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Technical Report

Transmission and Multiplexing (TM); Access networks; Requirements for the support of Voice over DSL

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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The present document is modelled after the DSL Forum's requirements for Voice over DSL, TR-039 [1] (Technical Report 039), and is intended to supplement it by providing information about Voice-over-DSL (VoDSL) applications and architectures specific to European networks. The document structure has been maintained from TR-039 [1], to allow easy comparison of contents. Since much of the information in TR-039 [1] is applicable to European networks, much of the present document consists of pointers; however, much information is new, and either supplements existing sections of TR-039 [1] or requires new sections entirely.

1 Scope

The present document specifies, from a European perspective, general AN functional requirements, in terms of transport means for signalling and voice channels, timing/synchronization, delay and BER performances, distribution of the relevant functions over AN elements and management, for in-band support of Voice and NB data communications over DSL systems. It is structured in the form of a supplement to the DSL Forum's TR-039 [1].

2 References (replaces clause 2/[1])

For the purposes of this Technical Report (TR), the following references apply:

[1] DSL Forum TR-039 (Version 1.1 - March 2001): "Requirements for Voice over DSL".

[2] ITU-T Recommendation I.411 (1993): "ISDN user-network interfaces - Reference configurations".

[3] ITU-T Recommendation G.995.1 (2001): "Overview of Digital Subscriber Line (DSL) Recommendations".

[4] ATM Forum af-tm-0150.000 (July 2000): "Addendum to Traffic Management v4.1 optional minimum desired cell rate indication for UBR".

[5] ANSI T1.508: "Network Performance - Loss Plan for Evolving Digital Networks".

[6] ITU-T Recommendation G.114 (2003): "One-way transmission time".

[7] ITU-T Recommendation G.131: "Talk echo and its control".

[8] ITU-T Recommendation G.165: "Echo cancellers".

[9] ITU-T Recommendation G.168: "Digital network echo cancellers".

[10] ITU-T Recommendation G.992.1: "Asymmetric digital subscriber line (ADSL) transceivers".

[11] ITU-T Recommendation G.992.2: "Splitterless asymmetric digital subscriber line (ADSL) transceivers".

[12] ITU-T Recommendation G.107 (2003): "The E-model, a computational model for use in transmission planning".

[13] ETSI EN 300 347-1: "V Interfaces at the digital Local Exchange (LE); V5.2 Interface for the support of Access Network (AN); Part 1: V5.2 Interface Specification".

[14] ITU-T Recommendation G.960 (1993): "Access digital section for ISDN basic rate access".

[15] IEEE Draft P802.3ah/D3.3: "Draft amendment to - Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications - Media Access Control Parameters, Physical Layers and Management Parameters for subscriber access networks".

[16] ETSI TS 101 388: "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Asymmetric Digital Subscriber Line (ADSL) - European specific requirements [ITU-T Recommendation G.992.1 modified]".

[17] ETSI TS 101 524: "Transmission and Multiplexing (TM); Access transmission system on metallic access cables; Symmetric single pair high bitrate Digital Subscriber Line (SDSL)".

[18] ETSI TS 101 270-2: "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very High Speed Digital Subscriber Line (VDSL); Part 2: Transceiver specification".

[19] ITU-T Recommendation G.711: "Pulse Code Modulation (PCM) of voice frequencies".

[20] ITU-T Recommendation G.726: "40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)".

[21] ETSI ETS 300 297: "Integrated Services Digital Network (ISDN); Access digital section for ISDN basic access".

[22] ETSI EN 300 324-1: "V interfaces at the digital Local Exchange (LE); V5.1 interface for the support of Access Network (AN); Part 1: V5.1 interface specification".

3 Definitions

For the purposes of the present document, the terms and definitions given in TR-039 [1] apply.

