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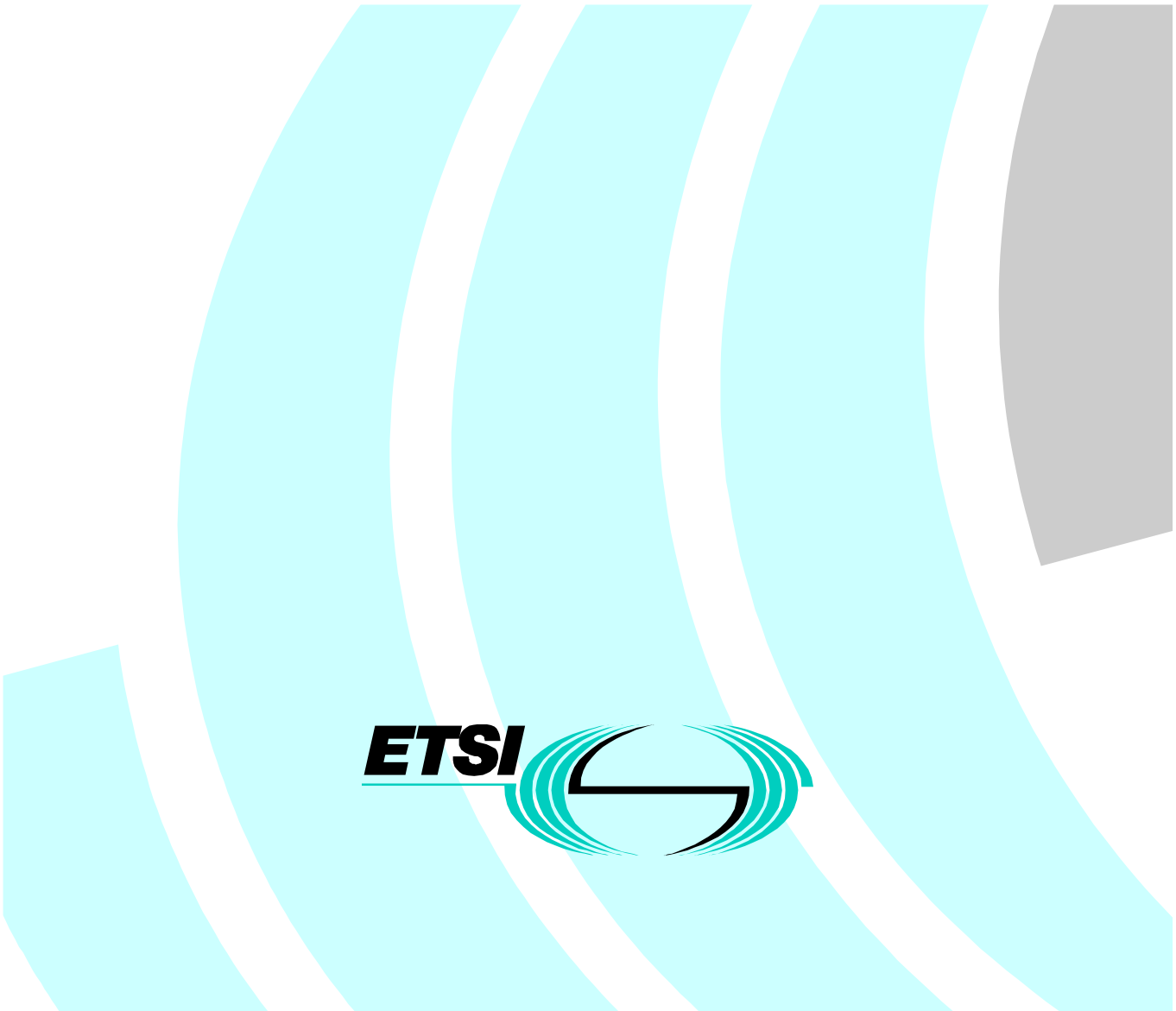
Technical Specification

Technical Framework for the Provision of Interoperable ATM Services; Network-Network Interface (NNI) User and Control Plane Specification (including Network Functions and Service Aspects) Phase 1



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Foreword

This Technical Specification (TS) has been produced by ETSI Project ATM Services Interoperability (EASI).

1 Scope

The present document is part of a set of specifications (see [47]) defining the network-network interface to enable service interoperability between ATM networks. These documents specify an interface for the transfer of user information and connection control for interoperable ATM services. This interface, for which hereafter the term "NNI.easi interface" will be used, allows for the interconnection of ATM networks in order to provide ATM based services also across network boundaries. The present document describes the NNI.easi interface for Phase 1.

For this purpose, the present document covers the following areas:

- a description of some aspects of the network architecture;
- the definition of the interface with regard to the user and the control plane;
- the Quality of Service and performance objectives; and
- the ATM transfer capabilities at the NNI.easi interface.

2 References

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

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

[1] ITU-T Recommendation E.164 (1997): "The international public telecommunication numbering plan".

[2] ITU-T Recommendation E.191 (1996): "B-ISDN numbering and addressing".

[3] ETS 300 166: "Transmission and Multiplexing (TM); Physical and electrical characteristics of hierarchical digital interfaces for equipment using the 2 048 kbit/s - based plesiochronous or synchronous digital hierarchies".

[4] ETS 300 337: "Transmission and Multiplexing (TM); Generic frame structures for the transport of various signals (including Asynchronous Transfer Mode (ATM) cells and Synchronous Digital Hierarchy (SDH) elements) at the ITU-T Recommendation G.702 hierarchical rates of 2 048 kbit/s, 34 368 kbit/s and 139 264 kbit/s".

[5] ITU-T Recommendation G.811 (1997): "Timing characteristics of primary reference clocks".

[6] ITU-T Recommendation G.823 (1993): "The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy".

[7] ETS 300 417 Series: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment".

[8] ITU-T Recommendation I.732 (1996): "Functional characteristics of ATM equipment".

[9] ETS 300 147 (1997): "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); Multiplexing Structure".

[10] ITU-T Recommendation G.825 (1993): "The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)".

[11] ITU-T Recommendation I.432.1 (1999): "B-ISDN user-network interface - Physical layer specification: General characteristics".

[12] ETS 300 300: "Broadband Integrated Services Digital Network (B-ISDN); Synchronous Digital Hierarchy (SDH) based user network access; Physical layer User Network Interfaces (UNI) for 155 520 kbit/s and 622 080 kbit/s Asynchronous Transfer Mode (ATM) B-ISDN applications".

[13] ITU-T Recommendation G.957 (1995): "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy".

[14] ITU-T Recommendation G.652 (1997): "Characteristics of a single-mode optical fibre cable".

[15] ETS 300 687: "Business TeleCommunications (BTC); 34 Mbit/s digital leased lines (D34U and D34S); Connection characteristics".

