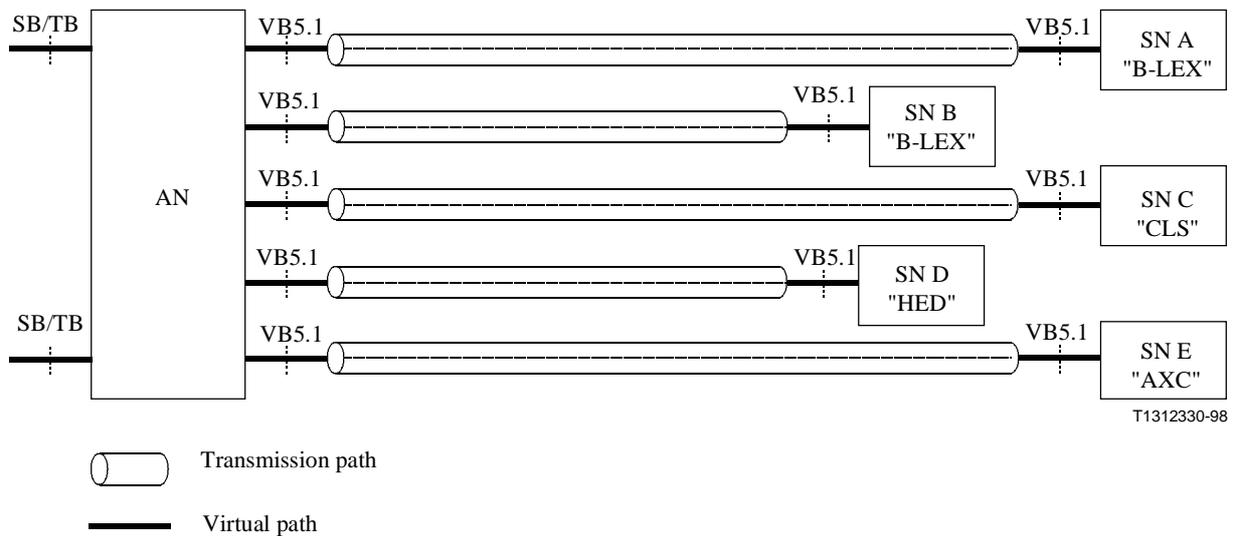
NOTE – For simplicity, only one VP per VB5.1 reference point is shown.

**Figure 6/G.967.1 – Support of several SNs via individual
transmission paths at VB5.1 reference points**

Transmission path

Virtual path
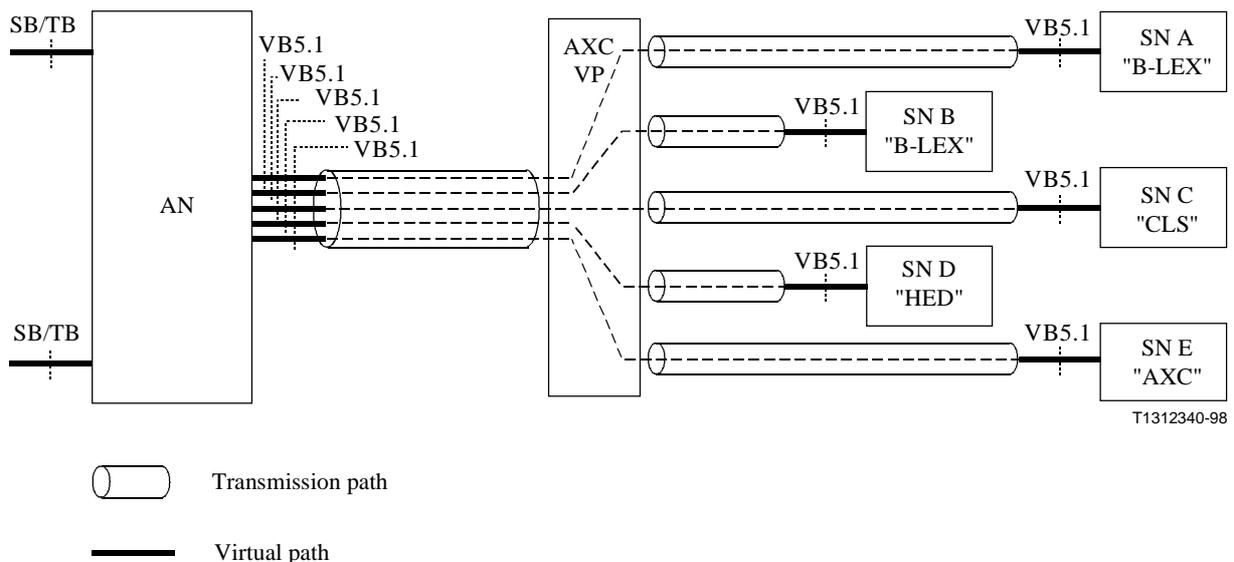
NOTE – For simplicity, only one VP per VB5.1 reference point is shown.

Figure 7/G.967.1 – Support of several SNs via an ATM VP cross-connect

However, for a particular access from a UNI to a SN it is required that not more than one VB5.1 reference point is present within the relevant access connection element, i.e. VB5.1 reference points and the associated RTMC functions can not be concatenated.

As a consequence, it is not supported within the framework of the VB5.1 reference point concept that the remote access to an SN #1 is realized via an SN #2 between the AN and SN #1. As illustrated in Figure 8, access to an SN behind an SN with VB5.1 reference point requires the application of other reference points and/or interfaces (e.g. NNI).

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⊂◯◯⊃ Transmission path

▬▬▬ Virtual path

■ ■ ■ ■ ▪ Virtual channel carrying RTMC information
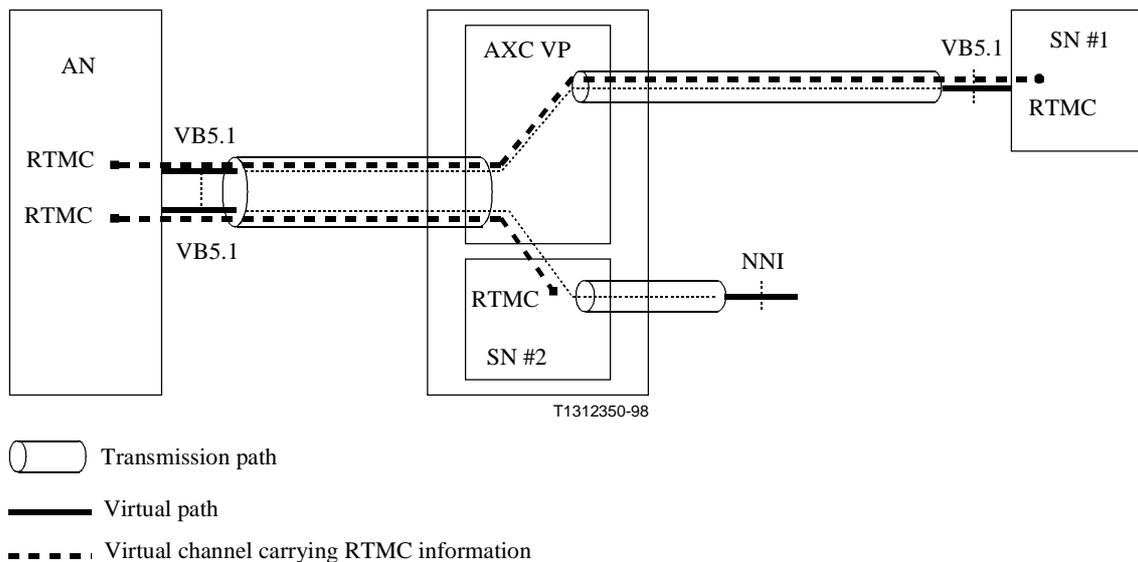
NOTE – For simplicity, only one VP per VB5.1 reference point is shown.

Figure 8/G.967.1 – Configuration examples for remote access to different SNs

5 Introduction to the VB5.1 reference point concept

This clause defines the fundamental principles and requirements as well as the general functional architecture of remote access arrangements with a VB5.1 reference point.

The interface at the VB5.1 reference point is an ATM-based instance of a service node interface (SNI).The VB5.1 reference point concept is based on Recommendation G.902 [3].

Applying the terminology and definitions introduced in Recommendation G.902 [3], the general characteristics of the VB5.1 reference point concept can be described as follows:

– The VB5.1 reference point belongs to the access integrating class of V reference points, i.e. the signal structure is a multiplex of several accesses of the same or of different access types.

– The VB5.1 reference point supports both service specific SNs (e.g. broadband local exchange, ATM based leased line SN) and modular SNs (e.g. combined narrow-band and broadband local exchange).

5.1 General VB5.1 design principles

Within this subclause the fundamental principles for remote access arrangements with VB5.1 reference point are defined:

a) An AN is used in order to multiplex/demultiplex the signalling and data streams from UNIs in a cost-effective manner and then to present this information stream to the SN in a manner such that the SN can determine the source or sink UNI.

b) The AN does not interpret (user) signalling.

c) The responsibility for call control and associated connection control resides in the SN (i.e. the AN may have no knowledge of ongoing services and the call state during normal operation of the VB5.1 reference point).

d) Selection of the service provider by the AN based on user signalling information shall not be possible, because this would require SN functionality in the AN.

However, for ATM-based access types the AN shall support access to different SNs through a single UNI at the same time by using the corresponding VPs associated to these SNs via provisioning (see also 5.3.1, shared UNI). In this case, the selection of the service provider is a matter of the user terminal and does not concern the AN or the SNI.

e)   Time critical management functions which require real-time coordination between AN and SN shall be performed by communication across the VB5.1 reference point.

f)   According to Recommendation I.414 [18] the VB5.1 reference point concept supports ATM multiplexing/cross-connecting in the AN, but does not support on-demand VP or VC link allocation in the AN.

g)   Charging information is transparently passed between the VB5.1 reference point and the user by the AN, when the user requires it as part of a service. This information is not passed over the VB5.1 reference point for use by the AN.

h)   Tones and announcements shall be generated in the SN and not in the AN.

i)   If multicasting is provided in the AN, this shall be allowed to be performed in the SNI-to-UNI direction only. Otherwise, multicasting is presumed to be a service provided by the SN.

j)   Traffic control and congestion control functions (at the ATM layer) such as:

–   use of VPs for network resource management;

–   connection admission control (CAC);

–   usage parameter control (UPC)/network parameter control (NPC) functions;

–   priority control;

–   traffic shaping;

–   fast resource management;

–   congestion control by selective cell discard and/or explicit forward congestion indication,

shall be performed in accordance with Recommendations I.371 [17], I.732 [26] and E.736 [1].

Some of the traffic control and congestion control functions (e.g. NPC, traffic shaping) are network options according to Recommendation I.371 [17].

5.2   General reference model for the VB5.1 reference point

In this subclause, the individual and specific resources to be operated, administered and maintained (i.e. with the help of provisioning and control functions) for remote access arrangements with VB5.1 reference point are identified. The overall framework for such remote access arrangements with VB5.1 reference points is illustrated in Figure 9.

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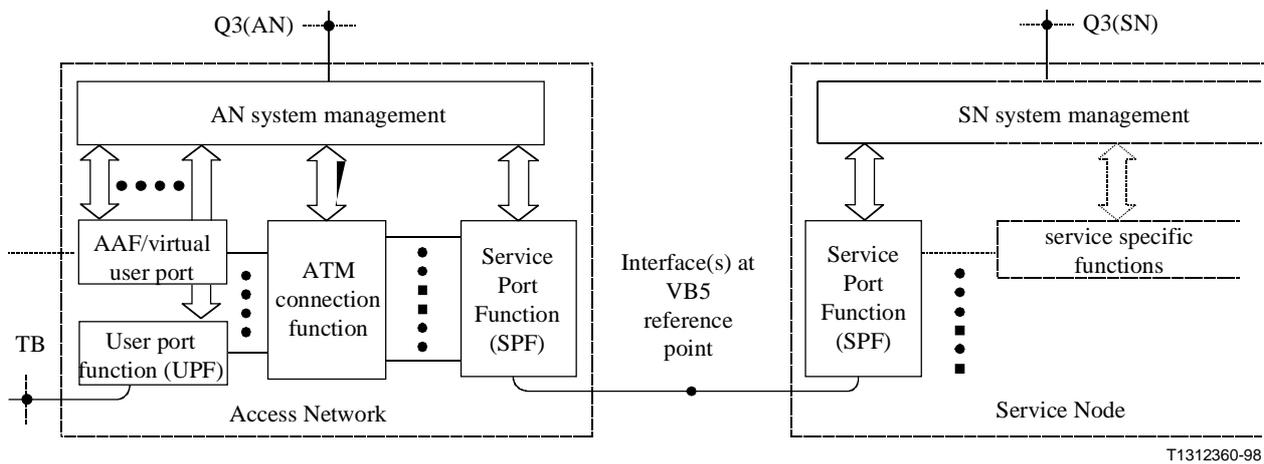
NOTE 1 – The ATM connection function in this figure covers both transport functions and core functions as defined in Recommendation G.902 [3].

NOTE 2 – The ATM connection function, used in conjunction with the VUP, is provided for modelling purposes and may not necessarily exist in practice.

Figure 9/G.967.1 – Access arrangements with VB5.1 reference point

Based on this overall framework for remote access arrangements across VB5.1 reference points as illustrated in Figure 9, a functional modelling approach to identify the resources to be provisioned and controlled is illustrated in Figure 10. This approach concentrates on the functional groupings identified in Figure 9, i.e. the User Port Function (UPF), the ATM connection function and Service Port Function (SPF).

The specification model illustrated in Figure 10 is based on a separation of the user port function into a physical and a logical user port function and a separation of the service port function into a physical and a logical service port function.

A virtual user port has parallels with a physical user port though its full functions are not specified due to the wide range of non-B-ISDN access types that can be supported using this concept. Therefore the virtual user port is not shown as a separate entity within Figure 10. Details of the virtual user port concept are given in clause 8.
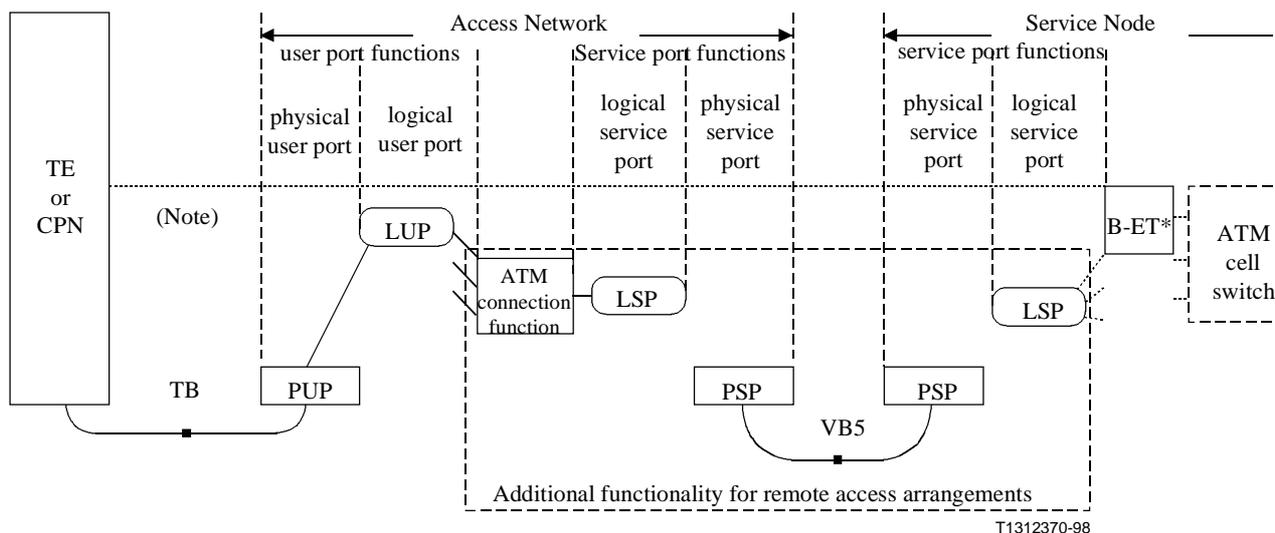
NOTE – Control plane communication between TE/CPN and SN.

**Figure 10/G.967.1 – Overall functional specification
model for VB5.1 reference point concept**

The following general relationships between functional blocks within the access network and the service node are identified:

a)   A Physical User Port (PUP) comprises the physical layer functions related to a single transmission convergence function at the UNI. A PUP has no counterpart at the SN side.

b)   A Logical User Port (LUP) comprises the set of VPs at the UNI associated with one single VB5.1 reference point. An LUP is logically associated with the B-ET* in the SN and configuration management actions have to be coordinated with the SN.

    NOTE – The term "B-ET*" is used to make a clear distinction between the B-ET for the direct access and the remote access via an access network.

c)   A physical service port comprises the physical layer functions related to a single transmission convergence function at the VB5.1 reference point. A PSP exists both at AN side and SN side. In the general case of an ATM-based transport network (i.e. VP cross-connect function) between AN and SN, a one-to-one relationship between PSP at the AN side and PSP at SN side does not exist.

d)   A logical service port comprises the set of VPs at one VB5.1 reference point. An LSP exists at both the AN and SN sides and there is always a one-to-one relationship between LSP at the AN side and LSP at the SN side.

5.3   General characteristics of individual functional groups

5.3.1   User port function characteristics

The general requirements for the concept applied to user ports within an access arrangement with VB5.1 reference point are defined below. Only those aspects having impact on a modelling approach for a user port function in a VB5.1 environment are detailed here.

a)   *Multiple physical UNI*

    A UNI may consist of one or several physical interfaces, i.e. the user VPs assigned to a VB5.1 reference point may be carried on different transmission convergence functions.

These VPs may be controlled by the same signalling virtual channel (i.e. non-associated signalling).

b)   *Shared UNI*

The UNI may be a shared UNI as defined in Recommendation G.902 [3], i.e. at the UNI it is possible to access different SNs at the same time by activating the corresponding logical user port functions. The individual logical user ports carry all the required information providing the access bearer capability including signalling.

5.3.2   ATM connection function characteristics

a)   *Association of user VPs to VB5.1 reference point*

A VP at the UNI shall be associated to one and only one VB5.1 reference point. The association is established on a static basis through provisioning of the corresponding logical user port and has to be coordinated with the relevant SN.

b)   *ATM cross-connections*

The ATM connection function provides ATM cross-connections at the VP and/or the VC level.

5.3.3   Service port function characteristics

The general requirements for the concept applied to service ports within an access arrangement with a VB5.1 reference point are defined below. Only those aspects having impact on a modelling approach for a service port function in a VB5.1 environment are detailed here.

a)   *Multiple physical SNI*

The information flow at the VB5.1 reference point is carried via one or several transmission convergence functions.

b)   *Remote connection*

In case of a remote connection, the transparent transport network between AN and SN may include ATM cross-connection functions at VP level.

c)   *Shared SNI*

VPs assigned to different VB5.1 reference points may be carried on common physical link(s); i.e. the transmission convergence function(s) may be shared between information flows belonging to separate VB5.1 reference points.

5.4   Functional modelling

This subclause specifies the modelling concepts applied to the user port function, service port function and the ATM connection function within an access arrangements with VB5.1 reference point. The modelling concepts are based on the general characteristics identified in 5.3.1 and 5.3.2.

5.4.1   Modelling of user port function

The concept applied for the modelling of a user port takes into account the general user port function characteristics identified in 5.3.1. It is based on a separation of physical user port functions and logical user port (i.e. service related) functions as defined above and illustrated in Figure 11.
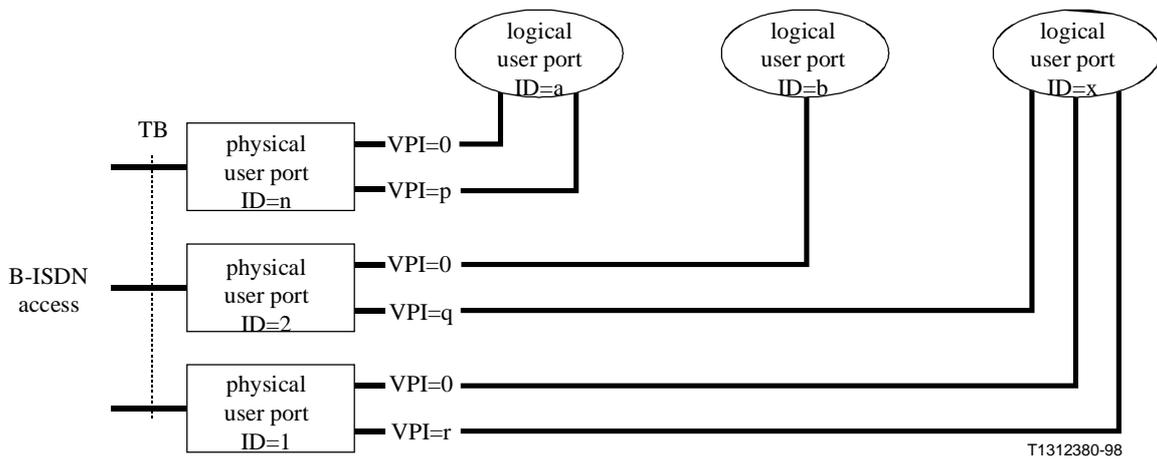
Figure 11/G.967.1 – Functional modelling of the user port functions

5.4.2 Modelling of service port function

The concept for the modelling of a service port takes into account the general service port function characteristics identified in 5.3.2. It is based on a separation of physical layer functions and service related functions as defined above and is illustrated in Figure 12.
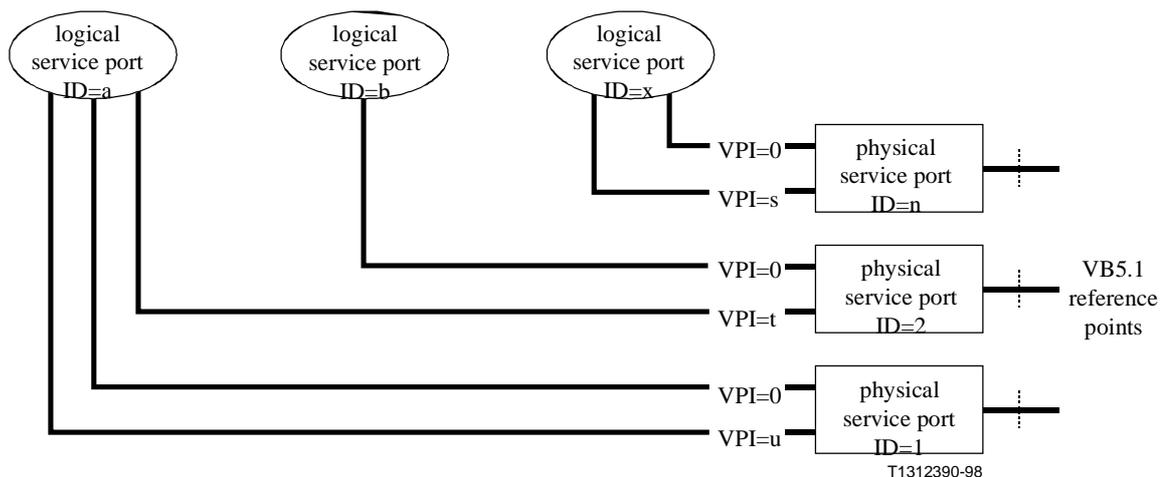
NOTE – As illustrated for the PSPs with ID=1 and ID=2, in general a one-to-one relationship between VB5.1 reference point and PSP does not exist.

Figure 12/G.967.1 – Functional modelling of the service port functions

5.4.3 Modelling of ATM connection function

The ATM connection function within an AN with a VB5.1 reference point provides:

– ATM cross-connections at VP level;

– ATM cross-connections at VC level,

within the provisioned association of a logical user port to a logical service port. In case of a VC cross-connection function, all VC links within a VP at a logical user port are cross-connected to VC links at the same logical service port.

The functional model for the ATM connection function within the AN is illustrated in Figure 13 for a configuration example where two logical service ports (i.e. VB5.1 reference points) exist in the AN.
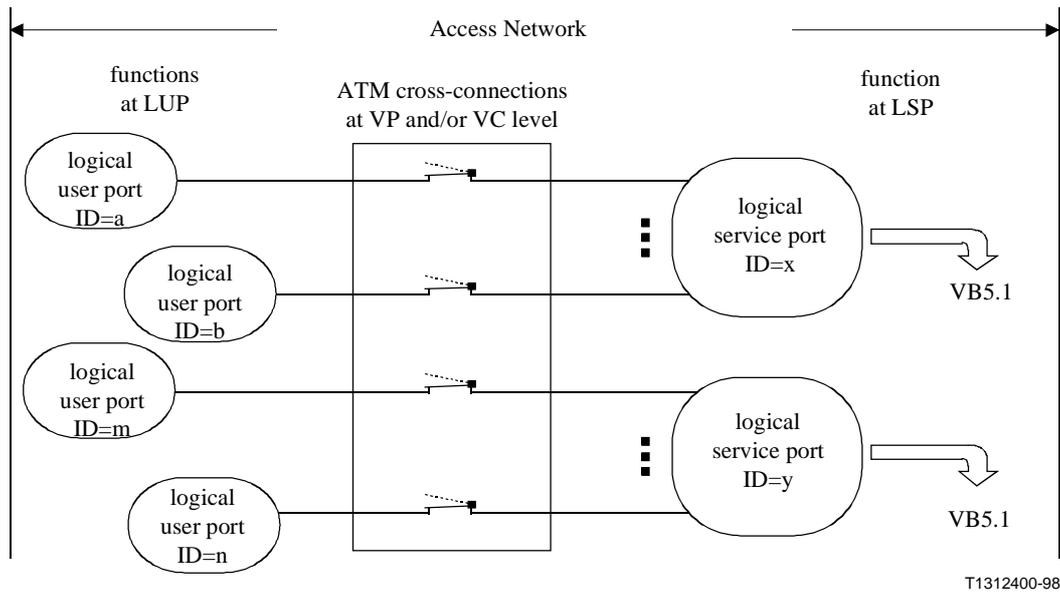
**Figure 13/G.967.1 – Functional model for
ATM connection function within AN**

The modelling approach of the individual ATM cross-connections at VP and/or VC level is described in Recommendation I.751 [27].

5.5   AN view and SN view of physical and logical ports

One of the main issues of the VB5.1 reference point concept is the decoupling of the different views related to the B-ISDN access infrastructure provider (the operator of the access network) and the B-ISDN service provider (the operator of the service node).

This subclause describes the different views of the access network and the service node with regard to physical and logical functional groupings as relevant to the VB5.1 reference point concept.

A summary of the AN view and SN view of physical and logical ports related to management is given in Table 1.

Table 1/G.967.1 – Overview on management of user port and service port functions

	Physical user port	Logical user port		Logical service port		Physical service port	
		SN side	AN side	SN side	AN side	SN side	AN side
Management of admin. States via Q3(AN)	Y	–	N	–	Y	–	Y
Management of admin. states via Q3(SN)	–	Y	–	Y	–	Y	–
Responsibility for provisioning	Q3(AN)	C	C	C	C	Q3(SN)	Q3(AN)
C Coordinated provisioning via Q3(SN) and Q3(AN).							
Y Management of administrative state is possible.							
N Management of administrative state is not possible.							
– Not applicable.							

5.5.1 View from access network

The view of user ports and service ports from the B-ISDN access infrastructure provider (i.e. operator of the access network) is illustrated in Figure 14. Within this figure a User-Network Interface (UNI) with only a single physical link is shown for simplicity reasons.
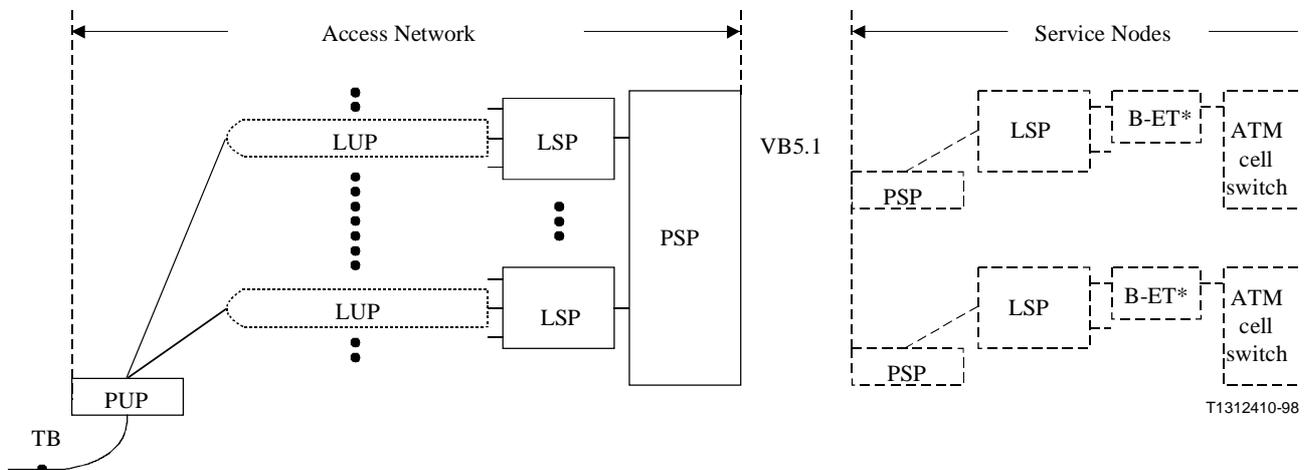
Solid boxes: Both configuration management actions (e.g. provisioning of VPs) and manipulation of administrative state are under the responsibility of the AN operator. For some configuration management actions, coordination with the SN operator is required.

Dashed-dotted boxes: Configuration management actions (e.g. provisioning of VPs) are under the responsibility of the AN operator, but no administrative state is present. For some configuration actions, coordination with the SN operator is required.

Dashed boxes: Not visible to the AN operator.

Figure 14/G.967.1 – View of physical and logical ports from access network

5.5.2 View from service node

The view of physical and logical ports from the B-ISDN service provider (i.e. operator of the service node) is illustrated in Figure 15. In this figure, only one single access network is shown for simplicity reasons.
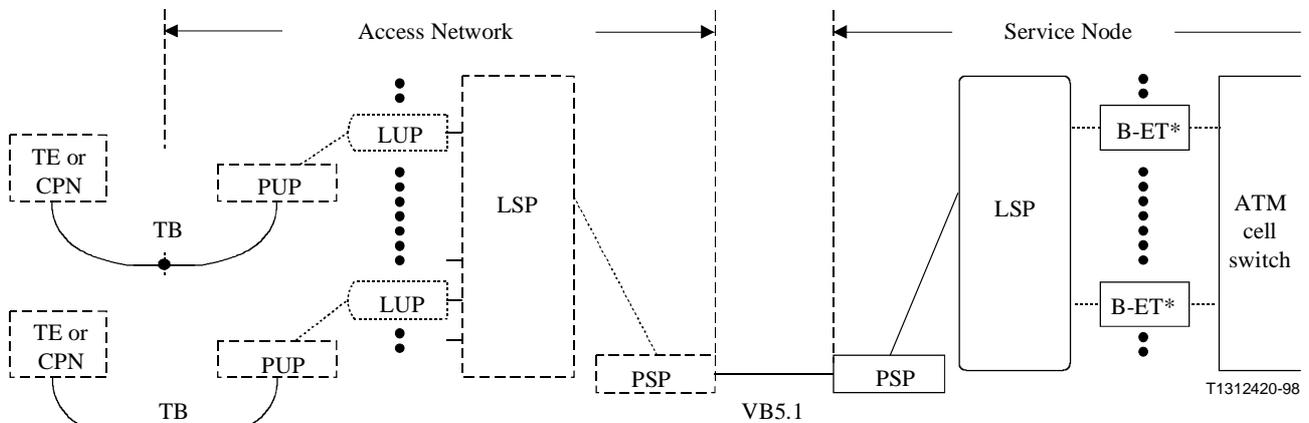
Solid boxes: Both configuration management actions (e.g. provisioning of VPs) and manipulation of administrative state are under the responsibility of the SN operator. For some configuration management actions, coordination with the AN operator is required.

Dashed-dotted boxes: The logical user port is used as a naming convention. It is logically associated with the B-ET*.

Dashed boxes: Not visible to the SN operator.

Figure 15/G.967.1 – View of physical and logical ports from service node

6 Procedural interface requirements

6.1 Introduction

The functional description of the VB5.1 reference point at a (physical) interface is illustrated in Figure 16.
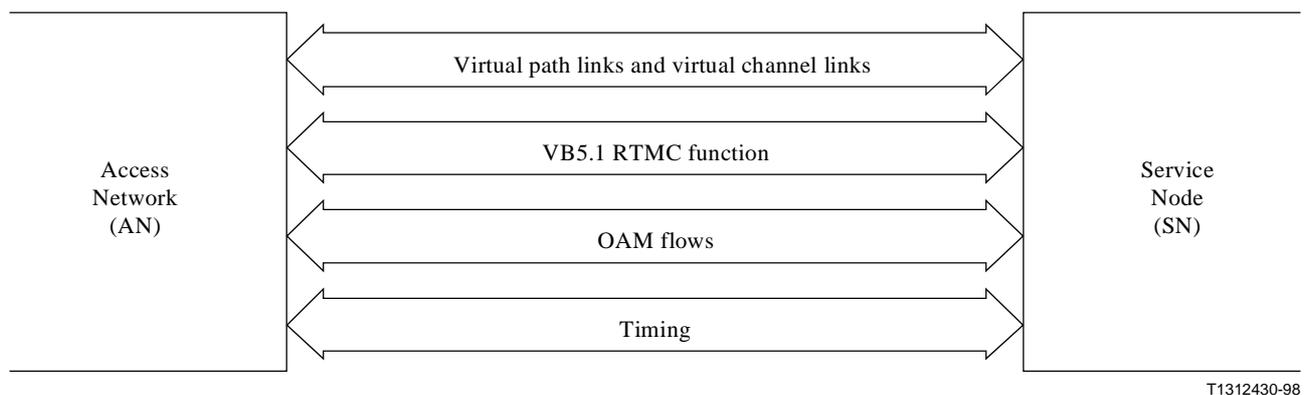
Figure 16/G.967.1 – Functions at an interface at the VB5.1 reference point

The indicated functions are briefly described below:

a)   *Virtual path links and virtual channel links*

The VB5.1 supports the ATM layer for user plane (i.e. user data), control plane (i.e. user-to-network signalling) and management plane (e.g. meta-signalling, if any, and RTMC function) information. This information will be carried on virtual channel links. The virtual channel links will be carried in virtual path links.

b)   *VB5.1 Real-time Management Coordination (RTMC) function*

This function provides management plane coordination (including synchronization and consistency) between access network and service node via a dedicated protocol (referred to as RTMC protocol) across the VB5.1 reference point. The protocol is used for exchanging time critical management plane information between AN and SN.

Non-time critical functions (e.g. provisioning of user ports) that require a coordinated view at both sides of the VB5.1 are performed via Q3 interfaces (i.e. via system management functions of AN and SN) (see also Recommendation G.902 [3]).

c)   *OAM flows*

This function provides layer related exchange of OAM information. These flows exist at the ATM layer and may exist at the physical layer.

d)   *Timing*

This function provides the necessary information for bit (signal element) transmission, octet and cell boundaries (i.e. cell delineation).

For the definition of the functional and procedural interface requirements, the B-ISDN Protocol Reference Model (PRM) defined in Recommendation I.321 [9] is applied in the following subclauses.

6.2   Physical layer requirements

6.2.1   General

In order to enable interconnection of an Access Network from one provider with a Service Node of another provider, the physical layer needs to be specified. It is, however, outside the scope of the Recommendation to fully specify the physical layer. Instead, some general requirements will be given in this clause.

The specifications within this Recommendation are decoupled from the physical layer specifications as far as possible. This allows manufacturers and purchasers to develop the most flexible designs from the standard without having to modify the basic mechanisms whenever a new physical layer alternative is introduced.

However, the physical layer at the VB5.1 reference point shall apply existing physical layer standards and Recommendations from ITU-T. The relevant standards shall provide the necessary physical medium and transmission convergence sublayer specifications.

6.2.2   Basic characteristics of the VB5.1 interface

The VB5.1 interface carries ATM layer characteristic information over one or more TC layer (e.g. VC4 in case of SDH) for which ATM mapping is specified (see Figure 17 for a single TC layer and Figure 18 for multiple TC layers).

Even in the case of a single TC layer, the VB5.1 interface can be carried over different physical media, provided that the information flow of the different media is combined via physical layer

functionality to a single TC layer. For example, for reasons of bidirectional information transport or for reasons of protection, different physical media may be required.

The physical layer may also support multiple VB5.1 interfaces within a single TC layer. For example, the latter case is possible by the use of a VP cross-connect in between one or more ANs and one or more SNs (see Figure 19).
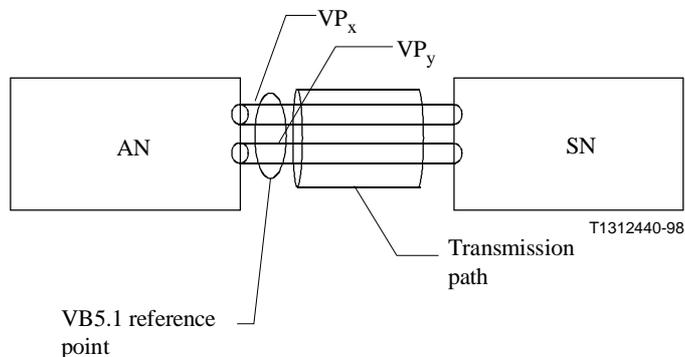
**Figure 17/G.967.1 – VB5.1 interface, grouping
of VPLs within a single TC layer**
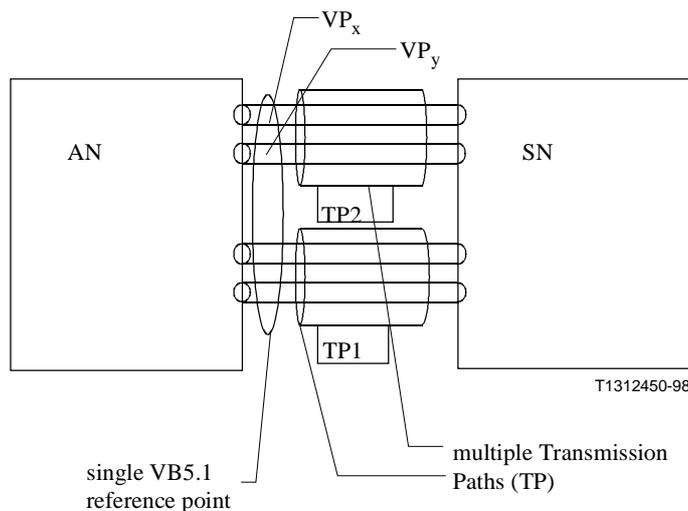
**Figure 18/G.967.1 – VB5.1 interface, grouping
of VPLs within multiple TC layers**
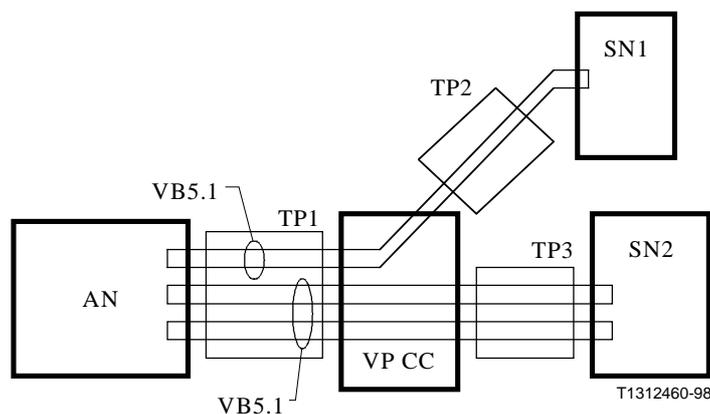
**Figure 19/G.967.1 – Multiple VB5.1 reference
point within a single TC layer**

6.2.3 VB5.1 interface options

Appendix III gives examples of some recommended physical layer options for the VB5.1 interface.

6.2.4 Interface requirements

6.2.4.1 Interface topology and transfer capability

The interface at the VB5.1 reference point is point-to-point at the physical layer in the sense that there is only one sink (receiver) in front of one source (transmitter).

The transfer capability is defined for each individual physical interface at VB5.1 reference point, i.e. it is part of the transmission convergence sublayer specification.

6.2.4.2 Maximum number of transmission convergence functions

The information flow at the VB5.1 reference point is carried via one or several transmission convergence functions.

The maximum number of transmission convergence functions which may be accommodated at a VB5.1 reference point is governed by two factors:

a)   the addressing capacity of the VPCI field in the RTMC protocol (16 bits) and the requirements with regard to the uniqueness of VPCIs within logical ports (see 7.3.2);

b)   the maximum number of VPs permitted on the transmission convergence functions.

Independent of the particular configuration, this permits at least 16 transmission convergence functions at the SNI. However, in a typical configuration, much more transmission convergence functions may be accommodated.

6.2.4.3 Timing

In normal operation, the transmitter is locked to the timing received from the network clock. However, the methods for overall network synchronization are outside the scope of this Recommendation.

The AN may use the timing information of the physical layer at the VB5.1 reference point to synchronize on the network clock. The associated operation and maintenance procedures (i.e. failure detection and consecutive actions, timing status communication) shall be part of the relevant standards of the physical layer; i.e. no additional procedures/protocols are introduced at the VB5.1 reference point.

6.2.4.4   OAM

OAM procedures as specified by the relevant standard for the physical layer shall be applied. At the physical layer, Recommendation I.610 [24] is applicable as it specifies relations between the ATM layer and the physical layer (e.g. primitives for generation of the VP-AIS).

The operational functions as defined in Recommendation I.432 series [19], [20], [21], [22], [23] (e.g. state matrix for layer 1 functions) relate to the UNI and shall be handled by the AN.

6.2.4.5   Protection

No VB5.1 specific protection mechanisms are provided other than those which are available at the physical layer (e.g. section protection mechanism of SDH) and/or at the ATM layer. The relevant standard for the physical layer and ATM layer shall be applied.

6.2.4.6   Transmission path identification

The physical layer at the VB5.1 reference point shall provide an embedded transmission path identification method (e.g. path trace mechanism in SDH). No additional transmission path identification mechanisms are provided other than those which are available at the physical layer. The relevant standard for the physical layer shall be applied.

6.2.4.7   Pre-assigned cell headers for use by the physical layer

Pre-assigned cell header values for use by the physical layer are defined in Recommendation I.361 [13].

6.3   ATM layer requirements

The user information together with the information for connection related functions (e.g. user-to-network signalling) and OAM information (at the ATM layer or at a higher layer) are carried in ATM cells belonging to a virtual channel link and virtual path link.

6.3.1   Cell header format and encoding and pre-assigned cell headers for use by the ATM layer

The cell header format and encoding and the pre-assigned headers for use by the ATM layer used at the VB5.1 reference point shall comply with the NNI specifications of Recommendation I.361 [13].

6.3.2   Cell Loss Priority (CLP)

Depending on the network conditions, cells where the CLP is set (i.e. value of the CLP bit is 1) are subject to be discarded prior to cells where the CLP is not set (i.e. value of the CLP bit is 0). See Recommendation I.371 [17] for further details about the use of the CLP bit.

6.3.3   VPC carrying RTMC protocol VCC

The VPC which contains the RTMC protocol VCC shall not carry any user data or user signalling traffic.

6.3.4   OAM

The operation and maintenance principles based on F4 and F5 OAM flows as defined in Recommendation I.610 [24] are applicable.

6.4 Higher layer interface requirements

6.4.1 User plane

For ATM-based accesses, the layers above the ATM layer are transparent to the access network.

For the support of non-B-ISDN access types which do not support the ATM layer, ATM Adaptation Layer (AAL) functions have to be provided within the access network.

No other higher layer interface requirements are identified for the transfer of user plane information across the VB5.1 reference point.

6.4.2 Control plane

User-to-network signalling applied at the CPE is handled transparently within the AN. The peer entity is the SN.

In order to support some specific non-B-ISDN accesses (see clause 8), the AN may also apply B-UNI signalling.

It is noted that an access network conformant to VB5.1 can be used with other broadband user-to-network signalling systems applied at the CPE and the SN and transported transparently over the AN. This feature is a consequence of the basic principle that user-to-network signalling is not terminated by the AN. This is, however, outside the scope of this Recommendation.

6.4.3 Management plane

For the management of an AN/SN configuration using a VB5.1 interface, coordination between management plane functions of the AN and SN is required. Two types of coordination exist:

– non-real-time management coordination;

– real-time management coordination.

Non-real-time management coordination is realized via the TMN and hence the respective Q3 interfaces of the involved network elements: i.e. Q3(AN) and Q3(SN).

VB5.1 Real-Time Management Coordination (RTMC) shall be supported via a dedicated protocol. The RTMC function and associated procedures belong to the plane management functions of AN and SN. These functions are specified in separate clauses in this Recommendation.

6.4.4 Establishment of VP and VC links/connections

6.4.4.1 Establishment of VP links and connections

Virtual path links (VPLs) at the VB5.1 reference point are always established via management plane functions of the AN, SN and (if applicable) the transport networks.

6.4.4.2 Establishment of VC links and VC connections

VCLs at the VB5.1 reference point are carried by VPLs/VPCs, which are established at the VB5.1 reference point according to 6.4.4.1. The same is valid for the VCLs at the UNI or VUP. With relation to the VCLs and VCCs, the following types can be distinguished:

a) *VCLs of VCCs cross-connected in the AN*

VCLs which are part of VCCs that are cross-connected in the AN are established via management plane functions of the AN and SN.

b)   *VCLs carried in VPCs that are cross-connected in the AN*

VCLs carried in VPCs which are cross-connected in the AN are established either via management plane functions or via control plane functions. These management plane or control plane functions are located in the SN; and

–   are in the B-ISDN customer premises equipment (e.g. in case of B-ISDN access types); or

–   are in access adaptation functions which are considered to be part of the AN (e.g. in case of non B-ISDN access types).

c)   *The VCL of the VCC carrying the RTMC function*

The VCL of the VCC which is carrying the RTMC function is established via management plane functions of the AN and SN.

6.4.5   ATM Adaptation Layer for the RTMC function

6.4.5.1   General AAL requirements

The VB5.1 RTMC protocol shall use the Signalling ATM Adaptation Layer (SAAL). This AAL consists of the following parts: Recommendations I.363.5 [16], Q.2110 [29] and Q.2130 [31].

6.4.5.2   AAL5 requirements

The requirements for the AAL5 are defined in Recommendation I.363.5 [16].

The following selections apply:

–   The VB5.1 RTMC protocol uses the message mode service of AAL5.

–   Corrupted messages will not be delivered to the RTMC protocol entity.

6.4.5.3   SSCOP requirements

The requirements for the SSCOP are defined in Recommendation Q.2110 [29].

The following selections apply:

–   local data retrieval: This function is not needed by the VB5.1 RTMC protocol;

–   re-synchronization is an inherent part of the SSCOP and has to be supported;

–   status reporting: No management data needs to be exchanged between the two peer entities for the VB5.1 RTMC protocol;

–   the SSCOP protocol entities will not exchange extra data between them (SSCOP-user-to-user) for the VB5.1 RTMC protocol;

–   at release of the connection the message buffers should also be cleared;

–   the value for MaxSTAT as defined in 7.7/Q.2110 shall be one of the default values;

–   the other values are given in 6.4.5.4;

–   the default window size shall be 5 as defined in Appendix IV/Q.2110.

6.4.5.4   SSCF requirements

The requirements for the SSCF are defined in Recommendation Q.2130 [31].

The following selections apply:

–   the VB5.1 RTMC protocol needs only the "assured transfer of data" but not the "unacknowledged transfer of data";

–   the VB5.1 RTMC protocol does not need the AA-Parameter SSCOP-user-to-user;

–   the parameters of Table 4/Q.2130 shall apply.

6.5   Meta-signalling

Broadband meta-signalling applied at the CPE is handled transparently within the AN. The peer entity is the SN.

In order to support some specific non-B-ISDN accesses (see clause 8), the AN may also apply broadband meta-signalling.

At the VB5.1 reference point, B-ISDN user meta-signalling (Recommendation Q.2120 [30]) shall be applied for the allocation of signalling virtual channel links at the VB5.1 reference point, which are handled transparently between the user ports or virtual user ports (see clause 8) and the SN. The meta-signalling VCC is part of and carried over the VB5.1 reference point.

It is noted that an access network conform to VB5.1 can be used with other broadband meta-signalling systems applied at the CPE and the SN and transported transparently over the AN. This feature is a consequence of the basic principle that meta-signalling is not terminated by the AN. This is, however, outside the scope of this Recommendation.

6.6   Interface management application

Examples are described in Recommendation M.3610 [28]. For further study.

7   Broadband access network connection types

This clause specifies the basic broadband connection types which are required across access networks with VB5.1 reference point. This Recommendation does not imply that every access network with VB5.1 reference point shall have the capability to support all these connection types.

7.1   Introduction to connections/connection elements

An overall B-ISDN connection may comprise a number of "tandem" connections (also called segments) of different networks (e.g. public B-ISDN and private B-ISDN) as illustrated in Figure 20 and may be further decomposed into local, transit and international B-ISDN connection elements.

The overall B-ISDN connection can be considered to end either at the SB reference point (in the case where the customer network is a B-ISDN, i.e. providing the same B-ISDN connection as in the public B-ISDN) or at the coincident SB/TB reference point (in the case where the customer network is null).