4 Abbreviations

For the purposes of the present document, the abbreviations given in TR-039 [1] and the following apply:

AAL2	ATM Adaptation Layer 2
AAL5	ATM Adaptation Layer 5
ABR	Available Bit Rate
ADPCM	Adaptive Differential Pulse-Code Modulation
AN	Access Network
BA	Basic rate Access
BCC	Bearer Channel Connection
BER	Bit-Error Rate
B-NT2	Broadband - NT2
CAC	Connection Admission Control
CBR	Constant Bit Rate
CLR	Cell-Loss Ratio
CTD	Cell-Transfer Delay
CVoDSL	Channelized Voice over DSL
DRR	Dynamic Rate Repartitioning
DS	Digital Section
EFaddr	Envelope Function address
EFM	Ethernet in the First Mile
EN	European Norm
eoc	embedded operations channel
FCS	Frame Check Sequence
FE	Function Element
GFR	Guaranteed Frame Rate
HDLC	High-level Data Link Control
IEEE	Institute of Electrical and Electronic Engineers
IOM®-2	ISDN-Oriented Modular interface revision 2

NOTE: IOM®-2 is a registered trademark of SIEMENS AG. This information is given for the convenience of users of the present document and does not constitute an endorsement by ETSI of the product named. Equivalent products may be used if they can be shown to lead to the same results.

IP	Internet Protocol
ISDN BA	ISDN Basic rate Access
LAPD	Link Access Protocol for ISDN D channel
LAPV5	Link Access Protocol for V5 interface
LAPV5-DL	LAPV5 Data Link sublayer
LAPV5-EF	LAPV5 Envelope Function sublayer
LE	Local Exchange
LFA	Loss of Frame Alignment
LOS	Loss Of Signal
LTU	Line Termination Unit
MPH	communication between Management and PHysical layer

MPH-AI	MPH-Activation Indication
MPH-AR	MPH-Activation Request
MPH-AWI	MPH-AWake Indication
MPH-DI	MPH-Deactivated Indication
MPH-DSAI	MPH-Digital Section partial Activation Indication
nrt-VBR	Near-Realtime Variable Bit Rate
N-ISDN	Narrowband Integrated Services Digital Network
N-NT2	Narrowband NT2
NT1	Network Termination 1
NT1/2	NT1 integrated with NT2
NT2	Network Termination 2
NTU	Network Termination Unit
OSI	Open Systems Interconnection
PCM	Pulse-Code Modulation
PH	communication between data-link layer and PHysical layer
PHY	PHYsical layer
PMD	Physical Medium-Dependent
PMS	Physical Medium-Specific
PMS-TC	Physical Medium-Specific Transmission Convergence
PTM	Packet Transfer Mode
rt-VBR	Real-Time Variable Bit Rate
RTP	Real-time Transfer Protocol
SDSL	Symmetric single pair high bit rate Digital Subscriber Line
STM	Synchronous Transfer Mode
TA	Terminal Adapter
TC	Transmission Convergence
TPS	Transmission Protocol-Specific
TPS-TC	Transmission Protocol-Specific - Transmission Convergence
TS	Technical Specification
UBR	Unspecified Bit Rate
V5DLaddr	V5 Data Link address
VDSL	Very high bitrate Digital Subscriber Line
VoATM	Voice over ATM
VoDSL	Voice over DSL
VoIP	Voice over Internet Protocol
VoSTM	Voice over Synchronous Transfer Mode
xDSL	collective term referring to any of the various types of DSL technologies

5 VoDSL Reference Model (replaces clause 5/[1])

Figure 1 depicts the reference configuration for a generic DSL system.

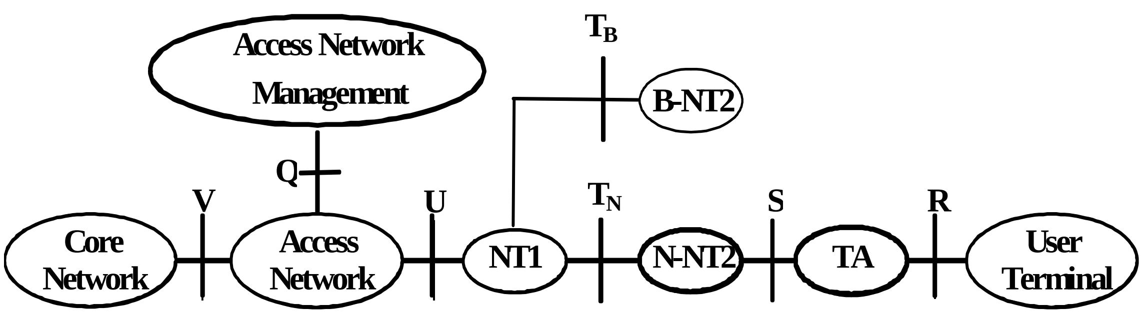


Figure 1: Reference configuration for DSL

This reference configuration is based on the reference configuration used for the N-ISDN in ITU-T Recommendation I.411 [2] and is also given in ITU-T Recommendation G.995.1 [3], and identifies the reference points in the context of access network.