[16] ITU-T Recommendation M.2100 (1995): "Performance limits for bringing-into-service and maintenance of international PDH paths, sections and transmission systems".

[17] ETS 300 298-2: "Broadband Integrated Services Digital Network (B-ISDN); Asynchronous Transfer Mode (ATM); Part 2: B-ISDN ATM layer specification" [ITU-T Recommendation I.361(1995)].

[18] ETS 300 298-1: "Broadband Integrated Services Digital Network (B-ISDN); Asynchronous Transfer Mode (ATM); Part 1: B-ISDN ATM functional characteristics" [ITU-T Recommendation I.150].

[19] ETS 300 301: "Broadband Integrated Services Digital Network (B-ISDN); Traffic control and congestion control in B-ISDN" [ITU-T Recommendation I.371 (1996)].

[20] ETS 300 464: "Broadband Integrated Services Digital Network (B-ISDN); Asynchronous Transfer Mode (ATM); ATM layer cell transfer performance for B-ISDN connection types".

[21] ITU-T Recommendation I.356 (1996): "B-ISDN ATM layer cell transfer performance".

[22] ITU-T Recommendation I.357 (1996): "B-ISDN semi-permanent connection availability".

[23] ITU-T Recommendation I.610 (1999): "B-ISDN Operation and Maintenance Principles and Functions abstract".

[24] ETS 300 404: "Broadband Integrated Services Digital Network (B-ISDN); B-ISDN Operation And Maintenance (OAM) principles and functions".

[25] ITU-T Recommendation I.363.5 (1996): "B-ISDN ATM Adaption Layer specification, Type 5 AAL".

[26] ITU-T Recommendation Q.2110 (1994): "B-ISDN ATM adaptation layer - Service specific connection oriented protocol (SSCOP)".

[27] ITU-T Recommendation Q.2140 (1995): "B-ISDN ATM adaptation layer - Service specific coordination function for signalling at the network node interface (SSCF at NNI)".

[28] ITU-T Recommendation Q.2210 (1996): "Message transfer part level 3 functions and messages using the services of ITU-T Recommendation Q.2140".

[29] ITU-T Recommendation Q.708: "Numbering of international signalling point codes".

[30] ETS 300 657: "Broadband Integrated Services Digital Network (B-ISDN); Signalling System No.7; B-ISDN User Part (B-ISUP) Capability Set 1 (CS1); Supplementary services" [ITU-T Recommendation Q.2730 (1995), modified].

[31] ITU-T Recommendation E.735 (1997): "Framework for traffic control and dimensioning in B-ISDN".

[32] ITU-T Recommendation F.811 (1996): "Broadband connection-oriented bearer service".

[33] ITU-T Recommendation F.812 (1992): "Broadband connectionless data bearer service".

[34] ETS 300 217: "Network Aspects (NA); Connectionless Broadband Data Service (CBDS) Parts 1 to 4".

[35] ITU-T Recommendation Q.2761 (1995): "Broadband integrated services digital network (B-ISDN) - Functional description of the B-ISDN user part (B-ISUP) of signalling system No. 7".

[36] ITU-T Recommendation Q.2762 (1995): "Broadband integrated services digital network (B-ISDN) - General functions of messages and signals of the B-ISDN user part (B-ISUP) of Signalling System No. 7".

[37] ITU-T Recommendation Q.2763 (1995): "Broadband Integrated Services Digital Network (B-ISDN) - Signaling System No. 7 B-ISDN user part (B-ISUP) - Formats and codes".

[38] ITU-T Recommendation Q.2764 (1995): "Broadband Integrated Services Digital Network (B-ISDN) - Signalling system no. 7 B-ISDN user part (B-ISUP) - Basic call procedures".

[39] ITU-T Recommendation Q.2610 (1995): "Broadband integrated services digital network (B-ISDN) - usage of cause and location in B-ISDN user part and DSS 2".

[40] ITU-T Recommendation Q.2730 (1995): "Broadband integrated services digital network (B-ISDN) signalling system no. 7 B-ISDN user part (B-ISUP) - supplementary services".

[41] ITU-T Recommendation Q.2723.1 (1996): "B-ISDN User Part - Support of additional traffic parameters for Sustainable Cell Rate and Quality of Service".

[42] ITU-T Recommendation Q.2723.2 (1997): "Extensions to the B-ISDN User Part - Support of ATM transfer capability in the broadband bearer capability parameter".

[43] ITU-T Recommendation Q.2726.1 (1996): "B-ISDN user part - ATM end system address".

[44] ITU-T Recommendation Q.2735.1 (1997): "Stage 3 description for community of interest supplementary services for B-ISDN using SS No. 7: Closed User Group (CUG)".

[45] ITU-T Recommendation G.826 (1996): "Error performance parameters and objectives for international constant bit rate digital paths at or about the primary rate".

[46] AF-TM-0121.000 (1999): "ATM Forum Traffic Management Specification Version 4.1".

[47] TR 101 673 (V1.1): "Technical Framework for the Provision of Interoperable ATM Services; Overview".

[48] IETF RFC 1483 (1993): "Multiprotocol Encapsulation over ATM Adaptation Layer 5".

[49] IETF RFC 2225 (1998): "Classical IP and ARP over ATM".

[50] EN 301 164 (V1.1): "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); SDH leased lines; Connection characteristics".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