Recommendations I.324 [10] (related to ISDN) and I.327 [11] (related to B-ISDN) explain how an overall B-ISDN connection is made up of Connection Elements (CE). This concept is illustrated in Figure 20 with the inclusion of a new additional connection element which is representing the "public access network" and the related "public access network" Connection Related Functions (CRFs).
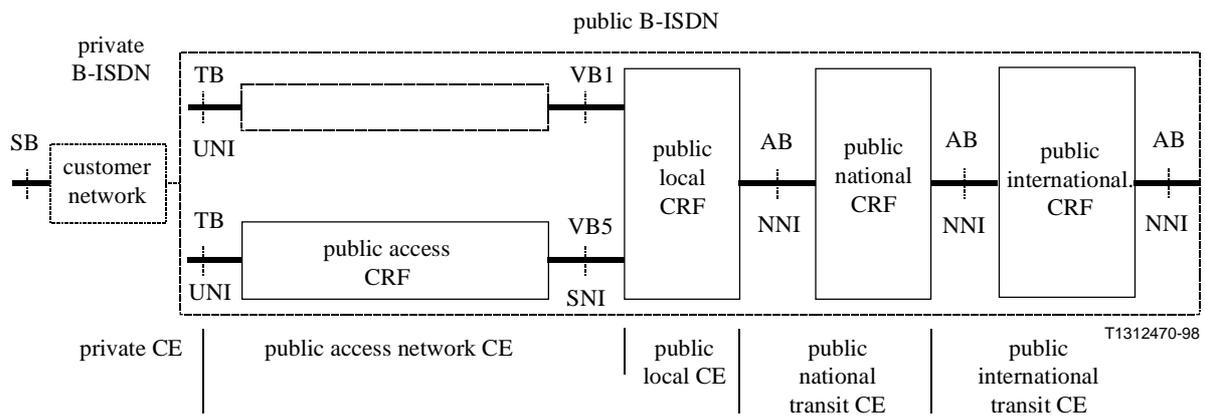
Figure 20/G.967.1 – Connection elements within an overall B-ISDN connection

7.2 Multipoint requirements

The access network (i.e. the ATM cross-connection function) shall be capable of supporting a point-to-multipoint (multicast) function on a given number of virtual connections.

The cell sequence integrity of the source shall be maintained for the point-to-multipoint connections.

The point-to-multipoint connections are unidirectional in the direction SN to UNI.

Requirements for bidirectional point-to-multipoint connections are for further study within ITU-T and their impact on the VB5 reference point will have to be investigated. (For example, for the case of bidirectional point-to-multipoint connections, the return peak cell rate on the root link may be required not to exceed the sum of the return peak cell rates on all the leaf ATM links to maintain suitable cell loss performance for the overall connection.)

A multipoint-to-multipoint connection is for further study.

7.3 Broadband access network connection element identifiers

Connection element identifiers have already been introduced in direct access arrangements for use by the user signalling procedures. For remote access arrangements with VB5.1 reference point, connection element identifiers are additionally required for the RTMC function.

7.3.1 Connection element identifiers in user-to-network signalling messages

The use of connection element identifiers (i.e. VPCIs and VCIs) in user-to-network signalling messages is described in Recommendation Q.2931 [32].

7.3.2 Connection element identifiers in RTMC messages

For the RTMC function, a mechanism for the unique identification of VPCs both at the UNI and the VB5.1 reference point is required.

The concept of VPCIs shall be applied within the RTMC protocol in order to identify the corresponding user information flow, i.e. VPC. Both the AN and the SN must understand the relationship between the VPCI value used in the RTMC protocol and the actual VPI value used in the cell header for the user information flow.

a)   *Identification of a VPC cross-connected in the AN* (see also Figure 24)

The VPCI allocated to a given VPC shall be unique within the corresponding logical user port. The logical user port is identified by an LUP identifier which is unique within each VB5.1 reference point.

Where user-to-network signalling is applied, the RTMC function shall use the same VPCI values as they are applied in the user-to-network signalling protocol.

b)   *Identification of a VPC at the UNI terminated at the user port function of the AN*

The same mechanism as for a VPC cross-connected in the AN shall be applied.

c)   *Identification of a VPC at the VB5.1 reference point terminated at the service port function of the AN* (see also Figure 28)

For the identification of a VPC at the VB5.1 reference point terminated at the service port side of the AN, the concept of VPCIs is applied as well. The VPCI allocated to a given VPC of this type shall be unique within the corresponding logical service port. The logical service port is identified by an LSP identifier.

7.4   Broadband access network connection type matrix

An overview of the broadband AN connection types in an access arrangement with VB5.1 reference point is given in Table 2. A detailed description is provided in 7.5 and 7.6.

Table 2/G.967.1 – Overview of broadband AN connection types

Connection type	Level	Configuration	Access types supported	Description
Type A	VP or VC	ptp or ptm	B-ISDN	Connections [under control of the Q3(AN) and Q3(SN) interfaces] between the UNI and the SN
Type B	VP or VC	ptp	–	Network internal connections [under control of the Q3(AN) and Q3(SN) interfaces] between AN and SN for the support of e.g. the RTMC function
Type D	VP or VC	ptp or ptm	Non B-ISDN	Connections [under control of the Q3(AN) and Q3(SN) interfaces] between a virtual user port and the SN
NOTE – In the SN, a broadband AN connection of type A or D may be either terminated or cross-connected. This depends on the service provided by the SN.				

The mapping between the service point of view and the access network point of view of broadband access network connections is provided in Table 3.

The two views of a broadband AN connection mentioned above differ in some cases, e.g.:

–   on-demand VC connections may be provided to the user via an AN which supports only VP connection and VP cross-connect functions, the VC connections being completely transparent to an AN;

–   a point-to-multipoint connection in the direction from the SN to several T_B reference points may have its replication functions in the SN and would then be considered in the AN to be a set of individual point-to-point connections;

–   a multipoint-to-point connection in the direction from several T_B reference points to the SN will at the AN be considered as a set of individual point-to-point connections.

Table 3/G.967.1 – Broadband Access Network connection type matrix

Broadband AN connection types		Services													
		(Semi-)permanent connections												Switched connections	
		User-to-user and User-to-SN connections				AN to SN connections		Support of NB access types	Support of other non-B-ISDN access types				User-to-user connections	Support of other non-B-ISDN access types	
		VP		VC		VP	VC	VC	VP (Note 1)		VC		VC	VC	
		ptp	ptm	ptp	ptm	ptp	ptp	ptp	ptp	ptm	ptp	ptm	ptp	ptp	ptm
A-VP (7.5.1.1)	ptp	x		x									x		
	ptm		x		x										
A-VC (7.5.1.2)	ptp			x											
	ptm				x										
B-VP (7.5.2)	ptp					x									
B-VC (7.5.2)	ptp						x								
D-VP (7.6.1)	ptp							x	x		x				x
	ptm									x		x			
D-VC (7.6.2)	ptp							x			x				
	ptm											x			

NOTE 1 – Only applicable to ATM based non-B-ISDN access types.

NOTE 2 – This table includes only those connection types which go across the VB5.1 reference point. User-to-AN connections are not included in this table.

NOTE 3 – Type C broadband access network connections are not applicable to the VB5.1 reference point.

NOTE 4 – Cell replication only in the AN support point-to-multipoint services is considered above. The possibility of replicating cells in the SN to achieve the same function to the user is not indicated.

NOTE 5 – Type B-VP connections can carry A-VC, B-VC and D-VC connections.

NOTE 6 – User signalling VCs are considered as point to point semi-permanent user-to-SN connections.

7.5   B-ISDN type broadband access network connections

7.5.1   Type A broadband access network connections

Type A broadband access network connections are established, released and maintained by provisioning (i.e. management plane functions) and support the application of connections where the access network provides connection point functions as defined in Recommendation I.311 [8].

7.5.1.1   Type A-VP broadband access network connection

Type A-VP broadband access network connections support the application of point-to-point (see Figure 21) and unidirectional point-to-multipoint (see Figure 22) VP links where the access network provides VP connection point functions (e.g. translation of VPI values).
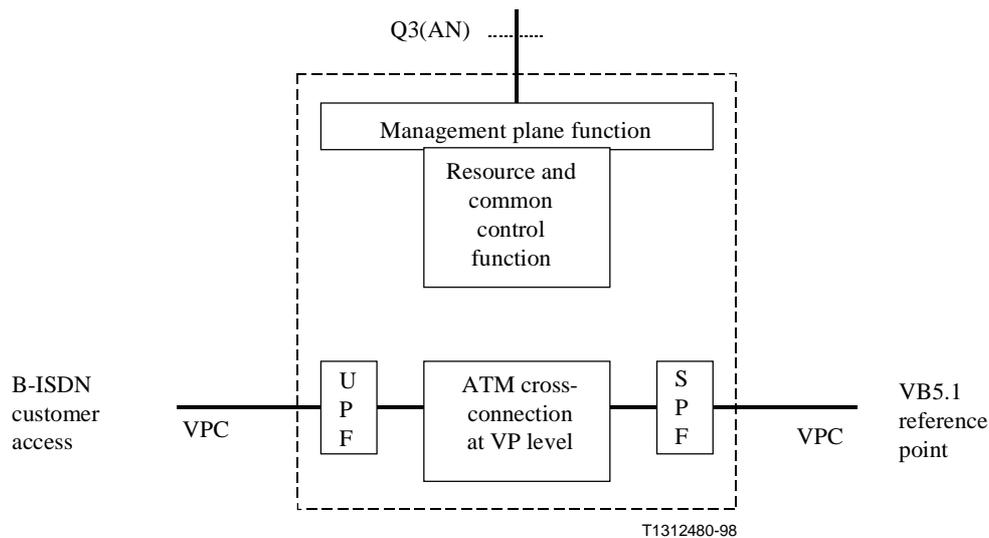
**Figure 21/G.967.1 – Type A-VP point-to-point
broadband access network connection**
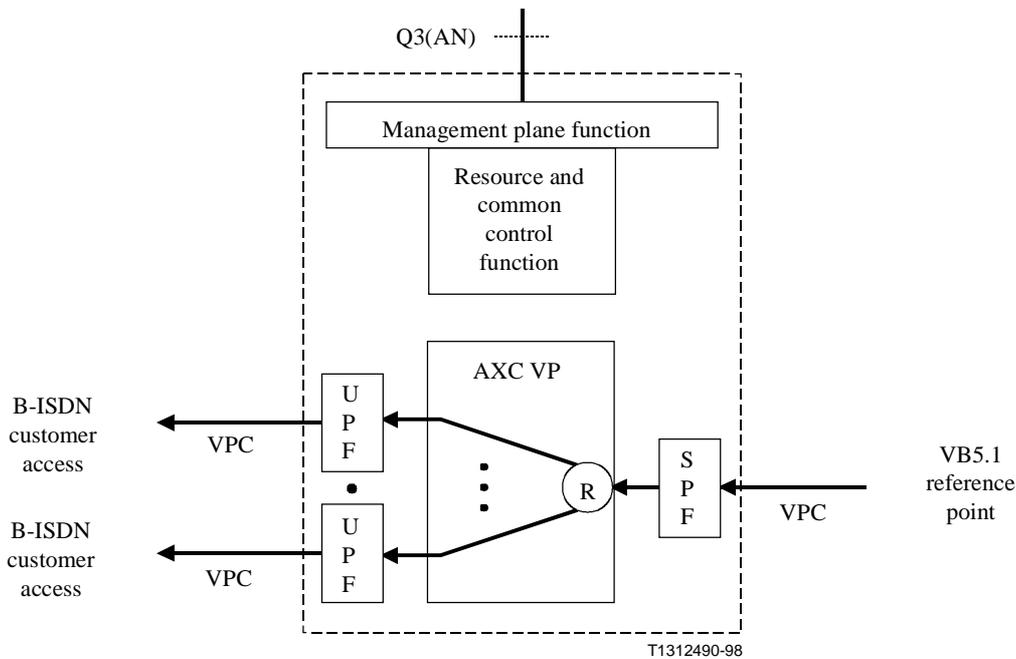
**Figure 22/G.967.1 – Type A-VP point-to-multipoint
broadband access network connection**

In addition to the VP connection point functions, the AN also provides the cell replication function.

7.5.1.1.1   Application of type A-VP ptp broadband AN connection

A scenario related to on-demand VCCs controlled by the SN is illustrated in Figure 23. This scenario consists of an AN providing VP cross-connect functionality and an SN providing broadband local exchange functions.
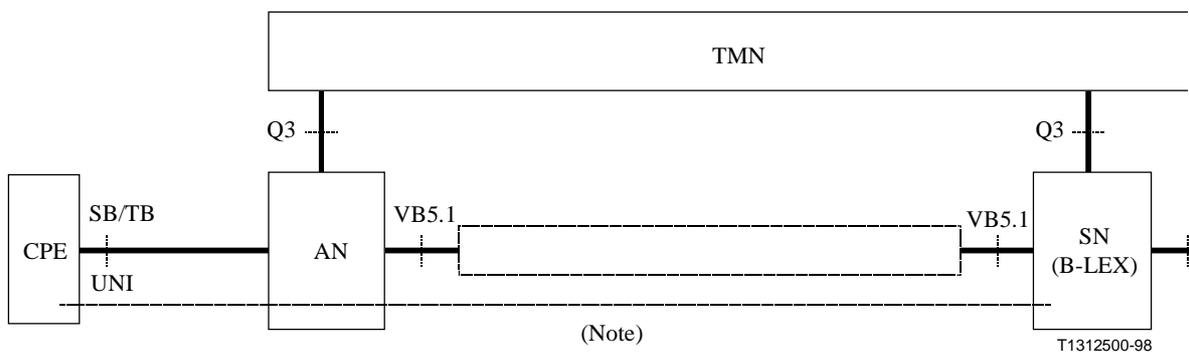
NOTE – Control plane communication (user-network signalling).

Figure 23/G.967.1 – Remote access via VB5.1 reference point to a "B-LEX" SN

An example for the handling of VPI and VPCI values of such a user-to-SN connection related to the configuration given in Figure 23 is illustrated in Figure 24.
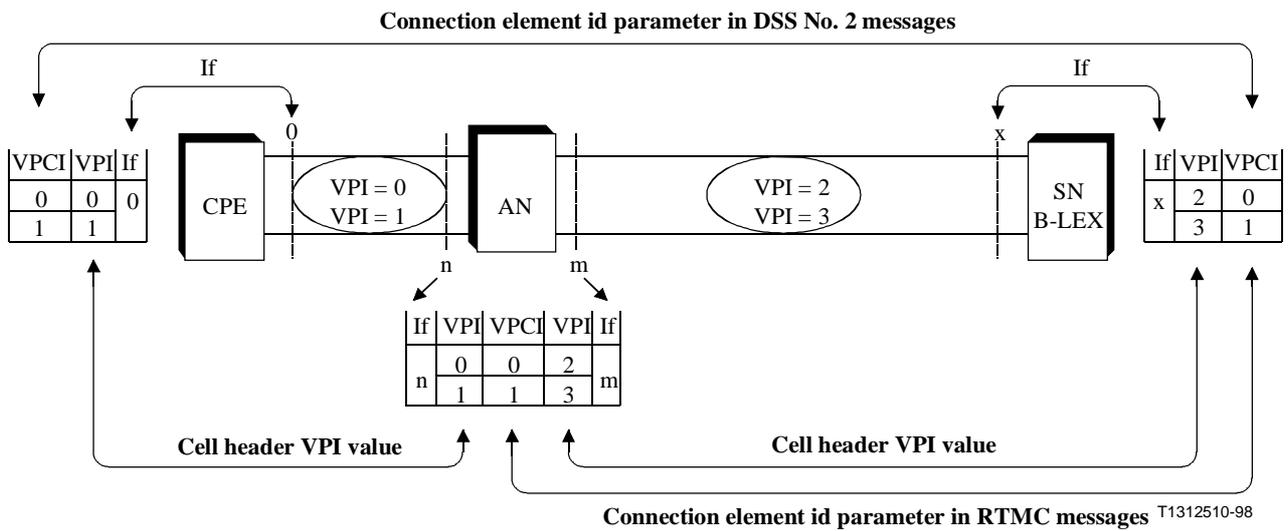
Figure 24/G.967.1 – Example for VPI and VPCI handling

NOTE 1 – The interface identifier If refers to a single physical interface (i.e. transmission convergence function).
NOTE 2 – The use of VCIs is not illustrated in this example.

Figure 24/G.967.1 – Example for VPI and VPCI handling

7.5.1.2   Type A-VC broadband access network connections

Type A-VC broadband access network connections support the application of point-to-point (see Figure 25) and unidirectional point-to-multipoint (see Figure 26) VC links where the access network provides VC connection point functions (e.g. translation of VCI values and re-assignment of VPI values).
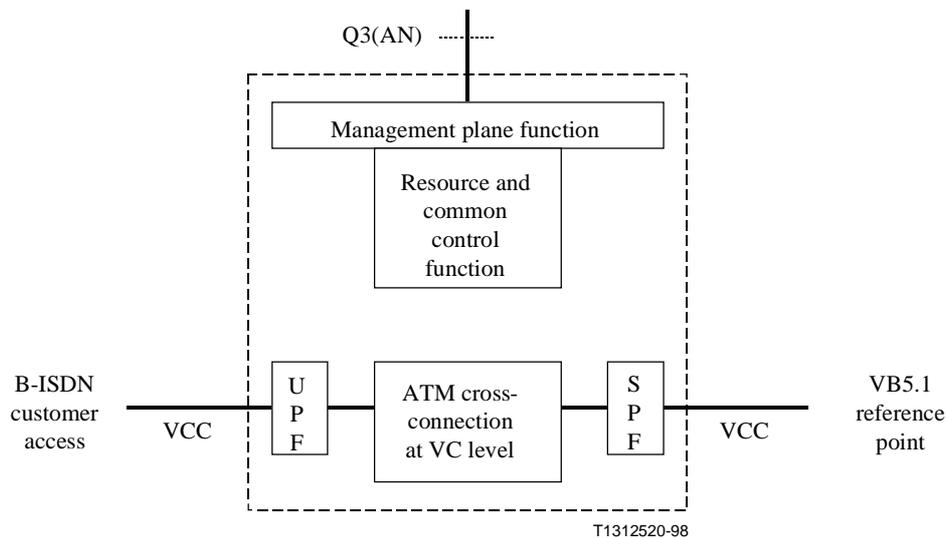
Figure 25/G.967.1 – Type A-VC ptp broadband access network connection
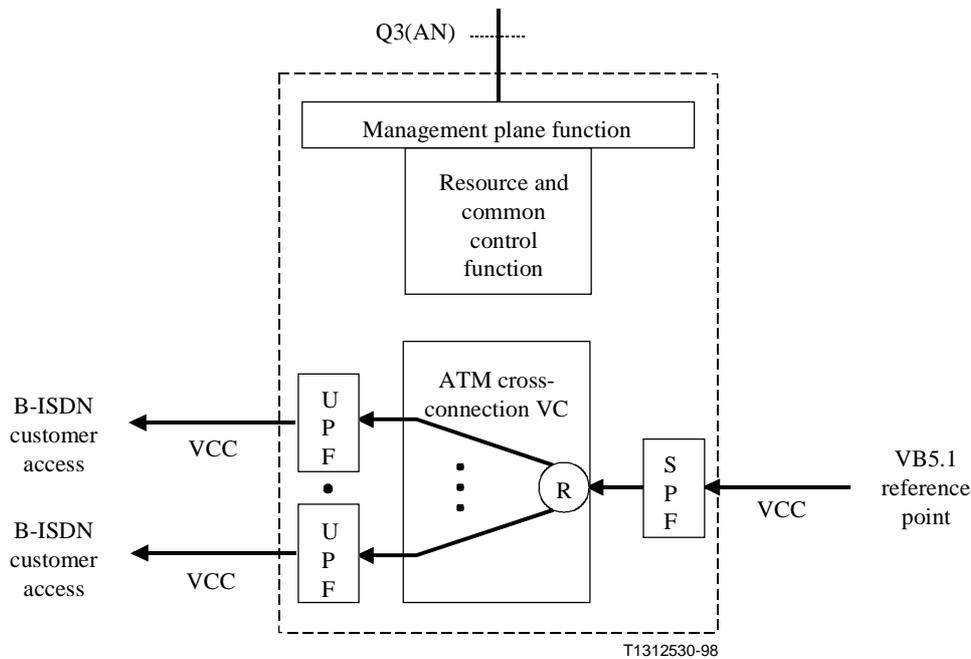
**Figure 26/G.967.1 – Type A-VC ptm broadband
access network connection**

In addition to the VC connection point functions, the AN also provides the cell replication function.

7.5.1.2.1   Application of type A-VC ptp broadband AN connection

A scenario related to (semi-)permanent VCCs provisioned between a user and an SN is illustrated in Figure 27. The scenario illustrated in Figure 27 consists of an AN and an SN which may provide higher layer services such as, for example, connectionless broadband data service.
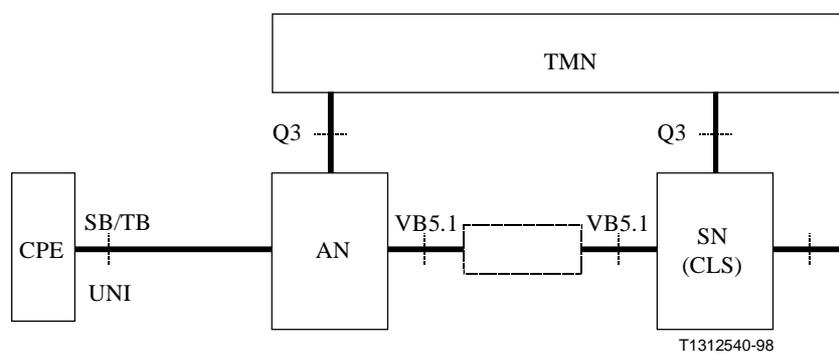
**Figure 27/G.967.1 – Remote access via VB5.1
reference point to a "CLS" SN**

An example for the handling of VPI and VPCI values of such a connection related to the configuration given in Figure 27 is illustrated in Figure 28.
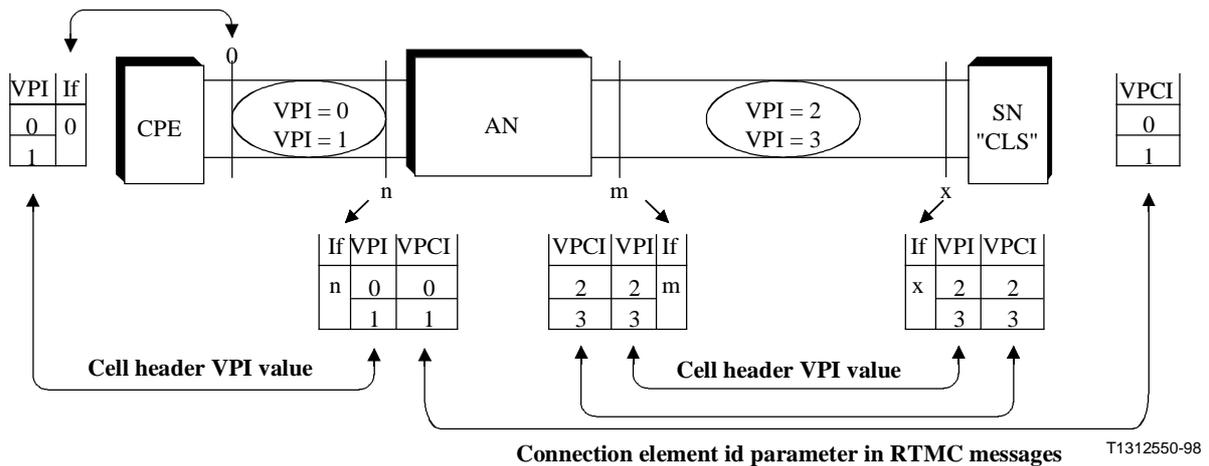
NOTE 1 – The interface identifier If refers to a single physical interface (i.e. transmission convergence function).
NOTE 2 – The use of VCIs is not illustrated in this example.

Figure 28/G.967.1 – Example for VPI and VPCI handling

7.5.2   Type B broadband access network connections

Type B broadband access network connections (see Figure 29) are established, released and maintained by provisioning (i.e. management plane functions) and support the application of both point-to-point VP connections (type B-VP) and point-to-point VC connections (type B-VC) where the access network and the service node provide connection end-point functions (i.e. termination of VPCs and VCCs, respectively) as defined in Recommendation I.311 [8].
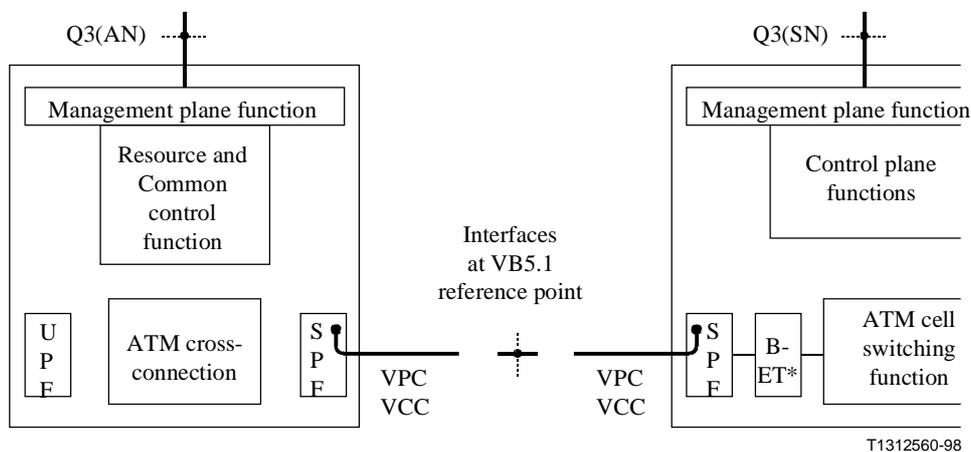
Figure 29/G.967.1 – Type B broadband access network connection

7.6   Non-B-ISDN type broadband access network connections (type D)

Type D broadband access network connections are established, released and maintained by provisioning (i.e. management plane functions) and support the application of connections between a circuit emulation function or a virtual user port and the VB5.1 reference point as defined in Recommendation I.311 [8].

7.6.1 Type D-VP broadband access network connection

Type D-VP broadband access network connections support the application of point-to-point and point-to-multipoint VP links where the access network provides VP connection point functions. In the case of non-ATM based accesses, the AN additionally provides VC and VP connection end-point functions (as part of the access adaptation functions).

7.6.2 Type D-VC broadband access network connection

Type D-VC broadband access network connections support the application of point-to-point and point-to-multipoint VC links where the access network provides VC connection point functions. In the case of non-ATM based accesses, the AN additionally provides VC connection end-point functions (as part of the access adaptation functions).

7.6.3 Application example of non-B-ISDN type broadband access network connections for the support of narrow-band access types

A specific application example of the non-B-ISDN type broadband access network connections is the support of narrow-band access types (see Figure 30). In this case, the access network connection (either of type D-VP ptp or of type D-VC ptp) provides the capability to transfer 2048 kbit/s bearer information between a narrow-band access network function on one side and a 64 kbit/s based local exchange on the other side.
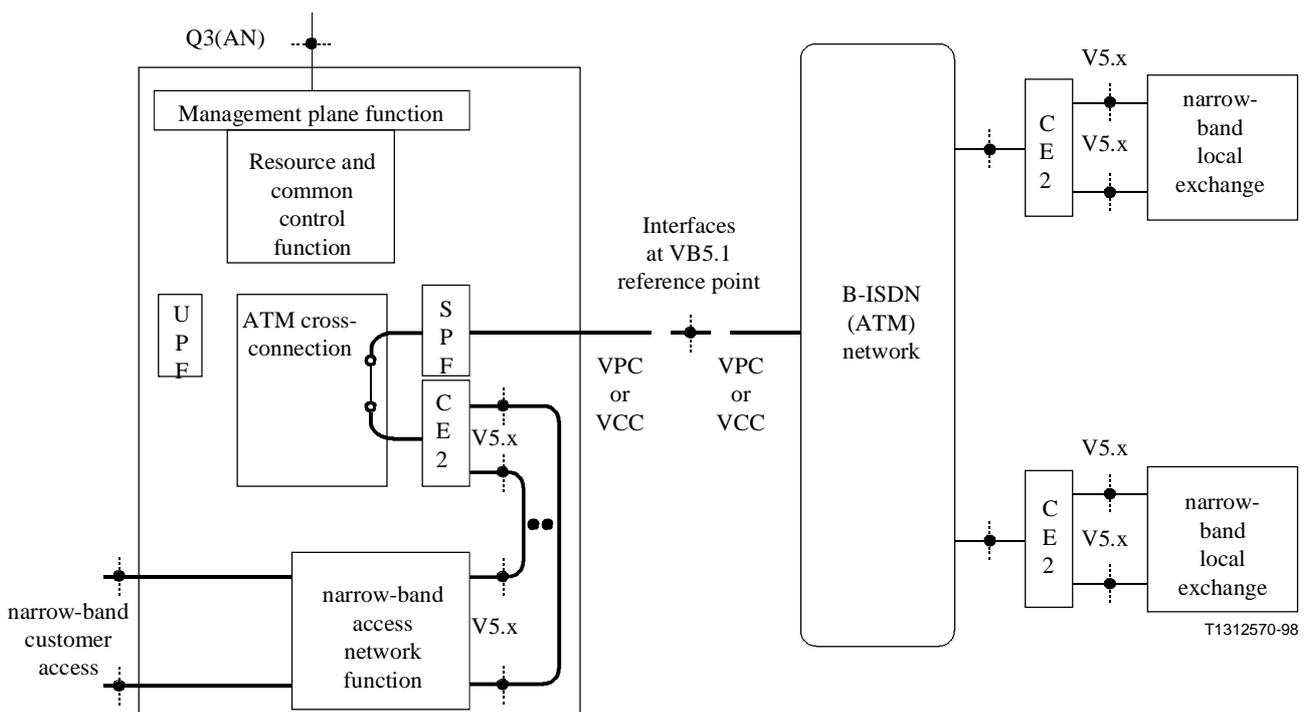
Figure 30/G.967.1 – Application example of non-B-ISDN type broadband access network connections

8   Non-B-ISDN access

8.1   General considerations

The broadband accesses defined under the general title of B-ISDN should become the predominant accesses to support telecommunications services at some point in the future. At present, the narrow-band accesses such as the access to the PSTN, ISDN-BA and ISDN-PRA are the predominant accesses for service offerings by telecommunications operators. There will be a need for an interim changeover period when broadband and narrow-band accesses coexist over the same Access Network infrastructure. In addition, other non-B-ISDN accesses will be supported by the Access Network.

The non-B-ISDN access types are split into two clearly defined subgroups: those supporting ATM as the only possible transport mode, and those which do not support ATM at all. The latter subgroup includes the narrow-band accesses. An access supporting a mix of ATM and non-ATM transport modes is not excluded (e.g. ATM and STM provided on a single physical access). The principles for ATM-based and non-ATM-based accesses shall be combined in such cases.

It is indicated that the VB5.1 reference point and associated functions are specified in a way that the AN is service independent. Therefore, the inclusion of service specific access types are not mandatory. Instead, they are considered as "plug-in" entities which rely on the service independent capabilities of the VB5.1 reference point and the associated AN.

Further, it is noted that non-B-ISDN accesses can also be supported by siting interworking/terminal adaptation functions on the customer side of the B-UNI.

The descriptions given in the next subclauses do not restrict any implementation strategy with respect to non-B-ISDN accesses.

8.2   ATM-based accesses

8.2.1   General approach

A number of interfaces, supporting the ATM layer, are currently being defined in order to provide cost-effective solutions to interconnect customer premises equipment to a broadband public network. It is likely that these interfaces will be supported in first implementations of broadband access networks, and should therefore be considered within the scope of this Recommendation.

It should be noted that it is possible that some of these accesses become part of B-ISDN as soon as the relevant standards are defined (e.g. within the UNI specification of the Recommendation I.432 series [19], [20], [21], [22], [23]). This is out of the scope of this Recommendation.

As a general principle, the support of these types of interfaces shall not impact the VB5.1 interface specifications as defined for B-ISDN accesses. In other words, all specifics related to these interfaces shall be hidden to the VB5.1 interface by additional functions within the AN.

The additional functions of the AN, to support ATM-based non-B-ISDN accesses, are referred to as "Access adaptation functions" (see Figure 31). Such functions may be necessary in the user plane and/or control plane and/or management plane. One or more Virtual User Ports (VUPs) may be introduced at the boundary of the access adaptation functions and the remaining ATM-based access network functions. The introduction of VUPs is required only if without them the characteristic information and protocols over the VB5.1 would be impacted.

Access adaptation functions may be introduced in any combination of user, control or management planes.

It is noted that the introduction of virtual user ports for the sake of adaptations in the management or control plane does not exclude the existence of Physical User Ports in the user plane.

A description along the line of the B-ISDN Protocol Reference Model is given in the following subclauses.
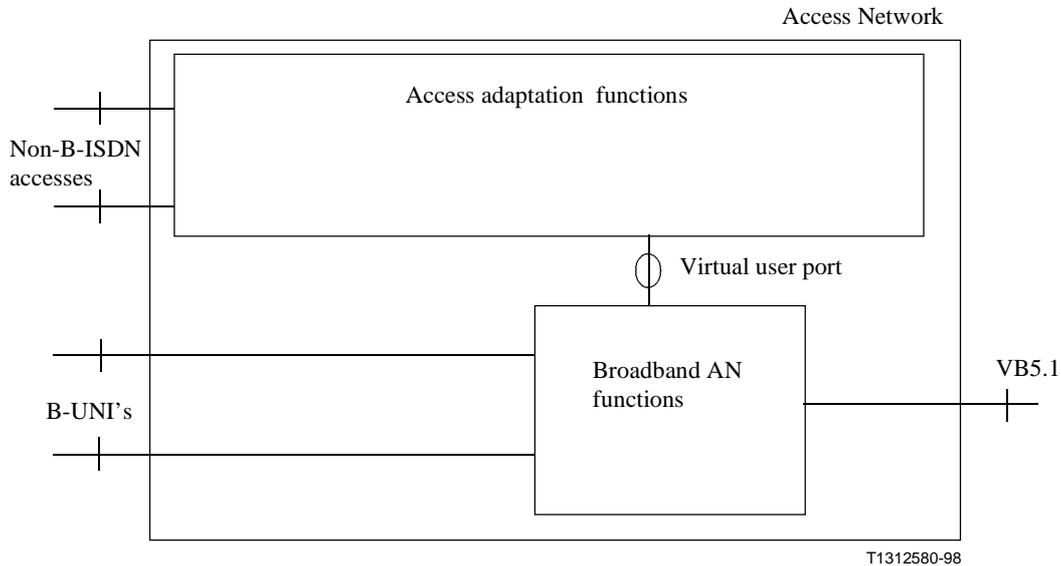
**Figure 31/G.967.1 – Generic model for
support of non-B-ISDN accesses**

8.2.2 User plane

If ATM, as described in Recommendations I.361 [13] and I.610 [24], is used on the non-B-ISDN ATM-based access, it shall have no additional impact on the VB5.1 reference point. The physical layer of the UNI is only known in the AN (i.e. not at the SN). In addition, no physical layer related information shall be conveyed across the VB5.1 reference point.

Deviation from the above shall be accommodated by the introduction of the appropriate ATM Adaptation Functions.

8.2.3 Control plane

The virtual channels supported on non-B-ISDN ATM based accesses shall be on-demand or semi-permanent.

On-demand VC connections are allocated either via B-ISDN user-network-signalling or by other means at the UNI. In order to comply with the control plane requirements (see 6.4.2) for VB5.1, the latter case requires access adaptation functions in the control plane. These access adaptation functions will then generate the B-ISDN user-to-network signalling.

The concept of the Virtual User Port can be used to support terminals at the CPE which do not have B-ISDN user-to-network signalling capabilities. Instead, such terminals could support dedicated signalling protocols which trigger the B-ISDN user-to-network signalling facility within the AN. This capability supports, for example proxy signalling agents within the AN.

For the support of semi-permanent VC connections, only management plane functions are involved.

8.2.4 Management plane

Access adaptation functions may be required as part of management plane procedures (e.g. conversion to B-ISDN meta-signalling).

The introduction of the virtual user port does not preclude that ATM-based non-B-ISDN access specifics are managed via the Q3(AN) interface. For example, the MIB of the AN should be extended if it is required to configure/monitor the physical layer of the UNI.

The establishment of a semi-permanent virtual channel connection, with one endpoint in the access adaptation functions, shall be possible via the Q3(AN). Cross-connections within the access adaptation function are outside the scope of this Recommendation.

Towards the CPE, a Local Management Interface (LMI) is optional as part of the AN (i.e. user port function). This is outside the scope of this Recommendation.

8.3 Non-ATM-based accesses

8.3.1 General approach

Non-ATM-based accesses need to be handled case by case to identify the functions within the AN supporting this access.

As a general principle, the support of these types of interfaces shall not impact the VB5.1 interface specifications. In other words, all specifics related to these interfaces shall be hidden to the VB5.1 interface by additional functions within the AN.

The additional functions of the AN, to support non-ATM, non-B-ISDN accesses, are referred to as "Access adaptation functions" (see Figure 31). Such functions will be required in the user plane. In addition, adaptation functions may be required for the control plane and/or the management plane.

A description along the lines of the B-ISDN Protocol Reference Model is given in the following subclauses.

8.3.1.1 User plane

The required functionality and associated protocol stack are depicted in Figure 32.

Compared to the case of a B-UNI access, a non-ATM-based access will require AAL functionality to be performed in the Access Network. This AAL shall be a standardized type. Other functionalities will depend on the type of the access and are referred to as "Specific Access Functions" (SAF) in Figure 32.

Figure 32 gives the general approach for treating non-ATM-based accesses. The SAF and associated AAL functionality, apart from the narrow-band access (see 8.3.2), is out of the scope of this Recommendation and should be covered by other standards.
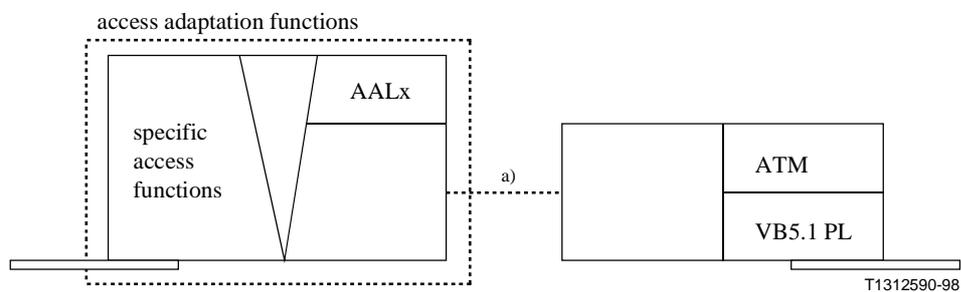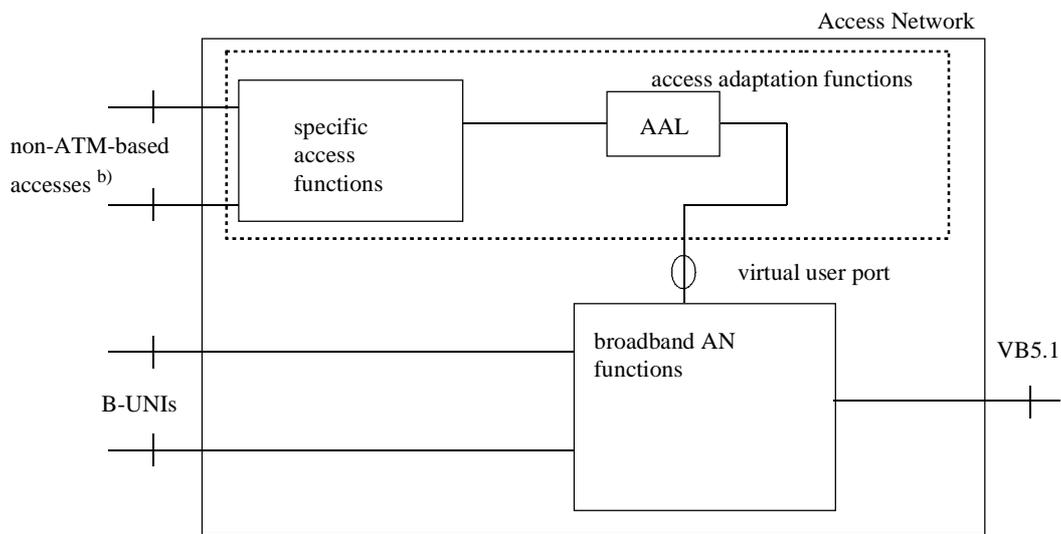
a) Internal reference point representing the virtual user port, which is assumed to be ATM based.

b) Including narrow-band accesses; these are further described in 8.3.2.

**Figure 32/G.967.1 – User plane functionality and
protocol stack for non-ATM-based accesses**

At the level of the VB5.1 interface, traffic from non-ATM-based accesses will be supported via virtual channels. The associated virtual channel connections are terminated within the access adaptation functions. The other connection termination point can be located in the SN or further on in the network.

Within the AN there may or may not exist a connection point for this virtual channel.

8.3.1.2 Control plane

The virtual channels supporting the user plane traffic from non-ATM-based accesses shall be on-demand or semi-permanent. For on-demand VC connections, B-ISDN user-to-network signalling will be required within the AN as part of the AAFs. The signalling originated in the AAF shall be treated as transparent data within the AN.

For semi-permanent VC connections, only management plane functions are involved.

8.3.1.3 Management plane

Access adaptation functions may be required as part of management plane procedures (e.g. conversion to B-ISDN meta-signalling).

The introduction of the virtual user port does not preclude that non-ATM-based non-B-ISDN access specifics are managed via the Q3(AN) interface. For example, the MIB of the AN should be extended for the AAL and the access specific functions.

The establishment of a semi-permanent virtual channel connection, with one endpoint in the access adaptation functions, shall be possible via the Q3(AN).

8.3.2 Analogue and 64 kbit/s based narrow-band accesses as supported by V5 interfaces

Narrow-band accesses as supported by the V5.1 and V5.2 interfaces are also supported by VB5.1. These will include analogue telephone access, ISDN basic access, ISDN primary rate access, and other analogue or digital accesses for semi-permanent connections without associated out-band signalling information.

8.3.2.1 Principles

Support of narrow-band accesses as supported by the V5.1 and V5.2 interfaces shall be provided by 2048 kbit/s circuit emulation of V5.1 and/or V5.2 links and/or V3 interfaces, each carried by different virtual channels across the VB5.1 interface.

Each V5.1 and/or V5.2 and/or V3 interface carried over a VB5.1 interface shall contain the full set of protocols as defined in the relevant V5/V3 interface specifications including the frame format according to Recommendation G.704 [2], but with the exception of the physical medium. The physical layer may or may not be reproduced in order to terminate the narrow-band streams in a defined manner, inside the AN or SN.

NOTE – The application of OAM flows at the circuit emulation function (e.g. insertion of AIS signals in case of failure detection) has yet to be defined in relevant specifications.

The circuit emulation principle follows the general approach for non-ATM-based accesses as defined above. The AAF includes the narrow-band AN functionality, including management, control and user plane functions. A single AAF may cover multiple narrow-band accesses.

Further specifics for narrow-band accesses are:

a) Circuit emulation is performed by applying standard AAL1 functions as specified in 8.3.2.2.

b) The ATM layer connection characteristics for the support of circuit emulation information are given in 8.3.2.3.

c) For the PRA, two alternatives exist:
   – transport via a V5.2 circuit emulation;
   – transport via V3 circuit emulation.

d) Digital accesses used for semi-permanent connections without associated out-band signalling shall be handled as NB access or as other non-B-ISDN, non-ATM based access (see 8.3.3).

e) Analogue accesses, either used as access to the PSTN or used for semi-permanent connections, shall always be handled as NB accesses.

f) Other means for transporting data originating from NB accesses across the VB5.1 are outside the scope of this Recommendation (e.g. circuit emulation of a BA).

g) Configuration, fault and performance management of the circuit emulation function shall be possible via the Q3(AN).

8.3.2.2 AAL for 2048 kbit/s circuit emulation

The AAL type 1 "unstructured mode" according to Recommendation I.363.1 [14] shall be applied for emulation of 2048 kbit/s streams (i.e. V5.1 and/or V5.2 links and/or V3 interfaces). For the AAL

type 1 protocol, the parameters provided in II.1.2/I.363.1 [14] (case of synchronous transport) shall be used:

CBR rate at AAL service boundary:	2048 kbit/s
Source clock frequency recovery:	synchronous
Error correction mode:	not used
Error status indication at receiver:	not used
Pointer:	not used
Partially cell fill method:	not used

8.3.2.3 Connection characteristics for circuit emulation

The broadband access network connection type shall be of type D-VP or D-VC. The attribute values are:

Broadband Connection Oriented Bearer Service sub-category:	A
Information transfer rate:	2048 kbit/s, augmented with AAL1 overhead and OAM cell rate
Establishment of communication:	(semi-)permanent
Channel:	VCC
Symmetry:	symmetric bidirectional
Communication configuration:	point-to-point

8.3.3 Other non-ATM-based non-B-ISDN accesses

The general approach shall be applied. A virtual user port shall be introduced to support one or more accesses.

This category may include the support of narrow-band accesses handled by using e.g. AAL2 [15]. The impact of this on the VB5.1 protocol is for further study.

The specifications of the "Specific access functions" and "AAL" functions are outside the scope of this Recommendation.

9 Transfer and layer management functions

This clause covers the definition of the transfer and layer management functions to support services and includes a specification of a functional model of remote access arrangements with VB5.1 reference point.

This specification does not preclude the realization of further transfer functions (e.g. additional cross-connections) within the AN. However, the behaviour from the UNI to the SNI is normative within this Recommendation, i.e. from an SNI point of view a remote access arrangement with VB5.1 reference point shall behave as if the functions in this clause were implemented.

9.1 General functional architecture

In Figure 33 the application of the functional architecture for a general ATM network element as defined in Recommendation I.731 [25] to remote access arrangements with VB5.1 reference point is

illustrated. It is based on the B-ISDN Protocol Reference Model described in Recommendation I.321 [9].

This divides the AN into functional areas as follows:

a) *Transfer functions*

Transfer functions are mainly related to the lower layers of the B-ISDN Protocol Reference Model (i.e. physical and ATM layer) and include all functions required for the transport of user, signalling, OAM and resource management information. The transfer functions are common for all higher layer services in B-ISDN.

ATM adaptation layer functions are considered as part of the transfer functions and are required to enable higher layer protocols (i.e. RTMC protocol) to use the service-independent ATM layer.

AAL functions in the AN are also required to provide for the transport of information from (non-ATM-based) non-B-ISDN access types across the VB5.1 reference point.

b) *Layer management functions*

Management information associated with a given transfer layer function is passed to (or received from) the corresponding layer management functions, e.g. for processing of configuration, fault monitoring, performance monitoring, UPC/NPC. Configuration, performance, fault and accounting information may be passed to plane management for further processing and/or communication to external network management entities and/or operating systems. Layer management functional blocks correspond one-to-one with transfer functional blocks.

c) *Plane management functions*

Plane management deals with the set of functions applicable to management of the network element as a whole or those functions related to the relationships with management systems external to the network element. It includes coordination between layer management entities.

Plane management includes the VB5.1 system. The VB5.1 system is responsible for the real-time coordination between AN and SN across the VB5.1 reference point. Requirements for real-time coordination are described in clause 11, structure and architecture of the VB5.1 system are specified in clause 13.

Within this Recommendation only those aspects of plane management are described which are not specified in the Recommendations on management interfaces associated with the VB5.1 reference point (as developed by ITU-T Study Group 4).

d) *Timing functions*

These functions deal with the actions required to synchronize the equipment interfaces, either ATM-based interfaces or non-ATM interfaces, to a clock source (e.g. network, external or internal).

Q3(AN)

Plane management

VB5.1 system

Note

Transfer functions

Layer management functions

SAAL — ATM adaptation LME

SAP

ATM virtual channel (VC) — VC LME

ATM virtual path (VP) — VP LME

Transmission path (TP) — TP LME

Section/path adaptation and other lower layer functions — lower LME

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Non-B-ISDN accesses

B-ISDN accesses

VB5.1 reference points

Timing block
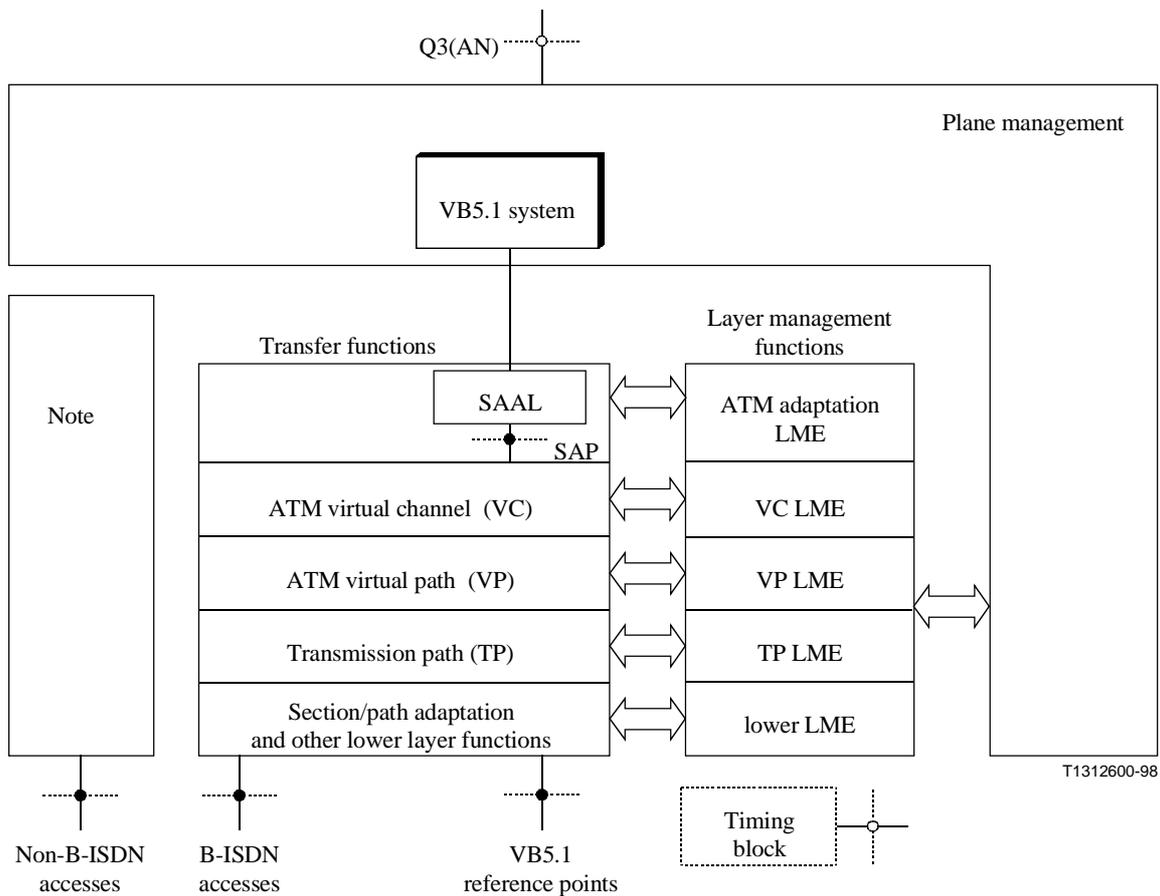
NOTE – Access adaptation functions to support non-B-ISDN access types. For specific non-B-ISDN access types, these functions include AAL functions.