NOTE: The reference configuration in figure 1 shows the functional groupings, which may or may not correspond to physical groupings. Physical groupings may comprise of one or more functional groupings.

One or more of the elements in the reference configuration may be null or could be merged in different scenarios. At the functional interfaces there are reference points, although existence of a physical interface is not implied. There may be more than one interface specification for each of these reference points. The exact interpretation at these reference points will depend upon the local network architecture and regulatory environment.

5.1 VoDSL Reference Model Functional Block Definitions (replaces all of clause 5.1/[1])

5.1.1 Core Network

The Core Network is part of the Public Switched Telephone Network, which transports telephony services between subscribers. Where needed, the Core Network translates between the signalling and bearer methods used by existing telephony equipment and signalling and bearer methods used by the Access Network.

5.1.2 Access Network (AN)

The Access Network provides concentration for multiple NT1 devices, each with its own U reference point, to the Core Network, at the V reference point. In the case of VoDSL, this device is often referred to as a DSL Access Multiplexer (DSLAM). The reference architecture does not preclude the support of multiple services transported over DSL (e.g. VoSTM and VoATM in parallel).

5.1.3 Network Termination 1 (NT1)

The NT1 provides physical termination to the line from the Access Network (indicated at the U reference point), and provides service presentation to a customer at a logical or physical interface (indicated at the T reference point). The NT1 might not terminate the transport protocol from the Access Network (e.g. ATM) for user traffic. The NT1 may implement transport protocol functions such as rate adaptation required to support different T/U reference point characteristics.

5.1.4 Network Termination 2 (NT2)

An NT2 connects to the network at the T reference point, and may connect to multiple user terminals at the S reference point. The NT2 terminates the transport protocol (e.g. ATM) for user traffic, and may implement switching/routing functions. The NT2 may be integrated with an NT1 to form an NT1/2.

The term "NT" designates the generic Network Termination for various services. For some services, it might be part of the Access Network, and for others not. The inclusion of the NT in the Access Network, or its exclusion, should not be taken to determine the ownership. The reference architecture does not preclude the integration of the Network Termination with other User Terminal functions.

5.1.4.1 B-NT2

The B-NT2 terminates the transport protocol (e.g. AAL5/ATM) for broadband data.

5.1.4.2 N-NT2

The N-NT2 terminates the transport protocol (e.g. AAL2/ATM) for voice data.

5.1.5 Terminal Adapter (TA)

The Terminal Adapter adapts the transport protocol to the specific requirements of a User Terminal.

5.1.6 User Terminal

Voice and data services are delivered to the users' voice and data terminals.

5.1.7 Access Network Management

Access Network Management element depicts the management functionalities.

5.2 VoDSL Reference Model Interface Definitions (replaces all of clause 5.2/[1])

5.2.1 Interfaces at the V Reference Point

The V reference point indicates the connection of the Core Network with the Access Network. Examples of interfaces at this point include ISDN or POTS over V5.2.

5.2.2 Interfaces at the U Reference Point

The U reference point indicates the connection of the physical layer from the Access Network with the NT1 at each customer's premises. Examples of interfaces at this reference point include ISDN basic rate and primary rate access transmission systems.

5.2.3 Interfaces at the T_N and T_B Reference Points

The T_N reference point indicates the connection of the NT1 with the N-NT2, and the T_B reference point indicates the connection of the NT1 with the B-NT2. The interfaces at these reference points may be internal functions when the NTs are integrated into an NT1/2.

Logical or physical interfaces at the T_N and T_B reference points provide service presentation to customers.

An N-NT2 that connects to the network at the T_N reference point, or a B-NT2 that connects to the network at the T_B reference point, may connect to multiple user terminals on interfaces at the S reference point.

5.2.4 Interfaces at the S Reference Point

The S reference point indicates the connection of the N-NT2 with the User Terminals.

5.2.5 Interfaces at the R Reference Point

The R reference point indicates the connection of the Terminal Adapter to the User Terminal.

5.2.6 Interfaces at the Q Reference Point

Access Network and the Access Network Management elements are separated at the Q reference point.

5.3 VoDSL IWF Reference Model

See clause 5.3 of TR-039 [1].