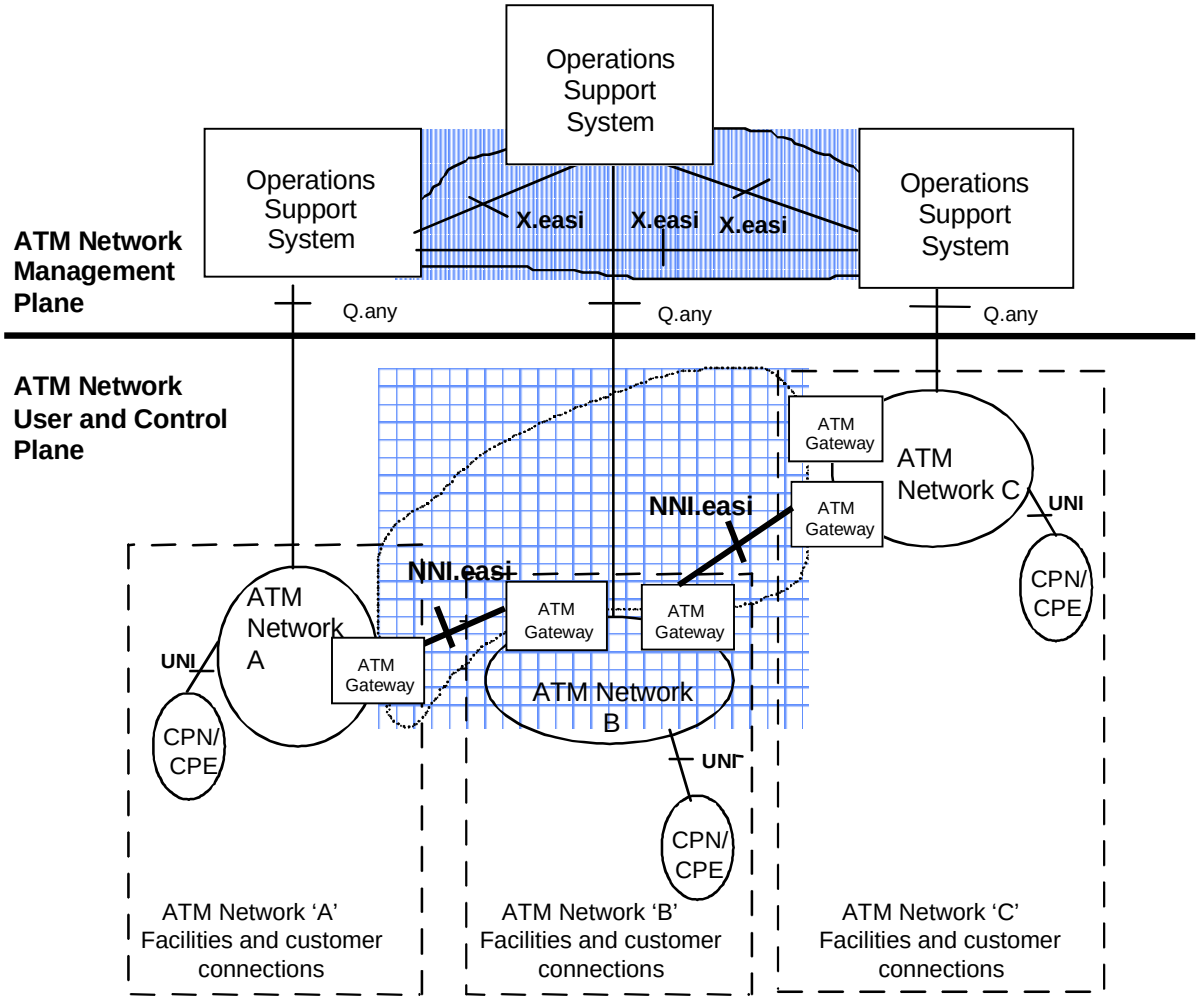
AAL	ATM Adaptation Layer
AESA	ATM End System Addresses
ARP	Address Resolution Protocol
ATC	ATM Transfer Capability
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband Integrated Services Digital Network
B-ISUP	Broadband ISDN User Part (protocol)
CAC	Connection Admission Control
CBDS	Connectionless Broadband Data Service
CBR	Constant Bit Rate (ATM Forum term for DBR)
CDV (T)	Cell Delay Variation (Tolerance)
CLIP	Calling Line Identification Presentation
CLIR	Calling Line Identification Restriction
CLP	Cell Loss Priority
COLP	Connected Line Identification Presentation
COLR	Connected Line Identification Restriction
CPCS	Common Part Convergence Sublayer
CPE	Customer Premises Equipment
CPN	Customer Premises Network
CS	Capability Set
CS1	Capability Set 1
CUG	Closed User Group
DBR	Deterministic Bit Rate (ITU-T term for CBR)
DDI	Direct Dial In
DQDB	Distributed Queue Dual Bus
DSS2	Digital Signalling System number 2
G	Gateway (exchange)
GCRA	Generic Cell Rate Algorithm
IBT	Intrinsic Burst Tolerance
IP	Internet Protocol
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LIS	Logical IP Subnet
MBS	Maximum Burst Size
MPT	Measurement Point
MSN	Multiple Subscriber Number
MTP	Message Transfer Point
NNI	Network-to-Network Interface
NPC	Network Parameter Control
OAM	Operation Administration and Maintenance
OSI	Open System Interconnection
PCR	Peak Cell Rate
PNNI	Private Network Node Interface
PVC	Permanent Virtual Channel
PVCC	Permanent Virtual Channel Connection
PVPC	Permanent Virtual Path Connection

QoS	Quality of Service
SAAL	Signalling ATM Adaptation Layer
SAR	Segmentation and Reassembly Sublayer
SBR	Statistical Bit Rate
SCR	Sustainable Cell Rate
SDH	Synchronous Digital Hierarchy
SIG	SMDS Interest Group
SMDS	Switched Multimegabit Data Service
SP	Signalling Point
SS	Supplementary Service
SSCF	Service Specific Co-ordination Function
SSCOP	Service Specific Connection Oriented Protocol
STM	Synchronous Transfer Mode
STP	Signalling Transfer Point
SUB	Subaddressing
SVC	Switched Virtual Channel
UBR	Unspecified Bit Rate
UI	User Interface
UNI	User Network Interface
UPC	Usage Parameter Control
UUS	User to User Signalling
VBR	Variable Bit Rate
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VP	Virtual Path
VPC	Virtual Path Connection
VPCI	VPC Identifier
VPI	Virtual Path Identifier

4 Network Architecture

The network architecture forming the basis for the present document is described in the Overview Document to the present document, see [47]. Figure 4.1 gives an overview of the technical scope and the interfaces to be provided for the interconnection of ATM networks. These interfaces allow for the interoperability of ATM networks and the exchange of information between their Management Planes, in order to provide services based on or supported by ATM across network boundaries. In particular, the present document is founded on the use of "Gateways" that separate the inter-domain part from the internal part of the ATM networks.

This clause addresses two further network aspects, i.e. the numbering plan to be supported and the issue of interworking with non-ATM networks.



Legend Scope of the management plane

Scope of the User and Control planes

Figure 4.1: Technical scope and the interfaces

4.1 Numbering Plan

The NNI.easi interface shall support one numbering plan with two different address representations:

- addresses in accordance with the numbering plan specified in ITU-T Recommendation E.164 [1]; and
- ITU-T Recommendation E.164 [1] ATM End System Addresses (AESAs) based on the OSI-NSAP format (see ITU-T Recommendation E.191 [2]).

4.2 Interworking with non-ATM-Networks

The ATM capabilities defined in the present document may also be used to support other services, e.g. 64 kbit/s ISDN and frame relay services. The ISUP parameters needed for the support of these services shall be transported by the B-ISUP protocol, however, for Phase 1, no interworking with N-ISDN or with any dedicated data network is defined (i.e., if needed, interworking takes place outside the scope of the present document).

5 Generic Requirements and Capabilities of the ATM NNI.easi Interface for Phase 1

In the following, the NNI.easi interface is described with regard to:

- the user plane;
- the control plane;
- the technical capabilities to support services; and
- the security aspects supported at this interface.

5.1 User Plane

5.1.1 Physical Layer

Inter-carrier connectivity can be provided through two different types of interfaces, i.e. the E3 (34 Mbit/s PDH) and the STM-n (SDH) interface.