Figure 33/G.967.1 – General functional architecture of the AN

9.2 Functional architecture of transfer and layer management functions

The general functional architecture of the transfer functions within the AN and SN are illustrated in Figure 34. This illustration is based on the Protocol Reference Model representation as given in Recommendation I.732 [26].

This functional description concentrates on the "edge functions" of the AN and SN in order to ensure interoperability with other equipment (e.g. customer premises equipment or transport network equipment).

PSP Physical Service Port VCCT Virtual Channel Connection Termination
PUP Physical User Port VCE Virtual Channel Entity
LSP Logical Service Port VCME Virtual Channel Multiplex Entity
LUP Logical User Port VPCT Virtual Path Connection Termination
VUP Virtual User Port VPE Virtual Path Entity
AAF Access Adaptation Function VPME Virtual Path Multiplex Entity
TM/TP Transmission Media/Path

NOTE – The ATM connection function, used in conjunction with the VUP, is provided for modelling purposes and may not necessarily exist in practice.

**Figure 34/G.967.1 – Functional architecture of transfer
functions in remote access arrangements**

9.3 Transfer functions required for individual broadband AN connection types

In Table 4 the subset of transfer (and layer management) functions required to support a specific broadband AN connection type (see clause 7) is identified.

Table 4/G.967.1 – Transfer functions for broadband AN connection types

Connection type (Note)	User port side	Connection function	Service port side
B-ISDN connection types			
Type A-VP connections	VPE VPME TM/TP layer	VP connection entity	VPE VPME TM/TP layer
Type A-VC connections	VCE VCME VPCT VPE VPME TM/TP layer	VC connection entity	VCE VCME VPCT VPE VPME TM/TP layer
Type B-VP connections			VPCT VPE VPME TM/TP layer
Type B-VC connections			VCCT VCE VCME VPCT VPE VPME TM/TP layer
Non-B-ISDN connection types			
Type D-VP connections	VPE VUP/AAF	VP connection entity	VPE VPME TM/TP layer
Type D-VC connections	VCE VCME VPCT VPE VUP/AAF	VC connection entity	VCE VCME VPCT VPE VPME TM/TP layer
NOTE – Specifications for transfer and layer management functions for connections with point-to-multipoint configuration are still under study within ITU-T. The impact of these specifications on the functions required for the broadband AN connection types will have to be investigated.			

9.4 Functions associated with the physical user port

Within this subclause the functions at the physical user port of ANs are defined. The mapping between the general modelling concept for user ports specified in clause 5 and the B-ISDN Protocol Reference Model of functions at the physical user port is illustrated in Figure 34.

The physical user port provides the following functionality:

a) section/path adaptation, section termination and lower layer functions (e.g. physical medium dependent functions);

b) Transmission Path Termination (TP-T) function;

c) Virtual Path Multiplex Entity (VPME).

A list of the transfer and layer management functions associated with the PUP including references to the relevant ITU-T Recommendations is given in Table 5.

Table 5/G.967.1 – Transfer and layer management functions associated with PUP

Function	Specification
Section/path adaptation and lower layer functions	Recommendation I.432.2 (SDH-based and cell-based interfaces) Recommendation I.432.3 (PDH-based interfaces) Recommendation I.432.4 (51 840 kbit/s interface) Recommendation I.432.5 (25 600 kbit/s interface)
Transmission path termination	Recommendation I.432.2 (SDH-based and cell-based interfaces) Recommendation I.432.3 (PDH-based interfaces) Recommendation I.432.4 (51 840 kbit/s interface) Recommendation I.432.5 (25 600 kbit/s interface)
VP multiplex entity (direction from TB) – Mapping – Cell delineation, scrambling, HEC processing – Cell rate decoupling – TP usage measurement – Cell header verification – Generic Flow Control (GFC) (Note) – VPI verification, congestion control – VP demultiplexing	5.3.1/I.732
VP multiplex entity (direction to TB) – VP multiplexing, congestion control – Generic Flow Control (GFC) (Note) – TP usage measurement – Cell rate decoupling – HEC processing, scrambling, cell stream mapping	5.3.2/I.732
NOTE – Only the "uncontrolled transmission" set of procedures is implemented where the GFC is ignored (see 3.4.4/I.150. The GFC field in assigned cells is set to "0 0 0 0".	

9.5 Functions associated with the logical user port

Within this subclause the functions at and on top of the logical user port of ANs are defined. These functions are divided into ATM VP sublayer and ATM VC sublayer functions as illustrated in Figure 34.

9.5.1 ATM virtual path sublayer functions at the LUP

The ATM VP sublayer at the logical user port provides the Virtual Path Entity (VPE) function which includes all functions that are performed per individual VP, e.g. usage parameter control (VP), processing of segment F4 OAM flows. There is one instance of these functional blocks per VP.

9.5.2 ATM virtual channel sublayer functions on top of the LUP

The ATM VC sublayer on top of the logical user port provides the following functionalities:

a) *Virtual Path Connection Termination (VPCT)*

    Performs functions devoted to VP connection endpoints.

b) *Virtual Channel Multiplexing Entity (VCME)*

    Includes functions that are common to all VCs (e.g. multiplexing/demultiplexing of VCs).

c) *Virtual Channel Entity (VCE)*

    Includes all functions that are performed per individual VC, e.g. usage parameter control (VC), processing of segment F5 OAM flows. There is one instance of these functional blocks per VC.

A list of the transfer and layer management functions associated with and on top of the LUP including references to the relevant ITU-T Recommendations is given in Tables 6 and 7.

Table 6/G.967.1 – VP sublayer functions associated with LUP

Function	Specification
Functions at virtual path sublayer	
VP entity (direction from TB) – VP usage measurement – VP UPC (Note 1) – Traffic shaping (for further study) – F4 OAM non-intrusive monitoring – Resource management (Note 2) – F4 OAM cell insertion/extraction and processing	5.4.1/I.732
VP entity (direction to TB) – F4 OAM cell insertion/extraction and processing – Resource management (Note 2) – F4 OAM non-intrusive monitoring – VP usage measurement – EFCI setting, VPI setting	5.4.2/I.732
NOTE 1 – VP UPC shall be performed as described in Annex B. NOTE 2 – The specification of this function is still for further study within Recommendation I.732. Its impact on the VB5.1 reference point will have to be investigated.	

Table 7/G.967.1 – VC sublayer functions on top of the LUP

Function	Specification
Functions at virtual channel sublayer **(only for broadband AN connections of type A-VC and type D-VC)**	
VP connection termination (direction from TB) – End-to-end F4 OAM cell extraction and processing	5.6.1/I.732
VP connection termination (direction to TB) – End-to-end F4 OAM cell insertion	5.6.2/I.732
VC multiplex entity (direction from TB) – VCI verification and invalid cell discard – Congestion control, VC demultiplexing – Meta-signalling (Note 1)	5.7.1/I.732
VC multiplex entity (direction to TB) – VC multiplexing, congestion control – Meta-signalling (Note 1)	5.7.2/I.732
VC entity (direction from TB) – VC usage measurement – Traffic shaping (for further study) – F5 OAM non-intrusive monitoring – F5 OAM cell insertion/extraction and processing – VC UPC (Note 2) – Resource management (Note 3)	5.8.1/I.732
VC entity (direction to TB) – F5 OAM cell insertion/extraction and processing – F5 OAM non-intrusive monitoring – VC usage measurement – EFCI setting, VCI setting – Resource management (Note 3)	5.8.2/I.732
NOTE 1 – The AN is transparent for meta-signalling, i.e. no specific actions required. NOTE 2 – VC UPC shall be performed as described in Annex B. NOTE 3 – The specification of this function is still for further study within Recommendation I.732. Its impact on the VB5.1 reference point will have to be investigated.	

9.6 Functions associated with the adaptation of non-B-ISDN access types

9.6.1 Functions for the support of narrow-band accesses as supported by V5 interfaces

See 8.3.2.

9.6.2 Functions for the support of other non-B-ISDN access types

The access adaptation functions to enable to the support of other non-B-ISDN access types (either ATM-based or non-ATM-based) are outside the scope of this Recommendation.

9.7 Connection functions

Connection functions in the AN exist at the VP and/or the VC sublayer:

a)   *VP connection entity*

Includes functions for assigning VP links at service ports to VP links at user ports.

b)   *VC connection entity*

      Includes functions for assigning VC links at service ports to VC links at user ports.

The connection functions are specified in Table 8.

Table 8/G.967.1 – Connection functions

Function	Specification
VP connection entity – VP link interconnection (Note 1)	5.5/I.732
VC connection entity – VC link interconnection (Note 2)	5.9/I.732
NOTE 1 – Only for broadband AN connections of type A-VP and type D-VP. NOTE 2 – Only for broadband AN connections of type A-VC and type D-VC.	

9.8   Functions associated with the physical service port

Within this subclause the functions at the physical service port of the AN and the SN are defined. The mapping between the general modelling concept for service ports specified in clause 5 and the B-ISDN Protocol Reference Model of functions at the physical service port is illustrated in Figure 34.

The physical service port provides the following functionalities:

a)   section/path adaptation, section termination and lower layer functions (e.g. physical medium dependent functions).

b)   Transmission Path Termination (TP-T) function;

c)   Virtual Path Multiplex Entity (VPME) function.

A list of the transfer and layer management functions associated with the PSP including references to the relevant ITU-T Recommendations is given in Table 9.

Table 9/G.967.1 – Transfer and layer management functions associated with PSP

Function	Specification
Section/path adaptation and lower layer functions	(Note 1)
Transmission path termination	(Note 1)
VP multiplex entity (direction from VB5) (Note 2) – Mapping – Cell delineation, scrambling, HEC processing – Cell rate decoupling – TP usage measurement – Cell header verification – VPI verification, congestion control – VP demultiplexing	5.3.1/I.732
VP multiplex entity (direction to VB5) (Note 2) – VP multiplexing, congestion control – TP usage measurement – Cell rate decoupling – HEC processing, scrambling, cell stream mapping	5.3.2/I.732
NOTE 1 – Physical layer principles are described in clause 6. NOTE 2 – These functions shall be performed when a physical interface at the VB5.1 reference point is implemented.	

9.9   Functions associated with the logical service port

Within this subclause the functions at and on top of the logical service port of ANs are defined. These functions are divided into ATM VP sublayer and ATM VC sublayer functions as illustrated in Figure 34.

9.9.1   ATM virtual path sublayer functions at the LSP

The ATM VP sublayer at the logical service port provides the following functionality:

–   *Virtual Path Entity (VPE)*

   Includes all functions that are performed per individual VP. There is one instance of these functional block per VP.

9.9.2   ATM virtual channel sublayer functions on top of the LSP

The ATM VC sublayer on top of the logical service port provides the following functionalities:

a)   *Virtual Path Connection Termination (VPCT)*

   Performs functions devoted to VPC endpoints.

b)   *Virtual Channel Multiplexing Entity (VCME)*

   Includes functions that are common to all VCs.

c)   *Virtual Channel Entity (VCE)*

   Includes all functions that are performed per individual VC.

d)   *Virtual Channel Connection Termination (VCCT)*

   Performs functions devoted to VCC endpoints.

Adaptation functions (i.e. SAAL functions) on top of the logical service port are described in clause 13.

A list of the transfer and layer management functions at and on top of the LSP including references to the relevant ITU-T Recommendations is given in Table 10 (VP sublayer functions at AN and SN side) and Table 11 (VC sublayer functions at AN side).

For the AN to SN connection(s) carrying the RTMC protocol (i.e. broadband AN connection of type B-VC) the specification given in Table 11 also apply to the LSP at the SN side.

Table 10/G.967.1 – VP sublayer functions associated with LSP at AN and SN side

Function	Specification
Functions at virtual path sublayer	
VP entity (direction from VB5) – VP usage measurement – VP NPC (Note 1) – Traffic shaping (for further study) – F4 OAM non-intrusive monitoring – Resource management (Note 2) – F4 OAM cell insertion/extraction and processing	5.4.1/I.732
VP entity (direction to VB5) – F4 OAM cell insertion/extraction and processing – Resource management (Note 2) – F4 OAM non-intrusive monitoring – VP usage measurement – EFCI setting – VPI setting	5.4.2/I.732
NOTE 1 – The application of VP NPC is a network operator option. NOTE 2 – The specification of this function is still for further study within Recommendation I.732. Its impact on the VB5.1 reference point will have to be investigated.	

Table 11/G.967.1 – VC sublayer functions on top of LSP at AN side

Function	Specification
Functions at virtual channel sublayer **(only for broadband AN connections of type A-VC, type B-VC and type D-VC)**	
VP connection termination (direction from VB5) – End-to-end F4 OAM cell extraction and processing	5.6.1/I.732
VP connection termination (direction to VB5) – End-to-end F4 OAM cell insertion	5.6.2/I.732
VC multiplex entity (direction from VB5) – VCI verification and invalid cell discard – Congestion control – VC demultiplexing – Meta-signalling (Note 1)	5.7.1/I.732
VC multiplex entity (direction to VB5) – VC multiplexing – Congestion control – Meta-signalling (Note 1)	5.7.2/I.732
VC entity (direction from VB5) – VC usage measurement – Traffic shaping (for further study) – F5 OAM non-intrusive monitoring – F5 OAM cell insertion/extraction and processing – VC NPC (Note 2) – Resource management (Note 3)	5.8.1/I.732

Function	Specification
Functions at virtual channel sublayer **(only for broadband AN connections of type A-VC, type B-VC and type D-VC)**	
VC entity (direction to VB5) – F5 OAM cell insertion/extraction and processing – F5 OAM non-intrusive monitoring – VC usage measurement – EFCI setting – VCI setting – Resource management (Note 3)	5.8.2/I.732
VC connection termination (direction from VB5) – End-to-end F5 OAM extraction and processing (Note 4)	5.10.1/I.732
VC connection termination (direction to VB5) – End-to-end F5 OAM insertion (Note 4)	5.10.2/I.732
NOTE 1 – The AN is transparent for meta-signalling information, i.e. no specific actions are required. NOTE 2 – The application of VC NPC is a network operator option. NOTE 3 – The specification of this function is still for further study within Recommendation I.732. Its impact on the VB5.1 reference point will have to be investigated. NOTE 4 – Only for broadband AN connections of type B-VC at VC level.	

10 Provisioning principles and requirements

10.1 General

Provisioning is one of a number of aspects related to management plane functions. It has been separated from other management plane requirements because provisioning shall be performed through the Q3 interfaces of the AN and the SN and is therefore not directly relevant to the VB5.1 interface specification. Only those provisioning aspects having at least conceptual or indirect implication to the interface definition are defined below.

10.2 Principles

This subclause defines the provisioning principles and requirements related to the VB5.1 reference point.

a)   All data for provisioning, including modification and cessation, shall be handled by the relevant Q3 interface, i.e. Q3(AN) and Q3(SN). Data for provisioning shall be consistent with the splitting of management plane functionality between the SN and the AN, as specified in clause 11. For example, parameters related to physical user ports have to be available in the AN, whereas parameters related to the signalling standard applied at the UNI have to be available in the SN.

b)   All data related to a VUP and associated access adaptation functions are outside the scope of this Recommendation. This, however, does not preclude provisioning in the AN. A VUP is not known in the SN except through its associated LUPs and VP/VC connections.

c)   VPCs shall be established on a (semi-)permanent basis in the AN and the SN, i.e. by provisioning.

d)   The association of a VP link at the UNI or VUP to an LUP shall be provisioned in the AN and SN independently of the transmission path.

e)   The association of a VP link at the interface at the VB5.1 reference point to an LSP shall be provisioned in the AN and SN independently of the transmission path.

f)   The association of a VPCI to a VPC shall be provisioned in the AN and SN. The VPCI allocated to a given VPC shall allow a unique identification of that VPC with regard to the RTMC protocol (e.g. unique within an LUP).

g)   The Access Network shall support the provisioning of VP and/or VC cross-connectivity functions:

–   In case of a VP cross-connection in the AN, the association of a VP link at the UNI or VUP to a VP link at the VB5.1 reference point shall be provisioned in the AN.

–   In case of a VC cross-connection in the AN, the association of a VPC/VCL at the UNI or VUP to a VPC/VCL at the VB5.1 reference point shall be provisioned in the AN.

h)   *Provisioning of VCC to support the RTMC protocol*

In order to support the RTMC protocol, a particular VPC as well as a particular VCC within that VPC shall be provisioned at the VB5.1 reference point. There shall be no possibility of the RTMC protocol performance being compromised by the transport of other multiplexed traffic at the VB5.1 reference point.

The VPI value shall be in the range of 0 up to 4095; the VCI value shall be in the range of 32 up to 65 535.

i)   A single AN may have multiple VB5.1 interfaces. The association of an LUP to a VB5.1 interface, i.e. an LSP, shall be performed via provisioning in the AN and SN.

j)   The AN may support ports and services which are not associated to the VB5.1 interface. These ports and services shall not impact the operability of ports associated with the VB5.1 interface.

k)   Provisioning includes any installation testing of the AN carried out prior to its connection to the SN. AN testing shall be initiated by the Q3 interface and can be used to check the AN during this phase.

l)   For all managed entities which have to be provisioned in the AN and the SN in a coordinated way, and which support an administrative state, the following requirements with regard to the creation and deletion of instances of such entities apply:

–   When creating an instance either in the AN or in the SN, the administrative state shall be set to locked via the respective Q3 interface, by an Operations System.

–   Prior to deleting an instance in either the AN or in the SN, the administrative state shall be first set to locked via the respective Q3 interface, by an Operations System.

The management information models and Q3 specifications necessary to manage SN and AN are based on existing information models and Q3 specifications for ATM network elements (Recommendation I.751). VB5.1 specific information models to manage VB5.1 interfaces and ANs and SNs interconnected via VB5.1 interfaces are specified in Recommendation Q.832.1 [33].

11   Requirements for real-time coordination between AN and SN

This clause defines the requirements for real-time coordination between the AN and the SN across the VB5.1 reference point.

11.1 Principles and requirements for real-time management coordination (RTMC)

11.1.1 General principles for RTMC

The requirements for RTMC between the AN and the SN across the VB5.1 reference point are based on the principles given below:

a) The SN shall be able to determine whether in principle it is possible to offer service to a user, or not. Therefore the AN shall inform the SN about changes of the availability of resources inside the AN. The availability of this information in the SN is time-critical and requires real-time coordination between the AN and the SN (refer to Recommendation G.902 [3]).

   The relevant AN resources with regard to the service provision capability are given below:

   – physical user port;
   – physical service port;
   – logical service port (i.e. complete VB5.1 reference point);
   – VPC.

   With regard to RTMC, the logical user port in the AN is only a naming convention.

   The SN shall be informed whether the unavailability of the relevant AN resource(s) is due to administrative actions taken by the AN operator is due to faults.

b) There is no requirement that the SN informs the AN about the availability of resources inside the SN.

c) It shall be possible to perform service level tests from the AN while the user information flow for on-demand connections is excluded.

d) It shall be possible to verify the correct allocation of a VPCI to a VPC at the VB5.1 reference point.

e) The RTMC function shall allow a re-synchronization of the status of resources in the AN and the SN.

f) There shall be no possibility of the RTMC protocol performance being compromised by the transport of other multiplexed traffic at the SNI.

11.1.2 RTMC requirements related to administrative actions

11.1.2.1 General

a) Management services may change the availability of resources inside the AN or the SN from an administrative point of view. The administrative state of resources may be changed by means other than Q3 interfaces (e.g. craft terminals).

   The administrative events which shall be supported by the managed entity corresponding to a specific AN resource and which require RTMC between the AN and the SN are summarized in Table 12 and described in 11.1.2.2 and 11.1.2.3.

b) The RTMC function shall facilitate the coordination of the required status information between the AN and the SN so that in the case of a specific event at a managed entity of the AN, the following information relevant to the service is available at the SN:

   1) resources which are affected from an SN point of view;
   2) the status of these resource(s) with regard to availability at the AN:
      – Available (from an administrative point of view);
      – Not available for switched connections, but test calls allowed;

–   Unavailable due to an administrative event:

Either the resource itself or another resource which it depends on has been administratively prohibited from use.

c)   The SN operator may change administrative states of VB5.1 specific entities in the SN. However, this has no impact on the RTMC requirements since it is not required that the SN informs the AN about any state change resulting from such an action.

d)   If an AN resource becomes unavailable due to a non-Q3 action which is not distinguishable from a fault, then it shall be treated as a fault at that resource.

Table 12/G.967.1 – Administrative events which require RTMC between the AN and the SN

AN resource	Event at the AN	Description
PUP	LOCK SHUT DOWN UNLOCK	See 11.1.2.2
	PARTIAL LOCK PARTIAL SHUT DOWN PARTIAL UNLOCK	See 11.1.2.3
PSP (Note 1)	LOCK SHUT DOWN UNLOCK	See 11.1.2.2
LUP (Note 2)	–	
LSP (Note 1)	PARTIAL LOCK PARTIAL UNLOCK	See 11.1.2.3
VPC related entities (applicable to VPC cross-connected at AN, VPC terminated at user port, VPC terminated at service port)	LOCK SHUT DOWN UNLOCK	See 11.1.2.2
Broadcast or multicast VPC with branching point inside the AN	(Note 3)	
Any other AN resource where the VPCs dependent on that resource can be unambiguously identified	(Note 4)	
NOTE 1 – This type of resource also exists at the SN side where the same events at the corresponding managed entity shall be supported. However, according to the general RTMC principles, a change of the status of SN resources has no impact on the RTMC function and therefore requires no VB5 specific definitions within the scope of this Recommendation.		
NOTE 2 – With regard to the RTMC, the LUP is only a naming convention. The LUP does not have an administrative state in the AN.		
NOTE 3 – Administrative actions related to VPCs of this type are for further study.		
NOTE 4 – Events due to administrative actions which affect the service provision capability of those VPCs.		

11.1.2.2   Manipulation of generic administrative state attributes

These manipulations are related to events LOCK, UNLOCK and SHUT DOWN as defined in Recommendation X.731 [34] at the managed entity corresponding to an AN resource. The generic administrative state events shall be supported for the following AN resources: PUP, PSP and VPC(s).

a) A LOCK event administratively prohibits the resource being used. As a result, the cell flow carried on the resource shall be inhibited according to Recommendation Q.832.1 [33]. Neither normal calls nor test calls across the AN are possible in this case. The flow of cells on (semi-)permanent connections is interrupted.

b) A SHUT DOWN event causes a graceful shutting down of a resource without interference to ongoing on-demand services. After this event has occurred, no new switched connections (including new test calls) can be established on the resource. When the last switched connection has been released, the status of the resource automatically changes to locked and the user cell flow is inhibited. As a consequence, also the cell flow on (semi-) permanent connections is interrupted at this point in time.

   In contrast to a lock or unlock procedure, a shutting down procedure of an AN resource may require additional coordination with the SN, because the shutting down process needs information about the usage state of a resource which may not be present in the AN.

   With regard to the RTMC function, in these cases the shutting down of an AN resource is considered as a two-step procedure:

   – If a SHUT DOWN event occurs at the AN, the AN shall inform the SN via the RTMC function that no new switched connections shall be established on the relevant resource.

   – If no switched connection is present or if the last switched connection on the resource has been released, the SN shall inform the AN via the RTMC function that the resource is no longer used by switched connections.

c) An UNLOCK event may occur at any point in time and permits the resource being used again.

d) If the service provision capability of a VPC in the AN is affected due to administrative actions at another (e.g. implementation specific) AN resource, the SN should also be informed about the change of the availability status of that VPC.

11.1.2.3 Manipulation of VB5.1 specific state attributes

These manipulations are related to PARTIAL LOCK, PARTIAL UNLOCK and PARTIAL SHUT DOWN events at the managed entity corresponding to an AN resource. The VB5.1 specific state events shall be supported for the following AN resources: PUP, LSP. For the LSP, a PARTIAL SHUT DOWN is not required.

a) A PARTIAL LOCK event shall stop all switched connections and prohibit establishment of new switched connections on the resource. However, test calls across the AN initiated by the operator shall be possible from an administrative point of view, unless prohibited by administrative actions such as lock or shut down. This event has no impact on the cell flow on (semi-)permanent connections, including the VC carrying the RTMC protocol.

b) A PARTIAL SHUT DOWN event causes a graceful shutting down of a resource without interference to ongoing on-demand services. After this event has occurred, no new switched connections (including new test calls) can be established on the resource. When the last switched connection has been released, the status of the resource automatically changes to partial locked.

   In contrast to a partial lock or partial unlock procedure, a partial shutting down procedure of an AN resource may require additional coordination with the SN because the partial shutting down process needs information about the usage state of a resource which may not be present in the AN.

With regard to the RTMC function, in the following cases the partial shutting down of an AN resource is considered as a two-step procedure:

– If a PARTIAL SHUT DOWN event occurs at the AN, the AN shall inform the SN via the RTMC function that no new switched connections shall be established on the relevant resource.

– If no switched connection is present or if the last switched connection on the resource has been released, the SN shall inform the AN via the RTMC function that the resource is no longer used by switched connections.

c) A PARTIAL UNLOCK event may occur at any point in time.

11.1.3 RTMC requirements related to the occurrence of fault conditions

a) The occurrence of fault conditions may change the availability of resources inside the AN or the SN from an operational point of view.

The AN resources that require RTMC between the AN and the SN in the case of the occurrence/disappearance of fault conditions are given in Table 13.

b) The RTMC function shall facilitate the coordination of the required status information between the AN and the SN, so that in the case of a fault condition at the AN the following information relevant to the service is available at the SN:

1) resources which are affected from an SN point of view;

2) the status of these resource(s) with regard to availability at the AN:

– Available (from an operational point of view);

– Unavailable due to the occurrence of a fault condition.

c) The triggering of the RTMC function shall include correlation of fault conditions so that only the root fault conditions and no consequent (secondary) fault conditions are reported.

Table 13/G.967.1 – RTMC functions related to fault conditions at the AN

AN resource	Event at the AN
PUP	Occurrence/Disappearance of FAULT CONDITION at UNI
PSP	Occurrence/Disappearance of FAULT CONDITION at VB5.1 interface
LUP (Note 1)	
LSP (Note 2)	Occurrence/Disappearance of FAULT CONDITION
VPC related entities (applicable to – VPC cross-connected at AN – VPC terminated at user port – VPC terminated at service port)	Occurrence/Disappearance of FAULT CONDITION
Broadcast or multicast VPC with branching point inside the AN (Note 3)	Occurrence/Disappearance of FAULT CONDITION
Any other AN resource where the VPCs dependent on that resource can be unambiguously identified	Occurrence/Disappearance of FAULT CONDITION
NOTE 1 – With regard to the RTMC, the LUP in the AN is only a naming convention. NOTE 2 – In case of a fault condition at the LSP, the transfer of RTMC information may no longer be possible. NOTE 3 – These VPCs are unidirectional from the SN to the UNIs.	

11.1.4 Verification of LSP ID

The RTMC function shall provide a mechanism that allows (e.g. at system start-up time) checking of the correct connection of VB5.1 interfaces, by verifying an LSP ID, which is exchanged with the peer side.

11.1.5 Interface reset procedure

The RTMC function shall provide a procedure that forces the finite state machines on the peer side into a defined state. This procedure can be initiated by the AN or by the SN and may be used e.g. at interface start-up, after detection of severe failures, or after major re-provisioning.

It shall be possible:

a)   to reset all the FSMs on the peer side;

b)   to reset those FSM(s) on the peer side which are related to a particular VPC or a group of particular VPCs.

11.1.6 VPCI consistency check

The VPCI consistency check is provided to verify the consistent and correct allocation of a logical VPCI to a VP on the VB5.1 reference point.

The check is performed to guarantee that a user plane information flow is possible between the AN and the SN using the bilaterally agreed VPCI at the VB5.1 reference point. This is done using the loopback capability of Recommendation I.610 [24] that operates at the VP level. The consistency of the VPCI is checked in the SN by monitoring the receipt of a user plane test flow in a VPC at an LSP that is indicated by the VPCI. After completion of the check the result of the monitoring function (receipt of loopback cells at the VPC level) is available in the SN. The procedure can be initiated automatically or by operator command. Also, at the AN, a monitor function is to be established after the activation of a loopback. This function will check if loopback cells are received. This result shall be made available to the SN.

The VPCI consistency check shall be initiated by the SN. The VPCI consistency check should be initiated for only one VPC per VB5.1 reference point at a time.

NOTE – In case when multiple VPCI consistency check procedures are running across different VB5.1 reference points simultaneously, the result of the check may be incorrect due to a possible interference of the corresponding loopback cells. However, the probability of such an interference is considered insignificant.

The VPCI consistency check shall be performed on those VPCs at the LSP which are terminated both at the LSP(AN) and the LSP(SN), i.e. VPCs of type B.

11.1.7 Activation/deactivation of B-ISDN accesses under control of the SN

Activation of remote B-ISDN terminals is for further study.

NOTE – Currently no specification defining the activation and deactivation of B-ISDN accesses connected directly to the SN is available. As soon as such a procedure is standardized, the VB5.1 interface Recommendation would have to be enhanced to cover this function.

11.1.8 Procedural RTMC requirements

For the RTMC function the following procedural requirements apply:

a)   The RTMC function shall facilitate the exchange information about the availability of the AN resources:

–   LSP (i.e. complete VB5.1 reference point);

–   VPC(s).

This shall be applied to both VPCs cross-connected in the AN and to VPCs terminated in the AN.

Changes of the availability of PUP and PSP resources shall be coordinated through the exchange of information about the availability of the individual VPCs associated with the particular resource.

b)   The RTMC function shall support messages which carry status information about a set of VPCs. Whenever possible, such messages shall be applied in order to avoid a flood of RTMC messages across the VB5.1 reference point in the case where a status change in the AN affects the availability of a number of VPCs simultaneously.

11.1.9   Summary of RTMC functions

A summary of the RTMC functions across the VB5.1 reference point with regard to specific resources in the AN and the SN is provided in Table 14. In addition, Table 14 provides a mapping between the detailed RTMC requirements and the specification of the corresponding RTMC procedures by referring to the relevant subclauses of this Recommendation.

Table 14/G.967.1 – Overview of RTMC functions at VB5.1 reference point

Resource	RTMC function/ information flow	Resource identifier in RTMC information	Specification of RTMC requirements	Specification of RTMC procedures
PUP (AN)	Coordination of availability status/ AN ⇒ SN	Set of LUP/VPCI combinations	See 11.1.2 and 11.1.3	See 13.3.2.1 and 13.3.2.2
	Activation/deactivation of B-ISDN accesses		For further study	For further study
PSP (AN)	Coordination of availability status/ AN ⇒ SN	Set of LSP/VPCI and/or LUP/VPCI combinations (Note 1)	See 11.1.2 and 11.1.3	See 13.3.2.1 and 13.3.2.2
LUP (AN) (Note 2)				
LSP (AN)	Coordination of availability status/ AN ⇒ SN	LSP	See 11.1.2 and 11.1.3	See 13.3.2.1 and 13.3.2.2
	Verify LSP ID/ AN ⇒ SN or SN ⇒ AN	LSP	See 11.1.4	See 13.3.4.2
	Reset/ AN⇒ SN or SN ⇒ AN	LSP	See 11.1.5	See 13.3.4.3
VPC (AN)	Coordination of availability status/ AN ⇒ SN	LUP/VPCI or LSP/VPCI (Note 1)	See 11.1.2 and 11.1.3	See 13.3.2.1 and 13.3.2.2
	Reset/ AN⇒ SN or SN ⇒ AN	LUP/VPCI or LSP/VPCI (Note 1)	See 11.1.5	See 13.3.4.4
PSP (SN)	–			
LUP (SN)	–			

Table 14/G.967.1 – Overview of RTMC functions at VB5.1 reference point *(concluded)*

Resource	RTMC function/ information flow	Resource identifier in RTMC information	Specification of RTMC requirements	Specification of RTMC procedures
LSP (SN)	Verify LSP ID/ SN $\Rightarrow$ AN or AN $\Rightarrow$ SN	LSP	See 11.1.4	See 13.3.4.2
	Reset/ SN $\Rightarrow$ AN or AN $\Rightarrow$ SN	LSP	See 11.1.5	See 13.3.4.3
VPC (SN)	VPCI consistency check/ SN $\Rightarrow$ AN	LSP/VPCI	See 11.1.6	See 13.3.3
	Reset/ AN$\Rightarrow$ SN or SN $\Rightarrow$ AN	LUP/VPCI or LSP/VPCI (Note 1)	See 11.1.5	See 13.3.4.4
NOTE 1 – The application of connection element identifiers is described in 7.3.2.				
NOTE 2 – With regard to the RTMC, the LUP (AN) is only a naming convention.				

12 Performance design objectives

Two distinct performance areas are identified:

a)   Transfer functions – concerned with the transfer of user signalling and data via the interface;

b)   RTMC functions – concerned with the real-time management of the interface.

12.1 Performance design objectives for transfer functions

ANs supporting the VB5.1 reference point carry ATM cells between the UNI and the SNI in VCCs which do not terminate in the AN. The factors affecting the transfer of these cells are related directly to the performance of the transmission systems and connection functions in the AN.

ATM layer cell transfer performance requirements are defined in Recommendation I.356 [12], in particular:

–   cell transfer delay;

–   cell delay variation;

–   cell error ratio;

–   cell loss ratio;

–   cell misinsertion rate.

12.2 Performance design objectives for RTMC functions

For further study.

13 VB5.1 system architecture, structure and procedures

13.1 Introduction

This clause describes the VB5.1 RTMC protocol in two ways. First, the static protocol architecture (see 13.2) is presented; then, the dynamic behaviour is described (see 13.3).

The static structure is described by SDL system diagrams (see 13.2.1.3 and 13.2.1.4) and block diagrams (see 13.2.2).

The dynamic behaviour is presented by text – describing the principles of the procedures and how the procedures are embedded in the environment – and by Message Sequence Charts (MSCs), which are used to show the basic procedures of the RTMC protocol (see 13.3). Finally, the lowest level of the SDL hierarchy – the process diagrams – describe the detailed procedures. They can be found in Annex A. The behaviour represented by the SDLs plus the set of primitives which drive them should be followed exactly as described. However, no specific implementation is implied by the specification language employed. It is the functionality represented within clauses 13 and 14 and within Annex A which defines the VB5.1 system. In the case of ambiguities between text and process diagrams, the diagrams take precedence.

13.2 VB5.1 system architecture

13.2.1 System diagrams

13.2.1.1 SN and AN overview

An overview showing the basic VB5.1 functional blocks in AN and SN and how the RTMC protocol is related to these entities is provided by Figure 35.
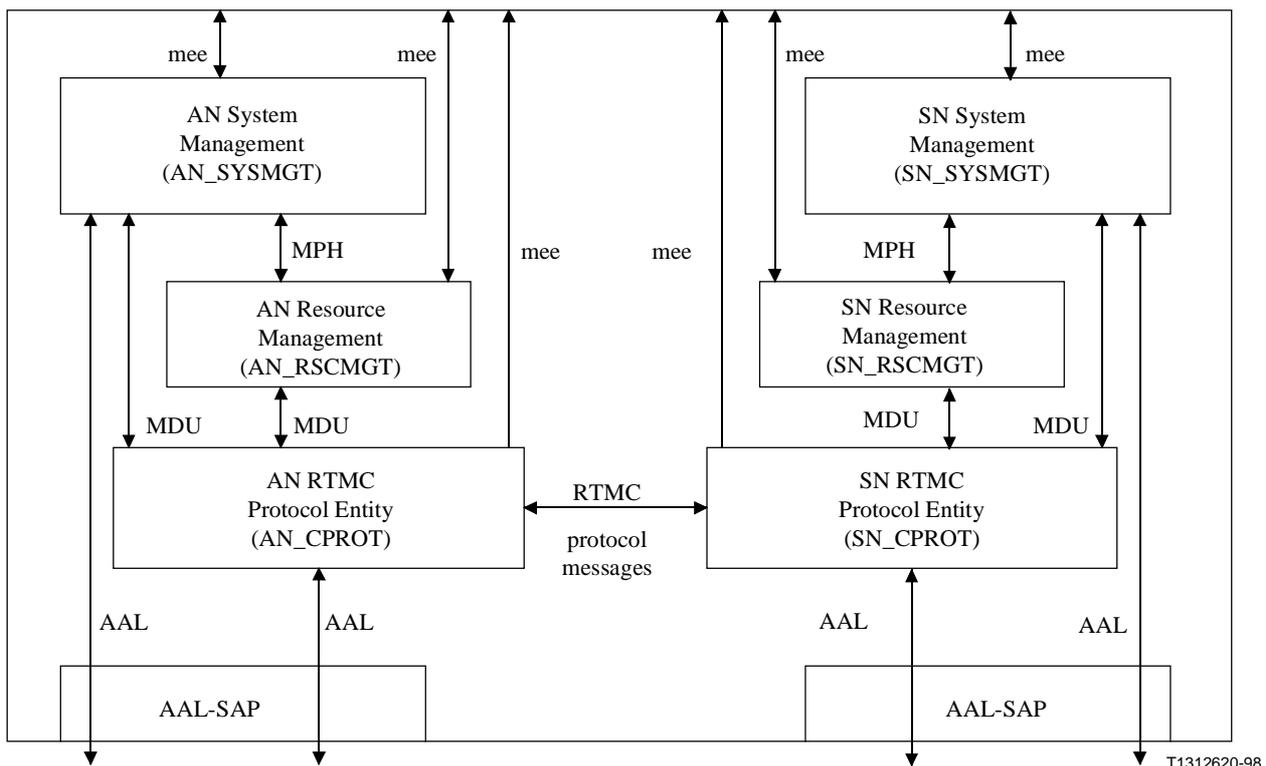
NOTE – The abbreviations shown at the arrows are classes of primitives used by VB5.1 (see Table 15).

Figure 35/G.967.1 – VB5.1 system overview

13.2.1.2 Naming conventions

VB5.1 primitives represent, in an abstract way, the exchange of information and control between entities internal to the AN and to the SN. They do not specify or constrain implementation. Table 15 classifies the introduced primitives.

Table 15/G.967.1 – Classification of VB5.1 primitives

Primitive classes	Prefix
Primitives between the VB5.1 system management and ATM adaptation layer service access point (Note 1)	AAL_
Primitives between VB5.1 system management or resource management and RTMC protocol	MDU_
Primitives between VB5.1 AN/SN system management or resource management and the environment within VB5.1 is running (the part of plane management which is external to VB5.1)	mee (Note 2)
Primitives internal to a SDL block	MIE_
Primitives between VB5.1 system management and VB5.1 AN/SN resource management	MPH_
NOTE 1 – VB5.1 messages are passed to the AAL-SAP via AAL DATA primitives. For the specification of the RTMC protocol, the messages are the relevant information. Therefore, in the following SDL diagrams, reference is made to the messages only.	
NOTE 2 – The prefix "mee" is used instead of "MEE_" for primitives to/from AN/SN environment in order to be in line with the naming scheme of the VB5.1 management specification.	

Symbols used to describe the SDL system and block diagrams as well as the message sequence charts are specified in Recommendations Z.100 [36], Z.105 [37] and Z.120 [38].

13.2.1.3 AN VB5.1 system

This subclause presents as an SDL system diagram the decomposition of an AN into functional entities related to the VB5.1 interface.

Each functional entity defined in this subclause comprises a number of processes. These processes are defined with SDL block diagrams in 13.2.2.

The functional entities composing an AN VB5.1 system are shown in Figure 36 and are further defined in Table 16.

The connection of the AN VB5.1 system to any non-VB5 AN entity is realized by AN_ENV which summarizes the environment within which the AN VB5.1 system is running. The VB5.1 system communicates with this external environment via channels (CH_...). The terms in square brackets reference the signal lists, which contain all signals which are transported on that channel (see Figures 38-45). The external entities are beyond the scope of VB5.1 and are not specified in further detail. Only basic requirements which are essential for cooperation between AN and SN are given.

Block Type AN 1(1)

[(SL_ANVB5_ENV)]

AN_ENV

[(SL_ENV_ANVB5)]

[(SL_ANSYS_ENV)]

ENV SAP
normative
interface

CH_ANSYS_ENV [(SL_ANRSC_ENV)]

[(SL_ENV_ANSYS)]

AN_SYSMGT

CH_ANRSC_ENV

[(SL_CPROT_ENV)]

[(SL_ANCPROT_SYS)] [(SL_RSC_SYS)]

[(SL_SAAL_SYS)] CH_ANSYS_RSC CH_ANCPROT_ENV

[(SL_SYS_RSC)] [(SL_ENL_ANRSC)]

AN_RSCMGT

CH_SYS_ANCPROT [(SL_ANCPROT_RSC)]

CH_SYS_SAAL CH_RSC_ANCPROT

[(SL_SYS_ANCPROT)] [(SL_RSC_ANCPROT)]

(SL_
ANCPROT
_VB5)

CH_ANCPROT_VB5 SN

AN_CPROT

[(SL_ANCPROT_VB5)] (SL_
_VB5_
_ANCPROT)

[(SL_VB5_ANCPROT)]

[(SL_SYS_SAAL)]

SAAL SAP
normative interface

VB5 RTMC Protocol
normative
interface

[(SL_SAAL_SYS)] T1312630-98

AN_SAAL [(SL_SYS_SAAL)]

Figure 36/G.967.1 – AN VB5.1 system

Table 16/G.967.1 – AN functional entities

Functional entity	Abbreviation in Figure 36	Purpose
AN system management	AN_SYSMGT	AN system management represents the coordination function of the AN VB5.1 system. During interface start-up, the AN system management shall: – request the SAAL establishment for the RTMC protocol; – invoke the RTMC protocol entity in order to inform the SN about a reset of the VB5.1 interface; – coordinate the unblocking of VPC Status FSMs and the LSP status FSM; – invoke the RTMC protocol entity in order to request the VB5 IF ID from the SN and verify the ID. On request of AN_ENV, the AN system management shall: – invoke the RTMC protocol entity in order to inform the SN about a reset of the VB5.1 interface; – invoke the RTMC protocol entity in order to request the LSP ID from the SN and verify the ID. The AN system management shall relay VPCI consistency information either to AN_ENV or AN_CPROT. AN system management supervises the RTMC protocol, i.e. reacts on errors and time-outs and passes them on to the AN_ENV entity.
AN resource management	AN_RSCMGT	In the case of an administrative state change of a resource affecting the availability of User VPCs, VB5 VPCs or the LSP itself the AN resource management shall: – initiate, coordinate and supervise state transitions of VPCs and/or LSP; – invoke the RTMC protocol entity in order to inform the SN about the unavailability of VPCs and/or LSP (Note). In the case of a faulty resource affecting the availability of User VPCs, VB5 VPCs or the LSP itself the AN resource management shall: – initiate, coordinate and supervise state transitions of VPCs and/or LSP; – invoke the RTMC protocol entity in order to inform the SN about the unavailability of VPCs and/or LSP.
AN RTMC protocol entity	AN_CPROT	The RTMC protocol entity terminates the VB5.1 RTMC protocol and shall: – build up the RTMC protocol messages; – supervise message transmission by timers; – re-transmit messages on timer expiration.
NOTE – This does not necessarily imply that the administrative state of the VPCs has changed as well. The term "User VPCs" addresses VPCs crossing the UNI, or at the VUP the term "VB5 VPCs" addresses VPCs crossing the VB5.1 interface and terminating in the AN.		

The functional entities are connected via channels on which messages and primitives are conveyed. The channels are defined in Table 17.

Table 17/G.967.1 – Channels in the AN

Channel	Abbreviation in Figure 36	Purpose/comments
AN System Management ⇔ AN environment	CH_ANSYS_ENV	Via CH_ANSYS_ENV, the AN_ENV entity shall trigger the AN VB5.1 system management to invoke the VB5.1 procedures: – interface start-up; – check VB5 interface ID; – VPCI consistency check.
AN Resource Management ⇔ AN environment	CH_ANRSC_ENV	Via CH_ANRSC_ENV, the AN_ENV entity shall trigger the AN VB5.1 resource management to invoke the VB5.1 procedures for blocking, unblocking or shutting down of resources in case of state changes due to administrative or operational reasons.
AN RTMC protocol entity ⇔ AN environment	CH_ANCPROT_ENV	Via CH_ANCPROT_ENV, the AN_ENV entity shall be informed about error situations within the RTMC protocol entity.
AN System Management ⇔ AN SAAL entity	CH_SYS_SAAL	Via CH_SYS_SAAL, the AN system management shall supervise the establishment/release of the SAAL of the VB5.1 RTMC protocol.
AN System Management ⇔ AN Resource Management	CH_ANSYS_RSC	Via CH_ANSYS_RSC, the AN system management shall send/receive information on blocking and unblocking of resources with regard to the system management procedures (e.g. Start-up).
AN System Management ⇔ AN RTMC protocol entity	CH_SYS_ANCPROT	Via CH_SYS_ANCPROT, the AN system management shall trigger the AN RTMC protocol entity to send messages to the SN. The RTMC protocol entity shall inform AN system management about receipt of messages from the SN (Note 1).
AN Resource Management ⇔ AN RTMC protocol entity	CH_RSC_ANCPROT	Via CH_RSC_ANCPROT, the AN resource management shall send/receive messages to/from the SN via AN RTMC protocol entity with regard to blocking, unblocking and shutting down of resources (Note 1).
AN RTMC protocol entity ⇔ VB5.1 interface	CH_ANCPROT_VB5	Via CH_CPROT_VB5, the RTMC protocol entity sends/receives VB5.1 RTMC messages to/from the SN (Note 2).
NOTE 1 – For state changes of VPC/LSP, the RTMC protocol entity is not invoked directly by the AN resource management because of the possibility of having "multi-VPC" messages.		
NOTE 2 – The underlying SAAL is not taken into account because it is beyond the scope of the VB5.1 protocol procedures.		

13.2.1.4 SN VB5.1 system

This subclause presents as an SDL system diagram the decomposition of an SN into functional entities related to the VB5.1 interface.

Each functional entity defined in this subclause comprises a number of processes. These processes are defined with SDL block diagrams in 13.2.2.

The functional entities composing an SN VB5.1 system are shown in Figure 37 and further defined in Table 18.

The connection of the SN VB5.1 system to any non-VB5 SN entities is realized by SN_ENV. SN_ENV itself is beyond the scope of VB5.1 and not specified in further detail. Only basic requirements which are essential for co-operation between AN and SN are given.

Figure 37/G.967.1 – SN VB5.1 system

Table 18/G.967.1 – SN functional entities

Functional entity	Abbreviation in Figure 37	Purpose
SN System Management	SN_SYSMGT	SN system management represents the coordination function of the SN VB5.1 system. During interface start-up the SN system management shall: – request the SAAL establishment for the RTMC protocol; – invoke the RTMC protocol entity in order to inform the AN about a reset of the VB5.1 interface; – coordinate the VPC Status FSMs and the LSP status FSM; – invoke the RTMC protocol entity in order to request the LSP ID from the SN and verify the ID. On request of SN_ENV the SN system management shall: – invoke the RTMC protocol entity in order to inform the AN about a reset of the VB5.1 interface; – invoke the RTMC protocol entity in order to request the LSP ID from the AN and verify the ID; – transport VPCI consistency messages. On receipt of messages from the AN, indicating the availability status of VPCs/LSP the SN VPC/LSP status FSM is informed. SN system management supervises the RTMC protocol, i.e. reacts on errors and time-outs and passes them on to the SN_ENV entity.
SN Resource Management	SN_RSCMGT	The SN resource management represents the availability due to remote administrative reasons or fault conditions of user VPCs, VB5 VPCs and VB5.1 interface
SN RTMC protocol entity	SN_CPROT	The RTMC protocol entity terminates the VB5.1 RTMC protocol and shall: – build up the RTMC protocol messages; – supervise message transmission by timers; – re-transmit messages on timer expiration.

The functional entities are connected via channels on which messages and primitives are conveyed. The channels are defined in Table 19.

Table 19/G.967.1 – Channels in the SN

Channel	Abbreviation in Figure 37	Purpose/comments
SN System Management ⇔ SN environment	CH_SNSYS_ENV	Via CH_SNSYS_ENV the SN_ENV entity shall trigger the SN VB5.1 system management to invoke the VB5.1 procedures: – interface start-up; – check VB5 interface ID; – VPCI consistency check.
SN Resource Management ⇔ SN environment	CH_SNRSC_ENV	Via CH_SNRSC_ENV the SN_ENV entity shall trigger the SN VB5.1 resource management to update the VPC/LSP status FSMs in case of state changes due to administrative or operational reasons.
SN RTMC protocol entity ⇔ SN environment	CH_SNCPROT_ENV	Via CH_SNCPROT_ENV the SN_ENV entity shall be informed about error situations within the RTMC protocol entity.
SN System Management ⇔ SN SAAL entity	CH_SYS_SAAL	Via CH_SYS_SAAL the SN system management shall supervise the establishment/release of the SAAL of the VB5.1 RTMC protocol.
SN System Management ⇔ SN Resource Management	CH_SNSYS_RSC	Via CH_SNSYS_RSC the SN system management shall update the status FSM within resource management with regard to the system management procedures (e.g. start-up).
SN System Management ⇔ SN RTMC protocol entity	CH_SYS_SNCPROT	Via CH_SYS_SNCPROT the SN system management shall trigger the SN RTMC protocol entity to send messages to the AN. The RTMC protocol entity shall inform SN system management about receipt of messages from the AN (Note 1).
SN Resource Management ⇔ SN RTMC protocol entity	CH_RSC_SNCPROT	Via CH_RSC_SNCPROT the SN resource management shall send/receive messages to/from the AN via SN RTMC protocol entity with regard to blocking, unblocking and shutting down of resources (Note 1).
SN RTMC protocol entity ⇔ VB5.1 interface	CH_SNCPROT_VB5	Via CH_SNCPROT_VB5 the RTMC protocol entity sends/receives VB5.1 RTMC messages to/from the AN (Note 2).
NOTE 1 – For state changes of VPC/LSP the RTMC protocol entity is not invoked directly by the SN resource management because of the possibility of having "multi-VPC" messages. NOTE 2 – The underlying SAAL is not taken into account because it is beyond the scope of the VB5.1 protocol procedures.		