5.4 General VoDSL Service Model

See clause 5.4 of TR-039 [1].

6 General Requirements for VoDSL

6.1 General DSL Requirements (supplements clause 6.1/[1])

See clause 6.1 of TR-039 [1].

The discussion of DRR for ADSL in TR-039 is also applicable to SDSL.

6.2 General System Requirements

6.2.1 Multi-Line Capability

See clause 6.2.1 of TR-039 [1].

6.2.2 Over-subscription

See clause 5.3 of TR-039 [1].

6.2.3 Dynamic Bandwidth Allocation for Voice (supplements clause 6.2.3/[1]

See clause 6.2.3 of [1], which includes discussion of Dynamic Bandwidth Allocation for xDSL generally.

When an SDSL link has an STM bearer and a Broadband bearer, the Dynamic Rate Repartitioning (DRR) procedure allows bandwidth to be lent from the STM to the Broadband bearer on a temporary basis. When an SDSL DSLAM provides voice service using CVoDSL, the support of the DRR procedure is highly recommended. When the CPE provides voice service using CVoDSL it is highly recommended that either the CPE support the DRR procedure, or else that it be possible to set up a permanent channel for voice service, via the management system.

Services requiring a guaranteed minimum of bandwidth, such as video streams, should be protected during rate partitioning. Should the maximum voice traffic load be demanded, enough broadband bandwidth should still be available to carry these high-priority services.

For example, when using the DRR procedure with a Broadband bearer carrying ATM services, it is important that services that require guaranteed bitrates are not affected; instead, the bandwidth lent by the voice bearer should only be used for best-effort services, such as UBR and UBR+ services (defined in the ATM Forum document af-tm-0150.000 [4]): Such services have no traffic-related service commitments, in terms of Cell-Loss Ratio (CLR) or Cell-Transfer Delay (CTD); nor is there any guarantee of fair utilization of bandwidth among these services.

Two parameters can be used to define the constraints on the DRR procedure:

- The bandwidth committed for broadband services, B_G: This is the amount of bandwidth that is **guaranteed** to be available for broadband services. For ATM services, B_G is the amount of bandwidth that must be known to the CAC function, for traffic management purposes, as that which is to be used for services that cannot tolerate delay: CBR, rt-VBR, nrt-VBR, ABR and GFR. The B_G must be calculated after start-up, and not changed during operation. The bandwidth committed for broadband is:

$$B_G = B_{NET} - B_V$$

  where B_{NET} is the net payload capacity of the link, and B_V is the bandwidth allocated to voice services (POTS or ISDN).

- The bandwidth currently available for broadband services, B_C: This is the total bandwidth that can be used for all broadband services. For ATM services, this includes UBR and UBR+ services; B_C is to be communicated to the ATM layer during DRR actions:

$$B_C = B_G + B_{V\text{-}R}$$

where B_{V-R} is the bandwidth that has been **assigned** to voice calls but which is not currently **in use**, and is thus available for release.

6.2.4 Voice Quality (replaces clause 6.2.4/[1])

Service Providers and end-users generally do not want to be forced to compromise on the quality of voice connections. Technology is available to ensure that the voice quality is indistinguishable from that provided by a conventional wireline connection to the PSTN. Maximum delay and echo cancellation requirements should be supported according to T1.508 [5], ITU-T Recommendations G.114 [6] or G.131 [7]. Examples include ITU-T Recommendations G.165 [8] or G.168 [9].

ITU-T Recommendation G.114 states that although a few applications may be slightly affected by end-to-end (i.e. "mouth-to-ear" in the case of speech) delays of less than 150 ms, if delays can be kept below this figure, most applications, both speech and non-speech, will experience essentially transparent interactivity. It also states that while delays above 400 ms are unacceptable for general network planning purposes, it is recognized that in some exceptional cases this limit will be exceeded.

These end-to-end delay figures given in ITU-T Recommendation G.114 include the delay introduced in the CP-IWF(s), DSL network(s), AN-IWF(s), and the transport network(s) between the call originator and the destination and any delay in CPE. Appendix II further describes delay issues.

The CP-IWF and AN-IWF implementations should take all measures to minimize the delay. In addition the delay in the DSL network itself can be significant. For example, with ADSL (ITU-T Recommendations G.992.1 [10] and G.992.2 [11]), network operators could consider using the fast path or setting minimal interleave depth.