Which of the physical layer interfaces that are listed in this clause are to be supported at a given instance of the NNI.easi interface is for bilateral negotiation. Other physical interfaces than E3 and STM-n are not precluded and may be chosen by bilateral agreement but they are out of the scope of the present document.

From the customer's point of view, the quality of the ATM service will play a crucial role. Therefore it is necessary to consider in the present document also the quality and the availability of the transmission layer below the ATM layer.

5.1.1.1 E3 Interface

1) An E3 inter-network interface shall conform to ETS 300 166 [3], ETS 300 337 [4] and ETS 300 417-5-1 [7].

2) Cell payload scrambling/descrambling as defined in ETS 300 337 [4] will be used at the NNI.easi interface.

The interface timing source shall be traceable to a primary reference clock. The E3 timing requirements shall meet ITU-T Recommendation G.811 [5].

NOTE: This allows a network to receive primary reference clock from another network.

3) The input jitter and wander tolerance will meet the requirements of ITU-T Recommendation G.823 [6]. Output jitter shall not exceed 0,05 UI when it is measured within the frequency range from 100 Hz to 800 kHz. Note that the requirement for the output of a single equipment is a lower limit than the network accumulated jitter in ITU-T Recommendation G.823 [6].

4) Idle cells will be transmitted over the interface for cell rate decoupling in alignment with ITU-T Recommendation I.432.1 [11].

5) Fault management shall be in accordance with ITU-T Recommendation I.732 [8] and related architecture and standards. Defects shall give rise to consequential action depending on the function.

6) The E3 signal should support a 16 Byte trace trail as defined in ETS 300 337 [4].

5.1.1.2 STM-n Interfaces

5.1.1.2.1 Electrical Interface

This interface is only available for the STM-1 rate.

1) The Physical Media sublayer shall be in alignment with ETS 300 166 [3], ETS 300 147 [9] and ETS 300 417 Series [7].

2) The input jitter tolerance and output jitter will meet the requirements of ITU-T Recommendation G.825 [10].

3) The Transmission Convergence sublayer shall be in alignment with ITU-T Recommendation I.432.1 [11] and with ETS 300 300 [12].

4) The Physical Layer related OAM functions shall be in alignment with ETS 300 300 [12] and ETS 300 417 Series [7].

5) The interface timing source shall be traceable to an ITU-T Recommendation G.811 [5] conformant clock.

NOTE: This allows a network to receive the primary reference clock from another network.

6) Idle cells will be transmitted over the interface for cell rate decoupling in alignment with ITU-T Recommendation I.432.1 [11].

7) The SDH VC-4 shall support a 16 Byte trail trace as defined in ETS 300 147 [9].

8) Fault management shall be in accordance with ITU-T Recommendation I.732 [8] and related architecture and standards. Defects shall give rise to consequential action depending on the function.

5.1.1.2.2 Optical Interface

NOTE 1: The requirements on STM-n (SDH) optical interfaces listed in the following subclause are primarily valid for the STM-1 interface. For STM-4 and STM-16 interfaces additional requirements apply, e.g. the mode of concatenation (contiguous or virtual).

1) The Physical Media sublayer shall be in alignment with ITU-T Recommendation G.957 [13] and with ETS 300 147 [9].

2) Two single mode fibres according to ITU-T Recommendation G.652 [14] will be used, each for one direction.

3) The input jitter tolerance and output jitter will meet the requirements of ITU-T Recommendation G.825 [10].

4) The Transmission Convergence sublayer shall be in alignment with ITU-T Recommendations I.432.1 [11] and with ETS 300 300 [12].

5) The Physical Layer related OAM functions shall be in alignment with ETS 300 300 [12] and ETS 300 417 Series [7].

6) The interface timing source shall be traceable to an ITU-T Recommendation G.811 [5] conformant clock.

NOTE 2: This allows a network to receive the primary reference clock from another network.

7) Idle cells shall be transmitted over the interface for cell rate decoupling in alignment with ITU-T Recommendation I.432.1 [11].

8) Fault management shall be in accordance with ITU-T Recommendation I.732 [8] and related architecture and standards. Defects shall give rise to consequential action depending on the function.

9) The SDH VC-4 shall support a 16 Byte trail trace as defined in ETS 300 147 [9].

5.1.1.3 Performance and Availability

The physical layer performance (either in service or taken out of service in order to perform an error measurement) shall meet the requirements as defined in:

- ETS 300 687 [15] of a European E3 leased line connection; and
- EN 301 164 [50] for a European SDH-VC-4 leased line connection.

NOTE: The basic transmission layer performance definitions are given in ITU-T Recommendation G.826 [45]. ITU-T Recommendation M.2100 [16] definitions will be applied for the performance limits of the international link.

When looking at the differences between ITU-T Recommendations G.826 [45] and M.2100 [16], it shall be taken into account that the two ITU-T Recommendations serve different purposes and can therefore not be compatible in all respects. ITU-T Recommendation M.2100 [16] is a maintenance recommendation which also allows short-term measurements. It can be used to indicate that the long-term requirements of ITU-T Recommendation G.826 [45] are met.

The allocation methodology for the performance objectives used in ITU-T Recommendation G.826 [45] for the definition of performance objectives differs from the methods applied in ITU-T Recommendation M.2100 [16]. Though there are differences, in most cases the requirements of ITU-T Recommendation G.826 [45] are satisfied when the objectives of ITU-T Recommendation M.2100 [16] are met.

The availability requirements for connections across the NNI.easi interface will be defined by technical and administrative agreements between the individual ATM network operators involved.

5.1.2 ATM Layer

5.1.2.1 Cell Header Format and Encoding

ATM cells at the NNI.easi interface will be in conformance with the NNI structure given by ETS 300 298-2 [17]. All 12 bits of the VPI field and all 16 bits of the VCI field are used for cell switching.

The use of some VCI values within a VPC is restricted (see ETS 300 298-2 [17]). Whether a cell with a particular VCI value is transferred transparently or not is described in ETS 300 298-1 [18].

5.1.2.2 ATM Traffic Control

5.1.2.2.1 ATM Transfer Capabilities and Traffic Parameters

The ATM Transfer Capabilities (ATC) are defined in ETS 300 301 [19].

In Phase 1, only DBR, SBR 1 and SBR 2 are supported. The corresponding traffic parameters shall be supported within the network and, for a given connection, shall be declared by management actions and/or by means of signalling.

Table 5.1: ATM Transfer Capabilities and Corresponding Traffic Parameters

Parameters (ETS 300 301 [19])	DBR	SBR1	SBR2
PCR (0+1), τ_{PCR} (0+1)	X	X	X
SCR (0), MBS (0), τ_{SCR}(0)			X
SCR (0+1), MBS (0+1), τ_{SCR}(0+1)		X	
PCR (OAM), τ_{PCR} (OAM)	X (option)		

NOTE: Instead of the parameter "MBS" (Maximum Burst Size), also the parameter "IBT" (Intrinsic Burst Tolerance) can be used. Each of these two parameters can be derived arithmetically from the other.