13.2.1.5 Signallists

This subclause defines the signallists which group the various signals appearing on the channels. Refer to Annex A for detailed signal declarations.

/* Declaration of Signallists
common for AN and SN */

/* Declaration of Signallists between the System
Management and the Resource Management */

signallist SL_CTR_STATUS =
MPH_stop_traffic,
MPH_start_traffic;

signallist SL_RESET_STATUS =
MPH_unblock_rsc_req,
MPH_unblock_rsc_ind;

signallist SL_STATUS_RESET =
MPH_unblock_rsc_conf,
MPH_unblock_rsc_res;

signallist SL_SYS_RSC =
(SL_CTR_STATUS),
(SL_RESET_STATUS);

signallist SL_RSC_SYS =
(SL_STATUS_RESET);

/* Declaration of Signallists between the
VB5-System Management and the SAAL */

signallist SL_SYS_SAAL =
AAL_establish_req,
AAL_release_req;

signallist SL_SAAL_SYS =
AAL_establish_ind,
AAL_establish_conf,
AAL_release_ind,
AAL_release_conf;

/* Declaration of Signallists between the VB5-System
Management and the Environment */

signallist SL_CTR_ENV =
meeLSPFFailureInd,
meeStartupConf,
meeStartupInd,
meeStopTrafficConf;

signallist SL_RESET_ENV =
meeErrorInd,
meeResetRscConf,
meeResetRscInd;

signallist SL_LSPID_ENV =
meeErrorInd,
meeVerifyLspIdConf;

signallist SL_ENV_CTR =
meeStartupReq,
meeStopTrafficReq;

signallist SL_ENV_RESET =
meeResetRscReq;

signallist SL_ENV_LSPID =
meeVerifyLspIdReq;

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Figure 38/G.967.1 – Signallists common for AN and SN (1)

Package VB5_1

/* Declaration of Signallists
common for AN and SN */

/* Declaration of Signallists between the VB5-System
Management and the CPROT Management */

signallist SL_LSPID_CPROT =
MDU_LSP_ID_req,
MDU_LSP_ID_res,
MDU_Ispid_prc_started,
MDU_abort_req;

signallist SL_RESET_CPROT =
MDU_reset_req,
MDU_reset_res,
MDU_resrsc_prc_started,
MDU_abort_req;

signallist SL_CTR_CPROT =
MDU_start_traffic,
MDU_stop_traffic;

signallist SL_CPROT_LSPID =
MDU_LSP_ID_conf,
MDU_LSP_ID_ind;

signallist SL_CPROT_RESET =
MDU_reset_conf,
MDU_reset_ind;

/* Declaration of Signallists between the
Environment and the CPROT Management */

signallist SL_CPROT_ENV =
meeErrorInd;

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Figure 39/G.967.1 – Signallists common for AN and SN (2)

Package VB5_1

/* Declaration of AN Signallists for primitives
from the environment */

signallist SL_ENV_ANVB5 =
(SL_ENV_ANSYS),
(SL_ENV_ANRSC);

signallist SL_ENV_ANSYS =
(SL_ENV_CTR),
(SL_ENV_RESET),
(SL_ENV_LSPID),
(SL_ENV_ANCONS);

signallist SL_ENV_ANCONS =
meeConsCheckRes,
meeConsCheckEndRes;

signallist SL_ENV_ANRSC =
meeBlockRscReq,
meeUnblockRscReq,
meeAwaitClearReq,
meeVPCCreateReq,
meeVPCDeleteReq;

/* Declaration of AN Signallists for primitives
to the environment */

signallist SL_ANVB5_ENV =
(SL_ANSYS_ENV),
(SL_ANRSC_ENV);

signallist SL_ANSYS_ENV =
(SL_CTR_ENV),
(SL_RESET_ENV),
(SL_LSPID_ENV),
(SL_ANCONS_ENV);

signallist SL_ANCONS_ENV =
meeErrorInd,
meeConsCheckInd,
meeConsCheckEndInd;

signallist SL_ANRSC_ENV =
meeErrorInd,
meeBlockRscConf,
meeUnblockRscConf,
meeAwaitClearConf,
meeVPCCreateConf,
meeVPCDeleteConf;

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Figure 40/G.967.1 – Signallists in the AN (1)

Package VB5_1

/* Declaration of Signallists for
AN_CPROT primitives */

signallist SL_ANCPROT_SYS =
(SL_CPROT_RESET),
(SL_CPROT_LSPID),
(SL_CPROT_ANCONS);

signallist SL_CPROT_ANCONS =
MDU_cons_check_ind,
MDU_cons_check_end_ind;

signallist SL_SYS_ANCPROT =
(SL_RESET_CPROT),
(SL_LSPID_CPROT),
(SL_ANCONS_CPROT),
(SL_CTR_CPROT);

signallist SL_ANCONS_CPROT =
MDU_cons_check_res,
MDU_cons_check_end_res,
MDU_cons_prc_started,
MDU_abort_req;

signallist SL_RSC_ANCPROT =
MDU_unblock_req,
MDU_block_req,
MDU_await_clear_req,
MDU_status_prc_started,
MDU_abort_req;

signallist SL_ANCPROT_RSC =
MDU_unblock_conf,
MDU_block_conf,
MDU_await_clear_conf;

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Figure 41/G.967.1 – Signallists in the AN (2)

Package VB5_1

/* Declaration of AN Signallists for VB5 messages */

signallist SL_VB5_ANCPROT =
UNBLOCK_RSC_ACK,
BLOCK_RSC_ACK,
AWAIT_CLEAR_ACK,
AWAIT_CLEAR_COMP,
RESET_RSC,
RESET_RSC_ACK,
REQ_LSPID,
LSPID,
CONS_CHECK_REQ,
CONS_CHECK_END,
PROTOCOL_ERROR,
SIM_SN_started,
unknown_message,
msg_too_short,
trans_id_err,
unknown_protdisc;

signallist SL_ANCPROT_VB5 =
UNBLOCK_RSC,
BLOCK_RSC,
AWAIT_CLEAR,
AWAIT_CLEAR_COMP_ACK,
RESET_RSC,
RESET_RSC_ACK,
REQ_LSPID,
LSPID,
CONS_CHECK_REQ_ACK,
CONS_CHECK_END_ACK,
PROTOCOL_ERROR,
SIM_AN_started;

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Figure 42/G.967.1 – Signallists in the AN (3)

Package VB5_1

/* Declaration of SN Signallists for primitives
from the environment */

signallist SL_ENV_SNVB5 =
(SL_ENV_SNRSC),
(SL_ENV_SNSYS);

signallist SL_ENV_SNSYS =
(SL_ENV_CTR),
(SL_ENV_RESET),
(SL_ENV_LSPID),
(SL_ENV_SNCONS);

signallist SL_ENV_SNCONS =
meeConsCheckReq,
meeConsCheckEndReq;

signallist SL_ENV_SNRSC =
meeAwaitClearRes,
meeVPCCreateReq,
meeVPCDeleteReq;

/* Declaration of SN Signallists for primitives
to the environment */

signallist SL_SNVB5_ENV =
(SL_SNRSC_ENV),
(SL_SNSYS_ENV);

signallist SL_SNSYS_ENV =
(SL_CTR_ENV),
(SL_RESET_ENV),
(SL_LSPID_ENV),
(SL_SNCONS_ENV);

signallist SL_SNCONS_ENV =
meeErrorInd,
meeConsCheckConf,
meeConsCheckEndConf;

signallist SL_SNRSC_ENV =
meeErrorInd,
meeBlockRscInd,
meeUnblockRscInd,
meeAwaitClearInd,
meeVPCCreateConf,
meeVPCDeleteConf;

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Figure 43/G.967.1 – Signallists in the SN (1)

/* Declaration of SN Signallists for
   SN_CPROT primitives */

signallist SL_SNCONS_CPROT =
MDU_cons_check_req,
MDU_cons_check_end_req,
MDU_cons_prc_started,
MDU_abort_req;

signallist SL_RSC_SNCPROT =
MDU_unblock_res,
MDU_block_res,
MDU_await_clear_ack,
MDU_await_clear_res,
MDU_status_prc_started,
MDU-abort_req;

signallist SL_SNCPROT_RSC =
MDU_unblock_ind,
MDU_block_ind,
MDU_await_clear_ind;

signallist SL_CPROT_SNCONS =
MDU_cons_check_conf,
MDU_cons_check_end_conf;

signallist SL_SYS_SNCPROT =
(SL_RESET_CPROT),
(SL_LSPID_CPROT),
(SL_SNCONS_CPROT),
(SL_CTR_CPROT);

signallist SL_SNCPROT_SYS =
(SL_CPROT_RESET),
(SL_CPROT_LSPID),
(SL_CPROT_SNCONS);

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Figure 44/G.967.1 – Signallists in the SN (2)

Package VB5_1

/* Declaration of SN Signallists for VB5 messages */

signallist SL_SNCPROT_VB5 =
UNBLOCK_RSC_ACK,
BLOCK_RSC_ACK,
AWAIT_CLEAR_ACK,
AWAIT_CLEAR_COMP,
RESET_RSC,
RESET_RSC_ACK,
REQ_LSPID,
LSPID,
CONS_CHECK_REQ,
CONS_CHECK_END,
PROTOCOL_ERROR,
SIM_SN_started;

signallist SL_VB5_SNCPROT =
UNBLOCK_RSC,
BLOCK_RSC,
AWAIT_CLEAR,
AWAIT_CLEAR_COMP_ACK,
RESET_RSC,
RESET_RSC_ACK,
REQ_LSPID,
LSPID,
CONS_CHECK_REQ_ACK,
CONS_CHECK_END_ACK,
PROTOCOL_ERROR,
SIM_AN_started,
unknown_message,
msg_too_short,
trans_id_err,
unknown_protdisc;

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Figure 45/G.967.1 – Signallists in the SN (3)

13.2.2   Block diagrams

13.2.2.1   System management

13.2.2.1.1   AN system management

The processes of the AN system management block are shown in Figure 46 and further described in Table 20.

Figure 46/G.967.1 – AN system management block

Table 20/G.967.1 – AN system management processes

System Management Processes	Abbreviation in Figure 46	Purpose
Interface control	AN_CTR:CTR	Coordination of VB5.1 interface start-up
SAAL control	AN_SAAL:SAAL_MGT	Supervision of SAAL establishment and release
Reset resources	AN_RESET:RESET_RSC	Supervision of the reset of the VB5.1 interface
Verify LSP ID	AN_LSPID:LSPID_VERIFY	Supervision of requesting the peer side LSP ID and checking for consistency
VPCI consistency check	AN_VPCI_CC	Coordination between Environment and AN_CPROT for the VPCI consistency check

The AN system management processes are connected via signal routes to each other which are defined in Table 21.

Table 21/G.967.1 – Internal signal routes for AN system management block

Signal Route	Abbreviation in Figure 46	Purpose/comments
Interface Control ⇔ SAAL control	SR_CTR_SAAL	Via SR_CTR_SAAL, the interface control process shall request a SAAL establishment.
Interface Control ⇔ Reset resources	SR_CTR_RESET	Via SR_CTR_RESET, the interface control process shall request a reset of the VB5.1 interface.
Interface Control ⇔ Verify LSP ID	SR_CTR_LSPID	Via SR_CTR_LSPID, the interface control process shall request the peer side LSP ID.
Interface Control ⇒VPCI CC Control	SR_CTR_ANCONS	Via SR_CTR_ANCONS, the interface control process shall start/stop the AN_VPCI_CC process.

13.2.2.1.2 SN system management

The processes of the SN system management block are shown in Figure 47 and further described in Table 22.

Figure 47/G.967.1 – SN system management block

Table 22/G.967.1 – SN system management processes

System Management Processes	Abbreviation in Figure 47	Purpose
Interface control	SN_CTR:CTR	Coordination of VB5.1 interface start-up
SAAL control	SN_SAAL:SAAL_MGT	Supervision of SAAL establishment and release
Reset resources	SN_RESET:RESET_RSC	Supervision of the reset of the VB5.1 interface
Verify LSP ID	SN_LSPID:LSPID_VERIFY	Supervision of requesting the peer side LSP ID and checking for consistency
VPCI consistency check	SN_VPCI_CC	Coordination between Environment and SN_CPROT for the VPCI consistency check

The SN system management processes are connected via signal routes to each other which are defined in Table 23.

Table 23/G.967.1 – Internal signal routes for SN system management block

Signal route	Abbreviation in Figure 47	Purpose/comments
Interface Control ⇔ SAAL control	SR_CTR_SAAL	Via SR_CTR_SAAL, the interface control process shall request a SAAL establishment.
Interface Control ⇔ Reset resources	SR_CTR_RESET	Via SR_ CRT_RESET, the interface control process shall request a reset of the VB5.1 interface.
Interface Control ⇔ Verify LSP ID	SR_CTR_LSPID	Via SR_CTR_LSPID, the interface control process shall request the peer side LSP ID.
Interface Control ⇔VPCI CC Control	SR_CTR_SNCONS	Via SR_CTR_SNCONS, the interface control process shall start/stop the SN_VPCI_CC process

13.2.2.1.3   System management internal signallists

The system management processes communicate with each other via internal signallists which are declared in Figure 48. Refer to Annex A for the signal declarations.

Package VB5_1

/* Declaration of Signallists
common for AN and SN */

/* Signallists from the
CTR process */

signallist SL_CTR_RESET =
MIE_reset_LSP_req,
MIE_stop_traffic,
MIE_start_traffic;

signallist SL_CTR_LSPID =
MIE_verify_LSP_ID_req,
MIE_stop_traffic,
MIE_start_traffic;

signallist SL_CTR_CONS =
MIE_stop_traffic,
MIE_start_traffic;

signallist SL_CTR_SAAL =
MIE_establish_SAAL_req,
MIE_release_SAAL_req;

/* Signallists to the
CTR process */

signallist SL_RESET_CTR =
MIE_reset_LSP_conf,
MIE_reset_LSP_ind,
MIE_error_ind;

signallist SL_LSPID_CTR =
MIE_verify_LSP_ID_conf,
MIE_verify_LSP_ID_ind;

signallist SL_SAAL_CTR =
MIE_establish_SAAL_conf,
MIE_release_SAAL_conf,
MIE_establish_SAAL_ind,
MIE_SAAL_failure;

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Figure 48/G.967.1 – System management internal signallists

13.2.2.2 Resource Management

13.2.2.2.1 AN Resource Management

The VB5.1 AN resource management entity, which represents the local availability status of the VPCs and LSP, consists of three processes. The AN resource management block AN_RSCMGT is shown in Figure 49 and its processes are described in Table 24.
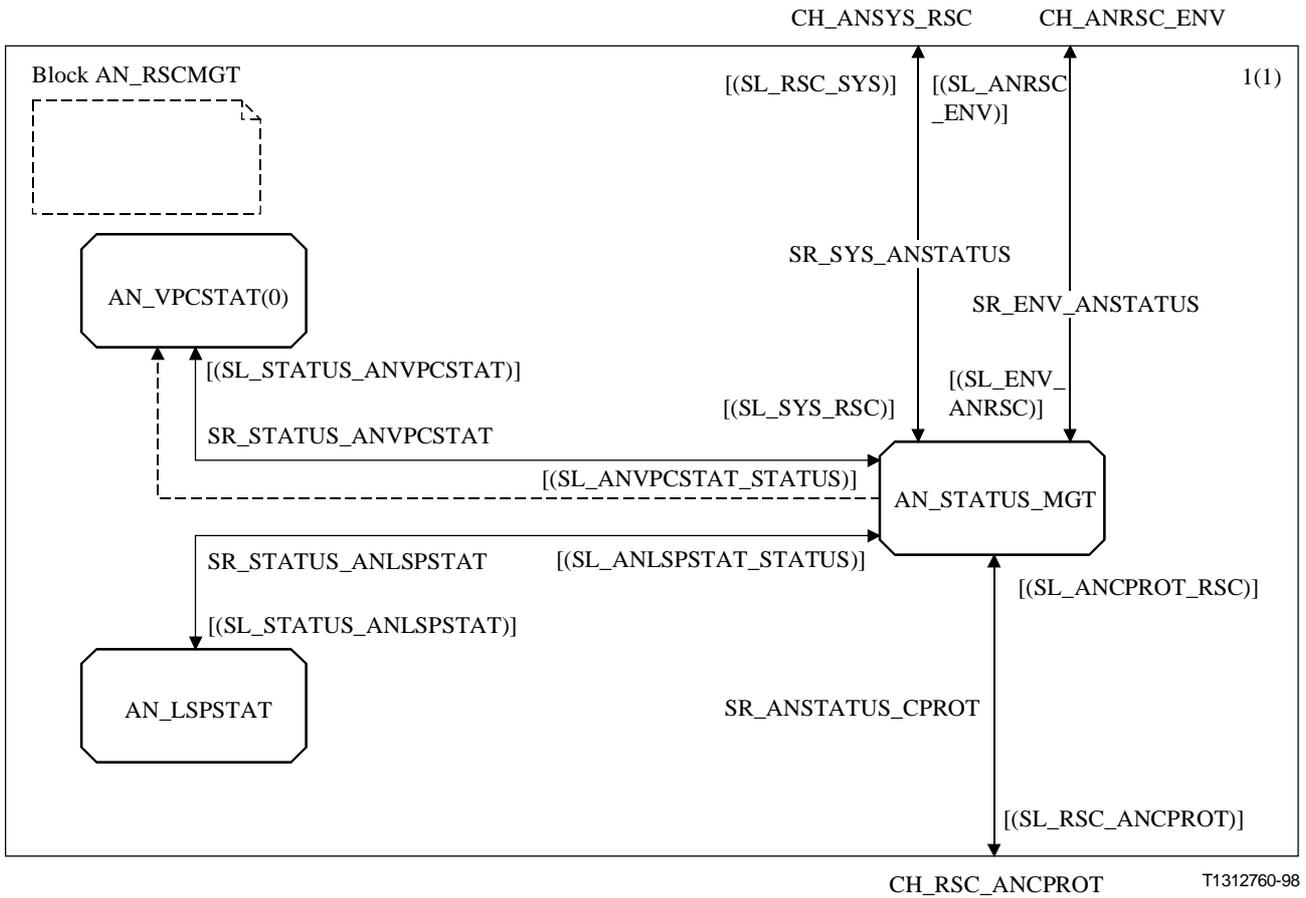
Figure 49/G.967.1 – AN resource management block

Table 24/G.967.1 – AN_RSCMGT processes

Process	Abbreviation in Figure 49	Purpose
AN status manager	AN_STATUS_MGT	Supervises the status changes of VPCs and LSP.
AN VPC status FSMs	AN_VPCSTAT	The VPC status FSMs represent the availability due to local administrative reasons or fault conditions of user VPCs as well as of VB5 VPCs. In the case of a state change, the VPC Status FSM decides upon the message to be sent to the SN. One FSM is provided per VPC.
AN LSP status FSM	AN_LSPSTAT	The LSP status FSMs represent the availability due to local administrative reasons or fault conditions of the VB5.1 interface. In the case of a state change, the LSP Status FSM decides upon the message to be sent to the SN.

The AN resource management processes are connected via signal routes to each other which are defined in Table 25.

Table 25/G.967.1 – Internal signal routes for AN resource management block

Signal Route	Abbreviation in Figure 49	Purpose/comments
Status management ⇔ VPC status FSMs	SR_STATUS_ ANVPCSTAT	Via SR_STATUS_ANVPCSTAT, the status management process shall update the VPC status FSMs.
Status management ⇔ LSP status FSM	SR_STATUS_ ANLSPSTAT	Via SR_STATUS_ANLSPSTAT, the status management process shall update the LSP status FSM.

The AN resource management processes communicate with each other via internal signallists which are declared in Figure 50. Refer to Annex A for the signal declarations.
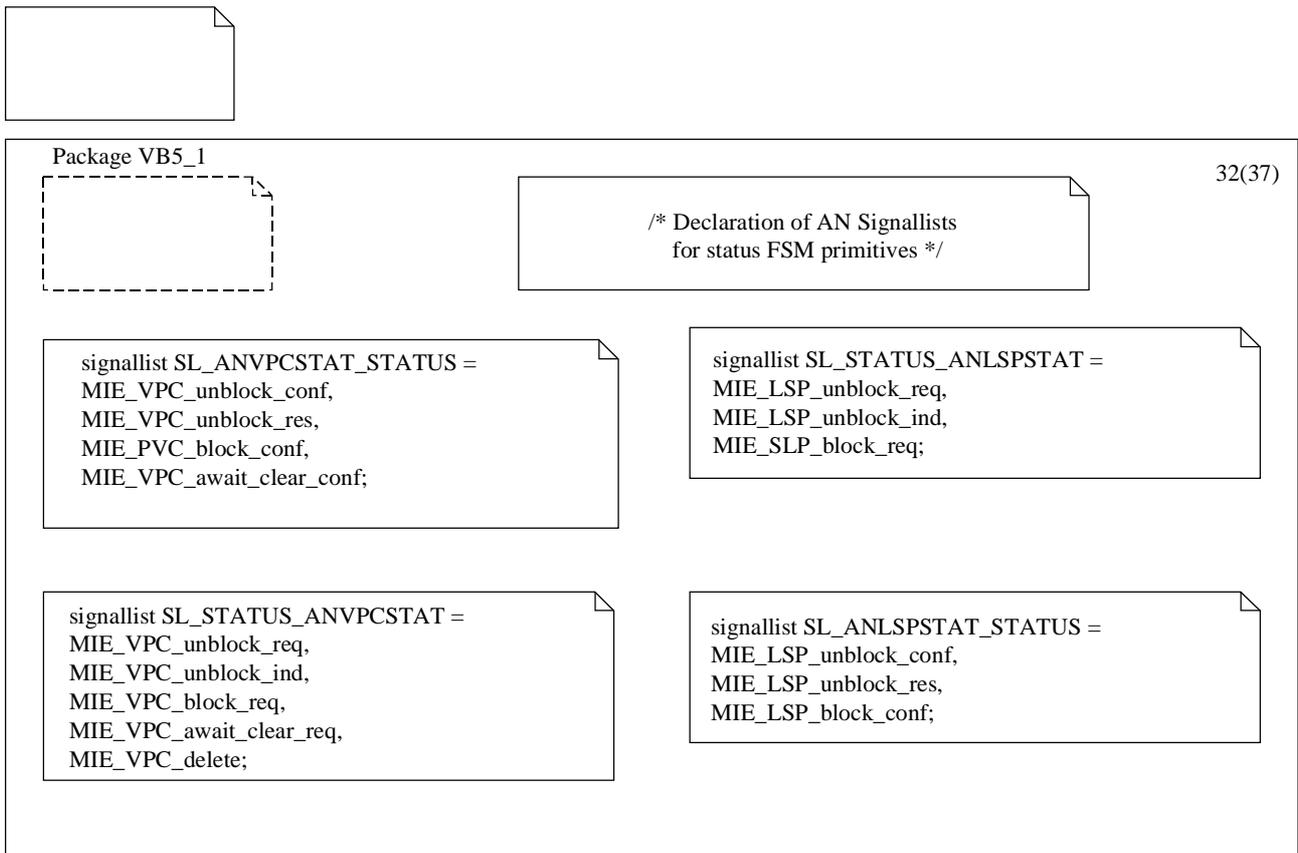
Figure 50/G.967.1 – AN resource management internal signallists

13.2.2.2.2 SN Resource Management

The VB5.1 SN resource management entity, which represents the remote availability status of the VPCs and LSP, consists of three processes. The SN resource management block SN_RSCMGT is shown in Figure 51 and its processes are described in Table 26.
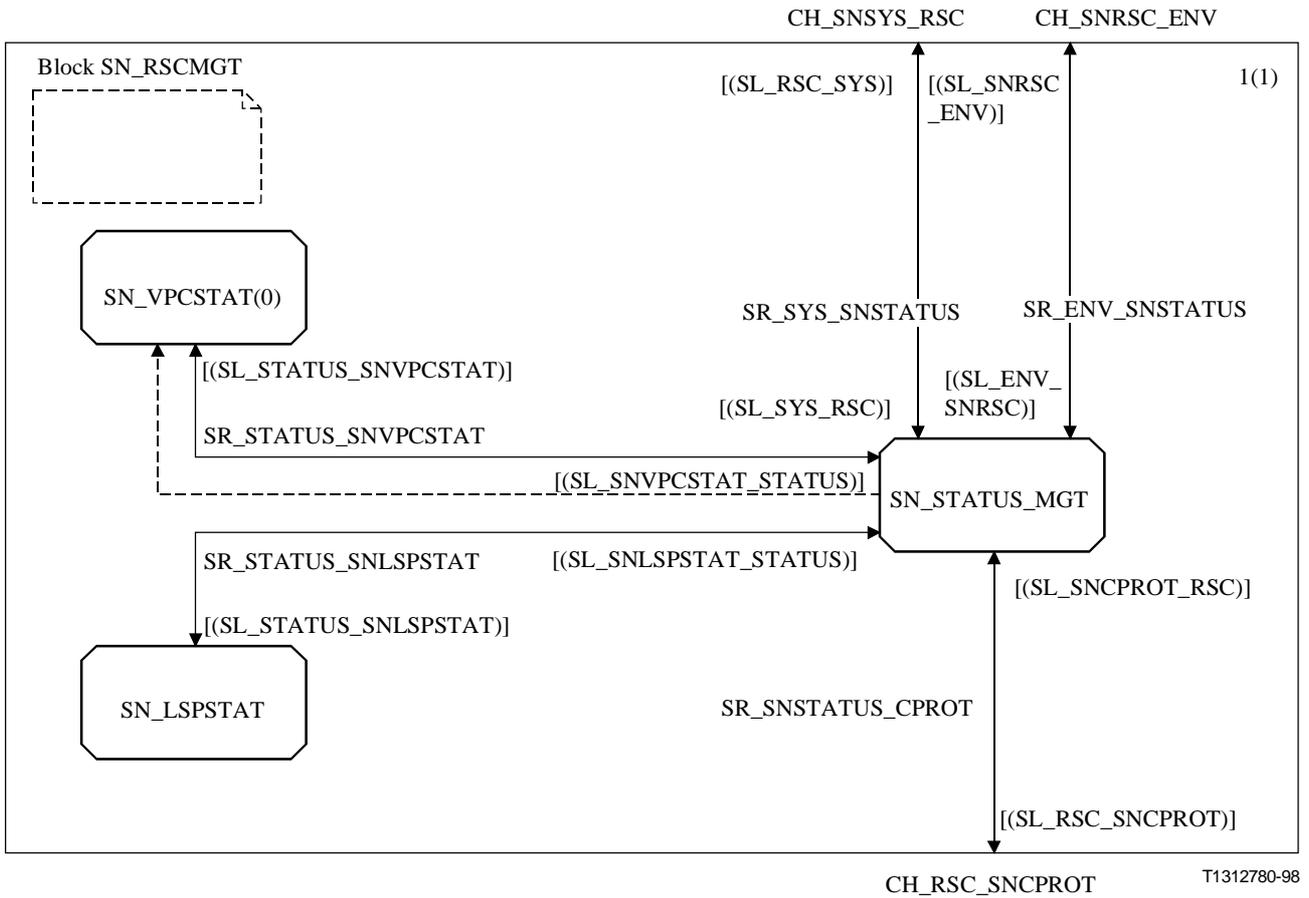
Figure 51/G.967.1 – SN resource management block

Table 26/G.967.1 – SN_RSCMGT processes

Process	Abbreviation in Figure 51	Purpose
SN status manager	SN_STATUS_MGT	Supervises the status changes of VPCs and LSP.
SN VPC status FSMs	SN_VPCSTAT	The VPC status FSMs represent the availability due to local administrative reasons or fault conditions of user VPCs as well as of VB5 VPCs. In the case of a state change, the VPC Status FSM decides upon the message to be sent to the SN. One FSM is provided per VPC.
SN LSP status FSM	SN_LSPSTAT	The LSP status FSMs represent the availability due to local administrative reasons or fault conditions of the VB5.1 interface. In the case of a state change, the LSP Status FSM decides upon the message to be sent to the SN.

The SN resource management processes are connected via signal routes to each other which are defined in Table 27.

Table 27/G.967.1 – Internal signal routes for SN resource management block

Signal route	Abbreviation in Figure 51	Purpose/comments
Status management ⇔ VPC status FSMs	SR_STATUS_ SNVPCSTAT	Via SR_STATUS_SNVPCSTAT, the status management process shall update the VPC status FSMs.
Status management ⇔ LSP status FSM	SR_STATUS_ SNLSPSTAT	Via SR_STATUS_SNLSPSTAT, the status management process shall update the LSP status FSM.

The SN resource management processes communicate with each other via internal signallists which are declared in Figure 52. Refer to Annex A for the signal declarations.

Package VB5_1   33(37)

/* Declaration of SN Signallists
for status FSM primitives */

signallist SL_STATUS_SNVPCSTAT =
MIE_VPC_unblock_ind,
MIE_VPC_unblock_req,
MIE_VPC_block_ind,
MIE_VPC_await_clear_ind,
MIE_VPC_delete;

signallist SL_STATUS_SNLSPSTAT =
MIE_LSP_unblock_ind,
MIE_LSP_unblock_req,
MIE_LSP_block_ind;

signallist SL_SNVPCSTAT_STATUS =
MIE_VPC_unblock_res,
MIE_VPC_unblock_conf,
MIE_VPC_block_res,
MIE_VPC_await_clear_res;

signallist SL_SNLSPSTAT_STATUS =
MIE_LSP_unblock_res,
MIE_LSP_unblock_conf,
MIE_LSP_block_res;

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Figure 52/G.967.1 – SN Resource management internal signallists

13.2.2.3 RTMC protocol entity

13.2.2.3.1 AN RTMC protocol entity

The VB5.1 AN RTMC protocol entity consists of two processes which are describe in Table 28.

Table 28/G.967.1 – AN CPROT processes

Process	Abbreviation in Figure 53	Purpose
AN RTMC protocol manager	AN_MGR_CPROT	Creates dynamically AN_CPROT processes for handling RTMC transactions. Allocates RTMC transaction identifiers.
AN RTMC protocol handler	AN_CPROT	Handles a single RTMC transaction.

The RTMC protocol block is shown in Figure 53.
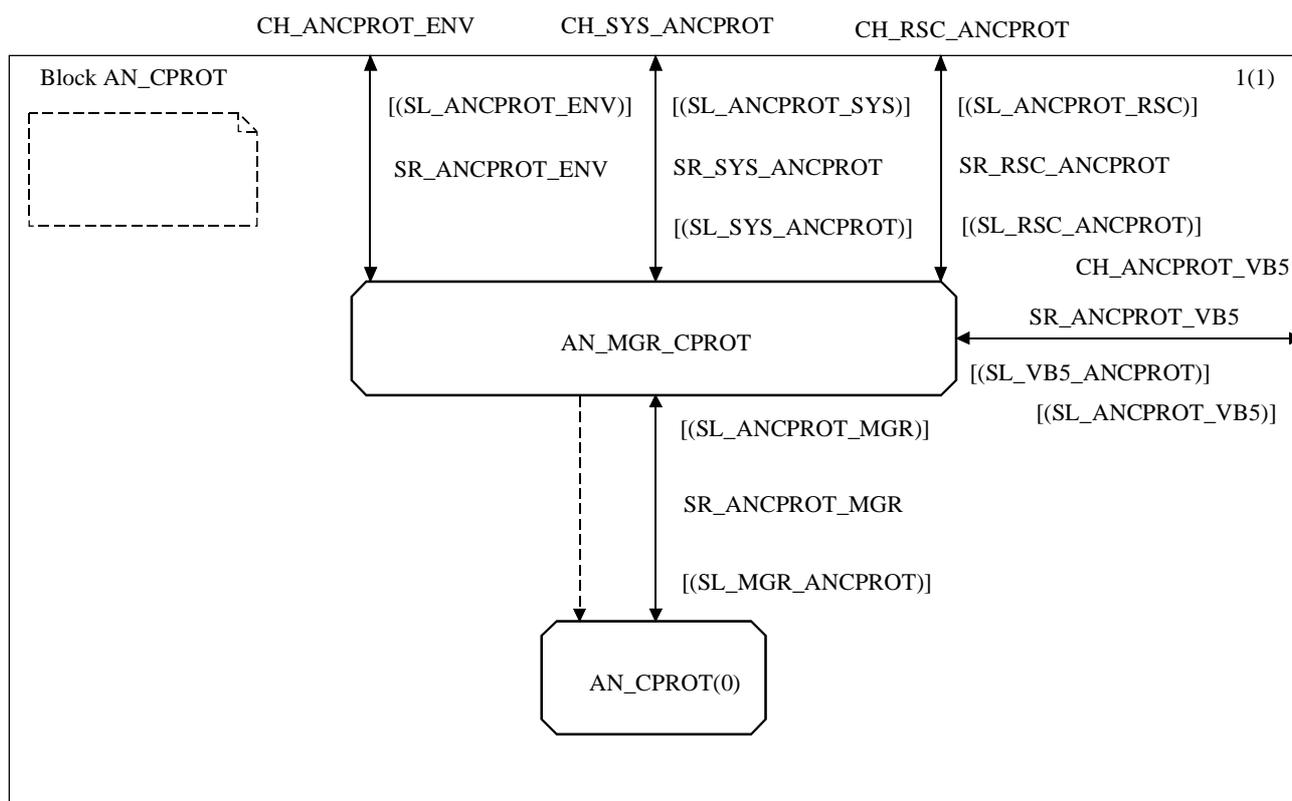
Figure 53/G.967.1 – AN RTMC protocol block

The AN RTMC protocol entity processes are connected via signal routes to each other which are defined in Table 29.

Table 29/G.967.1 – Internal signal routes for AN RTMC protocol entity

Signal route	Abbreviation in Figure 53	Purpose/comments
Protocol management ⇔ Protocol FSMs	SR_ANCPROT_MGR	Via SR_ANCPROT_MGR, the protocol management process creates and controls the protocol FSMs for handling an RTMC transaction.

The processes of AN RTMC protocol entity communicate with each other via internal signallists which are declared in Figure 54. Refer to Annex A for the signal declarations.

/* Declaration of Signallists
   for AN_CPROT */

signallist SL_MGR_ANCPROT =
RTMC_await_clear_ack,
RTMC_await_clear_comp,
RTMC_block_rsc_ack,
RTMC_cons_check_end,
RTMC_cons_check_req,
RTMC_LSPID,
RTMC_protocol_error,
RTMC_req_LSPID,
RTMC_reset_rsc_ack,
RTMC_reset_rsc,
RTMC_unblock_rsc_ack,
RTMC_unknown_message,
RTMC_msg_too_short,
RTMC_trans_id_err,
RTMC_unknown_protdisc,
MIE_LSP_ID_req,
MIE_LSP_ID_res,
MIE_abort_req,
MIE_await_clear_req,
MIE_block_req,
MIE_cons_check_res,
MIE_cons_check_end_res,
MIE_reset_req,
MIE_reset_res,
MIE_unblock_res;

signallist SL_ANCPROT_MGR =
RTMC_await_clear,
RTMC_await_clear_comp_ack,
RTMC_block_rsc,
RTMC_cons_check_end_ack,
RTMC_cons_check_req_ack,
RTMC_LSPID,
RTMC_protocol_error,
RTMC_req_LSPID,
RTMC_reset_rsc_ack,
RTMC_reset_rsc,
RTMC_unblock_rsc,
MIE_LSP_ID_conf,
MIE_LSP_ID_ind,
MIE_await_clear_conf,
MIE_block_conf,
MIE_cons_check_end_ind,
MIE_cons_check_ind,
MIE_error_ind,
MIE_reset_conf,
MIE_reset_ind,
MIE_unblock_conf;

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Figure 54/G.967.1 – Internal signallists for AN RTMC protocol entity

13.2.2.3.2   SN RTMC protocol entity

The VB5.1 SN RTMC protocol entity consists of two processes which are described in Table 30.

Table 30/G.967.1 – SN CPROT processes

Process	Abbreviation in Figure 55	Purpose
SN RTMC protocol manager	SN_MGR_CPROT	Creates dynamically SN_CPROT processes for handling RTMC transactions. Allocates RTMC transaction identifiers.
SN RTMC protocol handler	SN_CPROT	Handles a single RTMC transaction.

The RTMC protocol block with its processes is shown in Figure 55.
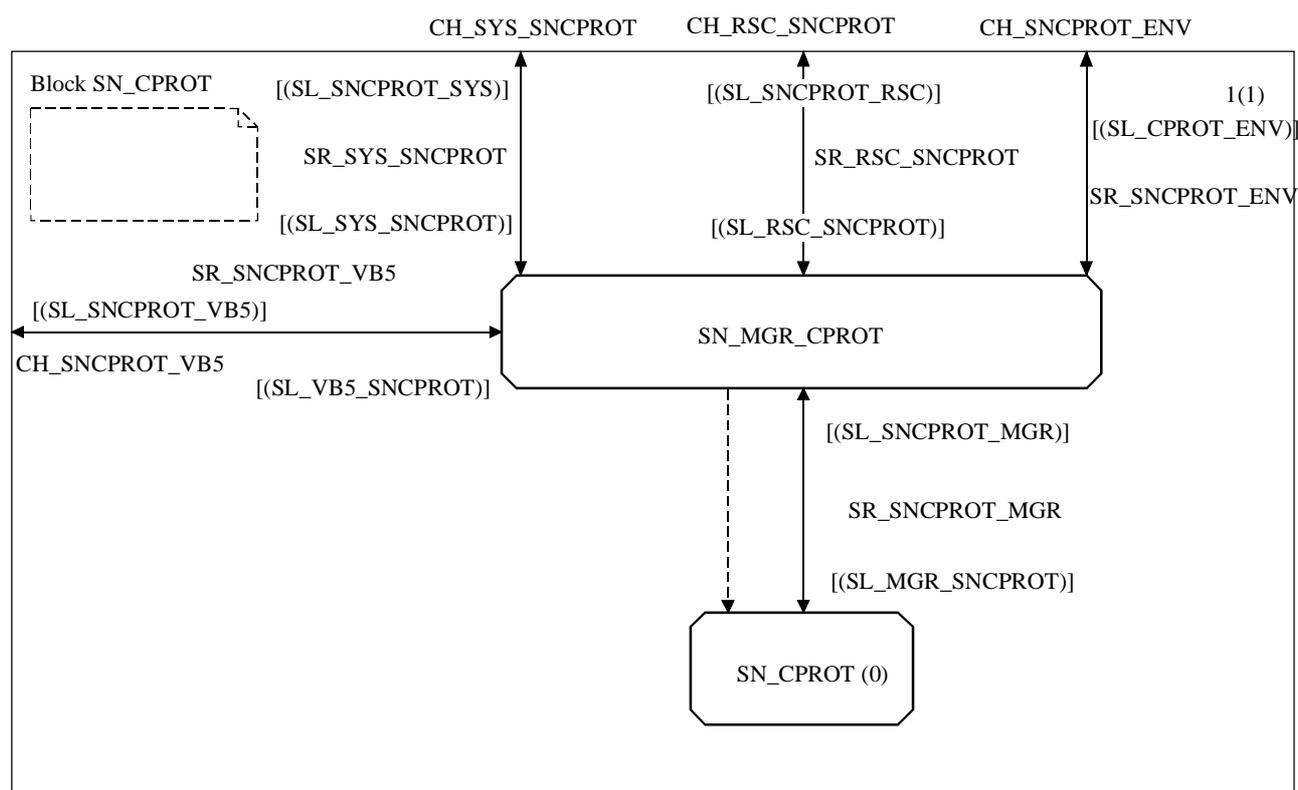
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Figure 55/G.967.1 – SN RTMC protocol block

The SN RTMC protocol entity processes are connected via signal routes to each other which are defined in Table 31.

Table 31/G.967.1 – Internal signal routes for SN RTMC protocol entity

Signal route	Abbreviation in Figure 55	Purpose/comments
Protocol management ⇔ Protocol FSMs	SR_SNCPROT_MGR	Via SR_SNCPROT_MGR, the protocol management process creates and controls the protocol FSMs for handling an RTMC transaction.

The processes of SN RTMC protocol entity communicate with each other via internal signallists which are declared in Figure 56. Refer to Annex A for the signal declarations.

```
                              /* Declaration of Signallists
                                    for SN_CPROT */
```

```
signallist SL_SNCPROT_MGR =          signallist SL_MGR_SNCPROT =
RTMC_await_clear_ack,                RTMC_await_clear,
RTMC_await_clear_comp,               RTMC_await_clear_comp_ack,
RTMC_block_rsc_ack,                  RTMC_block_rsc,
RTMC_cons_check_end,                 RTMC_cons_check_end_ack,
RTMC_cons_check_req,                 RTMC_cons_check_req_ack,
RTMC_LSPID,                          RTMC_LSPID,
RTMC_protocol_error,                 RTMC_protocol_error,
RTMC_req_LSPID,                      RTMC_req_LSPID,
RTMC_reset_rsc_ack,                  RTMC_reset_rsc_ack,
RTMC_reset_rsc,                      RTMC_reset_rsc,
RTMC_unblock_rsc_ack,                RTMC_unblock_rsc,
MIE_LSP_ID_conf,                     RTMC_unknown_message,
MIE_LSP_ID_ind,                      RTMC_msg_too_short,
MIE_await_clear_ind,                 RTMC_trans_id_err,
MIE_block_ind,                       RTMC_unknown_protdisc,
MIE_cons_check_conf,                 MIE_LSP_ID_req,
MIE_cons_check_end_conf,             MIE_LSP_ID_res,
MIE_error_ind,                       MIE_abort_req,
MIE_reset_conf,                      MIE_await_clear_ack,
MIE_reset_ind,                       MIE_await_clear_res,
MIE_unblock_ind;                     MIE_block_res,
                                     MIE_cons_check_end_req,
                                     MIE_cons_check_req,
                                     MIE_reset_req,
                                     MIE_reset_res,
                                     MIE_unblock_res;
```

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Figure 56/G.967.1 – Internal signallists for SN RTMC protocol entity

13.3   RTMC procedures

13.3.1   General principles for the RTMC procedures

This subclause describes principles and mechanisms independent of the specific procedures defined for the VB5.1 reference point.

13.3.1.1   VB5.1 system external events

As specified in clause 11, information related to changes of administrative states of managed entities and fault conditions shall be communicated from the AN to the SN. However, the actions triggered within the environment are filtered and mapped by the environment to the external events as seen by the VB5.1 system. The only AN resources seen by the VB5.1 system are those known to the SN, namely VPCs and LSP. The receiver of the information, the SN, is only interested in the service

relevance of the actions taken in the AN, i.e. the effect on existing connections and the connection set-up handling.

13.3.1.2 Single VP messages and multi-VP messages

Whenever commands are executed in the AN, which manipulate a single VPC or a LSP, the environment informs the VB5.1 system. But also other commands, i.e. locking of a PUP which have VP relevance, are mapped by the environment to VP specific actions and forwarded to the VB5.1 system. In that case, VB5.1 system management may receive, together with the action required, a list of affected VPCs. To avoid the generation of a multitude of messages of the same type, VB5.1 system management uses the list and requests the AN RTMC protocol entity to build a message where the resource identifier information elements are repeated. This method is used as a mere optimization; the VB5 logic is VPCI or LSP based. The method has some impact on the use of the transaction identifier (see 13.3.3).

The SAAL transfers SDUs up to 4096 octets. The RTMC protocol keeps track of that restriction and supports the decomposition of lists of VPCs into multiple messages. For the AN environment, this decomposition is transparent and therefore it shall receive one primitive as acknowledgement. The decomposition is also transparent to the receiver in the SN. In the SN, it is seen as two independent transactions.

13.3.1.3 Acknowledgements

The VB5.1 RTMC protocol makes use of the assured data transfer mode of SAAL. SAAL takes care for the transport of the messages. In addition, functional acknowledgements for all applications using the RTMC protocol are introduced to keep the synchronization between AN and SN as close as possible. The receiving application shall return a positive response, if it will execute, or has executed, the requested action or if no action has to performed. The receiving application shall return a negative response if the requested action can not be performed. To indicate the status, the resource identifier information element is contained in the acknowledgement.

13.3.1.4 Use of transaction identifiers

In general, a protocol transaction consists of a pair of a requesting message together with the corresponding acknowledgement and is identified by a transaction identifier.

An RTMC transaction is initiated by an RTMC message from either the SN side or from the AN side and terminated by the acknowledgement from the peer side.

Transaction identifier values are assigned by the originating side of the interface for a transaction. These values are unique to the originating side only assigned at the beginning of a transaction and remains fixed for the lifetime of a transaction. After a transaction ends, the associated transaction identifier value may be reassigned to a later transaction. Two identical transaction identifier values may be used when each value pertains to a transaction originated at opposite sides of the VB5.1 interface.

To avoid race conditions in certain error scenarios, it is suggested that implementors avoid immediate re-use of the transaction identifier values after they are released.

The transaction identifier flag can take the values "0" or "1". The transaction identifier flag is used to identify which side of the interface originated a transaction identifier. The originating side always sets the transaction identifier flag to "0". The destination side always sets the transaction identifier flag to a "1".

Hence, the transaction identifier flag identifies, who allocated the transaction identifier value; the only purpose of the transaction identifier flag is to resolve simultaneous attempts to allocate the same transaction identifier value.

For the coding of the transaction identifier, reference shall be made to a 14.1.1 item b).

13.3.1.5 General error handling

This subclause provides the general description for exceptional procedures. They apply to all of the procedures described in the following subclauses, unless otherwise specified.

13.3.1.5.1 Handling of protocol error conditions

All VB5.1 RTMC messages must pass the checks described in this subclause.

Detailed internal error handling procedures are implementation dependent and may vary from network to network. However, capabilities facilitating the orderly treatment of error conditions are provided for in this subclause and shall be provided in each implementation.

Items a) through h) are listed in order of precedence.

a)   *Protocol discrimination error*

When a message is received with a protocol discriminator coded other than specified in 14.1.1, that message shall be ignored. "Ignore" means to do nothing, as if the message had never been received.

b)   *Message too short*

When a message is received that is too short to contain a complete message length information element, that message shall be ignored.

c)   *Transaction identifier error*

1)   *Invalid transaction identifier format*

If the transaction identifier information element octet 1, bits 5 through 8, do not equal 0000, then the message shall be ignored.

If the transaction identifier information element octet 1, bits 1 through 4, indicate a length other than 3 octets (see 14.1.1), then the message shall be ignored.

2)   *Transaction identifier procedural errors*

–   When an acknowledgement message is received specifying a transaction identifier which is not recognized as relating to an active transaction in progress, no action should be taken.

–   When a message is received specifying a transaction identifier which is not recognized as relating to an active transaction in progress, and with a transaction identifier flag incorrectly set to "1", this message shall be ignored.

–   When an invoke message is received specifying a transaction identifier which is recognized as relating to an active transaction in progress, this message shall be ignored.

d)   *Message type or message sequence errors*

These error procedures apply only if the flag in the message compatibility instruction indicator is set to "message instruction field not significant". If it is set to "follow explicit instructions", the procedures in 14.1.7.2 take precedence.

Whenever an unexpected message or an unrecognized message is received, then a protocol error message containing a protocol error cause value of either "message not compatible with path state" or "message type unrecognized" shall be sent and no state change shall occur.

e) *Message length error*

   If the message length indicated in the message length information element is inconsistent with the length of the message actually received, the message shall be handled normally as far as possible and, if necessary, the error handling procedures of item f) shall be followed.

f) *General information element errors*

   1) *Information element sequence*

   If more than one information element of the same type is included in a message, and the repeated information elements do not immediately follow the preceding occurrence of this information element type, the receiving entity shall ignore subsequent information element of this type. The repeat indicator information element has to be placed in front of a list of information elements. Otherwise only the first information element from the list shall be handled and the rest shall be ignored.

   2) *Duplicated information elements*

   If an information element is repeated in a message in which repetition of the information element is not permitted, only the contents of the information element appearing first shall be handled and where all subsequent repetitions of the information element shall be ignored.

g) *Mandatory information element error*

   1) *Mandatory information element missing*

   When a message is received which has one or more mandatory information elements missing, then a protocol error message containing a protocol error cause value of "mandatory information element missing" shall be sent and no state change shall occur.

   2) *Mandatory information element content error*

   The error procedures in this subclause apply only if the flag (bit 5) in the instruction field is set to "IE instruction field not significant". If it is set to "follow explicit instruction", the procedures in 14.1.7.2 take precedence.

   When a message is received which has one or more mandatory information elements with invalid content, no action shall be taken on the message.

   Information elements with a length exceeding its maximum length will be treated as information element with content error.

h) *Non-mandatory information element errors*

   The error procedures in this subclause apply only if the flag (bit 5) in the instruction field is set to "IE instruction field not significant". If it is set to "follow explicit instruction", the procedures in 14.1.7.2 take precedence.

   The following identify actions on information elements not recognized as mandatory.

   1) *Unrecognized information element*

   When a message is received that has one or more unrecognized information elements, then the receiving entity shall proceed as follows.

   Action shall be taken on the message and those information elements which are recognized and have valid content.

   2) *Non-mandatory information element content error*

   When a message is received which has one or more non-mandatory information elements with invalid content, action shall be taken on the message and those information elements which are recognized and have valid content.

Information elements with a length exceeding the maximum length will be treated as an information element with content error.

3) *Unexpected recognized information element*

When a message is received with a recognized information element that is not defined to be contained in that message, the receiving entity shall (except as noted below) treat the information element as an unrecognized information element and follow the procedures defined in item 1).

NOTE – Some implementations may choose to process unexpected recognized information elements when the procedure for processing the information element is independent of the message in which it is received.

13.3.1.5.2 Error procedures with explicit action indication

The procedures to be used only if the flag of the message compatibility instruction indicator or information element instruction field is set to "follow explicit instructions" are defined in 14.1.7.2.

13.3.1.5.3 Error in communication with peer network element

It is the task of the RTMC protocol entity to supervise the acknowledgement messages by timers. The timer values shall be application dependent. In the case of time-out, the messages are repeated once. After the second time-out, a negative confirmation or an error indication is sent to the environment.

13.3.1.5.4 Resources unknown in peer network element

If the receiving application can not perform the requested action on the indicated resource, i.e. it is unknown to the receiver, this has to be reported to the peer side. An acknowledgement is used, where the result is given in the result indicator information element via an error code. The unknown resources are indicated in the unknown resource identifier parameter. In the case of a multi-VP message, the resource identifiers are repeated. In a multi-VP message, only the resource identifiers with negative acknowledgements are listed.