It should be noted that when the ADSL physical line bandwidth is sub-divided (e.g. into ADSL dual latency or other reserved channels) this will affect delay by reducing the "line rate" at which cells are inserted into the channel.

The choice of codec also has an effect on voice quality. Further information on the effect of codecs, delay and echo on perceived quality can be found in ITU-T Recommendation G.107 [12].

6.2.5 Service Feature Transparency

See clause 6.2.5 of TR-039 [1].

6.2.6 Continuous Availability

See clause 6.2.6 of TR-039 [1].

6.2.7 Performance

See clause 6.2.7 of TR-039 [1].

6.2.8 Management

See clause 6.2.8 of TR-039 [1].

6.2.9 Network Security

See clause 6.2.9 of TR-039 [1].

6.2.10 Network Compatibility

See clause 6.2.10 of TR-039 [1].

6.2.11 Reliability

See clause 6.2.11 of TR-039 [1].

6.2.12 Jitter and Wander

At the interface towards the Core Network (the V interface), jitter and wander requirements given in the ETSI V5.2 interface specification EN 300 347-1 [13] should be fulfilled.

To support ISDN basic rate access, the jitter and wander levels must not exceed the values given in ITU-T Recommendation G.960 [14].

To support POTS interfaces at the customer premises (the R interface), the jitter and wander levels must not exceed the values given in ITU-T Recommendation G.960 [14] at the digital interface of the codec at the customer premises.

6.2.13 Lifeline Voice Service

Support for lifeline voice service is optional; however, it should be noted that it may be necessary in some countries, because of regulatory requirements.

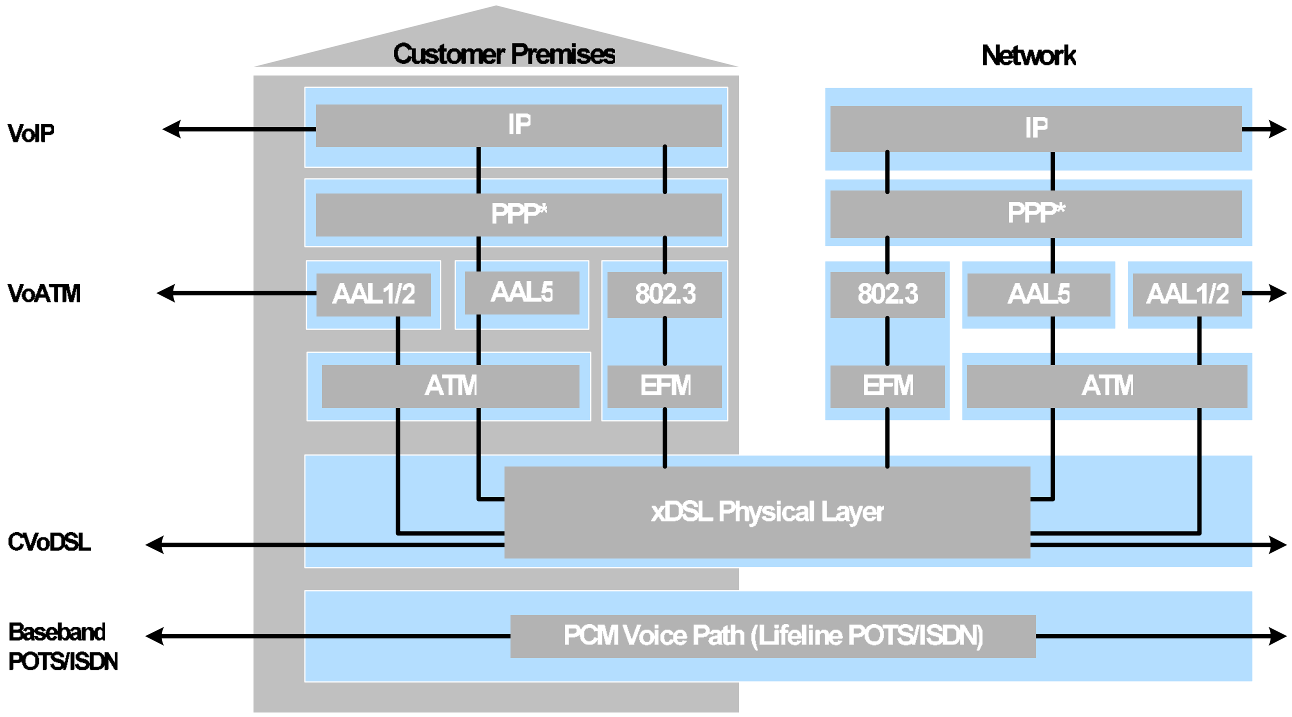
6.3 General Service Requirements (supplements clause 6.3/[1])

See clause 6.3 of TR-039 [1].