5.1.2.2.2 Association of ATM Transfer Capabilities and QoS Classes

ETS 300 301 [19] defines the ATCs. ETS 300 464 [20] which builds on ITU-T Recommendation I.356 [21] describes some Quality of Service Classes and network performance objectives and recommends that certain ATCs be associated with certain QoS classes.

The association between ATM Transfer Capabilities and corresponding QoS Classes that will be supported in Phase 1 are depicted in table 5.2.

Table 5.2: ATM Transfer Capabilities and QoS Classes

ATC name (ETS 300 301 [19])	QoS class (ETS 300 464 [20]/ ITU-T Rec. I.356 [21])	ATM Transfer Capability (ATC) definition	Equivalent ATM Forum service category and conformance definition in AF-TM-0121.000 [46]
DBR (Deterministic Bitrate)	QoS class 1 (note 1)	Category based on maximum (constant) bandwidth allocation	CBR (Constant Bitrate)
SBR 1 (Statistical Bitrate configuration 1)	QoS class 1	Category based on average (statistical) bandwidth allocation without priority control	rt VBR.1 (real time Variable Bitrate)
SBR 1 (Statistical Bitrate configuration 1)	QoS class 2 (note 1)	Category based on average (statistical) bandwidth allocation without priority control	nrt VBR.1 (non real time Variable Bitrate type 1)
SBR 2 (Statistical Bitrate configuration 2)	QoS class 3 (note 1)	Category based on average (statistical) bandwidth allocation with priority control - tagging not applied	nrt VBR.2 (non real time Variable Bitrate type 2)
DBR (Deterministic Bitrate)	QoS class U (note 2)	Category based on non-guaranteed bandwidth allocation	UBR.1 (Unspecified Bitrate type 1)

NOTE 1: These QoS classes are default classes. They can be supported even if signalling protocols are not able to provide an explicit indication of these classes.

NOTE 2: This class is not supported by the B-ISUP protocol. This means that in Phase 1 only permanent connections with this QoS class may be established.

It should be noted, that an equivalent concept, using a different terminology, is specified by the ATM Forum in document AF-TM-0121.000 "ATM Forum Traffic Management Specification Version 4.1" [46].

5.1.2.2.3 Functions of traffic control and congestion control

- Connection Admission Control

Connection Admission Control (CAC) is defined in ETS 300 301 [19] as the set of actions taken by the network at the call set up phase (or during call re-negotiation phase) in order to decide whether a request for a VCC or a VPC can be accepted or has to be rejected.

Connection Admission Control procedures are operator specific. Connection acceptance criteria are set up by the network on the basis of the network operator's policy.

- Network Parameter Control

The Network Parameter Control (NPC) is defined in ETS 300 301 [19] as a set of actions to be taken by the network to monitor and control the traffic offered at the NNI.easi interface. It is a network operator's choice to perform NPC functions at intermediate gateways and at the egress of the ATM transit network portion, as shown in figure 5.1.

Network Parameter Control procedures are operator specific. The values of parameters used in the NPC function are set up by the network on the basis of the network operator's policy.

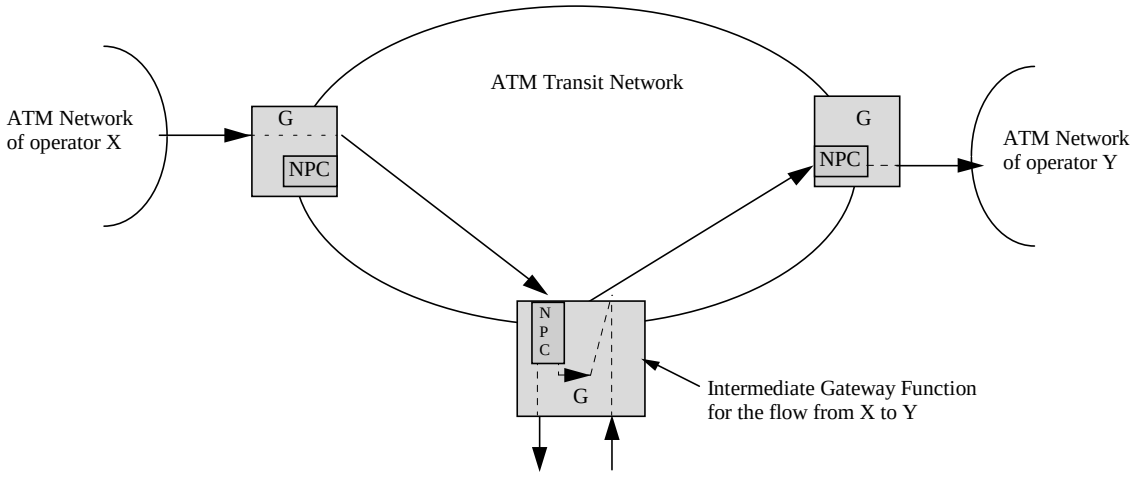


Figure 5.1: Location of NPC functions in the ATM Transit Network

It shall be possible to apply NPC on all VCC and VPC connections.

- During the connection lifetime, conformance to PCR will continuously be checked within the network by the GCRA mechanism as defined in ETS 300 301 [19].
- The NPC function may be disabled for certain ATCs (e.g. DBR class U).
  Depending on the accuracy of the implemented policing function, some of the cells may not be discarded by the NPC function, even when they are not in conformance with the standardized conformance definition.
- Tagging

In Phase 1, support of the tagging function is not required.

- Priority Control and Selective Cell Discard

The applicability of discarding CLP = 1 cells selectively inside the network depends on the ATM Transfer Capability used. When an ATC with selective cell discard is used (i.e. SBR2), the network shall apply this function in accordance with ETS 300 301 [19].

- Shaping

Traffic shaping or spacing as defined in ETS 300 301 [19] is not covered by the present document. However, in order to receive the expected QoS, the traffic must be compliant with the traffic contract agreed at the NNI.easi interface.

5.1.2.3 ATM Performance and Availability

The performance parameter definitions of ITU-T Recommendation I.356 [21] and the availability definition of ITU-T Recommendation I.357 [22] will be applied. The scope of performance and availability targets for the transit portion of an ATM connection is shown in figure 5.2.

The network performance objectives defined in ITU-T Recommendation I.356 [21] shall be met for end-to-end connections (i.e. between measurement points, MPTs) supported across the NNI.easi interface. The additional requirements defined in ITU-T Recommendation I.356 [21] (especially the number of ATM nodes in the connection with 34 Mbit/s output links) shall be taken into account by technical and administrative agreements between the individual ATM network operators involved.