13.3.1.5.5 Requested operation rejected by peer network element

If the environment at the peer network element (i.e. the receiving application within the environment) can not accept or perform the requested operation, this has to be reported to the invoke network element. The relevant acknowledgement message will give the rejection in the result indicator parameter via an error code.

13.3.2 Coordination of resource status change procedures

Status changes occur due to administrative actions or the occurrence of a fault condition which affects VPCs or the LSP. To report status changes of VPCs or the LSP from the AN to the SN, the following principles apply:

a) The AN environment shall inform the VB5.1 system about service relevant status changes of VPCs or the LSP. The AN environment shall provide the AN VB5.1 system with the full information about the reasons of status changes.

b) The AN VB5.1 system has the full knowledge about the current status of the VPCs and the LSP. The VPC/LSP status in the AN is reflected by the states of the AN_LSPSTAT and AN_VPCSTAT processes.

c) In the case of status changes, the AN_LSPSTAT and AN_VPCSTAT processes determine the appropriate RTMC messages and blocking reasons to be sent to the SN based on the primitives received at the primitive interface.

d)   The current service relevant status in the SN is reflected by the states of the SN_LSPSTAT and SN_VPCSTAT processes. Error states are, regardless of the service relevance to the SN, always reported to allow in the SN the distinction of unavailability because of error or administrative reasons.

e)   As long as a VPC or the LSP is not fully available for service, state changes shall only be reported to the SN by using BLOCK_RSC messages. The UNBLOCK_RSC message shall only be sent if a VPC or the LSP is fully available for service again.

f)   The SN_LSPSTAT and SN_VPCSTAT processes act as a pure slave of the AN_LSPSTAT and AN_VPCSTAT processes, i.e. they perform no self-standing state event logic but take the blocking reason delivered by the AN as the new overall status of the reported resource.

g)   After successful completion of a start-up or reset of complete LSP operation, the status of all VPCs and the LSP are unblocked at both the AN and SN. If VPCs are not available for service due to administrative reasons or fault conditions, they shall be blocked again via the block resource procedure triggered by AN environment.

13.3.2.1   Block and unblock procedures

13.3.2.1.1   General

The block/unblock procedures are used by the AN to inform the SN about the service relevance of the administrative actions taken in the AN as well of fault conditions occurring in the AN.

Administrative actions:

–   a lock/unlock of a VPC;

–   a partial lock/unlock of the LSP;

–   a lock or partial lock/unlock of an object which affects VPCs.

Fault conditions:

–   occurrence/disappearance of a fault which affects a VPC or VPCs;

–   occurrence/disappearance of a LSP fault.

As the effect on normal connections in the SN (see Table 32) is independent whether a lock or partial lock is applied or a fault occurred, the same messages are used. Nevertheless, the SN needs the information whether a resource is not available for normal service but is available for test connections, whether no service at all is possible or a fault occurred. This is done by using the following reason codes in the block messages:

–   admFull: resource not available due to administrative actions in the AN. It does not necessarily mean that the resource is locked in the AN;

–   admPart: resource not available for on-demand connections due to administrative reasons in the AN, but available for test connections and (semi-)permanent connections;

–   Err: resource not available due to a fault condition in the AN.

The reason code admFull does not apply for the resource complete LSP.

The meaning of the UNBLOCK_RSC message is as follows:

–   all blocking conditions are cleared and the resource is available for service again.

13.3.2.1.2 Procedure

The AN environment determines whether the administrative action or the occurrence of a fault condition has service relevance for the SN; only in this case the meeBlockRscReq primitive is sent.

That applies also for multiple VP messages, where only those VPCs are listed which undergo a state change which has service relevance.

In all cases, VB5.1 system management is triggered by a meeBlockRscReq primitive which includes the reason code (see Figure 57). The state change indicated in the meeBlockRscReq primitive is reported to the SN by the BLOCK_RSC message.

When receiving a BLOCK_RSC message, the SN VB5.1 system informs the environment. The reaction is listed in Table 32.

Table 32/G.967.1 – Effect of block message in the SN

Resource	Action in the SN environment
VPC	– all switched connections allocated to that VPC are released; – no new connections are allocated to that VPC. Whether test calls are possible or not is controlled by the remote blocked state in the SN, which reflects the reason code in the BLOCK_RSC.
Complete LSP	– all switched connections allocated to that LSP are released; – no new connections are allocated to that LSP with the exception that test calls are possible, because the only reason code allowed is admPart; – no impact on the VCC carrying the RTMC protocol.
NOTE – For VPCs cross connected in the SN, no action is taken.	

The SN acknowledges the BLOCK_RSC by a BLOCK_RSC_ACK if the affected entities have changed their state.

If all blocking and error conditions are cleared in the AN, VB5.1 system management is informed via the meeUnblockRscReq primitive.

The relationship between the MEE primitives and the messages exchanged across the VB5.1 reference point are specified in Table 33 for the AN side and in Table 34 for the SN side. These tables shows the principles of the interaction between block, unblock and await clear, i.e. how the primitives from the environment, the AN internal states of the status FSM and the VB5.1 messages are related in the case the treated entity is a VPC. For the LSP resource a subset applies. These tables reflects the clear separation of fault condition processing and processing of administrative actions.

Table 33/G.967.1 – Relationship between MEE primitives and messages at AN side

admin state	unlocked					shutting down	locked	
partadmin state	unlocked		locked		shutting down			
operational state	enabled	disabled	enabled	disabled	enabled		enabled	disabled
SDL state	LocUbl	LocErr	LocPartBl	LocPartBlErr	LocShutDown	LocShutDown	LocFullBl	LocFullBlErr
Column index / Event	1	2	3	4	5	6	7	8
meeUnblockRscReq	UNBLOCK_RSC; –	UNBLOCK_RSC; LocUbl	UNBLOCK_RSC; LocUbl	UNBLOCK_RSC; LocUbl	UNBLOCK_RSC; LocUbl	UNBLOCK_RSC; LocUbl	UNBLOCK_RSC; LocUbl	UNBLOCK_RSC; LocUbl
meeBlockRscReq (E)	BLOCK_RSC (E); LocErr	BLOCK_RSC (E); –	BLOCK_RSC (E); LocErr	BLOCK_RSC (E); LocErr	BLOCK_RSC (E); LocErr	BLOCK_RSC (E); LocErr	BLOCK_RSC (E); LocErr	BLOCK_RSC (E); LocErr
meeBlockRscReq (F)	BLOCK_RSC (F); LocFullBl	BLOCK_RSC (F); LocFullBl	BLOCK_RSC (F); LocFullBl	BLOCK_RSC (F); LocFullBl	BLOCK_RSC (F); LocFullBl	BLOCK_RSC (F); LocFullBl	BLOCK_RSC (F); –	BLOCK_RSC (F); LocFullBl
meeBlockRscReq (F, E)	BLOCK_RSC (F, E); LocFullBlErr	BLOCK_RSC (F, E); LocFullBlErr	BLOCK_RSC (F, E); LocFullBlErr	BLOCK_RSC (F, E); LocFullBlErr	BLOCK_RSC (F, E); LocFullBlErr	BLOCK_RSC (F, E); LocFullBlErr	BLOCK_RSC (F, E); LocFullBlErr	BLOCK_RSC (F, E); –
meeBlockRscReq (P)	BLOCK_RSC (P); LocPartBl	BLOCK_RSC (P); LocPartBl	BLOCK_RSC (P); –	BLOCK_RSC (P); LocPartBl	BLOCK_RSC (P); LocPartBl	BLOCK_RSC (P); LocPartBl	BLOCK_RSC (P); LocPartBl	BLOCK_RSC (P); LocPartBl
meeBlockRscReq (P, E)	BLOCK_RSC (P, E); LocPartBlErr	BLOCK_RSC (P, E); LocPartBlErr	BLOCK_RSC (P, E); LocPartBlErr	BLOCK_RSC (P, E); –	BLOCK_RSC (P, E); LocPartBlErr	BLOCK_RSC (P, E); LocPartBlErr	BLOCK_RSC (P, E); LocPartBlErr	BLOCK_RSC (P, E); LocPartBlErr
meeAwaitClearReq	AWAIT_CLEAR; LocShutDown	X	AWAIT_CLEAR; LocShutDown	X	AWAIT_CLEAR; –	AWAIT_CLEAR; –	X	X
AWAIT_CLEAR_COMP	meeAwaitClearConf; –	meeAwaitClearConf; –	meeAwaitClearConf; –	meeAwaitClearConf; –	meeAwaitClearConf; –	meeAwaitClearConf; –	meeAwaitClearConf; –	meeAwaitClearConf; –
reset	–; –	–; LocUbl	–; LocUbl	–; LocUbl	–; LocUbl	–; LocUbl	–; LocUbl	–; LocUbl

In this table, the following abbreviations for the reason codes apply:

F   admFull

P   admPart

E   Err

X   unexpected event

Table 34/G.967.1 – Relationship between MEE primitives and messages at SN side

	remoteUnblocked	remoteAwaitClear	remoteBlocked				
admin	none	shutting down	none	adminPartial		adminFull	
error	none		error	none	error	none	error
SDL state	RemUbl	RemShutDown	RemErr	RemPartBl	RemPartBlErr	RemFullBl	RemFullBlErr
Event \ Column index	1	2	3	4	5	6	7
UNBLOCK_RSC	meeUnblockRscInd; –	meeUnblockRscInd; RemUbl	meeUnblockRscInd; RemUbl	meeUnblockRscInd; RemUbl	meeUnblockRscInd; RemUbl	meeUnblockRscInd; RemUbl	meeUnblockRscInd; RemUbl
AWAIT_CLEAR	meeAwaitClearInd; RemShutDown	meeAwaitClearInd; –	meeAwaitClearInd; RemShutDown	meeAwaitClearInd; RemShutDown	meeAwaitClearInd; RemShutDown	meeAwaitClearInd; RemShutDown	meeAwaitClearInd; RemShutDown
meeAwaitClearRes	AWAIT_CLEAR_COMP; –	AWAIT_CLEAR_COMP; –	AWAIT_CLEAR_COMP; –	AWAIT_CLEAR_ COMP; –	AWAIT_CLEAR_ COMP; –	AWAIT_CLEAR_ COMP; –	AWAIT_CLEAR_ COMP; –
BLOCK_RSC (P)	meeBlockRscInd (P); RemPartBl	meeBlockRscInd (P); RemPartBl	meeBlockRscInd (P); RemPartBl	meeBlockRscInd (P); –	meeBlockRscInd (P); RemPartBl	meeBlockRscInd (P); RemPartBl	meeBlockRscInd (P); RemPartBl
BLOCK_RSC (F)	meeBlockRscInd (F); RemFullBl	meeBlockRscInd (F); RemFullBl	meeBlockRscInd (F); RemFullBl	meeBlockRscInd (F); RemFullBl	meeBlockRscInd (F); RemFullBl	meeBlockRscInd (F); –	meeBlockRscInd (F); RemFullBl
BLOCK_RSC (E)	meeBlockRscInd (E); RemErr	meeBlockRscInd (E); RemErr	meeBlockRscInd (E); –	meeBlockRscInd (E); RemErr	meeBlockRscInd (E); RemErr	meeBlockRscInd (E); RemErr	meeBlockRscInd (E); RemErr
BLOCK_RSC (P, E)	meeBlockRscInd (P, E); RemPartBlErr	meeBlockRscInd (P, E); RemPartBlErr	meeBlockRscInd (P, E); RemPartBlErr	meeBlockRscInd (P, E); RemPartBlErr	meeBlockRscInd (P, E); –	meeBlockRscInd (P, E); RemPartBlErr	meeBlockRscInd (P, E); RemPartBlErr
BLOCK_RSC (F, E)	meeBlockRscInd (F, E); RemFullBlErr	meeBlockRscInd (F, E); RemFullBlErr	meeBlockRscInd (F, E); RemFullBlErr	meeBlockRscInd (F, E); RemFullBlErr	meeBlockRscInd (F, E); RemFullBlErr	meeBlockRscInd (F, E); RemFullBlErr	meeBlockRscInd (F, E); –
reset	–; –	–; RemUbl	–; RemUbl	–; RemUbl	–; RemUbl	–; RemUbl	–; RemUbl

In this table, the following abbreviations for the reason codes apply:

F   admFull

E   Err

P   admPart

The input are the MEE primitives from the environment; the states and the respective state transitions are the states as defined in VPCSTAT, LSPSTAT (see Annex A) and the actions are the messages generated by AN_CPROT for transmission to the SN. Not shown are the acknowledgements which come either from the SN and are passed to the environment without affecting the state, or in the case where the requested action has no service relevance for the SN, are immediately acknowledged by VB5.1 system management.

Figure 58 shows the unblock procedure, where after a full block condition the service becomes available again.

Figure 59 shows the blocking of a PUP which results in a BLOCK_RSC message which contains a list of VPCs. In the case where the SN successfully executes the complete list, a list in the BLOCK_RSC_ACK message may be omitted.

Figure 60 shows the blocking of a PUP, where not all reported VPCs by the AN are known to the SN. Still, the BLOCK_RSC is acknowledged via a BLOCK_RSC_ACK message. Via the resource identifier element in the message (see 14.2.12) the resource (LUP ID, VPCI2) is reported as unknown. This situation is considered to be a problem of coordinated provisioning and is therefore brought via the SN and AN environment to the operator's attention.

If a PUP is unlocked and many VPCs are affected, then some of the VPCs may remain in a block condition while others may change to the unblock state. So AN environment generates two types of primitives:

– meeUnblockRscReq primitive with the list of VPCs, which are available for service;

– meeBlockRscReq primitive for those VPCs remaining in a block condition, but the change within the block condition has service relevance, i.e. change from full blocked to partial blocked.
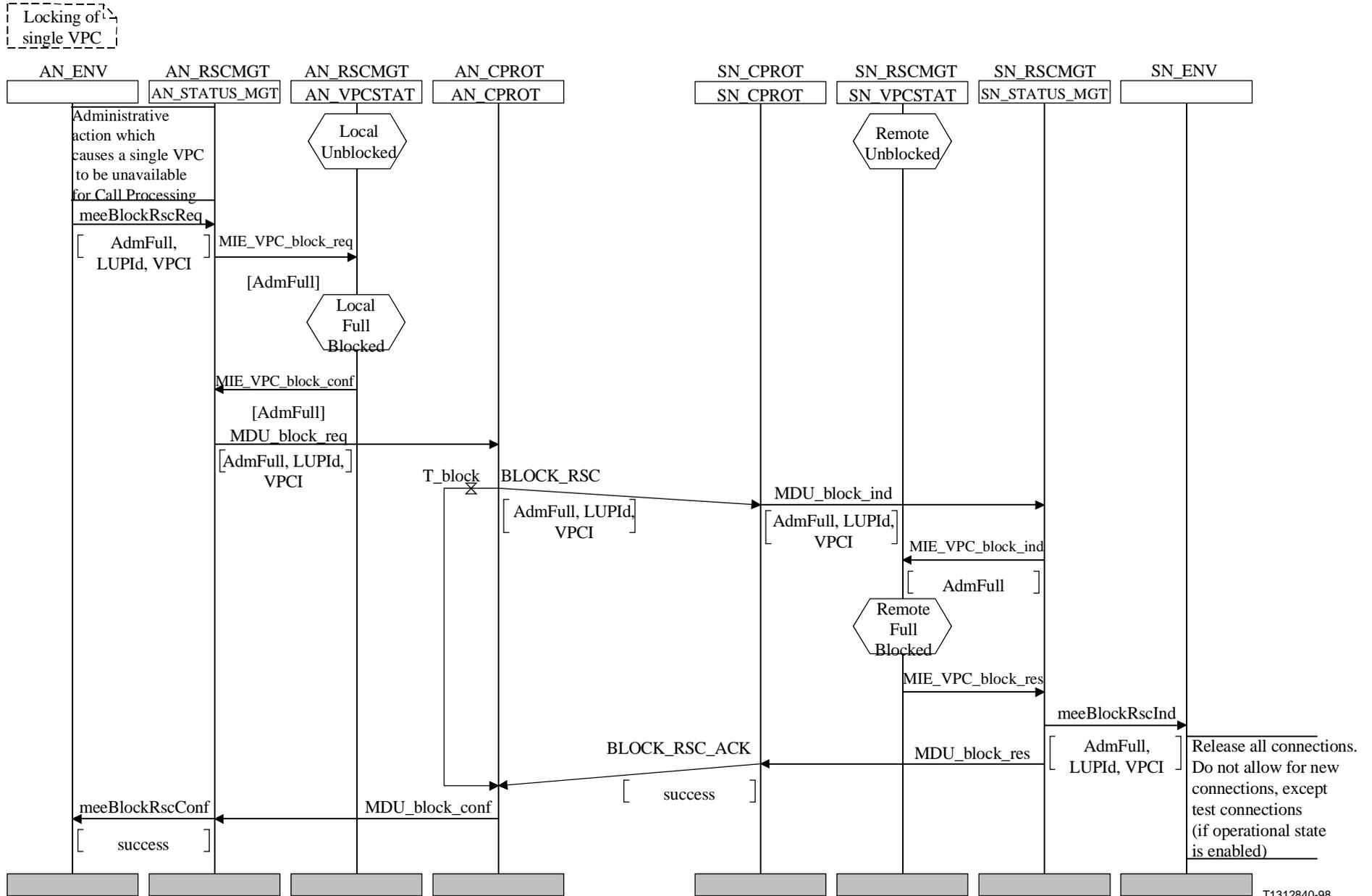
Figure 57/G.967.1 – Blocking of single VPC
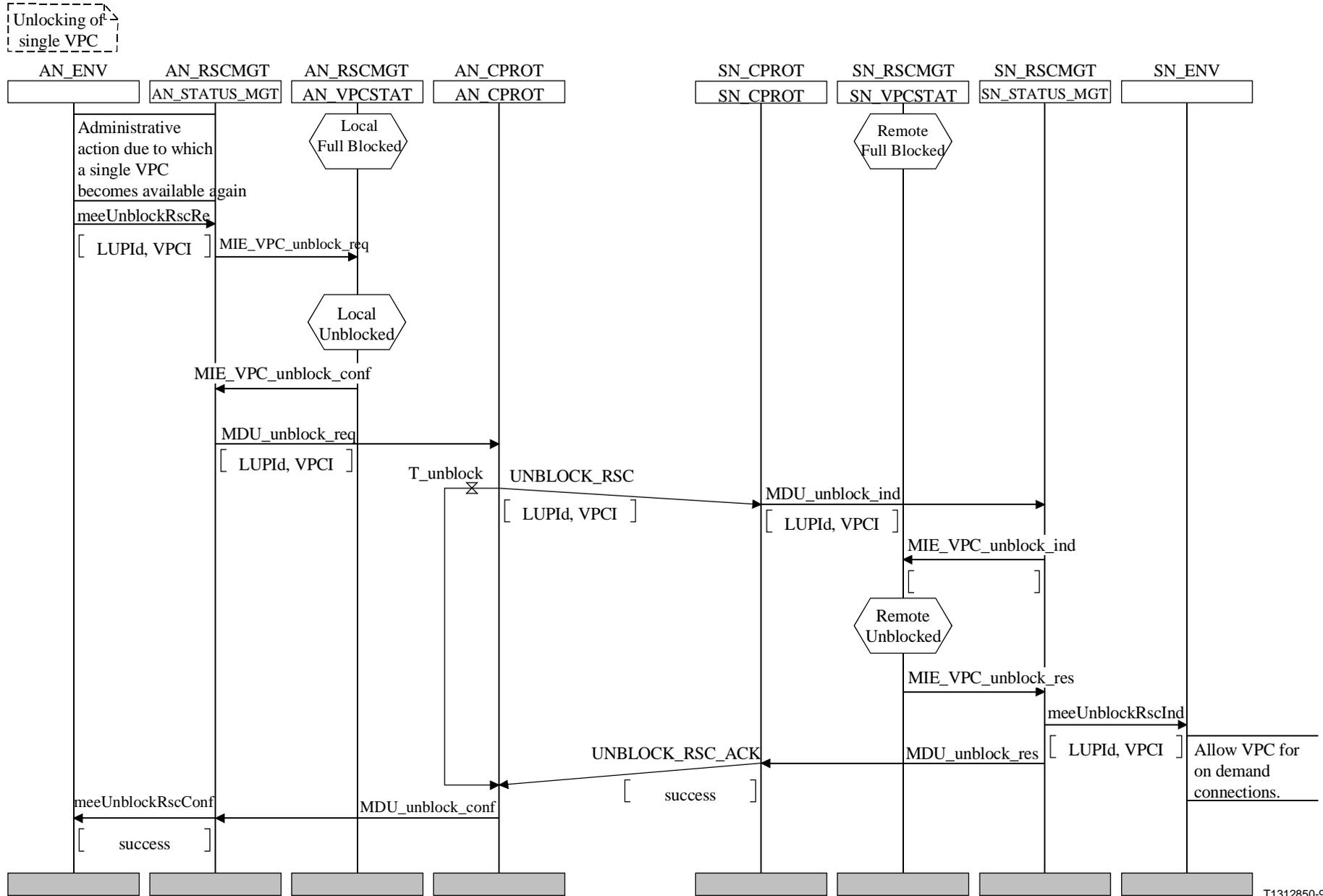
Figure 58/G.967.1 – Unblocking of single VPC
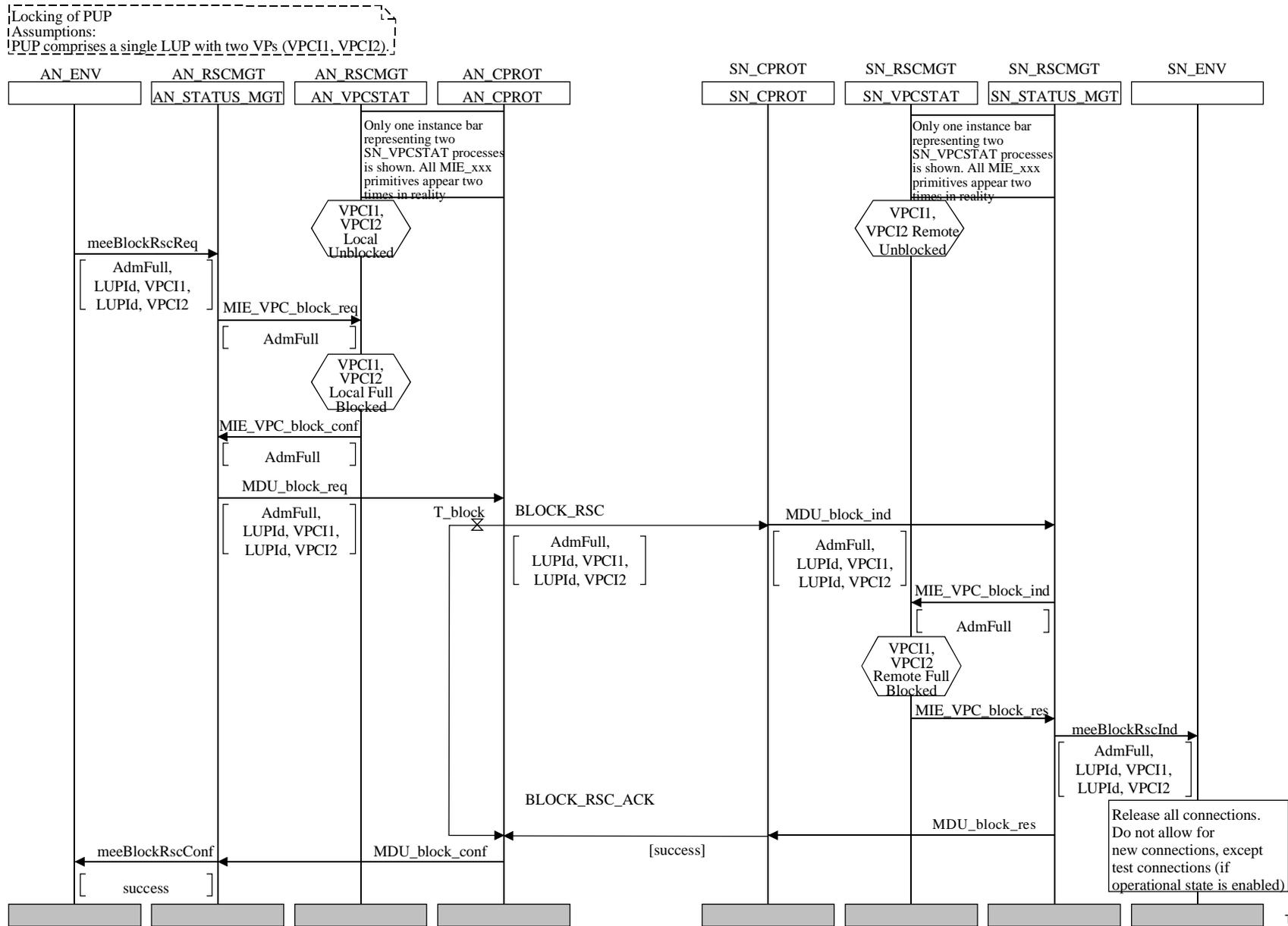
Figure 59/G.967.1 – Blocking of a PUP, normal case
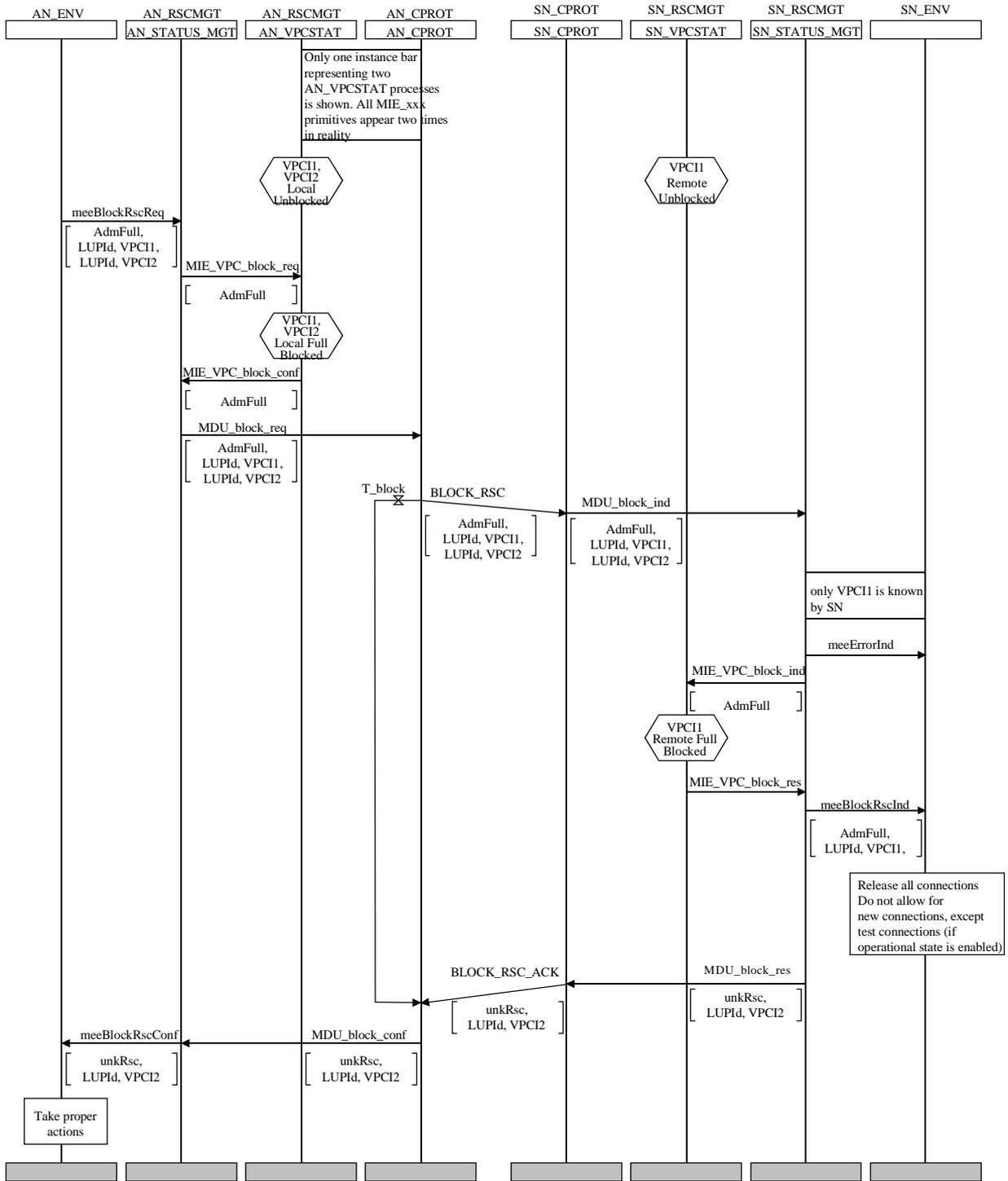
Figure 60/G.967.1 – Blocking of a PUP, exceptional case

13.3.2.1.3 Exceptional procedures

When the BLOCK_RSC/BLOCK_RSC_ACK or UNBLOCK_RSC/UNBLOCK_RSC_ACK message transmission fails (i.e. if either timer "T_block" or "T_unblock" expires for more than the maximum number of message repetitions), the AN environment is informed. A negative meeBlockRscConf/meeUnblockRscConf primitive is issued, for which the result attribute gives the indication "transmissionError".

When one or more of the indicated resources are unknown at the peer network element (i.e. service node), the unknown resources are included in the BLOCK_RSC_ACK/UNBLOCK_RSC_ACK messages with the indication "unknownResources". This information is reported to the AN environment (see Figure 60).

13.3.2.2 Shutting down of resources

13.3.2.2.1 General

The shutting down of resources as seen by the operator as a graceful locking/partial locking is broken down into two procedures on VB5.1 system level:

– shutting down procedure;

– block procedure (see 13.3.2.1).

This subclause deals with the shutting down procedure. For shutdown or partial shutdown of a resource, the same procedure applies. The operator may at any point of time unlock or lock resources, i.e. VPCs, for which the shutting down procedure is running.

13.3.2.2.2 Procedure

The shutting down procedure is subdivided into two independent transactions (see Figure 61):

a) AWAIT_CLEAR/AWAIT_CLEAR_ACK

The AN VB5.1 system is triggered by the AN environment via a meeAwaitClearReq primitive, which may include a list of VPCs. The shutting down procedure via the VB5.1 interface is identical for partial shutting down and shutting down. AN environment has to coordinate the possible interactions between partial shutting down and shutting down.

The response (AWAIT_CLEAR_ACK) from the SN also refers to the received list of VPCs and indicates that the shutting down in the SN is in progress. The acknowledgement is not shown in the table because it has no effect on the states and normally no effect on the environment. Only in the case when the SN reports VPCs for which the shutdown procedure in the SN could not be started, is a meeAwaitClearConf given to the environment (see below).

b) AWAIT_CLEAR_COMP/AWAIT_CLEAR_COMP_ACK

Even when using multi-VPC messages the shut-down procedure works on VPC basis. VB5.1 system management in the SN is triggered by the environment whenever a VPC or some VPCs are free of switched connections. VPCs which contain only permanent connections or no connections are reported immediately. This results in multiple transactions generated by SN_CPROT. Tables 33 and 34 also show this transaction. Dependent on the current state in the AN_VPCSTAT/AN_LSP_STAT, VB5.1 system management determines which primitive has to be passed to the AN environment. It is the AN environment which correlates the received AWAIT_CLEAR_COMP messages and finally triggers the VB5.1 system with a meeBlockRscReq primitive. Figure 61 further clarifies the principle of using individual AWAIT_CLEAR_COMP transactions. While a resource is being shut down, the AN operator may perform actions on VB5.1 specific or AN internal entities, which have

effects on VPCs being shut down and therefore VB5.1 system is triggered. The example (see Figure 62) shows the blocking of VPCs which are in the shutting-down state. For the AN VB5.1 system it is a new transaction, which is immediately executed. For the affected VPCs the shutdown is stopped and these VPCs will no longer be reported in a AWAIT_CLEAR_COMP message. The AN environment has to supervise and coordinate the operator actions.

Tables 33 and 34 summarizes the interaction between the environment and VB5.1 management for the shutting-down procedure in the AN.

Shutting down in the state "blocked partial" is a valid action to allow the graceful termination of test calls.

Figure 61/G.967.1 – Shutting down of a PUP: Normal case
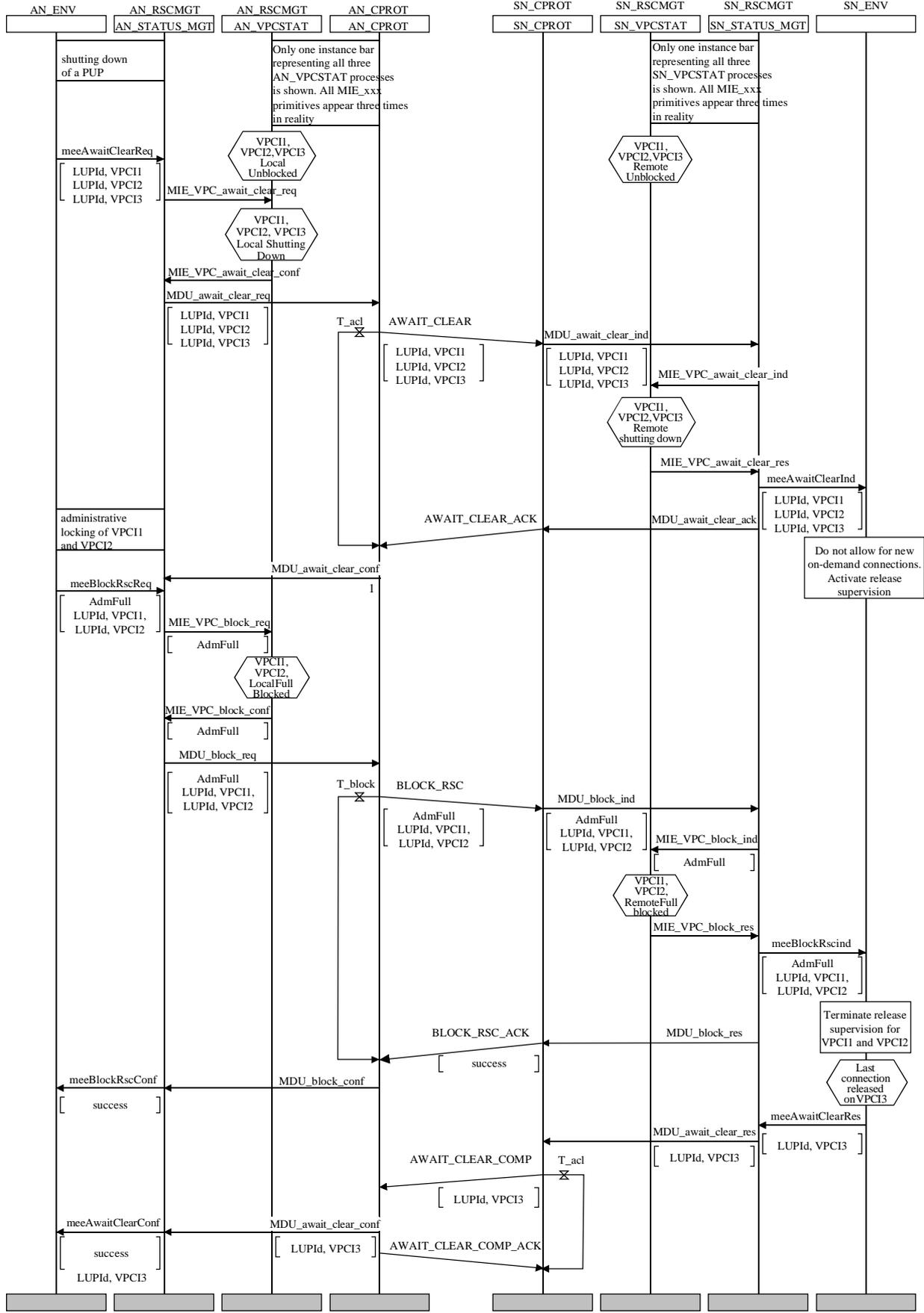
Figure 62/G.967.1 – Shutting down of PUP: Operator interference

13.3.2.2.3   Exceptional procedures

When the AWAIT_CLEAR/AWAIT_CLEAR_ACK message transmission fails (i.e. timer "T_acl" expires for more than the maximum number of message repetitions), the AN environment is informed. A negative meeAwaitClearConf primitive is issued, for which the result attribute gives the indication "transmissionError".

When the AWAIT_CLEAR_COMP/AWAIT_CLEAR_COMP_ACK message transmission fails (i.e. timer "T_acl" expires for more than the maximum number of message repetitions), the SN environment is informed by the meeErrorInd primitive.

When one or more of the indicated resources are unknown at the peer network element (i.e. service node), the unknown resources are included in the AWAIT_CLEAR_ACK message with the indication "unknownResources". This information is reported to the AN environment.

13.3.3   VPCI consistency check procedure

13.3.3.1   General

The VPCI consistency check is provided to verify the consistent and correct allocation of a logical Virtual Path Connection Identifier (VPCI) to a VPC on the VB5.1 reference point. The check is performed to guarantee that the user plane information flow is possible between the AN and the SN using the bilaterally agreed VPCI at the VB5.1 interface. The VPCI Consistency Check procedure makes use of the Loopback Capability of Recommendation I.610 [24] that operates on the VP level.

OAM flows of type end-to-end shall be used. The OAM cell format shall be as defined in 7.1/I.610 [24] and 7.2.4/I.610 [24]. The loopback location field ID shall not be used, i.e. the value of the field shall be all 1s. Also the default value for the source ID field is used which is all 1s. The procedures for the loopback are defined in Annex C/I.610 [24].

The consistency of the VPCI is checked in the AN by monitoring the receipt of a user plane test flow in a VPC of an LSP that is indicated by the VPCI given by the SN the initiator of the test. After the performance of the check, the result of the monitoring function (receipt of Loopback cells at the VPC level) is made available to the SN.

13.3.3.2   Procedure

The VPCI consistency check consists of a procedure between the AN and the SN to control the test, and in addition, relies on user plane information flow using the Recommendation I.610 [24] loopback capability. The responsible entities which perform and control the test are the SN and AN environments. The VB5.1 system supports the procedure between the AN and the SN by transporting the requested messages to the peer entity. The VPCI consistency check has no impact on existing connections.

CONS_CHECK_REQ and CONS_CHECK_END are confirmed operations. The message flow is shown in Figure 63.
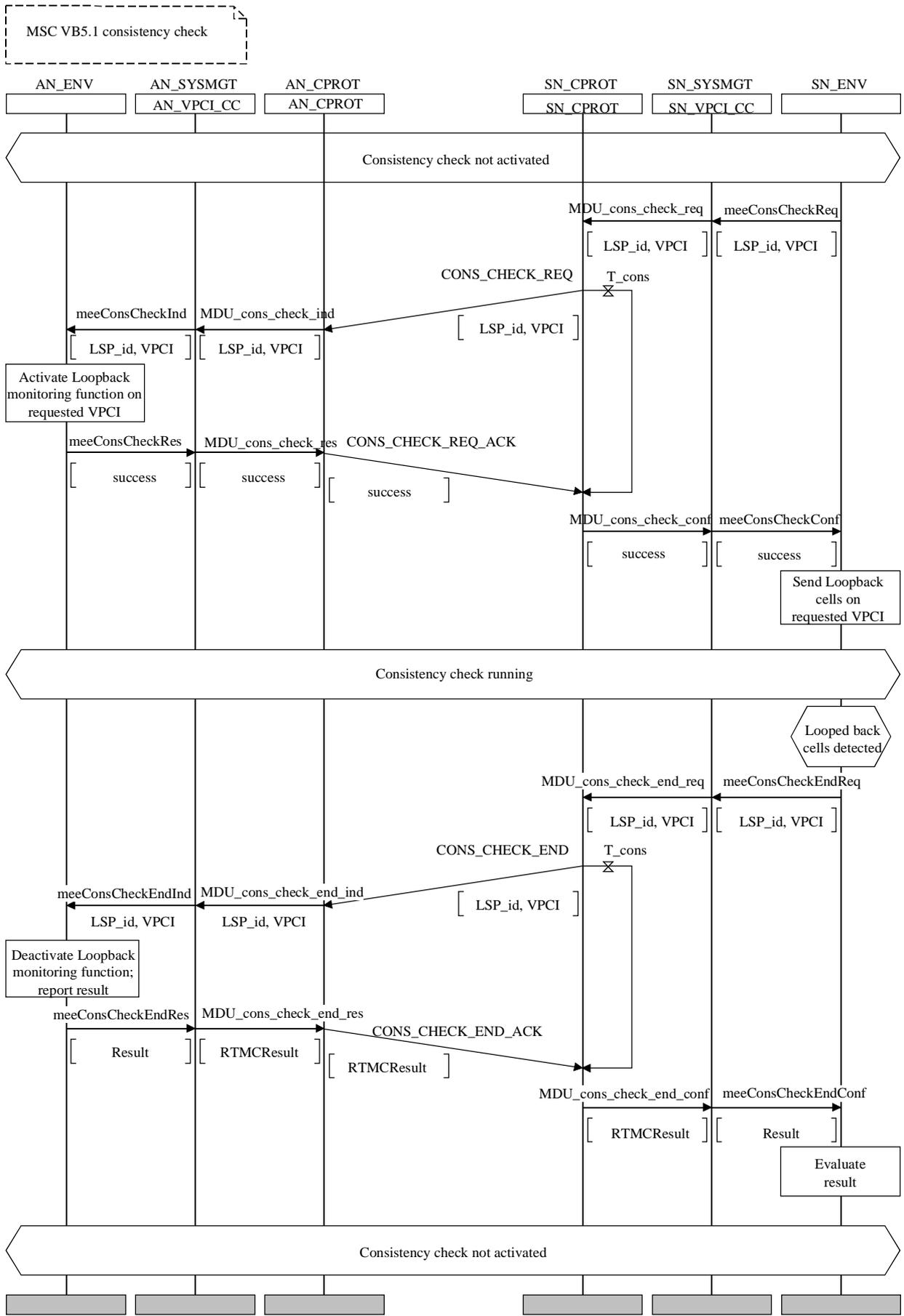
Figure 63/G.967.1 – VPCI consistency check procedure

13.3.3.2.1 Initiating VPCI consistency check

The VPC to be tested has to be in the operational state "enabled". When the environment in the SN initiates a VPCI consistency check, VB5.1 system management is triggered and a CONS_CHECK_REQ message is sent to the AN by SN CPROT. The message includes the relevant VPCI.

On receipt of a CONS_CHECK_REQ message from the SN, the AN environment will, if the VPC is applicable for the check, connect the monitor function to the standardized VC for F4 flows in the indicated VPC. The point where the loopback is performed is an endpoint, where the VPC is terminated in the AN. The AN environment shall confirm activation of the monitor function by requesting the VB5.1 system to send a CONS_CHECK_REQ_ACK message to the SN without a resource identifier information element. An acknowledgement is also sent, if the AN is not able to perform the VPCI consistency check. The result indicator information element within the message is set either to "reject" or "resource unknown".

On receipt of the CONS_CHECK_REQ_ACK message in the SN, indicating that the AN accepted the CONS_CHECK_REQ, the SN environment starts the loopback according to Recommendation I.610 [24].

13.3.3.2.2 Terminating VPCI consistency check

When the SN environment terminates a VPCI consistency check, a CONS_CHECK_END message is sent to the AN.

On receipt of a CONS_CHECK_END message from the SN, the AN environment will disconnect the monitor function from the standardized VC for F4 flows in the VPC under test. The AN shall return a CONS_CHECK_END_ACK message to the SN, which shall include the Consistency Check Result information in the result indicator information element (see 14.2.2.5). The VPCI check result indicator is set to the result of the user plane test flow monitoring function at the virtual path connection level. The possibilities are: "success", "failed" or if, due to any reason the monitoring function could not be performed properly, the VPCI check result indicator shall be set to "not performed". In that case, the SN can not conclude that there is a provisioning problem.

13.3.3.3 Exceptional procedures

13.3.3.3.1 Initiating VPCI consistency check

When the CONS_CHECK_REQ/CONS_CHECK_REQ_ACK message transmission fails (i.e. timer "T_consreq" expires for more than the maximum number of message repetitions), the SN environment is informed. A negative meeConsCheckConf primitive is issued, for which the result attribute gives the indication "transmissionError".

When the indicated resource is unknown at the peer network element (i.e. access network), the unknown resource is included in the CONS_CHECK_REQ_ACK message with the indication "unknownResources". This information is reported to the SN environment.

When the AN environment rejects the initiation request by the primitive meeConsCheckRes with result attribute "operationRejected" this is reported back in the CONS_CHECK_REQ_ACK message. This information is reported to the SN environment.

The VPCI consistency check procedure is terminated without any terminating sequence (see 13.3.4.2.2) in the case where the information element RTMCResult contained in the CONS_CHECK_REQ_ACK message does not indicate "success".

13.3.3.3.2 Terminating VPCI consistency check

When the CONS_CHECK_END/CONS_CHECK_END_ACK message transmission fails (i.e. timer "T_consend" expires for more than the maximum number of message repetitions), the SN environment is informed. A negative meeConsCheckEndConf primitive is issued, for which the result attribute gives the indication "transmissionError".

When the indicated resource is unknown at the peer network element (i.e. access network), the unknown resource is included in the CONS_CHECK_END_ACK message with the indication "unknownResources". This information is reported to the SN environment.

When the AN environment rejects the terminating request by the primitive meeConsCheckEndRes with result attribute "operationRejected" (e.g. indicated resources are different for initiating and terminating sequences), this is reported back in the CONS_CHECK_END_ACK message. This information is reported to the SN environment.

Any failure reason indicated by the AN environment in primitive meeConsCheckEnd is reported back in the CONS_CHECK_END_ACK message. This information is reported to the SN environment.

The AN environment will supervise the complete VPCI consistency check procedure (i.e. the correct sequence for both initiating and terminating sequence). If necessary, the AN environment will generate the primitive meeConsCheckEndRes with the result attribute set to value "operationRejected".

13.3.4 RTMC housekeeping procedures

13.3.4.1 Start-up procedure

13.3.4.1.1 General

The start-up procedure can be triggered in two circumstances:

a) *Operator requested start-up*

Only VB5.1 specifics are discussed in this subclause.

b) *Failure of the SAAL supporting the RTMC protocol*

The functionality of SSCOP allows that short-term problems are handled by SSCOP recovery actions. If the "NO Response" timer of SSCOP expires and VB5.1 system management is informed via AAL release indication, it assumes that a non-recoverable error occurred. Consequently, all VB5.1 system management processes enter the out-of-service state. The environment is informed (see Figure 65). It is the task of the environment to trigger the recovery action by providing a meeStartupReq primitive to the VB5.1 system.

13.3.4.1.2 Procedure

The procedure is controlled by the AN/SN VB5.1 system management control process and includes the following steps, as illustrated in Figure 64:

– SAAL establishment;

– verify logical service port Id (see also 13.3.4.2);

– reset complete LSP (see also 13.3.4.3).