Voice over DSL methods are characterized by different network transport mechanisms, which can be distinguished by their relative placement in the OSI reference model. These are:

- Voice over STM (VoSTM), more commonly known as Channelized Voice over DSL (CVoDSL): This approach embeds the voice information directly into the PHY layer, without involving higher layers of the DSL link.
- Voice over ATM (VoATM): The VoATM approach employs the functionality of the ATM layer, which is located roughly at the Data Link layer of the OSI reference model.
- Voice over IP (VoIP): The VoIP approach employs the IP protocols, at the Network layer of the OSI model, to transport voice data and signalling. The IP can be carried over ATM or over the IEEE 802.3ah EFM protocol stack [15].

Figure 2 illustrates the typical protocol stacks for each of these three transport methods.



NOTE 1: The baseband POTS/ISDN capability of ADSL and VDSL is not considered a "Voice over DSL" service.
NOTE 2: * PPP is not necessarily needed.

Figure 2: Principal Methods for VoDSL Services

The applicability of a particular VoDSL service model depends on the capabilities of the network architecture.

6.3.1 VoDSL Bearer Requirements

See clause 6.3.1 of TR-039 [1].

6.3.2 VoDSL Signalling Requirements

See clause 6.3.2 of TR-039 [1].

6.3.3 Class 5 Services

See clause 6.3.3 of TR-039 [1].

6.3.4 Class 4 Services

See clause 6.3.4 of TR-039 [1].

7 VoDSL Management

See clause 7 of TR-039 [1].

7.1 VoDSL Management Functions

See clause 7.1 of TR-039 [1].

7.2 VoDSL Management Architecture

See clause 7.2 of TR-039 [1].

Annex A: Voice over Asynchronous Transfer Mode (VoATM) (supplements Annex A/[1])

The VoATM approach uses ATM for the Data Link layer, transporting voice samples over ATM Adaptation Layer (AAL) type 1 or type 2. VoATM provided over AAL 2 has been suggested by the DSL Forum as the VoATM protocol of choice.

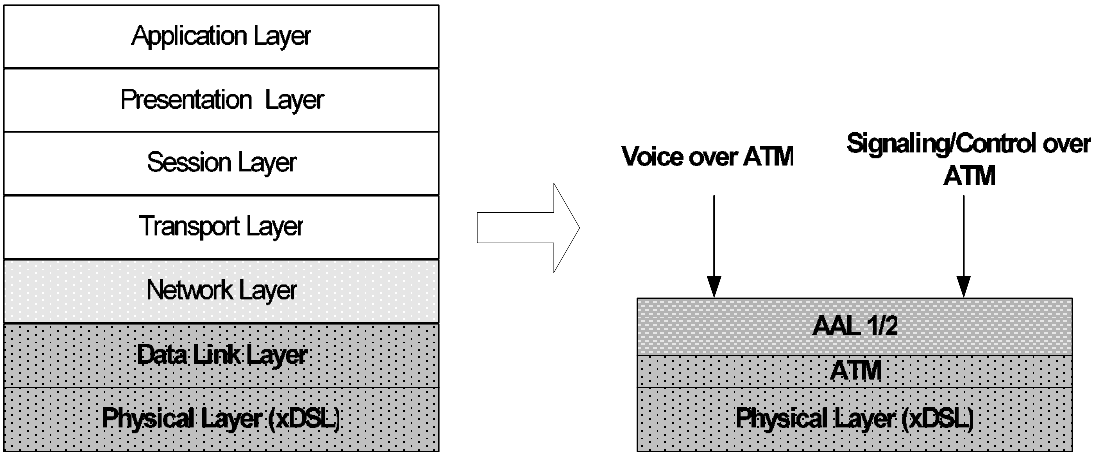


Figure A.1: VoATM OSI Layer Relations

Figure A.1 illustrates the transport of voice streams and signalling/control functions over ATM. These functions are out of scope for the present document. The VoATM approach is supported by all xDSL technologies defined by ETSI: ADSL (TS 101 388 [16]), SDSL (TS 101 524 [17]) and VDSL (TS 101 270-2 [18]).