The availability of end-to-end connections (i.e. between MPTs) shall be defined by technical and administrative agreements between the individual ATM network operators involved.

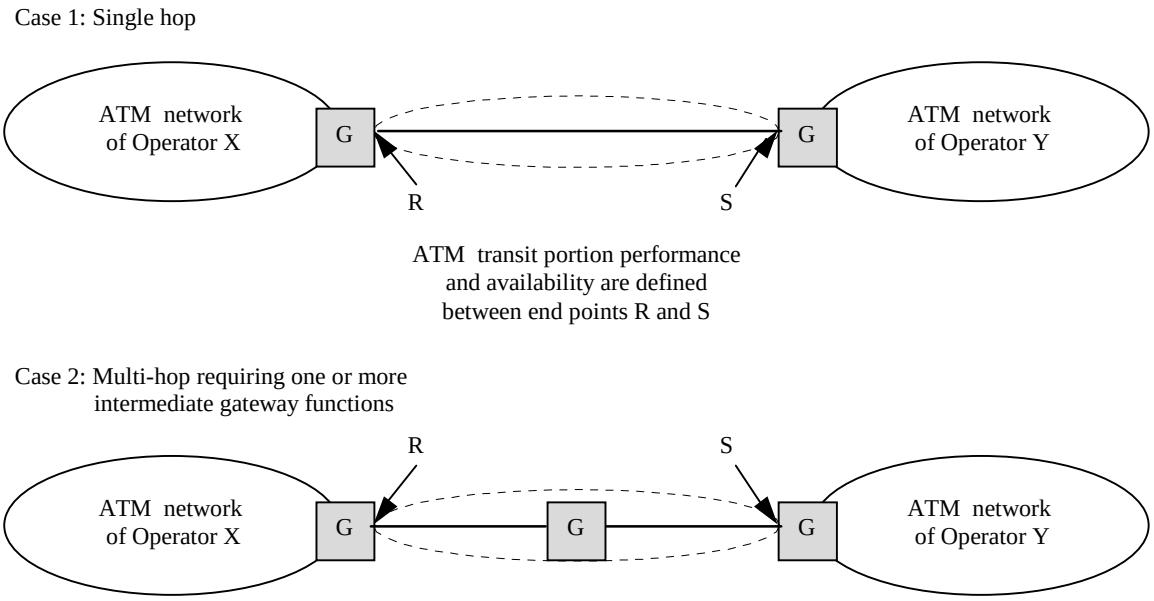


Figure 5.2: Scope of performance and availability targets for the ATM transit portion

5.1.2.4 ATM Operation and Maintenance

Wherever possible, the OAM flows recommended by ITU-T Recommendation I.610 [23] (ETS 300 404 [24]) for the ATM layer (F4 and F5) should be supported. In order to allow maintenance of the ATM layer across the NNI.easi interface, VC switched connections should be inserted in (semi-)permanent VPCs crossing the NNI.easi interface and such VPCs should be terminated inside the two operator's networks. End-to-end maintenance according to [24] will be performed.

When such VPCs are not terminated at the gateways, whenever possible VP segments should be established having endpoints inside the gateways or in another connecting point as close as possible to the gateway, and segment maintenance will be performed according to [24].

Establishment of segments across the NNI.easi interface(s) and the set of functions supported require mutual agreement of the operators involved.

With reference to figure 5.2, the transit measurement points (MPT) are assumed to be the last point in which the ATM layer is accessed at the sending side and the first point at which the ATM layer is accessed at the receiving side. Measurement mechanisms are defined in ITU-T Recommendation I.610 [23] (ETS 300 404 [24]).

If the mechanisms of [24] are implemented on both sides of the NNI.easi interface, the parameters of [21] and [22] should be measured.

Where an NPC function is included in the ATM transit portion, the availability and performance measurement process is for further study.

If on one or both sides of the inter-domain connection the mechanisms of [24] are not implemented, or not fully implemented, the basis on which to measure availability and performance, and the related objectives, shall be established by mutual agreement between operators, according to the available functions.

Means should be provided for generating and verifying test traffic to be sent through the inter-domain connections on a periodical basis. Criteria and procedures for the use of test traffic should be established by mutual agreement between operators.

5.2 Control Plane

The purpose of this subclause is to define the requirements concerning the control plane to provide the basis for switched ATM services across the NNI.easi interface.

As concerns interworking between N-ISDN and B-ISDN in Phase 1, see subclause 4.2.

At the NNI.easi interface the SS No. 7 protocol stack is used. This protocol stack is defined by four different levels:

Level 4 B-ISUP

The **B**-ISDN User Part protocol (B-ISUP) is a flexible application protocol. This protocol incorporates mechanisms to allow for future enhancements. Therefore, the ITU-T B-ISUP shall be used across the NNI.easi interface as application protocol within the SS No.7 protocol stack. For Phase 1, B-ISUP is defined by ITU-T Recommendations Q.2761 to Q.2764 (CS1) [35] to [38] and part of CS2.1 (refer to 5.2.1.3).

Level 3 MTP-3b

The Message Transfer Part (MTP) allows for the transmission of signalling information within the signalling network with very high reliability. It consists of functions to manage the signalling network and allows for the use of conventional as well as of broadband SAAL-links (refer to 5.2.1.2).

Level 2 SAAL

Signalling ATM Adaptation Layer consists of typical layer 2 functionalities of the OSI reference model (Data Link Layer). The SAAL protocol stack at the NNI itself is structured as follows (beginning with the highest layer (refer to 5.2.1.1)):

1) *SSCF* Service Specific Co-ordination Function (NNI);
2) *SSCOP* Service Specific Connection Oriented Protocol;
3) *CPCS* Common Part Convergence Sublayer;
4) *SAR* Segmentation and Reassembly Sublayer.

Level 1 ATM Layer/Physical Layer

5.2.1 Protocol Stack at the NNI.easi interface

Figure 5.3 shows the protocol stack at the NNI.easi interface:

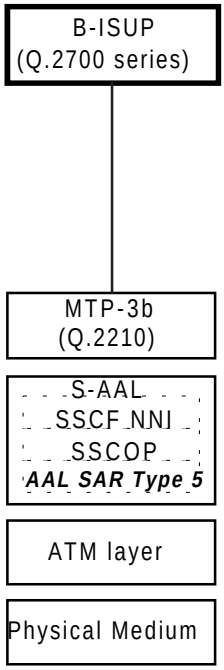


Figure 5.3: Protocol stack at the NNI.easi interface

5.2.1.1 SAAL

The SAAL to be used shall be based on ITU-T Recommendations I.363.5 [25] (AAL type 5), Q.2110 [26] (SSCOP) and Q.2140 [27] (SSCF at NNI).

5.2.1.2 MTP

The MTP-3b shall be based on ITU-T Recommendation Q.2210 [28].