When all steps are successfully completed, then the VB5.1 reference point is in service, the RTMC protocol is active and the states of the complete LSP and the individual VPC unblocked. If VPCs are not available for service due to administrative reasons or fault conditions, they shall be blocked again via the block procedure triggered by AN environment. Whenever one of the above-mentioned steps fails, then the start-up is stopped, and the environment informed.
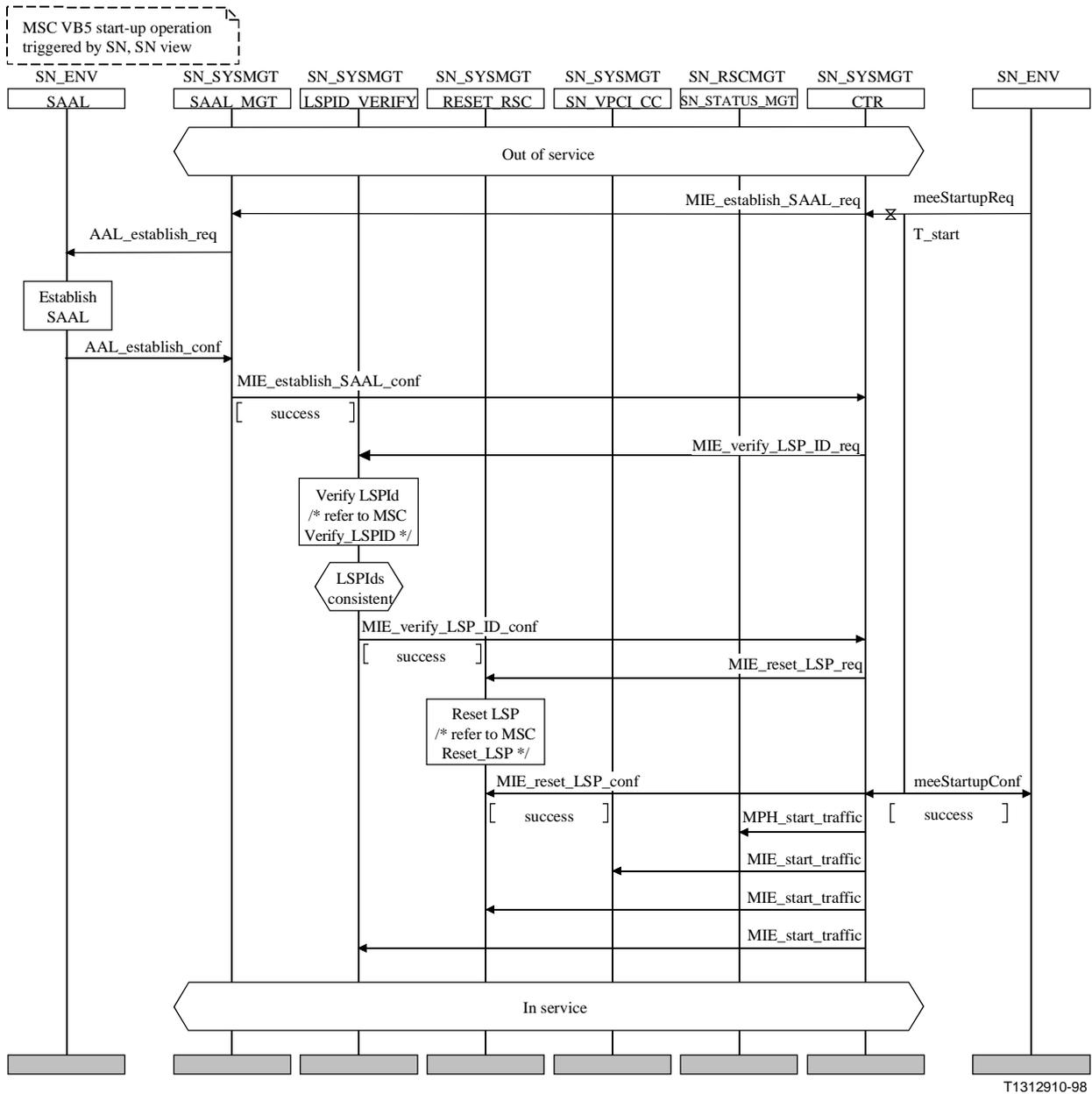
Figure 64/G.967.1 – VB5.1 interface start-up procedure
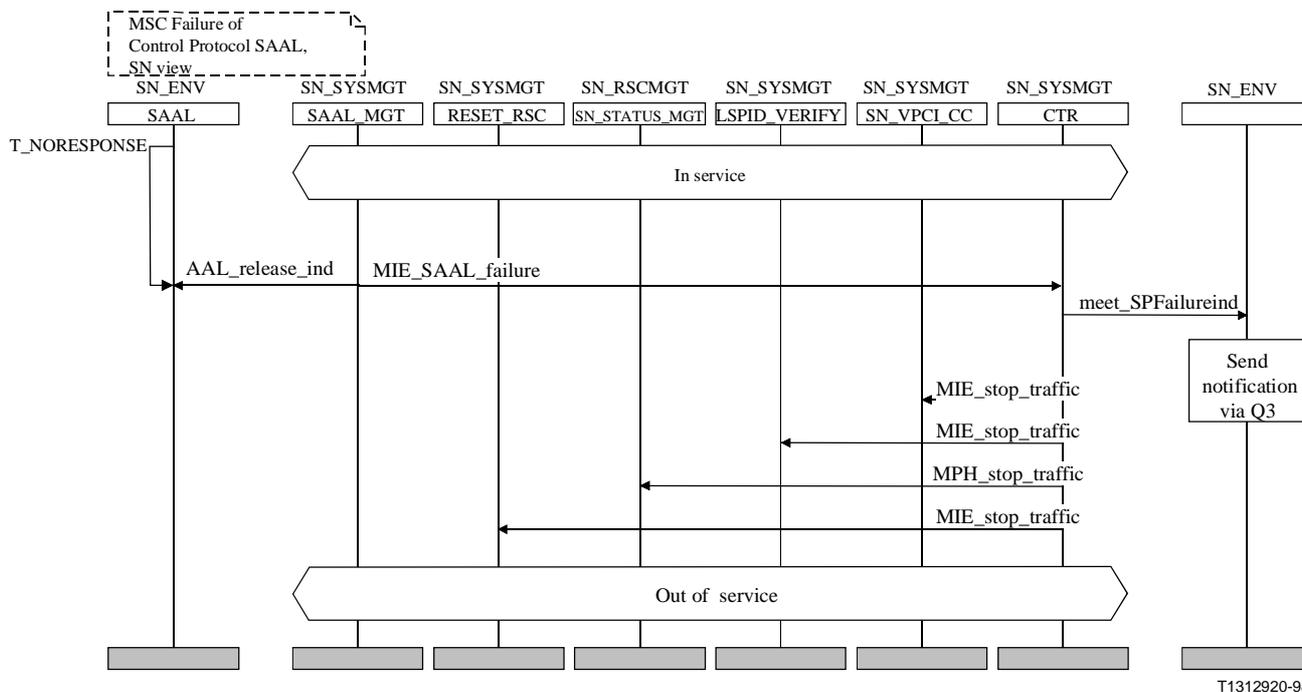
Figure 65/G.967.1 – SAAL failure procedure

13.3.4.1.3 Exceptional procedures

When the establishment of the SAAL fails, the environment of the initiating network element is informed. A negative meeStartupConf primitive is issued, for which the result attribute gives the indication "SAAL".

When one of the message transmission fails (i.e. supervised by timers), the environment of the initiating network element is informed. A negative meeStartupConf primitive is issued, for which the result attribute gives the indication "transmissionError".

When one of the procedures Verify LSP Id or Reset Resource (complete LSP) fails, the environment of the initiating network element is informed. A negative meeStartupConf primitive is issued, for which the result attribute is set to the failure code of the relevant procedure.

13.3.4.2 Verify logical service port Id procedure

13.3.4.2.1 General

The verify Logical Service Port (LSP) Id procedure is triggered by two events:

a)   by the environment as a result of input via the Q3 interface;

b)   by the start-up procedure (see 13.3.4.1).

13.3.4.2.2 Procedure

A simple handshaking procedure between the AN and SN LSPID_VERIFY processes is performed (see Figure 66). In the case of start-up, the LSPID_VERIFY process is triggered by VB5.1 system management process CTR. If the check was successful, start-up continues. If the check failed, VB5.1 system management CTR stops the start-up and informs the environment by a meeStartupConf primitive with a negative result indicator.

If the trigger was provided by the environment, then the procedure is the same, but VB5.1 system takes no action in the case of failure and simply informs the environment via a meeVerifyLSPIdConf primitive with a negative result indicator.
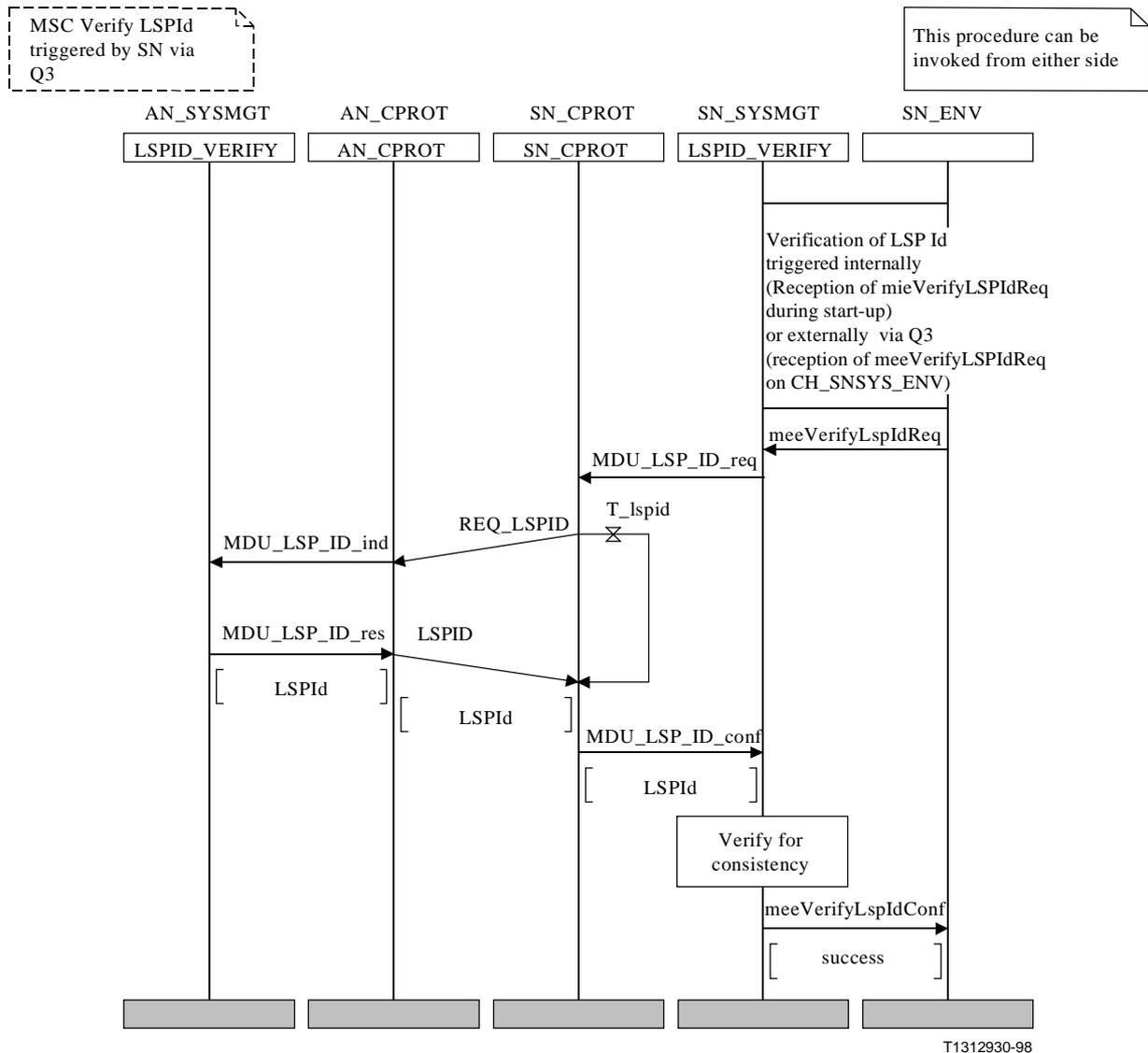
Figure 66/G.967.1 – Verify logical service port Id

13.3.4.2.3 Exceptional procedures

When the REQ_LSPID/LSPID message transmission fails (i.e. timer "T_lspid" expires for more than the maximum number of message repetitions), the environment is informed. A negative meeVerifyLSPIdConf primitive is issued, for which the result attribute gives the indication "transmissionError".

In case that a mismatch between the local and remote LSP identifier is detected, the environment is informed. A negative meeVerifyLSPIdConf primitive is issued, for which the result attribute gives the indication "mismatch".

13.3.4.3   Reset complete Logical Service Port (LSP) procedure

13.3.4.3.1   General

The reset complete Logical Service Port (LSP) procedure is triggered by two events:

a)   by the environment via a meeResetRscReq [LSP] primitive;

b)   by the start-up procedure (see 13.3.4.1).

13.3.4.3.2   Procedure

The reset complete LSP procedure is a handshaking procedure between the RESET_RSC processes in the AN and the SN (see Figure 67). If the reset is triggered by the environment in the SN, the SN environment has to take care that the appropriate actions are performed; e.g. for some services the SN may decide to release on-demand connections. If the reset is triggered by the environment in the AN, then RESET_RSC in the SN informs the environment via meeResetRscInd. The SN should take the appropriate actions at this point; e.g. for some services the SN may decide to release on-demand connections. meeResetRscInd is also the trigger to the environment, that the reset procedure is completed and that, for example, new on-demand connections are possible.

The result of the reset complete LSP procedure is that the states of all VPCs and the state of the LSP are unblocked. VPCs not available for service shall be brought to the blocked state again by the environment. Shutdown procedures, verify LSP Id procedures, and VPCI consistency checks in progress shall be aborted by the environment.

If the reset complete LSP procedure fails, then the environment is informed either by a meeResetRscConf or a meeStartupConf primitive with negative result indicator.
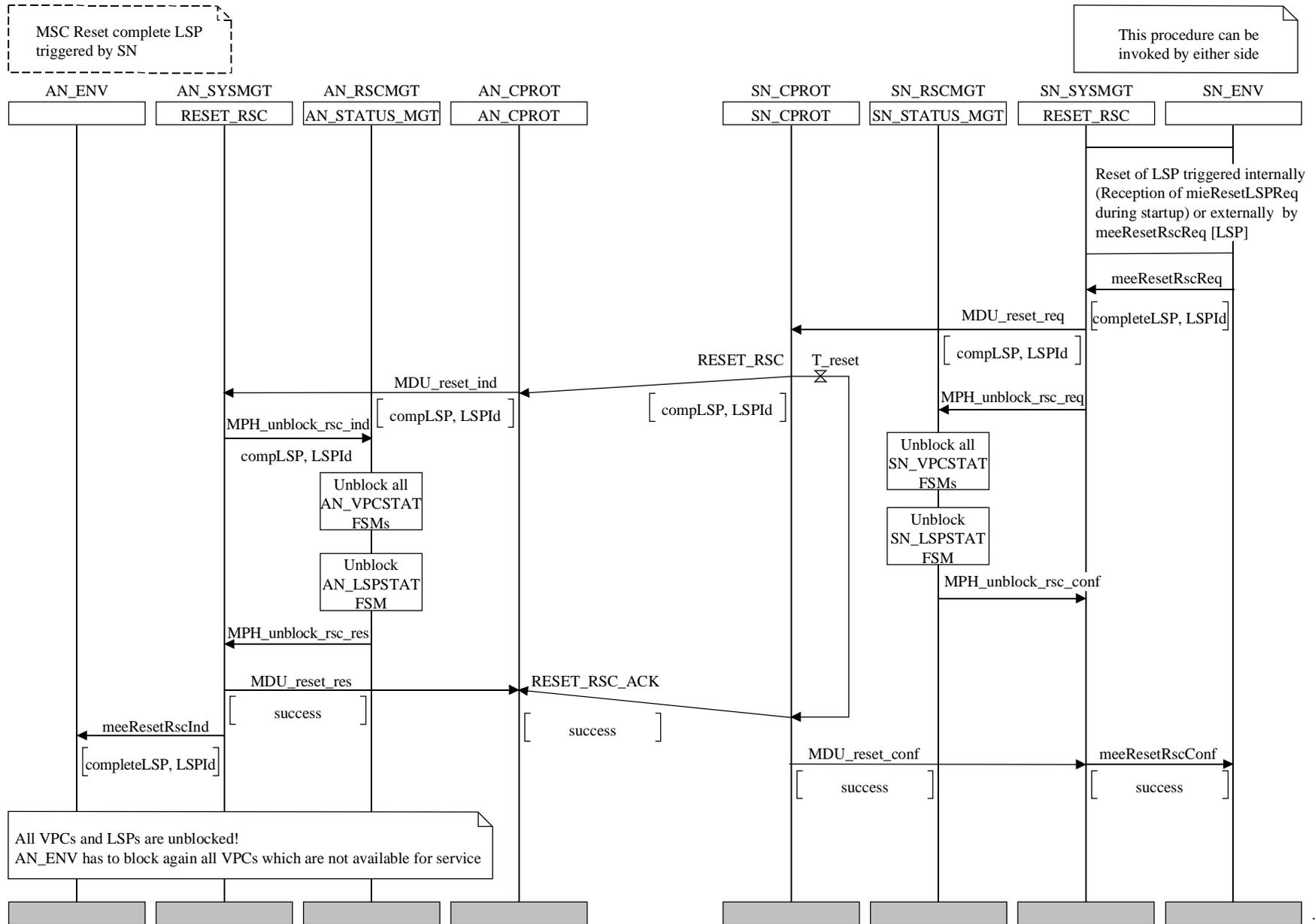
Figure 67/G.967.1 – Reset complete logical service port procedure

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13.3.4.3.3 Exceptional procedures

When the RESET_RSC/RESET_RSC_ACK message transmission fails (i.e. timer "T_reset" expires for more than the maximum number of message repetitions), the environment is informed. A negative meeResetRscConf primitive is issued, for which the result attribute gives the indication "transmissionError".

When the indicated resource is unknown at the peer network element, the unknown resource is included in the RESET_RSC_ACK message with the indication "unknownResources". This information is reported to the environment.

13.3.4.4 Reset VPC procedure

13.3.4.4.1 General

The reset VPC procedure is triggered by the environment via a meeResetRscReq [VPC] primitive.

13.3.4.4.2 Procedure

The reset VPC procedure is a handshaking procedure between the RESET_RSC processes in the AN and the SN. If the reset is triggered by the environment in the SN, the SN environment has to take care that the appropriate actions are performed; e.g. for some services the SN may decide to release on-demand connections. If the reset is triggered by the environment in the AN, then RESET_RSC in the SN informs the environment via meeResetRscInd. The SN should take the appropriate actions at this point; e.g. for some services the SN may decide to release on-demand connections. meeResetRscInd is also the trigger to the environment that the reset procedure is completed and that, for example, new on-demand connections are possible.

The result of the reset VPC procedure is that the state of the VPC is unblocked. If the VPC is not available for service, it shall be brought to the blocked state again by the environment. A shutdown procedure or a VPCI consistency check in progress shall be aborted by the environment.

If the reset VPC procedure fails, then the environment is informed by a meeResetRscConf primitive with negative result indicator.

13.3.4.4.3 Exceptional procedures

See 13.3.4.3.3.

14 Message format and codes

This clause defines the message format and the coding of the information elements. For each information element, the coding of the different fields is provided.

Within each octet, the bit designated "bit 1" shall be transmitted first, followed by bits 2, 3, 4, etc.

Similarly, the octet shown at the top of each figure shall be sent first.

14.1 Message and information elements encoding principles

14.1.1 Encoding principles for messages

Within this protocol, every message shall consist of an integral number of octets and encompasses the following parts (as illustrated in Figure 68):

a) Protocol discriminator

The purpose of the protocol discriminator is to discriminate between VB5 specific protocols and other non-VB5 protocols. Only one VB5.1 specific protocol, the VB5.1 RTMC protocol, is defined in this Recommendation.

The protocol discriminator shall be the first part of every message.

The protocol discriminator shall be coded according to Table 35.

b) *Transaction identifier*

The purpose of the transaction identifier is to identify the transaction at the VB5.1 protocol virtual channel to which the particular message applies.

The transaction identifier is the second part of every message. The transaction identifier is coded as shown in Figure 68 and in Table 35. The length of the transaction identifier value, in octets, is indicated in octet 2, bits 1-4. The length of the transaction identifier information element shall be 4 octets.

For a detailed description of the transaction identifier, reference shall be made to 13.3.1.4.

c) *Message type*

The purpose of the message type is to identify the specific VB5 protocol the message belongs to as well as the function of the message being sent. Acknowledge messages are coded with bit 1 set to "1", while the corresponding normal message are coded with bit 1 set to "0". The following message type values shall be reserved: all bits = 0 for a future escape mechanism to specific messages; all bits = 1 for an extension mechanism when all other message type values are exhausted.

The message type consists of a fixed length field (i.e. 1 octet) and shall be the third part of every message.

The message type is coded as shown in Figure 68 and Table 35.

d) *Message compatibility instruction indicator*

The message compatibility instruction indicator consists of a one-octet field with zeros and is mandatory for all messages. It defines the behaviour of the peer network element if the message is not understood. The message compatibility instruction indicator shall be the fourth part of every message. The format and coding of the message compatibility instruction indicator is shown in Figure 68 and Table 35.

e) *Message length*

The purpose of the message length is to identify the length of the contents of a message. It is the binary coding of the number of octets of the message contents, i.e. the number of octets following the message length octets themselves. The message length consists of a fixed length field (i.e. 2 octets) and is the mandatory fifth part of every message. The message length is coded as shown in Figure 68.

The coding of the message length follows the coding rules for integer values outlined in 14.1.5.

f) *Other information elements, as required*

The protocol discriminator, the transaction identifier value, the message type and the message length are common to all the messages and shall always be present, while other information elements are specific to each message type.

This organization is illustrated in the example shown in Figure 68.

8	7	6	5	4	3	2	1	Octet
Protocol discriminator								1
"0"B	"0"B	"0"B	"0"B	Length of transaction identifier value (in octets)				2
TAIdflag			Transaction identifier value					3
								4
								5
Message type								6
Message compatibility instruction indicator								7
ext. "1"B	spare "00"B		Flag	spare "00"B		Msg action indicator		
Message Length								8
								9
Variable length information elements as required								10, etc.

Figure 68/G.967.1 – General message organization example

Table 35/G.967.1 – General message information coding

Protocol discriminator (octet 1)

8	7	6	5	4	3	2	1	bits
0	1	0	0	1	0	0	1	VB5 specific protocols

Transaction identifier (octets 2 to 5)

Transaction identifier flag (TAIdflag)

8	bit
0	The message is sent from the side that originated the transaction identifier
1	The message is sent to the side that originated the transaction identifier

Transaction identifier value

The transaction identifier value shall be coded as a 23 bit binary value. The values with either all bits set to "0" or all bits set to "1" are reserved.

Message type (octet 6)

8	7	6	5	4	3	2	1	bits	Reference
0	0	0	0	0	0	0	0	reserved	14.1.1 item c)
0	0	0	x	x	x	x	x	VB5.1 RTMC protocol message types	
			0	0	0	1	0	BLOCK_RSC	14.2.1.2.1
			0	0	0	1	1	BLOCK_RSC_ACK	14.2.1.2.2
			0	0	1	0	0	CONS_CHECK_REQ	14.2.1.3.1
			0	0	1	0	1	CONS_CHECK_REQ_ACK	14.2.1.3.2
			0	0	1	1	0	CONS_CHECK_END	14.2.1.3.3
			0	0	1	1	1	CONS_CHECK_END_ACK	14.2.1.3.4
			0	1	0	0	0	REQ_LSPID	14.2.1.4.2
			0	1	0	0	1	LSPID	14.2.1.4.1
			0	1	0	1	0	PROTOCOL_ERROR	14.2.1.4.5
			0	1	1	0	0	RESET_RSC	14.2.1.4.3
			0	1	1	0	1	RESET_RSC_ACK	14.2.1.4.4
			0	1	1	1	0	AWAIT_CLEAR	14.2.1.2.3
			0	1	1	1	1	AWAIT_CLEAR_ACK	14.2.1.2.4
			1	0	0	0	0	AWAIT_CLEAR_COMP	14.2.1.2.5
			1	0	0	0	1	AWAIT_CLEAR_COMP_ACK	14.2.1.2.6
			1	0	0	1	0	UNBLOCK_RSC	14.2.1.2.7
			1	0	0	1	1	UNBLOCK_RSC_ACK	14.2.1.2.8
1	1	1	1	1	1	1	1	reserved	14.1.1 item c)

All other values are reserved.

Message compatibility instruction indicator (octet 7)

Flag

5	bit
0	Instruction field not significant (i.e. regular error handling procedures apply)
1	Follow explicit instructions (see 14.1.7)

Message action indicator (Msg action indicator)

2	1	bits
0	0	Reject (by PROTOCOL_ERROR message)
0	1	Discard and ignore, i.e. the information shall be treated as if it was not received (see 14.1.7.2.1)
1	0	Discard and report (see 14.1.7.2.1)

All other values are reserved.

14.1.2 Encoding principles for information elements

The content of each information element contains a number of subfields. Within each subfield, the least significant bit of the field is represented by the lowest-numbered bit and the most significant bit is represented by the highest-numbered bit. In case a subfield exceeds one octet, the significance of the bits, if applicable, is indicated.

Each information element of consists of an integral number of octets and encompasses the following parts (as illustrated in Figure 69):

a)   *Information element type*

The purpose of the information element type is to identify the specific VB5 protocol the information element belongs to as well as the function of the information element being sent. The information element type value with all bits set to 1 is reserved for an extension mechanism when all other message type values are exhausted.

It consists of a fixed length field (i.e. 1 octet) and shall be the first part of every information element. The information element is coded as shown in Figure 69 and in Table 36.

b)   *Information element compatibility instruction indicator*

The information element compatibility instruction indicator consists of a one-octet field and is mandatory for all information elements. It defines the behaviour of the peer network element if the information element is not understood. It shall be the second part of every information element. The format and coding of the information element compatibility instruction indicator is shown in Figure 69 and in Table 36.

c)   *Information element length*

The purpose of the information element length is to identify the length of the contents of an information element. It is the binary coding of the number of octets of the information element contents, i.e. the number of octets following the information element length octets themselves. The information element length consists of a fixed length field (i.e. 2 octets) and is the mandatory third part of every information element. The information element length is coded as shown in Figure 69.

The coding of the information element length follows the coding rules for integer values outlined in 14.1.5.

d)   *Information element content, i.e. subfields as required*

The content of each information element contains a number of subfields listed and described in the relevant subclauses related to the information elements. The length of a subfield may be fixed or variable.

8	7	6	5	4	3	2	1	Octet
Information element type								N + 1
Information element compatibility instruction indicator								N + 2
ext. "1"B	spare "00"B		Flag	spare "0"B	IE action indicator			
Information element length								N + 3
								N + 4
Information element content								N + 5, etc.
i.e. subfields as required								

Figure 69/G.967.1 – General information element organization example

Table 36/G.967.1 – Information element type coding

Information element type (octet N + 1)

8	7	6	5	4	3	2	1	bits	Reference
1	0	0	0	0	0	0	0	Blocked resource identifier	14.2.2.2
0	0	0	0	1	0	0	0	Protocol error cause (Note)	14.2.2.3
0	1	0	0	0	0	1	1	Repeat indicator (Note)	14.2.2.4
1	0	0	0	0	1	0	0	Result indicator	14.2.2.5
1	0	0	0	0	1	0	1	Resource identifier	14.2.2.6
1	1	1	1	1	1	1	1	reserved	14.1.2 item a)

All other values are reserved.

Information element compatibility instruction indicator (octet N + 2)

Flag

5	bits
0	Instruction field not significant (i.e. regular error handling procedures apply)
1	Follow explicit instructions (see 14.1.7)

Information element action indicator (IE action indicator)

3	2	1	bits
0	0	0	Reject (by PROTOCOL_ERROR message)
0	0	1	Discard information element and proceed
0	1	0	Discard information element, proceed, and report (see 14.1.7.2.2)
1	0	1	Discard message, and ignore, i.e. the information shall be treated as if it was not received.
1	1	0	Discard message, and report (see 14.1.7.2.2)

All other values are reserved.

NOTE – The coding is the same as in Recommendation Q.2931, where applicable. For VB5 specific information elements bit 8 is coded as "1".

14.1.3 Order of transmission

Since all the fields consist of an integral number of octets, the formats are presented as a stack of octets. The first octet transmitted to the underlying layer/level is the one shown at the top of the stack and the last is the one at the bottom.

Unless otherwise indicated, within each octet and subfield the bits are transmitted to the underlying layer/level with the least significant bit first.

14.1.4 Coding of extension indicator bit

The extension indicator bit (ext.) is used to indicate if an octet (N) continues through the next octet(s) (e.g. Na1, Nb, etc.) or is the last octet of a subfield. The bit value "0" indicates that the octet continues through the next octet. The bit value "1" indicates that this octet is the last octet. If one octet (Nb) is present, the preceding octets (N and Na) must also be present.

In the format descriptions appearing in the subclauses on information element encoding, bit 8 is marked as:

– "0/1 ext.", if another octet of this octet group may follow;

– "1 ext.", if this is the last octet in the extension domain;

– "0 ext.", if another octet of this octet group always follows.

Additional octets may be defined later ("1 ext." changed to "0/1 ext.") and equipments shall be prepared to receive such additional octets although the equipment need not be able to interpret or act upon the content of these octets.

14.1.5 Coding of integers

The following rules apply for the coding of integers. These rules apply if not indicated otherwise explicitly.

a)   Where integer values are coded using more than 1 octet, octets with lower octet numbers contain the more significant bits. In particular, the octet with the lowest octet number contains the most significant bits, and the octet with the highest octet number contains the least significant bits.

b)   Within one octet or within a field forming part of an octet, the following applies:

–   the bits with higher bit numbers contain the more significant bits;

–   in particular, the bit with the highest bit number of the integer coding denotes the most significant bit;

–   the bit with the lowest bit number of the integer coding denotes the least significant bit;

–   the bit representation is "right-aligned", i.e. aligned to the lowest bit numbers; therefore, if leading "zeros" are present, they have to appear on the "left-hand" side of the octet or field (i.e. on the side of the higher bit numbers).

c)   Where integer values are represented by a fixed number of octets, the bit representation is aligned to the higher octet numbers; i.e. if leading "zeros" are present, they appear within the octets with the lowest octet numbers.

d)   Where integer values are represented by a variable number of octets (e.g. by using bit 8 as an extension mechanism), the integer value shall be coded with a minimum number of octets, i.e. no leading all-zero octets are present.

14.1.6 Coding of spare bits

Spare bits are coded "0" unless indicated otherwise.

14.1.7 Compatibility instruction indicators

The instruction indicators are designed to support graceful evolution of the protocol; hence, for the initial release, the compatibility instruction indicator flags for messages and information elements shall be set to "0".

14.1.7.1 Regular error handling procedures

If the flag of the message compatibility instruction indicator or information element instruction field is set to "instruction field not significant" the regular error handling procedures, as defined and specified for the specific protocol function shall be used.

14.1.7.2 Procedures with explicit action indication

The procedures of this subclause shall only be used if the flag of the message compatibility instruction indicator or information element instruction field is set to "follow explicit instructions". These procedures supersede the regular error handling procedures.

14.1.7.2.1 Unexpected or unrecognized message type

If an unexpected or unrecognized message type is received, the following procedures are applicable.

If the message action indicator bits of the instruction field are set to "reject", the receiver shall take no action and a PROTOCOL_ERROR message shall be sent.

If the message action indicator bits are set to an undefined (reserved) value, the receiver shall handle the message as if the message action indicator bits had been set to "reject discard and report".

NOTE – The message action indicator bits of the instruction field set to "discard and ignore" and "discard and report" are reserved for future versions of the VB5 protocols, and not used by this Recommendation.

14.1.7.2.2   Information element errors

When a message is received which has one or more unexpected information elements, unrecognized information elements or information elements with unrecognized contents, the receiving entity shall examine the information element action indicator, and follow the procedures described below as appropriate.

If more than one information element is received in error, only one response shall be given. The response shall be according to the handling of the action indicator field according to the following order of priority: "reject" (highest priority), "discard message and report", "discard message, and ignore", "discard information element, proceed, and report", "discard information element and proceed".

a)   *Action indicator field = "reject"*

The receiver shall take no action but a PROTOCOL_ERROR message shall be sent.

b)   *Action indicator field = "discard message"*

The message shall be ignored.

c)   *Action indicator field = "discard information element and proceed"*

The information element shall be ignored and the message shall be processed as if the information element was not received.

d)   *Action indicator field = undefined (reserved) value*

The receiver shall handle the information element as if the action indicator field had been set to "discard information element and proceed".

NOTE – The information element action indicator bits of the instruction field set to "discard information element, proceed and report" and "discard message and report" are reserved for future versions of the VB5 protocols; they are not used by this Recommendation.

14.2   RTMC protocol messages and information elements

This subclause provides an overview of the VB5.1 RTMC message structure, including the functional definition and information content of each message. Each message definition includes:

a)   a brief description of the message use;

b)   a table listing the information elements. For each information element, the table indicates:

1)   the subclause of this Recommendation describing the information element;

2)   whether inclusion is mandatory "M" or optional "O", with a reference to notes explaining the circumstances under which the information element shall be included; and

3)   the length of the information element (or permissible range of lengths), in octets.

14.2.1 RTMC protocol messages for VB5

14.2.1.1 General

Table 37 summarizes the messages for the VB5.1 RTMC protocol.

For each message, the direction in which the message and the corresponding information elements may be sent is indicated; i.e. access network to service node "AN → SN", service node to access network "SN → AN", or "Both".

Table 37/G.967.1 – Messages for the VB5.1 RTMC protocol

Description of transaction	Message	Direction	Reference
Initiating shutting down of resources	AWAIT_CLEAR	AN→SN	14.2.1.2.3
	AWAIT_CLEAR_ACK	SN→AN	14.2.1.2.4
Terminating shutting down of resources	AWAIT_CLEAR_COMP	SN→AN	14.2.1.2.5
	AWAIT_CLEAR_COMP_ACK	AN→SN	14.2.1.2.6
Blocking of resources	BLOCK_RSC	AN→SN	14.2.1.2.1
	BLOCK_RSC_ACK	SN→AN	14.2.1.2.2
Terminating VPCI consistency check	CONS_CHECK_END	SN→AN	14.2.1.3.3
	CONS_CHECK_END_ACK	AN→SN	14.2.1.3.4
Initiating VPCI consistency check	CONS_CHECK_REQ	SN→AN	14.2.1.3.1
	CONS_CHECK_REQ_ACK	AN→SN	14.2.1.3.2
Verifying LSP ID	REQ_LSPID	Both	14.2.1.4.2
	LSPID	Both	14.2.1.4.1
Resetting of resources	RESET_RSC	Both	14.2.1.4.3
	RESET_RSC_ACK	Both	14.2.1.4.4
Unblocking of resources	UNBLOCK_RSC	AN→SN	14.2.1.2.7
	UNBLOCK_RSC_ACK	SN→AN	14.2.1.2.8
	PROTOCOL_ERROR	Both	14.2.1.4.5

In following subclauses the RTMC message layout is defined.

NOTE – The information elements indicated in a specific message may be sent in those directions in which the message itself may be sent. If certain information elements in a message may only be sent in a specific direction, then this is indicated as necessary.

All RTMC messages are composed by the common information as indicated in 14.1.1.

14.2.1.2 Messages for coordination of resource (un)available state related to service

The RTMC messages for coordination of immediate/deferred resource availability status changes related to services provided within the SN are defined in this subclause. The procedures are described in 13.3.2.1 and 13.3.2.2.

14.2.1.2.1 BLOCK_RSC message

This message is sent by the AN to the SN to inform the SN that the indicated resources in the AN are not available for service. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 38.

The blocked resource identifier may be used as a "list" information element (see 14.2.2.1). Each blocked resource identifier shall indicate both the reason for unavailability at the AN and either a complete LSP or combination(s) of either LUP/VPCI(s) or LSP/VPCI(s).

Table 38/G.967.1 – BLOCK_RSC message content

Information element	Reference	Type	Length
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Blocked resource identifier (RTMCBlRscId)	14.2.2.2	M	9, 11 or 13
NOTE – See 14.2.2.1.			

14.2.1.2.2 BLOCK_RSC_ACK message

This message is sent by the SN to the AN to acknowledge that the initiated activities upon receiving the BLOCK_RSC message by the SN have been completed. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 39.

The result indicator shall indicate either:

–   success: accepted by SN for all resources listed in the related BLOCK_RSC message. No further information elements shall be included; or

–   unknown resource (unkRsc): not accepted by SN for all resources listed in the related BLOCK_RSC message. Resource identifier information element(s) shall be included for the unknown resources only.

The optional resource identifier may be used as a "list" information element (see 14.2.2.1). Each resource identifier shall indicate both the unknown resource [i.e. LUP/LSP Id or combination(s) of LUP/VPCI(s) or LSP/VPCI(s)] and the unknown resource type (i.e. logical resource identifier or VPCI).

Table 39/G.967.1 – BLOCK_RSC_ACK message content

Information element	Reference	Type	Length
Result indicator (RTMCResult)	14.2.2.5	M	5
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Resource identifier (RTCMRscId)	14.2.2.6	O	8, 10 or 12
NOTE – See 14.2.2.1.			

14.2.1.2.3 AWAIT_CLEAR message

This message is sent by the AN to the SN to ask the SN not to allow any new on-demand switched call/connection set-up on the indicated VPCs. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 40.

The resource identifier may be used as a "list" information element (see 14.2.2.1). Each resource identifier shall indicate combination(s) of either LUP/VPCI(s) or LSP/VPCI(s).

Table 40/G.967.1 – AWAIT_CLEAR message content

Information element	Reference	Type	Length
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Resource identifier (RTMCRscId)	14.2.2.6	M	10 or 12
NOTE – See 14.2.2.1.			

14.2.1.2.4 AWAIT_CLEAR_ACK message

This message is sent by the SN to the AN to acknowledge that the first activities upon receiving the AWAIT_CLEAR message by the SN have been completed. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 41.

The result indicator shall indicate either:

– success: accepted by SN for all resources listed in the related AWAIT_CLEAR message. No further information elements shall be included; or

– unknown resource (unkRsc): not accepted by SN for all resources listed in the related AWAIT_CLEAR message. Resource identifier information element(s) shall be included for the unknown resources only.

The optional resource identifier may be used as a "list" information element (see 14.2.2.1). Each resource identifier shall indicate both the unknown resource [i.e. LUP/LSP Id or combination(s) of LUP/VPCI(s) or LSP/VPCI(s)] and the unknown resource type (i.e. logical resource identifier or VPCI).

Table 41/G.967.1 – AWAIT_CLEAR_ACK message content

Information element	Reference	Type	Length
Result indicator (RTMCResult)	14.2.2.5	M	5
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Resource identifier (RTMCRscId)	14.2.2.6	O	10 or 12
NOTE – See 14.2.2.1.			

14.2.1.2.5 AWAIT_CLEAR_COMP message

This message is sent by the SN to the AN to inform the AN about the progress of the remote shut-down procedure, i.e. all calls have been cleared or some failure has occurred. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 42.

The resource identifier may be used as a "list" information element (see 14.2.2.1). Each resource identifier shall indicate combination(s) of either LUP/VPCI(s) or LSP/VPCI(s).

Table 42/G.967.1 – AWAIT_CLEAR_COMP message content

Information element	Reference	Type	Length
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Resource identifier (RTMCRscId)	14.2.2.6	M	10 or 12
NOTE – See 14.2.2.1.			

14.2.1.2.6 AWAIT_CLEAR_COMP_ACK message

This message is sent by the AN to the SN to inform the SN on the receipt of an AWAIT_CLEAR_COMP message. The message is composed by the common message information (see 14.1.1) only.

14.2.1.2.7 UNBLOCK_RSC message

This message is sent by the AN to the SN to inform the SN that for the indicated resources all blocking conditions are cleared in the AN and these resources are available for service again. The message is composed of the common message information (see 14.1.1) and the information elements given in Table 43.

The resource identifier may be used as a "list" information element (see 14.2.2.1). Each resource identifier shall indicate either a complete LSP or combination(s) of either LUP/VPCI(s) or LSP/VPCI(s).

Table 43/G.967.1 – UNBLOCK_RSC message content

Information element	Reference	Type	Length
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Resource identifier (RTMCRscId)	14.2.2.6	M	8, 10 or 12
NOTE – See 14.2.2.1.			

14.2.1.2.8 UNBLOCK_RSC_ACK message

This message is sent by the SN to the AN to acknowledge that the initiated activities upon receiving the UNBLOCK_RSC message by the SN have been completed. The message is composed of the common message information (see 14.1.1) and the information elements given in Table 44.

The result indicator shall indicate either:

– success: accepted by SN for all resources listed in the related UNBLOCK_RSC message. No further information elements shall be included; or

– unknown resource (unkRsc): not accepted by SN for all resources listed in the related UNBLOCK_RSC message. Resource identifier information element(s) shall be included for the unknown resources only.

The optional resource identifier may be used as a "list" information element (see 14.2.2.1). Each resource identifier shall indicate both the unknown resource [i.e. LUP/LSP Id or combination(s) of LUP/VPCI(s) or LSP/VPCI(s)] and the unknown resource type (i.e. logical resource identifier or VPCI).

Table 44/G.967.1 – UNBLOCK_RSC_ACK message content

Information element	Reference	Type	Length
Result indicator (RTMCResult)	14.2.2.5	M	5
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Resource identifier (RTMCRscId)	14.2.2.6	O	8, 10 or 12
NOTE – See 14.2.2.1.			

14.2.1.3   VPCI consistency check messages

The RTMC messages for coordination of VPCI consistency check operation initiated by the Service Node (SN) are defined in this subclause. The procedures are described in 13.3.4.

14.2.1.3.1   CONS_CHECK_REQ message

This message is sent by the SN to the AN to check the consistency of a single VPC at the VB5.1 reference point. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 45.

The resource identifier information element shall indicate one single LSP/VPCI combination.

Table 45/G.967.1 – CONS_CHECK_REQ message content

Information element	Reference	Type	Length
Resource identifier (RTMCRscId)	14.2.2.6	M	10

14.2.1.3.2   CONS_CHECK_REQ_ACK message

This message is sent by the AN to the SN to indicate the acceptance of a CONS_CHECK_REQ message. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 46.

The result indicator shall indicate either:

– success: accepted by AN for the resource in the related CONS_CHECK_REQ message. No further information elements shall be included;

– unknown resource (unkRsc): not accepted by AN for the resource in the related CONS_CHECK_REQ message. Resource identifier information element shall be included for the unknown resource only; or

– rejected (opRej): not accepted by AN environment. The LSP/VPCI combination contained in the related CONS_CHECK_REQ message shall be included in the resource identifier information element.

The optional resource identifier shall indicate the resource (i.e. LSP/VPCI combination) and, if applicable, the unknown resource type (i.e. logical resource identifier or VPCI).

Table 46/G.967.1 – CONS_CHECK_REQ_ACK message content

Information element	Reference	Type	Length
Result indicator (RTMCResult)	14.2.2.5	M	5
Resource identifier (RTMCRscId)	14.2.2.6	O	10

14.2.1.3.3   CONS_CHECK_END message

This message is sent by the SN to the AN to indicate that the consistency check is finalized and to request the consistency check result of the peer entity. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 47.

The resource identifier information element shall indicate one single LSP/VPCI combination which shall be the same as used for the related VPCI consistency check initiation procedure.

Table 47/G.967.1 – CONS_CHECK_END message content

Information element	Reference	Type	Length
Resource identifier (RTMCRscId)	14.2.2.6	M	10

14.2.1.3.4 CONS_CHECK_END_ACK message

This message is sent by the AN to the SN to return the consistency check result to the requesting entity. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 48.

The result indicator shall indicate either:

– success: accepted by the AN for the resource in the related CONS_CHECK_END message. No further information elements shall be included;

– unknown resource (unkRsc): not accepted by the AN for the resource in the related CONS_CHECK_END message. The resource identifier information element shall be included for the unknown resource only;

– rejected (opRej): not accepted by the AN environment. The LSP/VPCI combination contained in the related CONS_CHECK_END message shall be included in the resource identifier information element;

– failed (opFail): not successfully performed by the AN environment. The LSP/VPCI combination contained in the related CONS_CHECK_END message shall be included in the resource identifier information element;

– not performed (notPerf): not performed by the AN environment. The LSP/VPCI combination contained in the related CONS_CHECK_END message shall be included in the resource identifier information element; or

The optional resource identifier shall indicate the resource (i.e. LSP/VPCI combination) and, if applicable, the unknown resource type (i.e. logical resource identifier or VPCI).

Table 48/G.967.1 – CONS_CHECK_END_ACK message content

Information element	Reference	Type	Length
Result indicator (RTMCResult)	14.2.2.5	M	5
Resource identifier (RTMCRscId)	14.2.2.6	O	10

14.2.1.4 RTMC housekeeping messages

The RTMC messages for coordinated housekeeping operations (i.e. verification of logical service port identifier, reset of resource(s), and protocol error) are defined in this subclause. The procedures are described in 13.3.4.1, 13.3.4.2, and 13.3.4.3. The reset of resource operation messages are restricted for the VB5.1 RTMC protocol to the complete Logical Service Port (LSP) only.

14.2.1.4.1 LSPID message

This message is sent by the SN to the AN or by the AN to the SN to return the identity of the logical service port at the peer network element to the requesting entity. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 49.

Table 49/G.967.1 – LSPID message content

Information element	Reference	Type	Length
Resource identifier (RTMCRscId) (Note)	14.2.2.6	M	8
NOTE – The resource identifier shall indicate a single LSP.			

14.2.1.4.2 REQ_LSPID message

This message is sent by the AN to the SN or by the SN to the AN to request the identity of the logical service port at the peer network element. The message is composed by the common message information (see 14.1.1) only.

14.2.1.4.3 RESET_RSC message

This message is sent by the AN to the SN or by the SN to the AN to reset a resource. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 50.

The resource identifier may be used as a "list" information element (see 14.2.2.1). Each resource identifier shall indicate either a complete LSP or combination(s) of either LUP/VPCI(s) or LSP/VPCI(s).

Table 50/G.967.1 – RESET_RSC message content

Information element	Reference	Type	Length
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Resource identifier (RTMCRscId)	14.2.2.6	M	8, 10 or 12
NOTE – See 14.2.2.1.			

14.2.1.4.4 RESET_RSC_ACK message

This message is sent by the SN to the AN or by the AN to the SN to acknowledge that the initiated activities upon receiving the RESET_RSC message have been completed. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 51.

The result indicator shall indicate either:

– success: accepted for all resources listed in the related RESET_RSC message. No further information elements shall be included; or

– unknown resource (unkRsc): not accepted for all resources listed in the related RESET_RSC message. Resource identifier information element(s) shall be included for the unknown resources only.

The optional resource identifier may be used as a "list" information element (see 14.2.2.1). Each resource identifier shall indicate both the unknown resource [i.e. LUP/LSP Id or combination(s) of LUP/VPCI(s) or LSP/VPCI(s)] and the unknown resource type (i.e. logical resource identifier or VPCI).

For the VB5.1 RTMC protocol, the usage of this message is restricted to the function "reset complete LSP" only.

Table 51/G.967.1 – RESET_RSC_ACK message content

Information element	Reference	Type	Length
Result indicator (RTMCResult)	14.2.2.5	M	5
Repeat indicator (RTMCRepeatInd)	14.2.2.4	O (Note)	5
Resource identifier (RTMCRscId)	14.2.2.6	O	8, 10 or 12
NOTE – See 14.2.2.1.			

14.2.1.4.5 PROTOCOL_ERROR message

This message is sent by the AN to the SN or by the SN to the AN to report certain error conditions. The message is composed by the common message information (see 14.1.1) and the information elements given in Table 52.

Table 52/G.967.1 – PROTOCOL_ERROR message content

Information element	Reference	Type	Length
Protocol error cause	14.2.2.3	M	5 to 7

14.2.2 RTMC function specific information elements

Table 53 summarizes the information elements for the VB5.1 RTMC protocol.

**Table 53/G.967.1 – Information elements
for the VB5.1 RTMC protocol**

Information element	Reference	Length
Blocked resource identifier (RTMCBlRscId)	14.2.2.2	9, 11, 13
Protocol error cause	14.2.2.3	5 to 7
Repeat indicator (RTMCRepeatInd)	14.2.2.4	5
Result indicator (RTMCResult)	14.2.2.5	5
Resource identifier (RTMCRscId)	14.2.2.6	8, 10, 12

All RTMC information elements are composed by the common information as indicated in 14.1.2.

14.2.2.1 General

For the RTMC function, specific information elements the following conventions are used:

a)   *"List" information elements*

Such information elements may consist of either the repeat indicator (RTMCRepeatInd) followed by a number (which shall not exceed the number of allowed repetitions) of repeated information elements of the same and only the same type or a single information element [optionally preceded by the repeat indicator (RTMCRepeatInd), see item b) below].

This type of information element applies to the information elements "blocked resource identifier" and "resource identifier".

b) *Repeat indicator (RTMCRepeatInd)*

The repeat indicator shall be included before the first occurrence of the information element type which will be repeated in a message. Use of the repeat indicator in conjunction with an information element that occurs only once in a message shall not in itself constitute an error.

c) *Maximum number of allowed repetitions of repeated information elements of the same type*

The SAAL can transfers SDUs up to a maximum length of 4096 octets. The mechanism employed to ensure that this limit is not exceeded in any practical system are specific to any given implementation and not specified in this Recommendation.

14.2.2.2 Blocked resource identifier

The blocked resource identifier information element identifies the resource(s) to which the remote blocking applies in the resource identifier subfield. It gives the actual remote blocking state for the resource(s) in the blocking reason indicator. This information element is specific for the BLOCK_RSC message sent in the AN to SN direction.

The blocked resource identifier information element is composed of the common information elements (see 14.1.2) and coded as shown in Figure 70 and in Table 54. The length of this information element is in the range of 9 to 13 octets.

8	7	6	5	4	3	2	1	Octet
ext.	Blocking reason indicator							N + 5
"1"B	Error reason		Administrative reason					
ext.	Reserved		Reserved	Spare	Resource			N + 6
"1"B	(Note 3)		(Note 3)	"0"B	indicator			
Logical port identifier								N + 7
(LSP Id or LUP Id)								N + 8
								N + 9
VPCI (Note 1)								N + 10 *
								N + 11 *
VPCI (Note 2)								N + 12 *
								N + 13 *

NOTE 1 – No VPCI(s) shall be present if the resource indicator indicates a complete logical service port.

NOTE 2 – The VPCI may be repeated once to indicate a range of consecutive VPCs.

NOTE 3 – These subfields are used in the resource identifier information element only.

Figure 70/G.967.1 – Blocked resource identifier information element coding

Table 54/G.967.1 – Blocked resource identifier information element values

Blocking reason indicator (octet N + 5)							
Error reason							
	7	6	bits				
	0	0	None				
	0	1	Error (Note)				
	All other values are reserved.						
Administrative reason							
	5	4	3	2	1	bits	
	0	0	0	0	0	None	
	0	0	0	0	1	Administrative reason – test calls allowed	
	0	0	0	1	0	Administrative reason – cell flow inhibited	
	All other values are reserved.						
Resource indicator – see 14.2.2.6							
Logical port identifier – see 14.2.2.6							
VPCI – see 14.2.2.6							
NOTE – Indication of the error location (user equipment or B-DS) is for further study.							

14.2.2.3 Protocol error cause

The protocol error cause information element provides the cause for rejection of a message or request. The protocol error cause information element is composed by the common information elements (see 14.1.2) and coded as shown in Figure 71 and in Table 55. The length of this information element is 5 to 7 octets.

8	7	6	5	4	3	2	1	Octet
1 ext.	Protocol error cause value							N + 5
Diagnostic(s) (if any)								N + 6*
								N + 7*
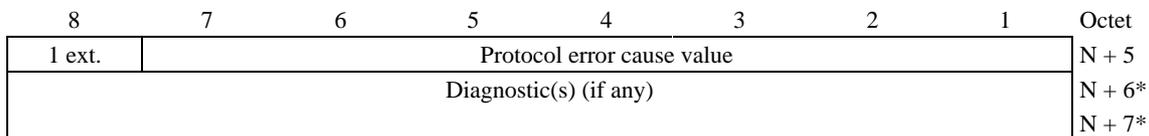
Figure 71/G.967.1 – Protocol error cause information element coding

Table 55/G.967.1 – Protocol error cause values

Bits							Protocol error cause value (octet 5)	Diagnostics
7	6	5	4	3	2	1		
0	0	0	0	0	0	1	Message type unrecognized	Message type identifier
0	0	0	0	0	1	1	Mandatory information element missing	Message type identifier Information element identifier
0	0	0	0	1	0	0	Unrecognized information element	Message type identifier Information element identifier
0	0	0	0	1	0	1	Information element content error	Message type identifier Information element identifier
0	0	0	0	1	1	0	Information element not allowed	Message type identifier Information element identifier
0	0	0	0	1	1	1	Message not compatible with path state	Message type identifier
All other values are reserved.								

14.2.2.4 Repeat indicator

The purpose of the repeat indicator information element is to indicate how repeated information elements shall be interpreted, when included in a message. The repeat indicator information element is included before the first occurrence of the information element which will be repeated in a message.

The current use of the repeat indicator information element is to indicate the repetition of the resource identifier information element for multiple VPCs to be operated on.

Use of the repeat indicator information element in conjunction with an information element that occurs only once in a message shall not in itself constitute an error.

The repeat indicator information element is composed by the common information elements (see 14.1.2) and coded as shown in Figure 72 and in Table 56. The length of this information element is 5 octets.

8	7	6	5	4	3	2	1	Octet
1	0	0	0					N + 5
ext.	Spare			Repeat indication				
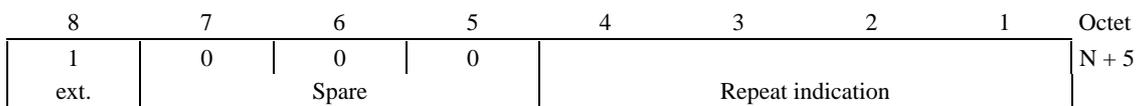
Figure 72/G.967.1 – Repeat indicator information element coding

Table 56/G.967.1 – Repeat indicator information element values

Repeat indication (octet 5)				
4	3	2	1	bits
0	0	1	1	List of multiple information elements
All other values are reserved.				

14.2.2.5 Result indicator

The result indicator information element is used in acknowledgement messages to indicate the result for the invoked operation. The result indicator information element consists of a fixed length field (i.e. 5 octets) and is composed of the common information elements (see 14.1.2) and the information as specified in Figure 73 and in Table 57.

8	7	6	5	4	3	2	1	Octet
ext.		Spare			Result			N + 5
"1"B	"0"B	"0"B	"0"B		indicator			
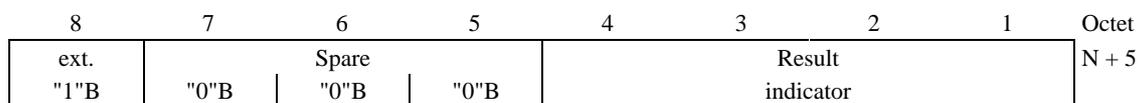
Figure 73/G.967.1 – Result indicator information element coding

Table 57/G.967.1 – Result indicator information element values

Result indicator (octet N + 5)				
4	3	2	1	bits
0	0	0	0	Success (i.e. requested operation accepted or successful)
0	0	0	1	UnkRsc – unknown resource(s)
0	0	1	0	OpRej – operation rejected
0	0	1	1	OpFail – operation failed
0	1	0	0	OpNotPerf – operation not performed
All other values are reserved.				

14.2.2.6 Resource identifier

The resource identifier information element identifies the resources on which the message applies. The resources are indicated by a resource indicator (type of resource), a logical port identifier (LSP Id or LUP Id), and, optionally, either one single or two VPCI values (see Notes 1 and 2 to Figure 74). The unknown resource indicator subfield shall only be used in acknowledgement messages. The network element receiving an invoke message shall ignore any coding of this subfield (see Note 3).

The resource identifier information element is composed of the common information elements (see 14.1.2) and coded as shown in Figure 74 and in Table 58. The length of this information element is in the range of 8 to 12 octets.

8	7	6	5	4	3	2	1	Octet
1 ext.	Unknown resource indicator (Note 3)		XC-flag (Note 4)	Spare	Resource indicator			N + 5
Logical port identifier (LSP Id or LUP Id)								N + 6 N + 7 N + 8
VPCI (Note 1)								N + 9* N + 10*
VPCI (Note 2)								N + 11* N + 12*

NOTE 1 – No VPCI(s) shall be present if the resource indicator indicates a complete logical service port.

NOTE 2 – The VPCI may be repeated once to indicate a range of consecutive VPCs.

NOTE 3 – This subfield has no meaning in invoke messages and shall be ignored. In acknowledgement messages it is used only if the result indicator is set to "UnkRsc" and it shall indicate the type of unknown resource(s).

NOTE 4 – This subfield is used for the AWAIT_CLEAR_COMP message only. It indicates if the resource is used for on-demand services or is cross-connected at the SN side.

Figure 74/G.967.1 – Resource identifier information element coding

Table 58/G.967.1 – Resource identifier information element values

Unknown resource indicator (octet N + 5) (Note 1)		
7	6	bits
0	0	Logical resource identifier unknown (i.e. LSP Id or LUP Id)
1	1	VPCI unknown
All other values are reserved.		

XC-flag (octet N + 5) (Note 2)	
5	bit
0	Resource is used for on-demand services at the SN side
1	Resource is cross-connected services at the SN side

Resource indicator (octet N + 5)				
3	2	1	bits	VPCI field (Note 3)
0	0	0	Complete logical service port	no
0	0	1	Connection(s) at the logical service port: VPCs	repeat
1	0	1	Connection(s) at the logical user port: VPCs	repeat
All other values are reserved.				

Logical port identifier (octets N + 6 to N + 8)

The logical port identifier value identifies either a Logical User Port (LUP) or a Logical Service Port (LSP). For the use of logical user port/logical service port identifiers, see 7.3.2. The numeric value is in the range of 0 through 16 777 215 and shall be coded as a binary 24-bit value.

VPCI (octets N + 9* to N + 10* and N + 11* to N + 12*)

The VPCI value(s) identifies a virtual path connection. For the use of VPCIs, see 7.3 "Broadband access network connection element identifiers".
The numeric value is in the range of 0 through 65 535 and shall be coded as a binary 16-bit value.

NOTE 1 – This field has no meaning in invoke messages and shall be ignored. In acknowledgement messages it is used only if the result indicator is set to "UnkRsc" and it shall indicate the type of unknown resource(s).

NOTE 2 – This field shall be used for the AWAIT_CLEAR_COMP message only. In other messages this field shall be ignored.

NOTE 3 – no: The VPCI field(s) shall be absent.

repeat: The VPCI field(s) shall be present and may be repeated one time to indicate a range of consecutive values.

ANNEX A

SDL process diagrams

This annex contains the SDL process diagrams for the VB5.1 RTMC protocol.

The contents of this annex are available in electronic form on one diskette, included in this Recommendation.

Three alternative versions are provided which are identified by the file names given below:

– vb51cif.zip (contains CIF file compressed by WinZIP);

– vb51sdl.zip (contains PostScript file compressed by WinZIP);

– vb51pr.zip (contains SDL-PR file compressed by WinZIP).

Further details are provided in a Readme.txt file contained in the directory listed above.

ANNEX B

UPC and NPC function location

B.1 Introduction

The main purpose of the UPC and NPC function is to protect network resources from malicious as well as from unintentional misbehaviour which can affect the QoS of other already established connections by detecting violations of negotiated parameters and by taking appropriate actions.

This annex shows the locations where the UPC and NPC functions are performed for the different cases of user VP termination in VB5.1 access arrangements. The VB5.1 reference point does not impose any requirements on policing other than those already specified in Recommendation I.371 [17]. Figure B.1 gives an overview of the possible user VP termination points which are relevant for the VB5.1 interfaces.
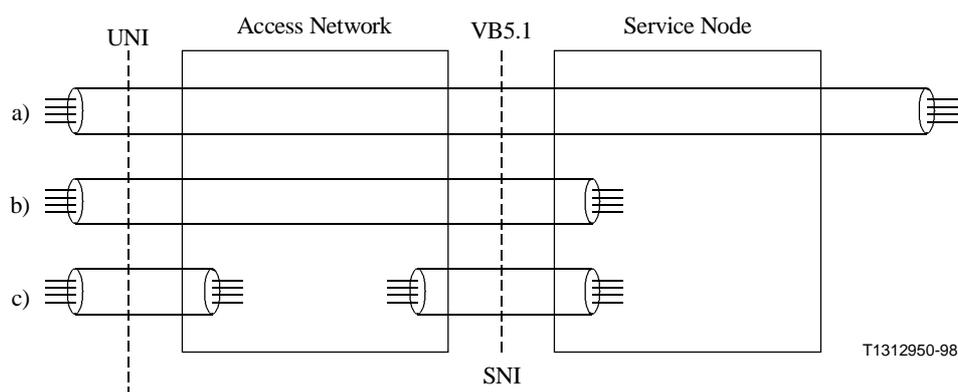
Figure B.1/G.967.1 – User VP termination point locations

Figures B.1, B.2 and B.3 illustrate:

a) The user VP is cross-connected both in the AN and in the SN. This is the case for a user-to-user permanent VP connection.

b) The user VP is cross-connected in the AN and terminated in the SN. VC switching and/or cross-connecting takes place in the SN.

c)   The user VP is terminated in the AN. VC cross-connecting takes place in the AN.

B.2   Location of the UPC function

The use of the UPC function is recommended in Recommendation I.371 [17]: "Usage parameter control is performed on VCCs or VPCs at the point where the first VP or VC links are terminated within the network."

The locations of the UPC functions are shown in Figure B.2. The locations of these functions do not change if a VP cross-connect is placed between the AN and SN.
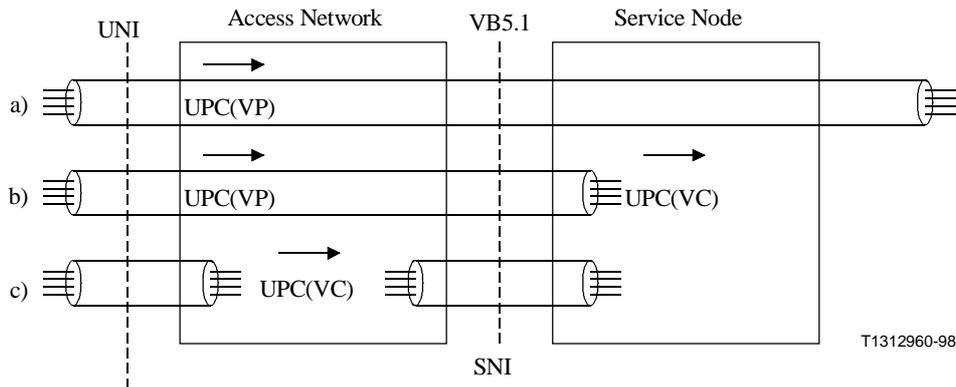
Figure B.2/G.967.1 – UPC function location

B.2.1   Location of the UPC(VP) function

Both the recommended location for the UPC(VP) function (at the point where the first VP link is terminated within the network) and the purpose of the UPC function (to protect network resources) imply that UPC(VP) must be performed in the AN for those user VPs which are cross-connected in the AN and multiplexed on the VB5.1 interface.

B.2.2   Location of the UPC(VC) function

The recommendation for the UPC(VC) location implies that UPC(VC) is always performed at the point where the user VP is terminated within the network: in case a), no UPC(VC) is done; in case b), UPC(VC) is performed in the SN; and in case c), UPC(VC) is performed in the AN.

B.3   Location of the NPC function

The use of the NPC function is optional in Recommendation I.371 [17]: "Network parameter control is performed on VCCs or VPCs at the point where they are first processed in a network after having crossed an Inter-Network Interface (INI)."

The locations of the NPC functions are shown in Figure B.3. In this figure the INI is at the SNI.
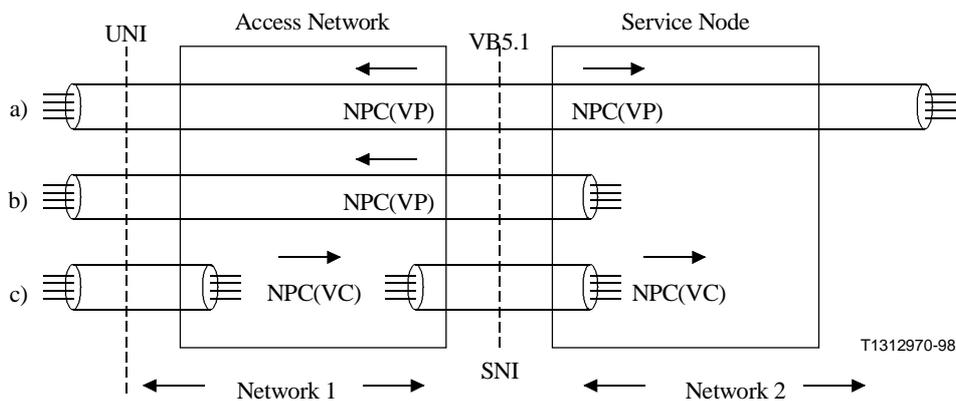
Figure B.3/G.967.1 – NPC function location

B.3.1 Location of the NPC(VP) function

NPC(VP) may be performed at the point where the VP which is crossing the INI is entering the first NE and is not terminated in that NE. This means that in case a), NPC(VP) may be performed both in the AN and the SN; in case b), NPC(VP) may be performed in the AN; and, in case c), no NPC(VP) will be performed.

The location of the NPC(VP) functions will change if a VP cross-connect is placed between the AN and the SN. If the VP cross-connect is part of network 1 (see Figure B.3), the NPC(VP) functions move from the AN to the VP cross-connect. If the VP cross-connect is part of network 2, the NPC(VP) functions move from the SN to the VP cross-connect.

B.3.2 Location of the NPC(VC) function

NPC(VC) may be performed at the point where the VP crossing the INI which carries the VC is terminated within the network. This implies that for case a) no NPC(VC) needs to be performed, for case b) no NPC(VC) needs to be performed because UPC(VC) is done in the SN for this case and for case c) NPC(VC) may be performed in the AN and SN.

ANNEX C

Primitive interface between VB5.1 protocol FSMs and environment

C.1 Introduction

Interfaces between the functional elements of the VB5.1 interface system and the environment (i.e. the VB5.1 related part of plane management) are defined using interface primitives. This primitive interface definition is provided only for the purpose of the two separate specifications for the VB5.1 interface system and VB5.1 management and does not assume any specific implementation. The use of primitives as a modelling tool does not imply any specific implementation in terms of interface primitives.

Where the functional element of VB5.1 interface system and environment (i.e. the VB5.1 related part of plane management) are modelled on the OSI 7 layer reference model (e.g. RTMC functions), service primitives are defined in line with Recommendation X.210.

C.2 General definition of the primitive interface

Primitives consist of commands and their respective responses (if any) associated with the services requested of the VB5.1 interface FSMs. The general syntax of a primitive is shown in Figure C.1.

X	Generic name	Specific name	Attribute(s) Mandatory	Attribute(s) Optional

X   designates the functional block providing the service ("mee" for RTMC function).

Generic name   describes the operation that should be performed.

Specific name indicates the direction of the primitive flow.

Attribute(s)   are the elements of information which are to be exchanged, if any are defined. Within this primitive interface specification, the attributes are organized in such way that mandatory attributes are given before optional attributes.

Figure C.1/G.967.1 – General primitive definition

Four specific names exist in general (see Figure C.2). Not all generic names contain all four specific names.

– Request (Req) – a primitive issued by service user to invoke a service element;

– Indication (Ind) – a primitive issued by a service provider to advise that a service element has been invoked by the service user at the peer service access point or by the service provider;

– Response (Res) – a primitive issued by the service user to complete at a particular service access point some service element whose invocation has been previously indicated at that service access point;

– Confirmation (Conf) – a primitive issued by a service provider to complete at a particular service access point some service element previously invoked by a request at that service access point.
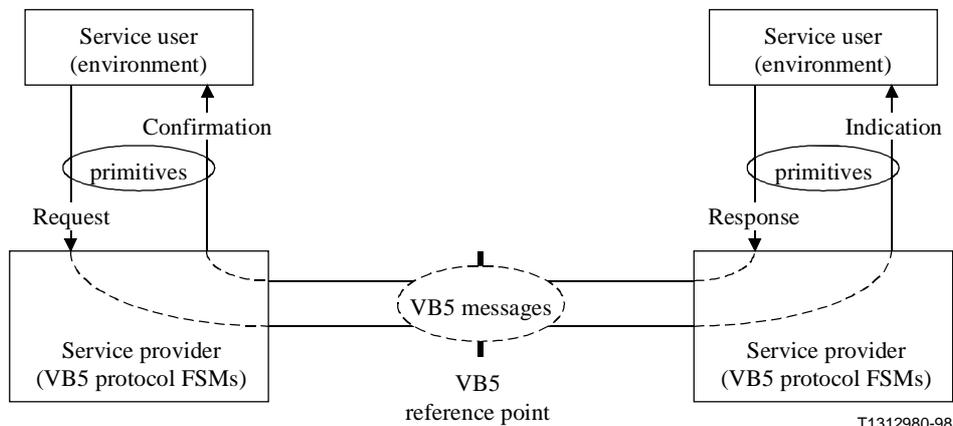
Figure C.2/G.967.1 – Overview on the primitive operation

For the purpose of the separated specifications related to the VB5.1 interface and VB5.1 management (i.e. environment), the following definition is used at the primitive interface, as illustrated in Figure C.3.

T1312990-98
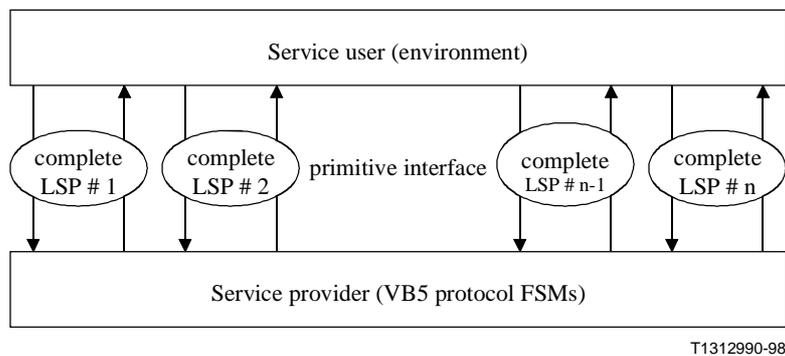
Figure C.3/G.967.1 – Relationship between primitive interface and VB5.1 protocol FSMs

For each complete Logical Service Port (LSP) its own primitive interface is assumed. Based on this definition, each primitive interface can be seen as decoupled from the others.

C.3 Primitive interface for the RTMC function

This subclause provides the definitions for the MEE primitive interface related to the RTMC function. The MEE primitives which are common for both network elements are listed in C.3.1.1. The MEE primitives which are specific for either the access network or the service node are listed in C.3.1.2 and C.3.1.3, respectively.

The primitive attributes and their association with the MEE primitives are given in C.3.2. It must be stated here that these specifications are provided only for the purpose of the two separate specifications for the VB5.1 interface and VB5.1 management and does not assume any specific implementation.

An overview of the mapping between the primitives and the messages to be exchanged across the VB5.1 reference point is given in C.3.3. This mapping is restricted to the successful performance of operations only. For the exception handling of operations, reference should be made to C.3.2.2.

In Appendix VI, the MEE primitives for the RTMC function are defined using the Abstract Syntax Notation No. 1 (ASN.1) according to Recommendation X.680.

The primitives and procedure for creation and deletion of VPC related objects across the primitive interface is defined in C.3.4. These procedures are defined in order to enable the coordinated creation and removal of objects related to VPC resources between the protocol FSMs and the environment.

C.3.1 General description for primitives

C.3.1.1 Primitives common to the access network and the service node

meeErrorInd	spontaneous indication of a detected protocol error. No attributes are defined for this primitive due to the fact that this will depend on the actual implementation.
meeLSPFailureInd	spontaneous indication of a SAAL failure which shall result in release of all on-demand connections. The start-up procedure shall be invoked.
meeResetRscReq	request to invoke the reset operation for the resource in both network elements.
meeResetRscInd	spontaneous indication of a reset operation invoked at the peer side.

meeResetRscConf	response to meeResetRscReq confirming either that the reset is completed (success/failed) in the AN and the SN or that the resource is unknown in the peer side.
meeStartupReq	request to invoke a coordinated start-up operation in both the local and the peer network element.
meeStartupInd	spontaneous indication of a start-up operation invoked at the peer side. The AN shall issue meeBlockRscReq primitives for all resources to be remote blocked in the SN. The SN shall enable the set-up of new on-demand connections.
meeStartupConf	response to meeStartupReq confirming that the start-up procedure is completed (success/failed) in both network elements. The SN shall enable the set-up of new on-demand connections.
meeStopTrafficReq	request to release the SAAL connection to the peer side and to put the local VB5.1 system FSMs in state "out of service". No attributes are defined for this primitive due to the fact that this will depend on the actual implementation.
meeStopTrafficConf	response to meeStopTrafficReq confirming that the local VB5.1 system FSMs are put in state "out of service". No attributes are defined for this primitive due to the fact that this will depend on the actual implementation.
meeVerifyLspIdReq	request to verify the consistency of the LSP Id in both the local and the peer network element.
meeVerifyLspIdConf	response to meeVerifyLspIdReq confirming either the consistency or a mismatch of the LSP Id in both the local and the peer network element.
meeVPCCreateReq	request for creation of a new VPC related entity within the VB5.1 FSMs.
meeVPCCreateConf	response to meeVPCCreateReq confirming that the VPC related entity within the VB5.1 FSMs is created.
meeVPCDeleteReq	request for deletion of an existing VPC related entity within the VB5.1 FSMs.
meeVPCDeleteConf	response to meeVPCDeleteReq conforming that the VPC related entity within the VB5.1 FSMs is deleted.

C.3.1.2   Primitives specific to the access network

C.3.1.2.1   Primitives for the coordination of resource status changes

meeAwaitClearReq	requesting to invoke the remote shut-down operation in the SN for the listed resource(s) due to an administrative or partial administrative shut-down event at the AN.
meeAwaitClearConf	response to a previous primitive meeAwaitClearReq indicating either the successful operation [i.e. the remote shut-down operation in the SN the on-demand connections are released on the resource(s) indicated by this response primitive] or the failed operation [i.e. resource(s) unknown in the SN, message transmission error].
meeBlockRscReq	requesting to set the remote blocking state in the SN for the indicated resource(s) according to the indicated reason value, i.e., the indicated resource(s) are no longer available for service.

meeBlockRscConf	response to a previous primitive meeBlockRscReq indicating either the successful operation [i.e. remote blocking states are set for the resource(s) listed in the meeUnblockRscReq] or the failed operation [i.e. resource(s) unknown in the SN, message transmission error].
meeUnblockRscReq	request to clear all remote blocking states for the indicated resource(s) at the service node, i.e. the indicated resource(s) are available for service.
meeUnblockRscConf	response to a previous primitive meeUnblockRscReq indicating either the successful operation [i.e. remote blocking states are cleared for the resource(s) listed in the meeUnblockRscReq] or the failed operation [i.e. resource(s) unknown in the SN, message transmission error].

C.3.1.2.2　Primitives for the coordination of the VPCI consistency check

meeConsCheckInd	indicating that the VPCI consistency check for the resource shall be invoked in the AN.
meeConsCheckRes	response to meeConsCheckInd either indicating that the VPCI consistency check can be accepted and the user plane test flow monitoring is activated in the AN or that the resource is unknown in the AN.
meeConsCheckEndInd	indicating that the VPCI consistency check for the resource shall be terminated and the consistency check result shall be reported back to the SN.
meeConsCheckEndRes	response to meeConsCheckEndInd providing the consistency check result for the resource.

C.3.1.3　Primitives specific to the service node

C.3.1.3.1　Primitives for the coordination of resource status changes

meeAwaitClearInd	indicating that for the listed resource(s) the remote shutdown operation shall be initiated in the SN.
meeAwaitClearRes	response to a previous received primitive meeAwaitClearInd indicating that as a result of the remote shutdown operation in the SN the on-demand connections are released on the listed resource(s) in the SN.
meeBlockRscInd	indicating that the remote blocking state shall be set for the indicated resource(s) according to the included reason value, i.e. the indicated resource(s) are no longer available for service.
meeUnblockRscInd	indication that for the listed resource(s) all remote blocking shall be reset, i.e. the indicated resource(s) are available for service.

C.3.1.3.2　Primitives for the coordination of the VPCI consistency check

meeConsCheckReq	requesting that the VPCI consistency check for the resource shall be invoked in the AN.
meeConsCheckConf	response to meeConsCheckReq confirming either that the VPCI consistency check can be accepted and the monitoring of the user plane test flow is initiated (success) or that it cannot be accepted or that the resource is unknown in the AN.
meeConsCheckEndReq	requesting that the VPCI consistency check on the resource shall be terminated in the AN.

meeConsCheckEndConf response to meeConsCheckEndReq confirming either the VPCI consistency check was successfully performed or that no user plane test flow was received or that it was not performed.

C.3.2 Description of primitive attributes

This subclause provides a description of the attributes used at the primitive interface. There are two types of attributes defined which either are "resource identifier" attributes or is the "result" attribute.

In Table C.1 an overview of the attributes is given together with the mapping to the primitives. The following primitives without attributes are not included in this table:

– meeErrorInd;

– meeLSPFailureInd;

– meeVPCCreateConf;

– meeVPCDeleteConf;

– meeStartupReq & Ind;

– meeStopTrafficReq & Conf;

– meeVerifyLSPId.

**Table C.1/G.967.1 – Overview on the usage of
attributes at the primitive interface**

			Blocked resource identifier list (BlRscList)
		Resource identifier list (RscList)	
	Resource identifier (RscId)		
MEE primitive	**Result**		
meeAwaitClearConf	M	–	M/O (Note)	–
meeAwaitClearReq & Ind & Res	–	–	M	–
meeBlockRscConf	M	–	O (Note)	–
meeBlockRscReq & Ind	–	–	–	M
meeConsCheckReq & Ind	–	M	–	–
meeConsCheckRes & Conf	M	O (Note)	–	–
meeConsCheckEndReq & Ind	–	M	–	–
meeConsCheckEndRes & Conf	M	O (Note)	–	–
meeResetRscConf	M	–	O (Note)	–
meeResetRscReq & Ind	–	–	M	–
meeStartupConf	M	–	–	–
meeUnblockRscConf	M	–	O (Note)	–
meeUnblockRscReq & Ind	–	–	M	–
meeVerifyLspIdConf	M	–	–	–
meeVPCCreateReq	–	M	–	–
meeVPCDeleteReq	–	M	–	–
NOTE – Optional for unknown resources to be reported.				
M = mandatory; O = optional.				

C.3.2.1 Resource identifier attributes

The resource identifier attributes are used to identify the resource related to the operation to be invoked. There are in general two types of attributes:

– "List" attributes, which may carry a multiple resource identifiers. These are the blocked resource identifier list and the resource identifier list. Each of these list attributes contain at least one resource identifier.

– Attribute resource identifier, for which only one single resource identifier is allowed.

C.3.2.2 Result attribute

The result attribute is used in confirmation (Conf) and result (Res) primitives in order to indicate the result for the invoked operation. Table C.2 gives an overview on the usage of this result attribute.

**Table C.2/G.967.1 – Overview on the usage of the
result attribute at the primitive interface**

Column codes (right to left): no recoverable failure of SAAL (SAAL); operation rejected local (opRejLoc); mismatch of identifier at local and peer network element (mismatch); message exchange transmission error (transErr); not performed (notPerf); operation failed (opFail); operation rejected remote (opRej); unknown resource(s) (unkRsc).

MEE primitive	Failure reason	unkRsc	opRej	opFail	notPerf	transErr	mismatch	opRejLoc	SAAL	Remarks
meeStartupConf	Transmission error					√				Timeout of T_xxxx
	LSP Id mismatch						√			No RscId included
	Timeout of T_start							√		
	SAAL failure								√	
meeLSPFailureInd	SAAL failure								√	No parameters
meeResetRscConf	Unknown resources	√								(Note)
	Transmission error					√				Timeout of T_reset (Note)
meeVerifyLspIdConf	LSP Id mismatch						√			No RscId included
	Transmission error					√				Timeout of T_lspid
meeBlockRscConf	Unknown resource	√								(Note)
	Transmission error					√				Timeout of T_block (Note)
meeUnblockRscConf	Unknown resource	√								(Note)
	Transmission error					√				Timeout of T_unblock (Note)
meeAwaitClearConf	Unknown resources	√								(Note)
	Transmission error					√				Timeout of T_acl (Note)
meeConsCheckRes	Rejected by environment							√		Convert to OpRej (Note)

**Table C.2/G.967.1 – Overview on the usage of the
result attribute at the primitive interface** *(concluded)*

Column result attributes (left to right: unkRsc, opRej, opFail, notPerf, transErr, mismatch, opRejLoc, SAAL):

- no recoverable failure of SAAL (SAAL)
- operation rejected local (opRejLoc)
- mismatch of identifier at local and peer network element (mismatch)
- message exchange transmission error (transErr)
- not performed (notPerf)
- operation failed (opFail)
- operation rejected remote (opRej)
- unknown resource(s) (unkRsc)

MEE primitive	Failure reason	unkRsc	opRej	opFail	notPerf	transErr	mismatch	opRejLoc	SAAL	Remarks
meeConsCheckConf	Unknown resource	√								(Note)
	Rejected by AN		√							Transparent in FSM (Note)
	Transmission error					√				Timeout of T_cons (Note)
meeConsCheckEndRes	Failed in environment			√						Transparent in FSM (Note)
	Not performed in env.				√					Transparent in FSM (Note)
	Rejected by environment							√		Convert to OpRej (Note)
meeConsCheckEndConf	Unknown resource	√								(Note)
	Rejected by AN		√							Transparent in FSM (Note)
	Failed at AN			√						Transparent in FSM (Note)
	Not performed at AN				√					Transparent in FSM (Note)
	Transmission error					√				Timeout of T_cons (Note)
Relevant in messages across VB5.1 reference point										**Specific to MEE primitives only**
NOTE – "unknown" resource identifier(s) shall be included in MEE primitive.										

C.3.3 Mapping between primitives and messages

This subclause provides an overview of the mapping between the primitives and the messages which are exchanged across the VB5.1 reference point. The illustration of mappings is divided into RTMC housekeeping operations (see Table C.3), coordinated resource status changes (see Table C.4), and VPCI consistency check (see Table C.5).

Table C.3/G.967.1 – Mapping for RTMC housekeeping operations

AN/SN		SN/AN
primitives	**VB5.1 messages**	**primitives**
meeStartupReq ⇒ (–)	⇒ (Note) ⇒	
meeStartupConf ⇐ (Result)	⇐ (Note) ⇐	⇒ meeStartupInd (–)
meeVerifyLspIdReq ⇒ (–)	⇒ REQ_LSPID ⇒	
meeVerifyLspIdConf ⇐ (Result)	⇐ LSPID ⇐ (RTMCRscId)	
meeResetRscReq ⇒ (RscList)	⇒ RESET_RSC ⇒ (RTMCRscList)	
meeResetRscConf ⇐ (Result [, RscList])	⇐ RESET_RSC_ACK ⇐ (RTMCResult [, RTMCRscList])	⇒ meeResetRscInd (RscList)
NOTE – During the start-up operation the messages for verify LSP Id and reset resource for complete LSP are exchanged.		

Table C.4/G.967.1 – Mapping for coordinated resource status changes

AN		SN
primitives	**VB5.1 messages**	**primitives**
meeAwaitClearReq ⇒ (RscList)	⇒ AWAIT_CLEAR ⇒ (RTMCRscList)	
meeAwaitClearConf ⇐ (Result [, RscList])	⇐ AWAIT_CLEAR_ACK ⇐ (RTMCResult [, RTMCRscList])	⇒ meeAwaitClearInd (RscList)
meeAwaitClearConf ⇐ (Result, RscList)	⇐ AWAIT_CLEAR_COMP ⇐ (RTMCRscList) ⇒ AWAIT_CLEAR_COMP_ACK ⇒	⇐ meeAwaitClearRes (RscList)
meeBlockRscReq ⇒ (BlRscList)	⇒ BLOCK_RSC ⇒ (RTMCBlRscList)	
meeBlockRscConf ⇐ (Result [, RscList])	⇐ BLOCK_RSC_ACK ⇐ (RTMCResult [, RTMCRscList])	⇒ meeBlockRscInd (BlRscList)
meeUnblockRscReq ⇒ (RscList)	⇒ UNBLOCK_RSC ⇒ (RTMCRscList)	
meeUnblockRscConf ⇐ (Result [, RscList])	⇐ UNBLOCK_RSC_ACK ⇐ (RTMCResult [, RTMCRscList])	⇒ meeUnblockRscInd (RscList)

Table C.5/G.967.1 – Mapping for VPCI consistency check operation

AN		SN
primitives	**VB5.1 messages**	**primitives**
meeConsCheckInd ⇐ (RscId)	⇐ CONS_CHECK_REQ ⇐ (RscId)	⇐ meeConsCheckReq (RscId)
meeConsCheckRes ⇒ (Result [, RscId])	⇒ CONS_CHECK_REQ_ACK ⇒ (RTMCResult [, RscId])	meeConsCheckConf ⇒ (Result [, RscId])
meeConsCheckEndInd ⇐ (RscId)	⇐ CONS_CHECK_END ⇐ (RscId)	⇐ meeConsCheckEndReq (RscId)
meeConsCheckEndRes ⇒ (Result [, RscId])	⇒ CONS_CHECK_END_ACK ⇒ (RTMCResult [, RscId])	meeConsCheckEndConf ⇒ (Result [, RscId])

C.3.4 Creation/deletion of VPC related entities across the primitive interface

The following scenarios for creation/deletion of entities related to VPCs should be considered:

a)   VPC carrying the RTMC protocol (see Figure C.4);

b)   other VPC entities (except the VP for the RTMC protocol).

In addition, the creation/deletion of entities related to VPCs should be considered according to the point in time either before or after the (first and initial) start-up procedure has taken place. Here the following points should be taken into account:

–   The VPC carrying the RTMC protocol must be created before the (first and initial) start-up operation can take place. In case this essential VPC is not created at the peer network element, a start-up operation must fail.

C.3.4.1 Creation/deletion of VPC carrying the RTMC protocol

i)   It is assumed here that the creation of the entity related to the VPC carrying the RTMC protocol will give birth to the VB5.1 reference point. That is, it is assumed on the one hand that no other VPCs can be created within the environment (VB5.1 management) before this entity exists and the confirmation from the VB5.1 interface FSM is received. On the other hand, it is assumed that the creation of this VPC will provide the Logical Service Port (LSP) identifier towards the VB5.1 interface FSM.

ii)   The deletion of this VPC means that the Logical Service Port (LSP) identifier is made invalid (set to NULL) within the VB5.1 interface FSM.

It is assumed that the above considerations apply in a symmetrical way to both the AN and SN sides of the VB5.1 reference point.

| Access Network (AN) | | VB5.1 | Service Node (SN) | |
management	interface		interface	management
creation of vb5interface entity				
⇒ meeVPCCreateReq ⇒				
[RscId (Note)]				
	Creation procedure for complete LSP			
⇐ meeVPCCreateConf ⇐				
deletion of vb5interface entity				
⇒ meeVPCDeleteReq ⇒				
[RscId (Note)]				
	Deletion procedure for complete LSP			
⇐ meeVPCDeleteConf ⇐				

NOTE – The creation and deletion of the complete LSP and the VPC carrying the RTMC protocol at both the AN and SN sides are considered as implementation specific activities and are out of the scope of this Recommendation.

Figure C.4/G.967.1 – Creation and deletion of VPC resource for RTMC protocol

C.3.4.2 Creation/deletion of other VPC entities

For the creation/deletion of other VPC entities (except the VP for the RTMC protocol), illustrations are provided in Figures C.5 to C.10 for the various cases.

Access Network (AN)		VB5.1	Service Node (SN)	
management	**interface**		**interface**	**management**
creation of VPC resource adS: locked				
⇒ meeVPCCreateReq ⇒				
(RscId)				
	creation procedure FSM: LocFullBl			
⇐ meeVPCCreateConf ⇐				
	creation of additional VPC resources			
operator may change administrative state or operational state may become disabled				
initial start-up operation				
⇒ meeStartupReq ⇒				
		⇔ VB5.1 messages ⇔		
⇐ meeStartupConf ⇐			⇒ meeStartupInd ⇒	
	all FSMs are unblocked			
report blocked resources				
⇒ meeBlockRscReq ⇒				
		⇔ VB5.1 messages ⇔		
⇐ meeBlockRscConf ⇐			⇒ meeBlockRscInd ⇒	
resources still blocked in AN and unknown in SN are reported	all FSMs in same state as environment		all FSMs in same state as environment	all resources have correct remote blocking state

Figure C.5/G.967.1 – Creation of VPC resource before start-up operation at AN side

Access Network (AN)		VB5.1	Service Node (SN)	
management	**interface**		**interface**	**management**
creation of VPC resource adS: locked opS: enabled/disabled				
⇒ meeVPCCreateReq ⇒				
(RscId)				
	creation procedure FSM: LocFullBl			
⇐ meeVPCCreateConf ⇐				
report blocked resources				
⇒ meeBlockRscReq ⇒				
		⇔ VB5.1 messages ⇔		
⇐ meeBlockRscConf ⇐			⇒ meeBlockRscInd ⇒	
resources unknown in SN are reported	all FSMs in same state as environment		all FSMs in same state as environment	all resources have correct remote blocking state

Figure C.6/G.967.1 – Creation of VPC resource after start-up operation at AN side

Access Network (AN)		VB5.1	Service Node (SN)	
management	**interface**		**interface**	**management**
				creation of VPC resource
				$\Leftarrow$ meeVPCCreateReq $\Leftarrow$
				(RscId)
			creation procedure FSM: RemFullBl	
				$\Rightarrow$ meeVPCCreateConf $\Rightarrow$

Figure C.7/G.967.1 – Creation of VPC resource at SN side

Access Network (AN)		VB5.1	Service Node (SN)	
management	**interface**		**interface**	**management**
Lock adS: locked				
$\Rightarrow$ meeBlockRscReq $\Rightarrow$				
		$\Leftrightarrow$ VB5.1 messages $\Leftrightarrow$		
$\Leftarrow$ meeBlockRscConf $\Leftarrow$				$\Rightarrow$ meeBlockRscInd $\Rightarrow$
resources unknown in SN are reported	all FSMs in same state as environment		all FSMs in same state as environment	all resources have correct remote blocking state
deletion of VPC resource				
$\Rightarrow$ meeVPCDeleteReq $\Rightarrow$				
(RscId)				
	deletion procedure			
$\Leftarrow$ meeVPCDeleteConf $\Leftarrow$				

Figure C.8/G.967.1 – Deletion of VPC resource at AN side

Access Network (AN)		VB5.1	Service Node (SN)	
management	**interface**		**interface**	**management**
				Lock
				adS: locked
				deletion of VPC resource
				$\Leftarrow$ meeVPCDeleteReq $\Leftarrow$
				(RscId)
			deletion procedure	
				$\Rightarrow$ meeVPCDeleteConf $\Rightarrow$

Figure C.9/G.967.1 – Deletion of VPC resource at SN side

Access Network (AN)		VB5.1	Service Node (SN)	
management	interface		interface	management
				remote await clear
				Lock
				adS: locked
			⇐ meeAwaitClearRes ⇐	
		⇔ VB5.1 messages ⇔		
⇐ meeAwaitClearConf ⇐				
⇒ meeBlockRscReq ⇒				
		⇔ VB5.1 messages ⇔		
			⇒ meeBlockRscInd ⇒	
				remote blocked
				deletion of VPC resource
			⇐ meeVPCDeleteReq ⇐	
			(RscId)	
			deletion procedure	
			⇒ meeVPCDeleteConf ⇒	
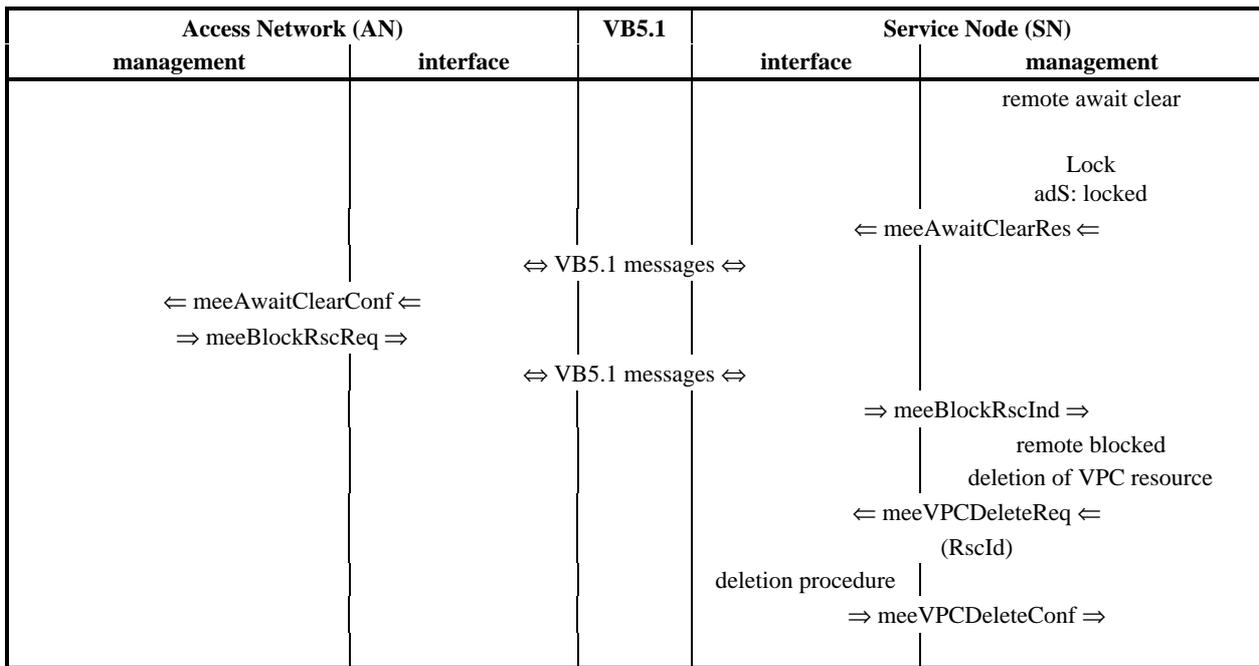
Figure C.10/G.967.1 – Deletion of VPC resource in remote await clear state at SN side

With respect to Figure C.10 it should be noted here that, if for a certain resource the coordinated await clear operation is initiated by the AN (i.e. primitive meeAwaitClearReq is issued by the environment, message AWAIT_CLEAR is generated, the message AWAIT_CLEAR_ACK send back, and primitive meeAwaitClearInd issued towards the SN environment), the following procedure should ensure that the administrative state shutting down can be resolved at the AN side.

If a "resource" in the SN will be deleted, the result should be identical to the event "last user quit" (reference should be made to Recommendation X.731) for both on-demand and cross-connected connections. That is, a meeAwaitClearRes primitive shall be generated which can be coded in such way that an automatic transition of the administrative state in the AN to "locked" can take place without additional operator actions.

C.3.5 Exceptional procedures at the primitive interface

C.3.5.1 General principles

The following general principles for reporting of unsuccessful operations are defined for the primitive interface related to the protocol for the RTMC function.

C.3.5.1.1 Transmission error across VB5.1 reference point

The nature of this error type is directly related to the message communication across the VB5.1 reference point. However, the reporting of such an error situation will take place locally within the network element (i.e. access network or service node) at which the problem is detected.

This applies to all operations which are performed across the VB5.1 reference point.

C.3.5.1.2 "Resource(s) unknown" at peer network element

For operations which are either not accepted or the execution is unsuccessful due to "Unknown resource(s)" at the peer network element, the mandatory message parameter result indicator shall indicate a negative response. The unknown resource(s) shall be reported back in the "unknown" resource identifier message parameter (modified information element) included in the relevant Ack

message. The unknown resource indicator subfield shall indicate the type of the unknown resource, i.e. logical resource identifier or VPCI. Otherwise (result indicator set to success), the message parameter "unknown" resource identifier shall be omitted from the relevant Ack message.

This applies to the following operations: await clear initiation, block resource, VPCI consistency check (both initiation and end), reset resource, and unblock resource.

C.3.5.1.3 "Operation rejected" by peer network element

For operations which are rejected by the peer network element because a VPCI consistency check is in progress or due to inconsistency of the VPCI values within initiating and terminating messages, the mandatory message parameter result indicator shall indicate a negative response. The resource(s) in question shall be reported back in the "unknown" resource identifier message parameter included in the relevant acknowledgement message.

This applies to the following operation: VPCI consistency check (both initiation and end).

C.3.5.1.4 "Operation rejected" by local network element

For operations which are rejected because a consistency check is in progress or due to inconsistency of VPCI value within initiating and terminating messages or due to expiry of start-up timer, the reporting of such an error situation will take place locally within the network element (i.e. access network or service node) at which the problem is detected.

This applies to the following operations: start-up, VPCI consistency check (both initiation and end).

C.3.5.1.5 "Operation failed" in peer network element

For operations which are failed in the peer network element because the user plane test flow monitoring function at VPC level has failed in the AN, the mandatory message parameter result indicator shall indicate a negative response.

This applies to the following operation: VPCI consistency check end.

C.3.5.1.6 "LSPID mismatch" detected in local network element

The inconsistency of the LSP Id of the local and peer network element is recognized. The reporting of such an error situation will take place locally within the network element (i.e. AN or SN) at which the problem is detected.

This applies to the following operations: start-up, verify LSP Id.

C.3.5.1.7 "SAAL failure" in local network element

The RTMC SAAL cannot be established. The reporting of such an error situation will take place locally within the relevant network element (i.e. AN or SN) at which the problem is detected.

This applies to the following operation: start-up.

C.3.5.1.8 "Not performed" by peer network element

For operations which are not performed for any reason in the peer network element, the mandatory message parameter result indicator shall indicate a negative response. The resource(s) in question shall be reported back in the "unknown" resource identifier message parameter included in the relevant acknowledgement message.

This applies to the following operation: VPCI consistency check end.

C.3.5.2 Example cases for the general principles

The following examples are given to explain these general principles:

1) The resource identifier in AWAIT_CLEAR, BLOCK_RSC, UNBLOCK_RSC message contains a Logical User Port (LUP) Id and a range of consecutive VPCIs (indicated by two VPCI values).

   – If the LUP Id is known but a single VPCI is unknown in the peer network element, an Ack message is issued with the "unknown" resource identifier included which contains this single LUP/VPCI combination. The result indicator is set to the value "unknown resource".

   – If the LUP Id is known but a number of consecutive VPCIs are unknown in the peer network element, an Ack message is issued with a number of additional "unknown" resource identifiers included. Each "unknown" resource identifier will report a single LUP/VPCI combination or a range of LUP/VPCI combinations. The result indicator is set to the value "unknown resource".

   – If the complete LUP is unknown in the peer network element, the Ack message shall contain the full list of resources in the included "unknown" resource identifier. The result indicator is set to the value "unknown resource".

2) The resource identifier in a CONS_CHECK_REQ message contains a Logical Service Port (LSP) Id and a single VPCI.

   – If the LSP Id is unknown in the peer network element, the Ack message shall contain this single LSP/VPCI combination in the included "unknown" resource identifier. The result indicator is set to the value "unknown resource".

   It must be stated here that this case needs special attention due to the fact that it indicates the case of "LSP Id mismatch".

   – If the LSP Id is known but the VPCI is unknown, an Ack message is issued with the "unknown" resource identifier included which contains this single LSP/VPCI combination. The result indicator is set to the value "unknown resource".

   – If this LSP/VPCI combination is known, a MEE primitive is issued towards the VB5.1 management (environment). However, the VB5.1 management can reject this request due to the fact that another VPCI consistency check is running. The operation will be rejected by a MEE primitive, which results in an ACK message with the result indicator set to the value "Rejected".

3) The VPCI consistency check end operation is not successful due to a mismatch of:

   – Resource identifier (i.e. LSP/VPCI combination) provided during the initiation and the end operation

   In this case a MEE primitive is issued by the environment (VB5.1 management) which results in an ACK message with the result indicator set to the value "Rejected" and the consistency check end information included.

   – RTMC message communication and the user plane OAM loop back cell flows (e.g. no OAM loop back cells detected by the environment before timeout of the associated timer)

   In this case a MEE primitive is issued by the environment (VB5.1 management) which results in an Ack message with the result indicator set to the value "Failed" and the consistency check end information included.

C.3.5.3 Individual cases for reporting of unsuccessful operations

In this subclause typical cases for reporting of unsuccessful operations are listed. It must be stated here that only the communication related to the RTMC function is taken into account.

C.3.5.3.1 Start-up operation

In Figure C.11 an overview for the start-up operation is illustrated. It must be noted here that the start-up operation can be initiated at both network elements in a symmetrical way.

Based on the illustration in Figure C.11, the following generic principles apply:

–   C.3.5.1.1   Transmission error across VB5.1 reference point;

–   C.3.5.1.4   "Operation rejected" by local network element.

–   C.3.5.1.6   "LSPID mismatch" detected in local network element.

The case "unknown resources" at the peer network element is not possible for both the verify LSP Id and reset complete LSP operations.

MEE	Access network (AN) VB5.1 interface FSM	VB5.1	Service node (SN) VB5.1 interface FSM	MEE
				⇐ meeStartupReq
			establish SAAL	
	EITHER SAAL establishment failure			
				⇒ meeStartupConf
				(SAAL)
	OR time out T_start			
			time out T_start	⇒ meeStartupConf
				(opRejLoc)
	Continues			
	⇐ REQ_LSPID ⇐			
	EITHER transmission error			
			time out T_lspid	⇒ meeStartupConf
				(transError)
	Continues			
	⇒ LSPID ⇒			
	(RscId)		verify consistency of local and remote LSP Id	
	EITHER mismatch of LSP Id			
			resource Id mismatch	⇒ meeStartupConf
				(mismatch)
	Continues			
	⇐ RESET_RSC ⇐			
	EITHER transmission error			
			time out T_reset	⇒ meeStartupConf
				(transError)
	Continues			
	⇒ RESET_RSC_ACK ⇒			
meeStartupInd ⇐				⇒ meeStartupConf
			start traffic	(success)

Figure C.11/G.967.1 – Start-up operation

C.3.5.3.2 Verify logical service port Id operation

In Figure C.12 an overview for the verify Logical Service Port (LSP) Id operation is illustrated. It must be noted here that the verify logical service port Id operation can be initiated at both network elements in a symmetrical way.

Based on the illustration in Figure C.12, the following generic principles apply:

–   C.3.5.1.1   Transmission error across VB5.1 reference point.

–   C.3.5.1.6   "LSPID mismatch" detected in local network element.