The Signalling Transfer Point (STP) function and all specific functions included in a Signalling Point (SP) with STP function is not required for Phase 1. Nevertheless, the SPs should include from the beginning all functions for interworking with a STP in the future, in order to allow an independent introduction of the Phase 2 functionality into a gateway.

The international part of ATM switching nodes shall have a SP function identified by an international SP code in accordance with the relevant ITU-T Standard, as a default Recommendation Q.708 [29] is used.

NOTE: The ATM switching nodes shall be identified by SP codes according to the relevant SP numbering plan.

5.2.1.3 B-ISUP

The B-ISUP within the ATM transit portion of the signalling network shall be used as defined in the ITU-T Q.27xx-series of Recommendations, without any items in the referenced documents marked as "national use" or "national option". National use and national option indications are treated as applying to a single network domain. These indications do not cross the NNI.easi interface. For the support of the basic functionalities of B-ISUP (CS1), the following ITU-T Recommendations apply:

- Q.2610 [39];
- Q.2761 [35];
- Q.2762 [36];
- Q.2763 [37];
- Q.2764 [38];
- Q.2730 [40].

In addition to the basic functionalities of B-ISUP, the following ITU-T Recommendations of CS2.1 apply:

- Q.2723.1 [41];
- Q.2723.2 [42];
- Q.2726.1 [43].

The following supplementary services are defined for B-ISUP:

DDI, MSN, CLIP, CLIR, COLP, COLR, SUB and UUS as part of CS1 and CUG as part of CS2.1 Concerning the support of supplementary services across the NNI.easi interface refer to 5.2.4.

5.2.2 Protocol Stack at the NNI.easi Interface based on the ATM Forum AINI Protocol

Not relevant for Phase 1.

5.2.3 ATM Transfer Capability of Signalling Channels

To fulfil the end-to-end performance according to ITU-T Recommendation I.356 [21], the signalling VC shall belong to QoS class 1. As ATC the transfer capability DBR shall be used.

The bandwidth depends on the engineering methods of the adjacent networks and has to be negotiated by the network operators.

The traffic parameter values used for the signalling VC are created by management procedures in the gateways involved.

5.2.4 Support of Supplementary Services Across the NNI.easi Interface

For Phase 1, there is no strict requirement to actively support supplementary services within the individual ATM networks of the operators. It has however to be ensured by all operators that a call incoming to a network not supporting a particular supplementary service shall not discard the parameters at the NNI.easi interface carrying the supplementary services information. Supplementary services which shall be supported are Direct Dialling in (DDI) [30], Multiple Subscriber Number (MSN) [30], Calling Line Identification Presentation (CLIP) [30], Calling Line Identification Restriction (CLIR) [30] and Subaddressing (SUB) [30]. They have an "M" in the second line of table 5.3.

In addition to the supplementary services mentioned above, also Connected Line Identification Presentation (COLP) [30], Connected Line Identification Restriction (COLR) [30], User-to-User Signalling, Service 1 (UUS1) [30] and Closed User Group (CUG) [44] may be supported. These supplementary services have an "O" in the second line of the table 5.3. The table 5.3 summarizes the support of the supplementary services:

Table 5.3: Support of supplementary services

Suppl. Service	DDI	MSN	CLIP	CLIR	COLP	COLR	SUB	UUS1	CUG
Offer to Users	O	O	O	O	O	O	O	O	O
NNI.easi Support	M	M	M	M	O	O	M	O	O
Type of NNI.easi Support	only implicit support	only implicit support	transfer & process number	transfer (only if number is present)	transfer & process number	transfer (only if number is present)	transfer	transfer	(depends on OA y/n)

M - mandatory O - optional OA y/n - outgoing access allowed / not allowed

NOTE: In case of a supplementary service is supported within a network, the detailed actions to be performed at the outgoing or incoming gateway are specified in ITU-T Recommendations Q.2730 [40] and Q.2735.1 [44].

5.3 Network Requirements

5.3.1 Multiplexing of VCCs into a VPC

Multiplexing of VCCs into a network-to-network VPC and the characterization and dimensioning of such VPCs shall be in alignment with ITU-T Recommendation E.735 [31]. Multiplexing of any combination of VCCs either with the same or with different ATCs into a single network-to-network VPC shall be possible. Such a VPC shall be established using a single cell rate and would meet the quality of service requirements of the most stringent VCC multiplexed into this VPC, see also ETS 300 301 [19].

5.3.2 Technical Capabilities to Support Services

For the time being no basic B-ISDN services have been defined in a similar manner as this has been done for N-ISDN services. Therefore, the B-ISDN services supported at the NNI.easi interface cannot be quoted by individual designations. Instead, only the technical capabilities required for the support of a service category or a group of applications can be addressed in the present document. When a certain combination of these technical capabilities are requested for a connection, then one could think of a service or an application. The technical capabilities relevant for services or applications are e.g.:

- **the transmission level**. Transmission can occur using virtual path connections (VPCs) or virtual channel connections (VCCs). Both connection types are supported at the NNI.easi interface;
- **the connection type**. Connections can be permanent/semi-permanent or switched (on-demand).

- Permanent/semi-permanent virtual connections are supported on virtual path connection level and on virtual channel connection level.
- In Phase 1, switched virtual connections are only supported on a virtual channel connection level.
- Permanent/semi-permanent virtual channel connections and switched virtual channel connections shall be transported in different virtual path connections;
- **the connection configuration**. Connections can be point-to-point or point-to-multipoint. In Phase 1, support of point-to-multipoint connections is not required;
- **the direction of transmission**. Transmission can be unidirectional (i.e. without any reverse information transport) or bi-directional. When bi-directional, transmission can be symmetric or asymmetric. At the NNI.easi interface, all modes of transmission as defined in ETS 300 298-2 [17], ETS 300 298-1 [18] shall be supported;
- **the quality of service** (see table 5.2); and
- **the ATM transfer capability** (see table 5.2).