MEE	Access network (AN) VB5.1 interface FSM	VB5.1	Service node (SN) VB5.1 interface FSM	MEE
meeVerifyLspIdReq ⇒				
	⇒ REQ_LSPID ⇒			
	EITHER transmission error			
	time out T_lspid			
meeVerifyLSPIdConf ⇐ (transError)				
	Continues			
	⇐ LSPID ⇐ (RscId)			
	compare local and remote resource Id			
	EITHER resource Id mismatch			
	resource Id mismatch			
meeVerifyLSPIdConf ⇐ (mismatch)				
	OR resource Id match			
	resource Id match			
meeVerifyLSPIdConf ⇐ (success)				
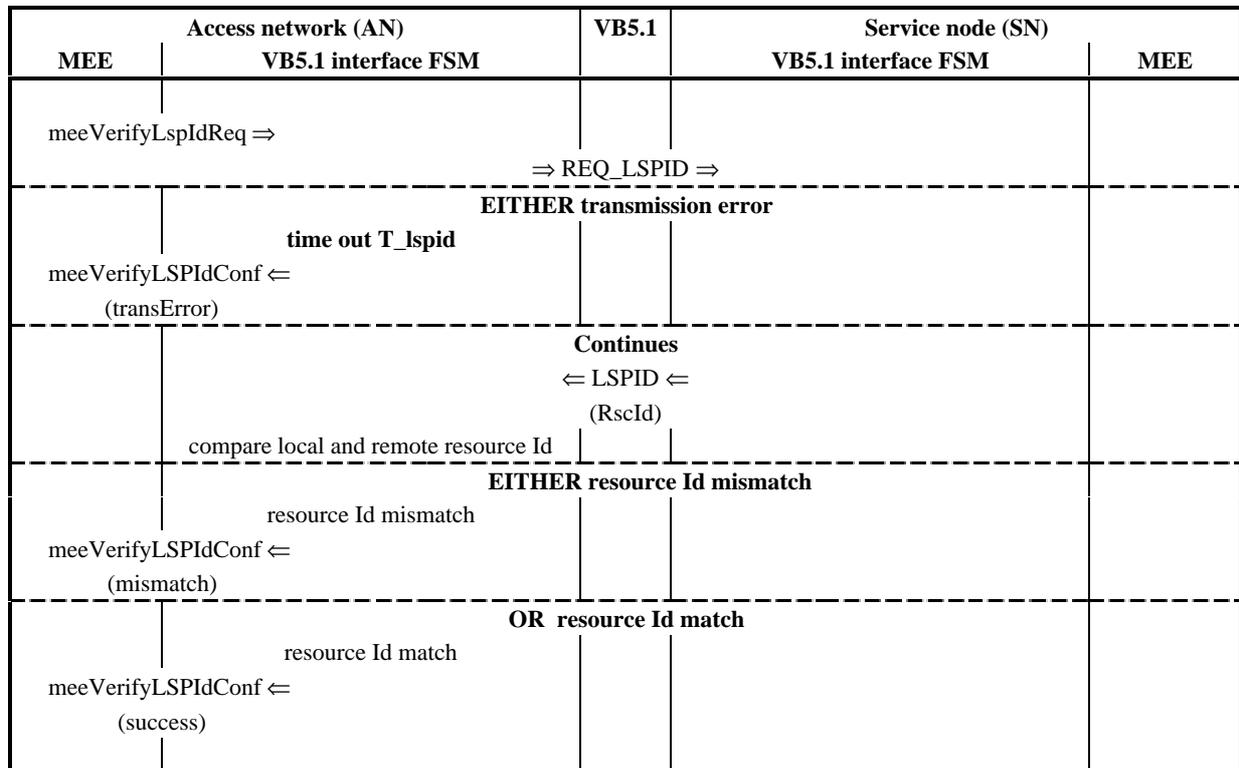
Figure C.12/G.967.1 – Verify LSP Id operation

C.3.5.3.3 Reset resource operation

In Figure C.13 an overview for the reset resource operation is illustrated. It must be noted here that the reset resource operation can be initiated at both network elements in a symmetrical way.

Based on the illustration in Figure C.13, the following generic principle applies:

–   C.3.5.1.1   Transmission error across VB5.1 reference point.

Access network (AN)		VB5.1	Service node (SN)	
MEE	VB5.1 interface FSM		VB5.1 interface FSM	MEE

			⇐ meeResetRscReq
			(RscList)
	⇐ RESET_RSC ⇐		
	(RscList)		

EITHER transmission error

time out T_reset

⇒ meeResetRscConf
(transError, RscList)

Continues

⇒ RESET_RSC_ACK ⇒

meeResetRscInd ⇐   ⇒ meeResetRscConf
(RscList)   (success)

End of operation
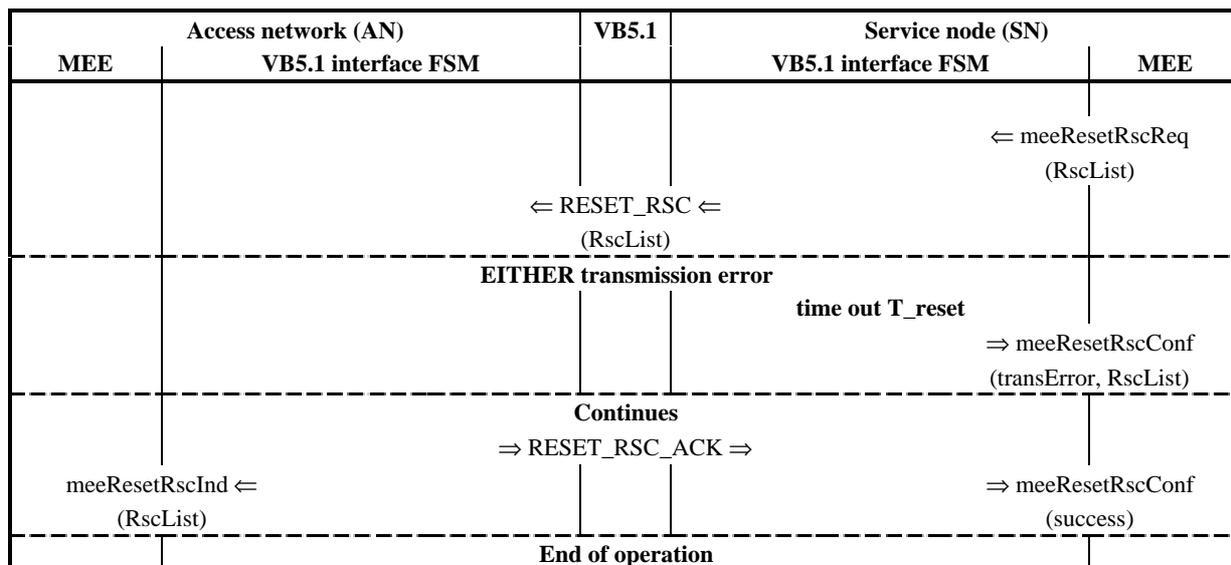
Figure C.13/G.967.1 – Reset resource operation

C.3.5.3.4   Block/unblock resource operation

In Figure C.14 an overview for the block/unblock resource operation is illustrated.

Based on the illustration in Figure C.14, the following generic principles apply:

–   C.3.5.1.1   Transmission error across VB5.1 reference point;

–   C.3.5.1.2   "Resource(s) unknown" at peer network element.

Access network (AN)		VB5.1	Service node (SN)	
MEE	**VB5.1 interface FSM**		**VB5.1 interface FSM**	**MEE**
mee(Un)BlockRscReq ⇒				
((Bl)RscList)	⇒ (UN)BLOCK_RSC ⇒			
	((RTMCBl)RscList)			
EITHER transmission error				
time out T_(un)block				
mee(Un)BlockRscConf ⇐				
(transError, RscList)				
OR all resources unknown				
			all resources unknown	
	⇐ (UN)BLOCK_RSC_ACK ⇐			
mee(Un)BlockRscConf ⇐	(unkRsc, RscList)			
(unkRsc, RscList)				
OR some resources unknown				
			Resource(s) unknown	
	⇐ (UN)BLOCK_RSC_ACK ⇐		⇒ mee(Un)BlockRscInd	
mee(Un)BlockRscConf ⇐	(unkRsc, RscList)		((Bl)RscList)	
(unkRsc, RscList)				
Continues				
			All resources known	
	⇐ (UN)BLOCK_RSC_ACK ⇐		⇒ mee(Un)BlockRscInd	
mee(Un)BlockRscConf ⇐	(success)		((Bl)RscList)	
(success)				

Figure C.14/G.967.1 – Remote blocking/unblocking resource operation

C.3.5.3.5   Await clear operation

In Figure C.15 an overview for the remote coordinated await clear operation is illustrated.

Based on the illustration for the remote coordinated await clear operation in Figure C.15, the following generic principles apply:

–   C.3.5.1.1   Transmission error across VB5.1 reference point;

–   C.3.5.1.2   "Resource(s) unknown" at peer network element.

Access network (AN)		VB5.1	Service node (SN)	
MEE	VB5.1 interface FSM		VB5.1 interface FSM	MEE

meeAwaitClearReq ⇒
   (RscList)
                    ⇒ AWAIT_CLEAR ⇒
                        (RscList)

EITHER transmission error

                time out T_acl

⇐ meeAwaitClearConf
  (transError, RscList)

OR all resources unknown

                        all resources unknown
                ⇐ AWAIT_CLEAR_ACK ⇐

⇐ meeAwaitClearConf
  (unkRsc, RscList)
             (unkRsc, RscList)

OR some resources unknown

                        some resource(s) unknown
                ⇐ AWAIT_CLEAR_ACK ⇐   ⇒ meeAwaitClearInd

⇐ meeAwaitClearConf
  (unkRsc, RscList)
             (unkRsc, RscList)   (RscList)

OR all resources known

                        all resources known
                ⇐ AWAIT_CLEAR_ACK ⇐   ⇒ meeAwaitClearInd
                    (success)   (RscList)

Continues

                                  ⇐ meeAwaitClearRes
                ⇐ AWAIT_CLEAR_COMP ⇐   (RscList)
                    (RscList)

EITHER transmission error

                          time out T_acl
                                     ⇒ meeErrorInd

Continues

⇐ meeAwaitClearConf   ⇒ AWAIT_CLEAR_COMP_ACK ⇒
  (success, RscList)

Figure C.15/G.967.1 – Remote await clear operation

C.3.5.3.6 VPCI consistency check operation

In Figures C.16 and C.17 an overview for the VPCI consistency check operations on initiation and termination is illustrated.

Based on the illustration for the VPCI consistency check initiation operation in Figure C.16, the following generic principles apply:

–   C.3.5.1.1   Transmission error across VB5.1 reference point;

–   C.3.5.1.2   "Resource(s) unknown" at peer network element;

–   C.3.5.1.3   "Operation rejected" by peer network element.

| Access network (AN) | | VB5.1 | Service node (SN) | |
MEE	VB5.1 interface FSM		VB5.1 interface FSM	MEE
				⇐ meeConsCheckReq
	⇐ CONS_CHECK_REQ ⇐			(RscId)
	(RscId)			
	EITHER transmission error			
			time out T_cons	⇒ meeConsCheckConf
				(transError, RscId)
	OR resource unknown			
Resource unknown	⇒ CONS_CHECK_REQ_ACK ⇒			
	(unkRsc, RscId)			⇒ meeConsCheckConf
				(unkRsc, RscId)
	Continues			
meeConsCheckInd ⇐	resource known			
(RscId)				
	EITHER environment reject			
meeConsCheckRes ⇒				
(reject, RscId)				
	⇒ CONS_CHECK_REQ_ACK ⇒			
	(opRej, RscId)			⇒ meeConsCheckConf
				(rejRem, RscId)
	Continues			
meeConsCheckRes ⇒				
(success)				
	⇒ CONS_CHECK_REQ_ACK ⇒			
	(success)			⇒ meeConsCheckConf
				(success)

Figure C.16/G.967.1 – VPCI consistency check initiation operation

Based on the illustration for the VPCI consistency check termination operation in Figure C.17, the following generic principles apply:

– C.3.5.1.1 Transmission error across VB5.1 reference point;

– C.3.5.1.2 "Resource(s) unknown" at peer network element;

– C.3.5.1.3 "Operation rejected" by peer network element;

– C.3.5.1.5 "Operation failed" in peer network element;

– C.3.5.1.8 "Not performed" by peer network element.

Access network (AN)		VB5.1	Service node (SN)	
MEE	VB5.1 interface FSM		VB5.1 interface FSM	MEE
				$\Leftarrow$ meeConsCheckEndReq
	$\Leftarrow$ CONS_CHECK_END $\Leftarrow$			(RscId)
	(RscId)			
EITHER transmission error				
			time out T_cons	$\Rightarrow$ meeConsCheckEndConf
				(transError, RscId)
OR resource unknown				
resource unknown	$\Rightarrow$ CONS_CHECK_END_ACK $\Rightarrow$			
	(unkRsc, RscId)			$\Rightarrow$ meeConsCheckEndConf
				(unkRsc, RscId)
Continues				
meeConsCheckEndInd $\Leftarrow$	resource known			
(RscId)				
EITHER environment reject				
meeConsCheckEndRes $\Rightarrow$				
(reject, RscId)	$\Rightarrow$ CONS_CHECK_END_ACK $\Rightarrow$			
	(opRej, RscId)			$\Rightarrow$ meeConsCheckEndConf
				(rejRem, RscId)
OR failed				
meeConsCheckEndRes $\Rightarrow$				
(failed, RscId)	$\Rightarrow$ CONS_CHECK_END_ACK $\Rightarrow$			
	(opFail, RscId)			$\Rightarrow$ meeConsCheckEndConf
				(failed, RscId)
OR not performed				
meeConsCheckEndRes $\Rightarrow$				
(notPerformed, RscId)	$\Rightarrow$ CONS_CHECK_END_ACK $\Rightarrow$			
	(opNotPerf, RscId)			$\Rightarrow$ meeConsCheckEndConf
				(notPerformed, RscId)
OR success				
meeConsCheckEndRes $\Rightarrow$				
(success)	$\Rightarrow$ CONS_CHECK_END_ACK $\Rightarrow$			
	(success)			$\Rightarrow$ meeConsCheckEndConf
				(success)

Figure C.17/G.967.1 – VPCI consistency check termination operation

APPENDIX I

Value-added features of VB5 interfaces applicable to other VBx interfaces

This appendix addresses the applicable added value features of the VB5.1 reference point to other VBx interfaces.

VBx interfaces, other than VB5.1, which inherit some value added features of the VB5.1 interface specification may be defined. The added value features of VB5.1 are e.g.:

–   VB5.1 specific facilities provided via Q3(AN) and Q3(SN);

–   similar configuration and supported connection types as well as the addressing facilities;

–   conceptual methodology to handle non-B-ISDN accesses, particularly narrow-band accesses;

–   functional split-up between AN and SN: e.g. AN is transparent for user signalling;

–   application of existing F4/F5 flows, according to Recommendation I.610 [24], across the VB5.1 reference point and/or across or within the associated access network;

–   value-added features of the VB5.1 RTMC protocol.

The merit of the RTMC protocol in VB5.1 lies in:

–   time-critical coordinated management between AN and SN.

Non-time-critical coordination (e.g. user port provisioning) is performed via Q3 interfaces of AN and SNs.

Examples of time-critical coordinated management across VB5.1 are:

–   informing the SN on administrative state changes in the AN which are affecting service. Such state changes are triggered by the AN operator via Q3(AN);

–   interface management: i.e. Reset and Interface ID Verification;

–   VP connection identification verification: i.e. VPCI consistency check.

In VB5.1, the information exchange about failures (and operational states of AN resources) is covered by embedded ATM maintenance flows (i.e. F4 and F5) and by additional messages on the RTMC protocol.

It is understood that other VBx (than VB5.1) could emerge for:

–   AN to SN interconnection, where the SN has restricted capabilities: for example, an SN which cannot handle the RTMC protocol (e.g. a non-intelligent SN, such as an ATM cross-connect);

–   initial deployment of a VBx interface which shall evolve to a VB5.1 interface in a later stage;

–   AN to SN interconnection, where bilateral agreements are the basis for AN-SN coordination (e.g. trial networks).

For these type of VBx interfaces it is recommended to inherit as much as possible the value-added features of the VB5.1.

Deviations from the VB5.1 specifications may lead to shortcomings; otherwise e.g. if the RTMC function is not supported, graceful shutdown of AN resources may not be possible at all or needs to rely on coordinated actions in the AN and SN via their respective Q3 interfaces. The same is valid for putting AN resources in dedicated state for e.g. test purposes (i.e. partial lock and shutdown). It should be noticed that coordination via human interactions may lead to unacceptable delays for handling AN resources. This could be particularly important in case of automated and repetitive test procedures.

In the absence of the RTMC function, the SN operator will not be able to be informed on a real time basis about administrative actions being performed by the AN operator. Indeed, if the unavailability of the AN resources is only communicated via F-flows, the SN cannot differentiate between administrative actions and operational state changes.

Also, the management capabilities of the RTMC may be shown to be extremely useful as mismatches (e.g. VP connection identifier) at both sides of the interfaces might only be detected after a long period of operation.

APPENDIX II

Application of the protection facility of SDH on the VB5.1 interface

Figure II.1 shows some examples to illustrate the protection methods on the VB5.1 interface.

a)   Example 1 shows how several ANs can be connected to the SN using one or more SDH rings. The VB5.1 interfaces themselves are not protected; the protection is provided by the SDH ring mechanisms, transparent to the network users. The narrow-band V5 interface may use the same SDH network and have the same level of protection.

b)   Example 2 shows how the short-haul interface can be applied. The traffic is protected at the SDH section level (duplicated 1+1 fibres). For an effective protection, the 4 fibres going to the same AN should not share the same cables or ducts. This method might only be used for small capacity ANs within a short range of the SN, in order to limit the number of optical fibres.

c)   Example 3 shows how a general-purpose SDH network, that supports diverse path routing, can be applied. The two VC4 SDH paths are routed through the SDH network, avoiding the use of any shared resource. In this example, the connection to the SN is even protected against failure of the transmission equipment itself, by having the duplicated path connected to a remote transmission node, using short haul optical transmission. The protection is at the path level; the subnetwork connection point that performs the protection is located in the AN and the SN. For clarity, only one AN is shown.

Figure II.1/G.967.1 – Protection methods of SDH on the VB5.1 interface
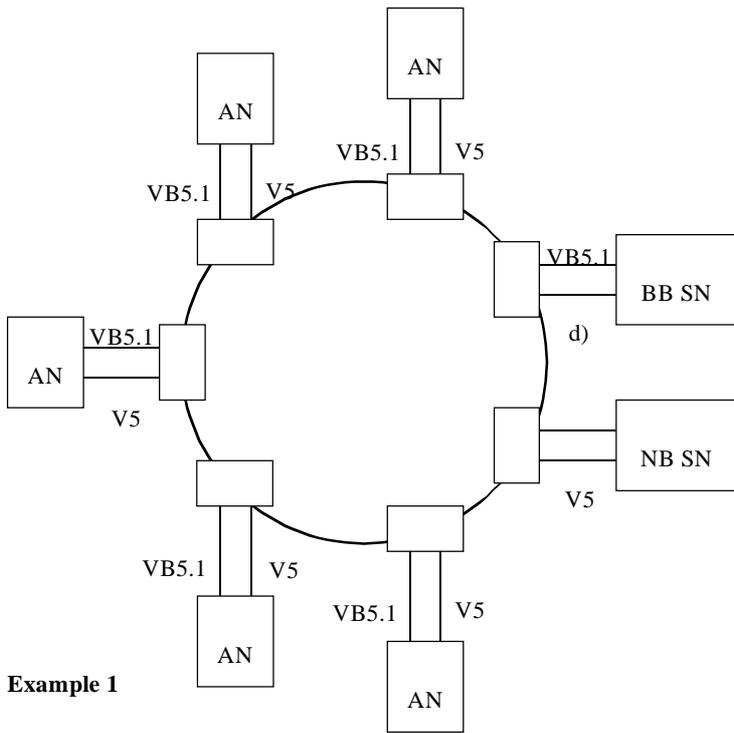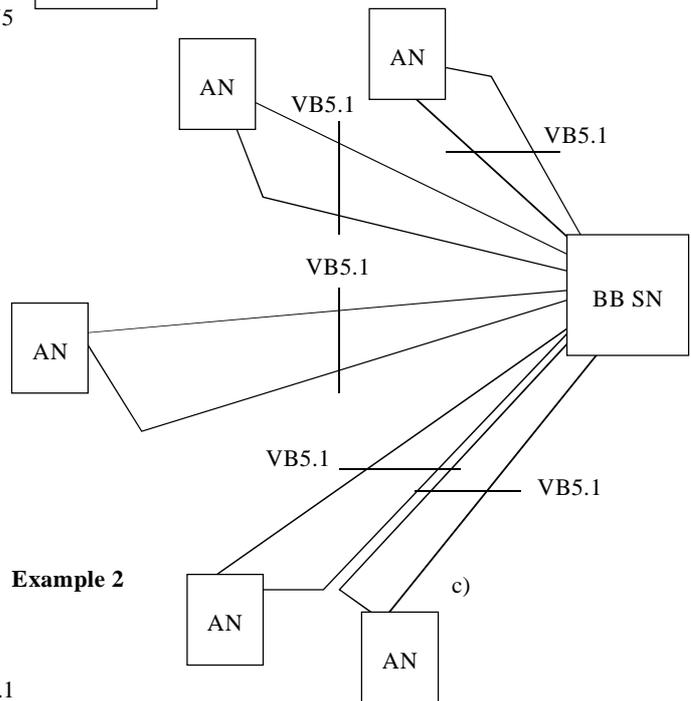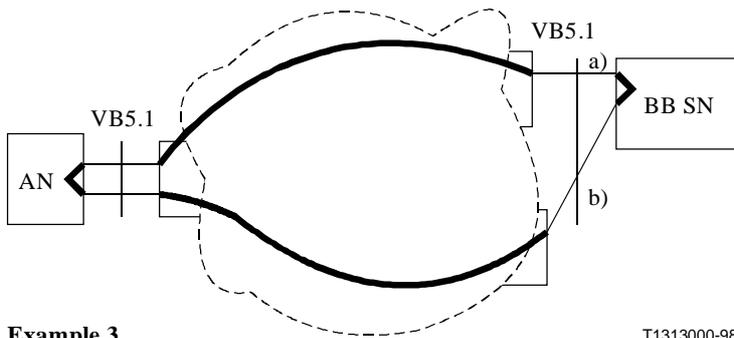
a) intra-office link
b) inter-office link (optical short haul)
c) all links are inter-office
d) all links connected to AN or SN are intra-office

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Examples of physical interface options for the VB5.1 interface

The selection of options is based on what is currently practical and on dimensioning considerations of real applications. For example, the use of ATM mapping in concatenated VC4s (i.e. VC4c) is not suggested as this transmission method is not widely deployed in current or planned transmission networks. Moreover, the capacity of a VC4c, compared to that of a VC4, hardly brings any gain with respect to dimensioning ANs conforming to the VB5.1 principles. Indeed, the bandwidth capacity required per access, in real situations, is expected to be sufficiently small compared to the capacity of a VC4. What results is that a VC4 capacity can efficiently be filled up with the traffic coming from a number of accesses. In order to support more accesses by a VB5.1 compliant AN, additional VB5.1 interfaces can be introduced.

Table III.1/G.967.1 – Physical layer options for the VB5.1 interface

Applications	Intra-office				Inter-office	
Digital hierarchy	PDH	SDH			SDH	
Medium (Note 1)	Electrical G.703	Electrical G.703	Optical G.957 Intra-office		Optical G.957 Short-haul	
Line rate (Note 2)	E3	STM1	STM1	STM4	STM1	STM4
Characteristics						
Max. Span length (Note 3)	~100 m		~2 km		~15 km	
Type of medium	Coax cable		1310 nm – G.652 – one fibre for each direction			
Section	No OH	SDH G.707 **reduced** SOH				
Path	G.832	VC4 G.707 POH				
ATM mapping	G.804	ATM cells in SDH VC4 conform to G.707				
Protection (Note 4)						
Section protection (Note 5)	None		1+1 **single ended**			
Path protection (Note 6)	None	1+1 VC4 subnetwork connection protection – **single ended** – **inherent monitoring** – G.841				

NOTE 1 – The topology is point-to-point.

NOTE 2 – Both directions have the same rate. Although the services supported on VB5.1 may to a large extend be asymmetrical in nature (more downstream bandwidth than upstream), this feature is not exploited.

NOTE 3 – Span length values are only given as an indication, and are not specified. Long-haul optical applications are supported through the use of a transport network.

NOTE 4 – The protection options (section, path) are optional. The same interfaces can operate without protection. Example applications using the protection facility of SDH on the VB5.1 interface are given in Appendix II.

NOTE 5 – Section protection is only applied to the optical interfaces. The electrical intra-office sections are assumed to be reliable enough so that cabling is not duplicated.

NOTE 6 – Subnetwork connection protection (known as path protection) with inherent monitoring relies on indications available at the SDH (high order) path layer to initiate protection switching (i.e. K1 and K2 bytes are not used). These indications reflect a failure that can be detected locally (i.e. via server signal fail) or somewhere remote in the transport network (i.e. via path-AIS). This protection method is therefore more generic than the section protection, where the protection switch and the optical line termination have to be located in one single equipment.

APPENDIX IV

Non-ATM-based non-B-ISDN accesses

IV.1   General

The examples given below mainly refer to a specific service or class of services. It is understood that all of these services might also be provided as part of B-ISDN. With respect to the customer access, this means that these services may also be supported via B-ISDN accesses and by ATM-based non-B-ISDN accesses. The latter access types are possible due to the fact that service independency is yet possible at ATM layer within the B-ISDN concepts.

Thanks to the concept of the virtual user port, also non-ATM-based non-B-ISDN accesses can be supported over the VB5.1 reference point. Some examples are given in the following subclause.

IV.2   Examples of non-ATM-based non-B-ISDN accesses

IV.2.1 LAN Accesses

For the purposes of this appendix, a **Local Area Network** is considered to be:

A data communication network confined to a small area within the customer premises. In its simplest form it can be reduced to an interface, interconnecting a single data communication terminal to the public network.

LAN accesses can be supported via the VB5.1 reference point. The general approach is applicable: i.e. a virtual user port may be introduced for one or more LAN accesses. Examples of LAN accesses are: Ethernet (IEEE 802.3), ATM DXI on $N \times 64$ kbit/s or E1 rate, 2048 kbit/s (E1) on a physical link conforming to Recommendation G.703, etc.

IV.2.2 Accesses for TV distribution services

For the VB5.1 reference points, digital broadcast TV channels presented across the VB5.1 reference point should be connectable to more than one access within the Access Network. Specifically, this is required for dedicated accesses for TV distribution (e.g. cable TV coax). For these type of accesses the general approach is applicable. The AAF may support one or more of these non-B-ISDN, non-ATM-based accesses. Typically, for a shared medium (e.g. coax tree and branch network), the AAF supports multiple accesses.

It is noted that digital broadcast TV channels can also be presented towards the AN via other type of VB interfaces. Nevertheless, the concept of the virtual user port can be applied as defined in 8.3.1.1.

The specific requirements for TV distribution services should be specified in dedicated standards. These requirements should not impact the VB5.1 interface if this type of SNI is used to feed the TV channels to the AN; e.g. when a broadcast connection for a TV channel is not being used by any access on the AN, then there is no requirement to continue feeding that TV channel into the AN unless a particular Access Network requires it. For this requirement the VB5.1 concept provides the facility to remove a VCL (carrying the TV channel), either by SN switching capabilities or via (re)provisioning via Q3(AN) or Q3(SN).

IV.2.3 Access for asymmetric services/multimedia (e.g. video on demand)

The specific requirements for asymmetric/multimedia services should be specified in dedicated standards. These requirements should not impact the VB5.1 interface if this type of SNI is used to carry the associated traffic.

For the cases where the access is non-ATM-based, the general VB5.1 principle based on the virtual user port should be applied.

The general approach for ATM-based accesses (B-ISDN and non-B-ISDN) for the VB5.1 reference point should be applied, if the SNI is VB5.1.

APPENDIX V

RTMC messages and information elements in ASN.1 notation

This appendix describes the VB5.1 RTMC message and information element formats and codes in the Abstract Syntax Notation No. 1 (ASN.1) according to Recommendation X.680 in order to provide a machine-readable description for these messages.

The description given in this appendix is only for informative purposes; the leading notation of the VB5.1 RTMC message and information element formats and codes is the tabular form as described in clause 14.

The encoding rules as described in Recommendations X.690 and X.691 do not apply.

**Table V.1/G.967.1 – Type and value definitions for RTMC
messages and information elements**

```
RTMCMessages { modules(2) messages (1) version0 (0) }
DEFINITIONS ::=
BEGIN


MessageTypes ::= CHOICE
{       awaitClear              AwaitClear ,
        awaitClearAck           AwaitClearAck ,
        awaitClearComp          AwaitClearComp ,
        awaitClearCompAck       AwaitClearCompAck ,
        blockRsc                BlockRsc ,
        blockRscAck             BlockRscAck ,
        consCheckEnd            ConsCheckEnd ,
        consCheckEndAck         ConsCheckEndAck ,
        consCheckReq            ConsCheckReq ,
        consCheckReqAck         ConsCheckReqAck ,
        lSPId                   LSPId ,
        protocolError           ProtocolError ,
        reqLSPId                ReqLSPId ,
        resetRsc                ResetRsc ,
        resetRscAck             ResetRscAck ,
        unblockRsc              UnblockRsc ,
        unblockRscAck           UnblockRscAck
}

-- definition of RTMC messages

AwaitClear ::= SEQUENCE
{       commonMessageInformation                CommonMessageInformation,
        resourceIdentifierList                  RTMCRscList     -- repeat indicator optional
}
```

**Table V.1/G.967.1 – Type and value definitions for RTMC
messages and information elements** *(continued)*

```
AwaitClearAck ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       resultIndicator                     ResultIndicator,
       resourceIdentifierList              RTMCRscList  OPTIONAL  -- repeat indicator optional
}
AwaitClearComp ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       resultIndicator                     ResultIndicator,
       resourceIdentifierList              RTMCRscList        -- repeat indicator optional
}

AwaitClearCompAck ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation
}

BlockRsc ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       blockedResourceIdentifierList       RTMCBlRscList     -- repeat indicator optional
}

BlockRscAck ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       resultIndicator                     ResultIndicator,
       resourceIdentifierList              RTMCRscList OPTIONAL   -- repeat indicator optional
}

ConsCheckEnd ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       resourceIdentifier                  RTMCRscId
}

ConsCheckEndAck ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       resultIndicator                     ResultIndicator,
       resourceIdentifier                  RTMCRscId  OPTIONAL
}

ConsCheckReq ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       resourceIdentifier                  RTMCRscId
}

ConsCheckReqAck ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       resultIndicator                     ResultIndicator,
       resourceIdentifier                  RTMCRscId  OPTIONAL
}

LSPId ::= SEQUENCE
{      commonMessageInformation            CommonMessageInformation,
       resultIndicator                     ResultIndicator,
       resourceIdentifier                  ResourceIdentifier  OPTIONAL
}
```

```
ProtocolError ::= SEQUENCE
{    commonMessageInformation              CommonMessageInformation,
     protocolErrorCause                    ProtocolErrorCause  OPTIONAL
}


ReqLspId ::= SEQUENCE
{    commonMessageInformation              CommonMessageInformation
}


ResetRsc ::= SEQUENCE
{    commonMessageInformation              CommonMessageInformation,
     resourceIdentifierList                RTMCRscList      -- repeat indicator optional
}


ResetRscAck ::= SEQUENCE
{    commonMessageInformation              CommonMessageInformation,
     resultIndicator                       ResultIndicator,
     resourceIdentifierList                RTMCRscList  OPTIONAL  -- repeat indicator optional
}


UnblockRsc ::= SEQUENCE
{    commonMessageInformation              CommonMessageInformation,
     resourceIdentifierList                RTMCRscList      -- repeat indicator optional
}


UnblockRscAck ::= SEQUENCE
{    commonMessageInformation              CommonMessageInformation,
     resultIndicator                       ResultIndicator,
     resourceIdentifierList                RTMCRscList  OPTIONAL  -- repeat indicator optional
}


-- In the following the common message information of VB5.1 messages is defined
CommonMessageInformation ::= SEQUENCE
{    protocolDiscriminator          ProtocolDiscriminatorVb5 ::= OCTET STRING (SIZE (1)) { '49'H },
     transactionIdentifier          TaId,
     messageType                    MessageType ::= OCTET STRING (SIZE (1)),
     messageCompatibilityInfo       MessageCompatibilityInfo,
     messageLength                  MessageLength ::= OCTET STRING (SIZE (2))
}


TaId ::= SEQUENCE        -- Transaction Identifier
{    spareBit4                 SpareBit4,
     lengthOfTaIdValue         BIT STRING (SIZE (4)),
     transactionIdentifierFlag TaIdFlag,
     transactionIdentifierValue INTEGER (0 .. 8388607)   -- maximum value 2²³ − 1
}


MessageCompatibilityInfo ::= SEQUENCE
{    extensionBitLast,
     spareBit2              SpareBit2 ,
     compatibilityInfoFlag  CompatibilityInfoFlag ,
     spareBit2              SpareBit2 ,
     compatInfoIndMessage   CompatInfoIndMessage
}
```

```
-- In the following the VB5.1 RTMC information elements are defined
BlockedResourceIdentifier ::= SEQUENCE        -- RTMC Blocked Resource Identifier
{      commonInformationElements          CommonInformationElements,
       blockedResourceIdentifierContent   RTMCBlRscId
}


RTMCBlRscList ::= SEQUENCE           -- RTMC Blocked Resource Identifier List
{      repeatIndicator               RTMCRepeatInd  OPTIONAL,
       multipleRTMCBlRscId           SEQUENCE OF RTMCBlRscId
}


ProtocolErrorCause ::= SEQUENCE      -- RTMC Protocol Error Cause
{      commonInformationElements          CommonInformationElements,
       protocolErrorCauseContent          RTMCProtErrCause
}


RepeatIndicator ::= SEQUENCE         -- RTMC Repeat Indicator
{      commonInformationElements          CommonInformationElements,
       repeatIndicatorOctet               RepeatIndicatorOctet
}


ResultIndicator ::= SEQUENCE         -- RTMC Result Indicator
{      commonInformationElements          CommonInformationElements,
       resultIndicationOctet              RTMCResultInd
}


ResourceIdentifier ::= SEQUENCE      -- RTMC Resource Identifier
{      commonInformationElements          CommonInformationElements,
       resourceIdentifierContent          RTMCRscId
}


RTMCRscList ::= SEQUENCE             -- RTMC Resource Identifier List
{      repeatIndicator               RTMCRepeatInd  OPTIONAL,
       multipleRTMCRscId             SEQUENCE OF RTMCRscId
}
-- In the following the common information elements of VB5.1 information are defined


CommonInformationElements ::= SEQUENCE
{      infoElementType               InfoElementType ::= OCTECT STRING (SIZE (1)),
       infoElementCompatibilityInfo  InfoElementCompatibilityInfo,
       infoElementLength             InfoElementLength ::= OCTET STRING (SIZE (2))
}


InfoElementCompatibilityInfo ::= SEQUENCE
{      extensionBitLast,
       spareBit2                     SpareBit2,
       compatibilityInfoFlag         CompatibilityInfoFlag,
       spareBit1                     SpareBit1,
       compatInfoIndParameter  CompatInfoIndIE
}


-- Supporting productions for VB5.1 RTMC messages and information elements
```

**Table V.1/G.967.1 – Type and value definitions for RTMC
messages and information elements** *(continued)*

```
CompatibilityInfoFlag ::= BIT STRING (SIZE (1))
      compatibilityInfoFlagNotSignif   CompatibilityInfoFlag ::= ('0'B)
            -- instruction field not significant
      compatibilityInfoFlagExplicit    CompatibilityInfoFlag ::= ('1'B)
            -- follow explicit Instructions


CompatInfoIndMessage ::= BIT STRING (SIZE (2))
      compatInfoIndMsgReject             CompatInfoIndMsg ::= ('00'B)
      compatInfoIndMsgDiscardIgnore      CompatInfoIndMsg ::= ('01'B)          -- discard and ignore
      -- compatInfoIndMsgDiscardAndReport '10'B not used by this VB5.1 version


CompatInfoIndIE ::= BIT STRING (SIZE (3))
      compatInfoIndIEReject                   CompatInfoIndIE ::= '000'B
      compatInfoIndIEDiscardAndProceed        CompatInfoIndIE ::= '001'B
      -- compatInfoIndPrmDiscardProceedAndReport '010'B not used by this VB5.1 version
      compatInfoIndIEDiscardAndIgnore         CompatInfoIndIE ::= '101'B
      -- compatInfoIndPrmDiscardAndReport '110'B not used by this VB5.1 version


ExtensionBit ::= BIT STRING (SIZE (1))
      extensionBitContinues    ExtensionBit ::= ('0'B)      -- another octet of this group follows
      extensionBitLast         ExtensionBit ::= ('1'B)      -- last octet of this octet group


LogId ::= CHOICE          -- logical port identifier
{     logicalServicePortIdentifier     LSPId ::= OCTET STRING (SIZE (3)) {(0 .. 16777215)},
      logicalUserPortIdentifier        LUPId ::= OCTET STRING (SIZE (3)) {(0 .. 16777215)}
}


ProtocolErrorCauseContent ::= SEQUENCE {
      extensionBitLast,
      protocolErrorCauseValue              ProtocolErrorCauseValue ::= BIT STRING (SIZE (7)),
      protocolErrorCauseDiagnostitics      ProtocolErrorCauseDiagnostics  OPTIONAL }


RepeatIndicatorOctet ::= SEQUENCE
{     extensionBitLast,
      spareBits3        SpareBits3,
      repeatIndication    RTMCRepeatInd
}


ResourceIndicatorOctet ::= SEQUENCE
{     extensionBitLast,
      unknownResourceIndicator         RTMCUnkRscInd  OPTIONAL,
      spareBits2                       SpareBits2,
      resourceIndicator                RTMCRscInd
}


ResultIndication ::= BIT STRING (SIZE (4))          -- result error values
      Success    ResultIndication ::= ('0000'B)     -- accepted or successful
      UnkRsc     ResultIndication ::= ('0001'B)     -- resource(s) unknown
      OpRej      ResultIndication ::= ('0010'B)     -- operation rejected
      OpFail     ResultIndication ::= ('0011'B)     -- operation failed
      NotPerf    ResultIndication ::= ('0100'B)     -- operation not performed
            -- all other values are reserved
```

Table V.1/G.967.1 – Type and value definitions for RTMC
messages and information elements *(concluded)*

```
ResultIndicatorOctet ::= SEQUENCE
{      extensionBitLast      ExtensionBitLast,
       spareBits3            SpareBits3,
       resultIndication      ResultIndication      -- result indication values
}


RTMCAdmReasonVal ::= BIT STRING (SIZE (5))
       RTMCAdmNone    RTMCAdmReasonVal ::= ('00000'B)
       RTMCAdmPart    RTMCAdmReasonVal ::= ('00001'B)
       RTMCAdmFull    RTMCAdmReasonVal ::= ('00010'B)


RTMCBlRscId ::= SEQUENCE  -- RTMC blocked resource identifier
{      blockingReasonIndicatorOctet      RTMCReason,
       resourceIndicatorContent          ResourceIndicatorContent
}


RTMCErrReasonVal ::= BIT STRING (SIZE (2))
       RTMCErrNone    RTMCErrReasonVal ::= ('00'B)
       RTMCErr        RTMCErrReasonVal ::= ('01'B)


RTMCReason ::= SEQUENCE    -- Blocking reason indicator octet
{      extensionBitLast        ExtensionBitLast,
       errorReason             RTMCErrReasonVal,     -- RTMC error reason value
       administrativeReason    RTMCAdmReasonVal      -- RTMC administrative reason value
}


RTMCRepeatInd ::= BIT STRING (SIZE (4))
       repeatIndicationMultipleList    RTMCRepeatInd ::= ('0011'B)


RTMCRscId ::= SEQUENCE
{      resourceIndicatorOctet    ResourceIndicatorOctet
       resourceLogicalIdentifier ResourceLogicalIdentifier ::= OCTET STRING (SIZE (3)),
       vPCIs                     VPCI
}


RTMCRscInd ::= BitString (SIZE (3))   -- RTMC resource indicator values
       CompLSP    RTMCRscInd ::= ('000'B)        -- complete LSP
       ConnLSP    RTMCRscInd ::= ('001'B)        -- connection(s) at LSP
       ConnLUP    RTMCRscInd ::= ('010'B)        -- connection(s) at LUP
            -- all other values are reserved


RTMCUnkRscInd ::= BIT STRING (SIZE (2))        -- RTMC unknown resource indicator
       unkLogId    RTMCUnkRscInd ::= ('01'B)    -- LSP/LUP Id unknown (implies VPCI is also unknown)
       unkVPCI     RTMCUnkRscInd ::= ('10'B)    -- VPCI unknown but LSP/LUP known


VPCI ::= SEQUENCE OF (SIZE (1 .. 2)) VPCIs
```

MEE primitives for the RTMC function in ASN.1 notation

This appendix describes the MEE primitives for the RTMC function in the Abstract Syntax Notation No. 1 (ASN.1) according to Recommendation X.680 in order to provide a machine-readable description for these primitives. For the purposes of this primitive interface specification, the rules of extensibility are applied by using the extension marker (e.g. a syntactic flag (an ellipsis) that is included in all types that form part of an extension series).

The encoding rules as defined in Recommendations X.690 and X.691 do not apply.

Table VI.1/G.967.1 – RTMC primitive type and value definitions

```
RTMCPrimmitives {…} DEFINITIONS ::= BEGIN

RTMCPrimitiveAnSn ::= CHOICE       -- RTMC primitive type definitions common for AN and SN
{       meeErrorInd               MEEErrorInd,
        meeLspFailureInd          MEELspFailureInd,
        meeResetRscReq            MEEResetRscReq,
        meeResetRscConf           MEEResetRscConf,
        meeResetRscInd            MEEResetRscInd,
        meeStartupReq             MEEStartupReq,
        meeStartupConf            MEEStartupConf,
        meeStartupInd             MEEStartupInd,
        meeStopTrafficReq         MEEStopTrafficReq,
        meeStopTrafficConf        MEEStopTrafficConf,
        meeVerifyLspIdReq         MEEVerifyLspIdReq,
        meeVerifyLspIdConf        MEEVerifyLspIdconf,
        meeVpcCreateReq           MEEVPCCreateReq,
        meeVpcCreateConf          MEEVPCCreateConf,
        meeVpcDeleteReq           MEEVPCDelReq,
        meeVpcDeleteConf          MEEVPCDelConf
... }

RTMCPrimitiveAn ::= CHOICE          -- RTMC primitive type definitions specific for AN
{       meeAwaitClearConf         MEEAwaitClearConf,
        meeAwaitClearReq          MEEAwaitClearReq,
        meeBlockRscReq            MEEBlockRscReq,
        meeBlockRscConf           MEEBlockRscConf,
        meeConsCheckInd           MEEConsCheckInd,
        meeConsCheckRes           MEEConsCheckRes,
        meeConsCheckEndInd        MEEConsCheckEndInd,
        meeConsCheckEndRes        MEEConsCheckEndRes,
        meeUnblockRscReq          MEEUnblockRscReq,
        meeUnblockRscConf         MEEUnblockRscConf
... }
```

```
RTMCPrimitiveSn ::= CHOICE          -- RTMC primitive type definitions specific for SN
{      meeAwaitClearInd          MEEAwaitClearInd,
       meeAwaitClearRes          MEEAwaitClearRes,
       meeBlockRscInd            MEEBlockRscInd,
       meeConsCheckReq           MEEConsCheckReq,
       meeConsCheckConf          MEEConsCheckConf,
       meeConsCheckEndReq        MEEConsCheckEndReq,
       meeConsCheckEndConf       MEEConsCheckEndConf,
       meeUnblockRscInd          MEEUnblockRscInd
... }

MEEAwaitClearConf ::= SEQUENCE
{      result                    Result,
       unknownResourceList       RscList  OPTIONAL,      -- reporting of unknown resources
       rtmcResourceList          RscList  OPTIONAL       -- resources with shutting down completed
... }

MEEAwaitClearInd ::= SEQUENCE
{      rtmcResourceList          RTMCRscList
... }

MEEAwaitClearReq ::= SEQUENCE
{      resourceList              RscList
... }

MEEAwaitClearRes ::= SEQUENCE
{      resourceList              RscList
... }

MEEBlockRscConf ::= SEQUENCE
{      result                    Result
       unknownResourceList       RscList  OPTIONAL        -- reporting of unknown resources
... }

MEEBlockRscInd ::= SEQUENCE
{      blockedResourceList       BlRscList
... }

MEEBlockRscReq ::= SEQUENCE
{      resourceList              RscList,
       blockingReason            ReasonVal
... }

MEEConsCheckConf ::= SEQUENCE
{      result                    Result,
       unknownResourceId         RTMCRscId  OPTIONAL       -- reporting of unknown resources
... }

MEEConsCheckEndConf ::= SEQUENCE
{      result                    Result,
       unknownResource           RTMCRscId  OPTIONAL,      -- reporting of unknown resources
... }
```

```
MEEConsCheckEndInd ::= SEQUENCE
 {    rtmcResourceIdentifier    RTMCRscId
 ... }


MEEConsCheckEndReq ::= SEQUENCE
 {    rtmcResourceIdentifier    RTMCRscId
 ... }


MEEConsCheckEndRes ::= SEQUENCE
 {    result                    Result,
      unknownResource           RTMCRscId  OPTIONAL,        -- reporting of unknown resources
 ... }


MEEConsCheckInd ::= SEQUENCE
 {    rtmcResourceIdentifier    RTMCRscId
 ... }


MEEConsCheckReq ::= SEQUENCE
 {    rtmcResourceIdentifier    RTMCRscId
 ... }


MEEConsCheckRes ::= SEQUENCE
 {    result                    Result,
 ... }


MEEErrorInd ::= SEQUENCE { ... }


MEELSPFailureInd ::= SEQUENCE { ... }


MEEResetRscConf ::= SEQUENCE
 {    result                              Result,
      unknownResourceList    RscList OPTIONAL,        -- reporting of unknown resources
 ... }


MEEResetRscInd ::= SEQUENCE
 {    rtmcResourceList   RTMCRscList
 ... }


MEEResetRscReq ::= SEQUENCE
 {    resourceList RscList
 ... }


MEEStartupConf ::= SEQUENCE
 {    result                   Result
 ... }


MEEStartupInd ::= SEQUENCE { ... }


MEEStartupReq ::= SEQUENCE { ... }


MEEStopTrafficConf ::= SEQUENCE { ... }


MEEStopTrafficReq ::= SEQUENCE { ... }
```

```
MEEUnblockRscConf ::= SEQUENCE
{       result                          Result,
        unknownResourceList             RscList  OPTIONAL        -- reporting of unknown resources
... }


MEEUnblockRscInd ::= SEQUENCE
{       rtmcResourceList                RTMCRscList
... }


MEEUnblockRscReq ::= SEQUENCE
{       resourceList                    RscList,
... }


MEEVerifyLspIdConf ::= SEQUENCE
{       result                          Result
... }


MEEVerifyLspIdReq ::= SEQUENCE { ... }


MEEVPCCreateConf ::= SEQUENCE { ... }


MEEVPCCreateReq ::= SEQUENCE
{       rtmcResourceIdentifier    RTMCRscId
... }


MEEVPCDeleteConf ::= SEQUENCE { ... }


MEEVPCDeleteReq ::= SEQUENCE
{       rtmcResourceIdentifier    RTMCRscId
... }


-- supporting productions


ACCTreatment ::= BOOLEAN    -- TRUE if resource is used for on-demand connections at SN


BlRsc ::= SEQUENCE      -- blocked resource
{       rtmcResourceIdentifier    RTMCRscId,
        blockingReason            ReasonVal
... }


BlRscList ::= SEQUENCE OF BlRsc -- environment block resource list


LogicalResource ::= INTEGER (0 .. 16777215)


ReasonVal ::= ENUMERATED
{ admPart,               -- administrative partial
        admFull,         -- administrative full
        error,           -- error
        admPartErr,      -- administrative partial and error
        admFullErr       -- administrative full and error
... }
```

Table VI.1/G.967.1 – RTMC primitive type and value definitions *(concluded)*

```
Result ::= ENUMERATED
{     success,        -- Success
      unkRsc,         -- unknown resource(s)
      opRejLoc,       -- operation rejected by local FSM
      opRejRem,       -- operation rejected by remote network element
      opFail,         -- operation failed in remote network element
      transErr,       -- message exchange transmission error
      mismatch,       -- mismatch of local and remote identifiers
      notPerf,        -- operation not performed
      SAAL            -- SAAL failure
... }

RscList ::= SEQUENCE OF RTMCRscId        -- environment resource list

RTMCRscId ::= SEQUENCE     -- RTMC resource identifier
{     resourceIndicator            RTMCRscInd,
      logicalResource              LogicalResource,
      vpci                         VPCI  OPTIONAL,
      awaitClearCompTreatment      ACCTreatment  OPTIONAL,
      unknownResourceIndicator     UnkRscInd  OPTIONAL
... }

RTMCRscInd ::= ENUMERATED      -- RTMC resource indicator
{     compLSP,    -- complete LSP
      connLsp,    -- connection(s) at LSP
      connLUP     -- connection(s) at LUP
... }

RTMCRscList ::= SEQUENCE OF RTMCRscId

UnkRscInd ::= ENUMERATED  -- unknown resource indicator
{     logicalResourceUnknown,     -- LSP Id or LUP Id unknown
      vpciUnknown                 -- VPCI unknown
... }

VPCI ::= INTEGER (0 .. 65535)      -- maximum value 2^16 – 1

END
```

APPENDIX VII

Bibliography

The following Recommendations are not referenced in the main body of the text, but may be helpful to the reader in order to provide more details on related issues.

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[1] Presently at the stage of draft.

–   ITU-T Recommendation I.413 (1993), *B-ISDN user-network interface.*

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–   ITU-T Recommendation M.3100 (1995), *Generic network information model.*

–   ITU-T Recommendation M.3610 (1996), *Principles for applying the TMN concept to the management of B-ISDN.*

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–   ITU-T Recommendation Q.850 (1998), *Use of cause and location in the digital subscriber Signalling System No. 1 and the Signalling System No. 7 ISDN user part.*

–   ITU-T Recommendation Q.2010 (1995), *Broadband integrated services digital network overview - Signalling capability set 1, release 1.*

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–   ITU-T Recommendation Q.2610 (1995), *Usage of cause and location in B-ISDN user part and DSS 2.*

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