5.4 Security of User and Control Plane

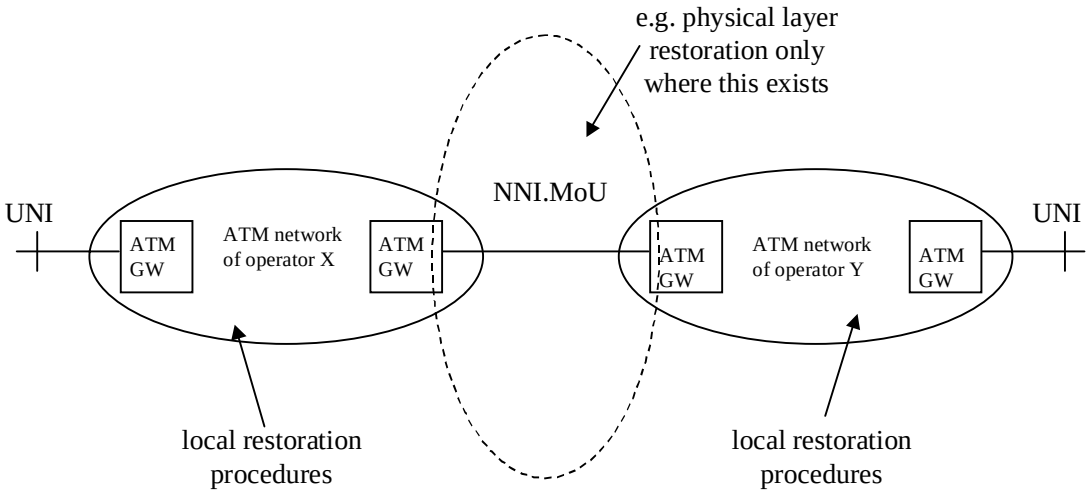
Protection against unauthorized access to the signalling networks of the individual network operators will be provided by the standardized gateway functions of ITU-T signalling system No. 7 described in subclause 5.2.

Regarding the security aspect of the user plane, for the time being there are no international recommendations or standards available with specific requirements for the interface between two networks. Therefore, protection against unauthorized access to user information shall be based on bilateral agreements.

5.5 Resilience Requirements

Failures of PVCCs and PVPCs will be handled as follows:

- Failures in each individual ATM network may be automatically restored, depending on the resiliency mechanisms local to each operator's network.
- Failures between gateways (in the ATM transit portion) may be restored automatically, e.g. where physical restoration exists.



GW: Gateway

Figure 5.4: Restoration procedures for PVCCs and PVPCs

6 Usage Metering Functionalities

The term "service usage metering" in this context is the process of gathering resource utilization information to be used for the purpose of revenue collection by each network operator which has contributed telecommunication resources to a call or connection.

When switched virtual channel connections are supported across the NNI, usage sensitive accounting shall be supported in addition to flat rate accounting. For this purpose, usage metering function shall be available in the gateways or elsewhere in the network. Usage metering is the set of activities that monitor the utilization of network resources allocated for and used by each connection, for the purpose of accounting.

Where only PVCs are supported across the NNI, there is no requirement to support usage sensitive accounting.

7 Testing and Conformance

Testing and conformance will be agreed bilaterally, and will not be further specified here.

Annex A (informative): Examples of Services supportable by the NNI.easi Interface

A.1 B-ISDN Services and ATM Transfer Capabilities

This attachment is considered not to form an integral part of the present document. It is for information only.

Given that a network operator has implemented the features of clause 3, in particular all ATCs listed in table 5.1, then the services listed hereafter are possible. These are examples only, and not the complete set of services supportable by the NNI.easi.

For information transfer, B-ISDN services make either exclusively use of ATM resources or they additionally make use of service specific network resources, e.g. connectionless servers. Services that only use ATM resources are always connection oriented. Services that use additional network elements may be connection oriented or connectionless.

A.2 Connection Oriented Services

This group of services includes the "Broadband Connection Oriented Bearer Service Category" provided in the reserved or on-demand mode (see ITU-T Recommendation F.811 [32]).

Sub-categories of this service are:

- constant bit rate services;
- variable bit rate services with real-time and end-to-end timing requirements; and
- non-real-time variable bit rate services without end-to-end timing requirements.

A.2.1 Examples of Constant Bit Rate Services

Constant bit rate services (CBR services) use connections with a static amount of bandwidth that is available during the lifetime of the connection. The CBR services are intended to support real-time applications requiring tightly constrained information transfer delay and delay variation. At the time being, only DBR connections with QoS class 1 fulfil these requirements and can be used for this service group. Examples of such services are e.g. the 64 kbit/s voice service, the transparent 64 kbit/s bearer service, the transparent nx64 kbit/s bearer service, constant bit rate video services and, the circuit emulation service. The transmission of a constant bit rate requires some additional functions in the ATM endsystems and in interworking units that interwork with the 64 kbit/s ISDN. These additional functions are allocated to the ATM adaptation layer. Currently, the AAL Type 1 protocol is the only protocol available that provides this additional functionality.

A.2.2 Examples of Real-time Variable Bit Rate Services

The real-time variable bit rate (rt-VBR) services group is intended for real-time applications which have bursty traffic characteristics. Examples of such services are a video conference service that uses variable bitrate video codecs or services for remote control applications. To support this service group, DBR and SBR1 with QoS class1 can be used.

A.2.3 Examples of Non-Real-time Variable Bit Rate Services

The non-real-time variable bit rate (nrt-VBR) services group is intended for non-real-time applications which have bursty traffic characteristics and no or loose requirements concerning transfer delay. Several ATCs/QoS classes may be used to support non-real-time variable bit rate services. The type of ATM Transfer Capability and QoS class used for a given ATM connection depends non the traffic characteristic and the performance requirements of the specific application. The ATM Frame Relay Service belongs to this service group. This service provides the same functionality as the frame relay service and allows an easy interworking with the 64 kbit/s ISDN frame relay service. The ATM Frame Relay Service makes use of the AAL Type 5 protocol.

A.3 Connectionless Services

A.3.1 Connectionless Broadband Data Service, CBDS

One of the services belonging to this category is the "Connectionless Broadband Data Service, CBDS". It is standardized in ITU-T Recommendation F.812 [33] and in ETS 300 217 [34]. This service allows for the connectionless transmission of data packets having variable but limited length. This service does not support error correction procedures.

A.3.2 Switched Multimegabit Data Service, SMDS

Another service of this category is the Switched Multimegabit Data Service (SMDS). SMDS is a public packet-switched connectionless service that provides for the exchange of variable length SMDS data units, up to a maximum of 9 188 octets of user information per SMDS data unit. The SMDS service allows for a wide variety of bit rates (64 kbit/s to 155 Mbit/s). Access to the SMDS is achieved through E1, E3, E4 or STM1 transmission systems. The SMDS has primarily been defined for LAN-LAN interconnection. Each SMDS packet contains ITU-T Recommendation E.164 [1] numbers which are used for routing through the SMDS network. Broadcast services are supported. First SMDS implementations have used Distributed Queue Dual Bus (DQDB) cells. Today's implementations may use ATM cells. DQDB and ATM cells can easily be converted into each other. The SMDS service is specified in a number of documents issued by the SMDS Interest Group (SIG).

A.3.3 Classical IP over ATM

A third service that can be supported with minimal functionality across the NNI.easi interface is the "Classical IP over ATM" service. Minimal functionality means that "IP over ATM" shall be based on Permanent Virtual Channel Connections (PVCCs). IP routers are established at the edge of the ATM network to which the national Logical IP Subnets (LISs) are connected. These routers are interconnected across the NNI.easi interface via permanent VC connections. Due to missing ITU or ETSI standards, the most relevant documents in this context are RFC 1483 [48] and RFC 2225 [49].

History

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