See annex A of TR-039 [1].

The provision of lifeline voice service in a VoATM scenario raises issues that need further study. It is expected that work underway in the DSL Forum will provide recommendations on this matter.

Annex B: Voice over Synchronous Transfer Mode (VoSTM)

The VoSTM approach (more commonly known as Channelized Voice over DSL (CVoDSL)) transports voice data over the xDSL PHY layer without additional protocol. PCM (ITU-T Recommendation G.711 [19]) or ADPCM (ITU-T Recommendation G.726 [20]) voice encoding is transported transparently between the LTU and the NTU.

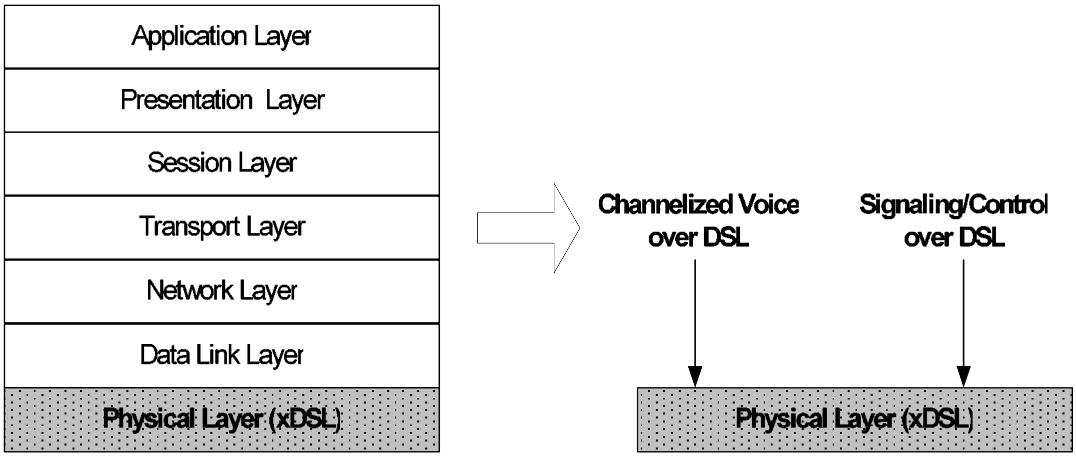


Figure B.1: CVoDSL OSI Layer Relations

As shown in figure B.1, the CVoDSL approach applies to the transport of voice over the access digital section. The realization of the CVoDSL TC layer is different for every xDSL technology. Call-related signalling and control are transported transparently, if applicable; in some aspects an interworking function at the customer premises (CP-IWF) is needed.

B.1 Interfaces for CVoDSL

The intent of the CVoDSL approach is to transport the usual voice services over xDSL access as transparently as possible, so that the usual voice terminals are connected to the PSTN or ISDN and handled in the usual way. There are three applicable interfaces to be met:

- The POTS interface.
- The ISDN interface.
- The ETSI V5.1/V5.2 interface, which supports both POTS and ISDN.

B.2 Channelized Voice over ADSL

For further study.

B.3 Channelized Voice over SDSL

TS 101 524 [17] supports several options for CVoDSL, as specified in several clauses:

- A.6 TPS-TC for Synchronous ISDN;
- A.7 TPS-TC for POTS;
- A.10 TPS-TC for LAPV5 enveloped POTS or ISDN.

Additionally, the clause A.9 of SDSL specifies a combination from among the above CVoDSL techniques:

- Type 1: STM + Broadband;
- Type 2: STM + ATM;
- Type 3: STM + Clear Channel.

B.3.1 POTS over SDSL

The SDSL POTS service, as defined by clause A.7 of TS 101 524 [17], provides the following required functions:

Transport

- 64-kbit/s PCM channels are mapped onto B-channels.
- POTS signalling is mapped onto Z-channel(s) or B-channel(s), depending on the required bandwidth.

Protocol Handling

- PCM voice is transported transparently.
- POTS signalling/control is converted by the CP-IWF in accordance with TS 101 524 [17].

An example showing the functional relation to relevant reference points (with respect to the VoDSL Architectural Reference Model) shown in figure B.2.

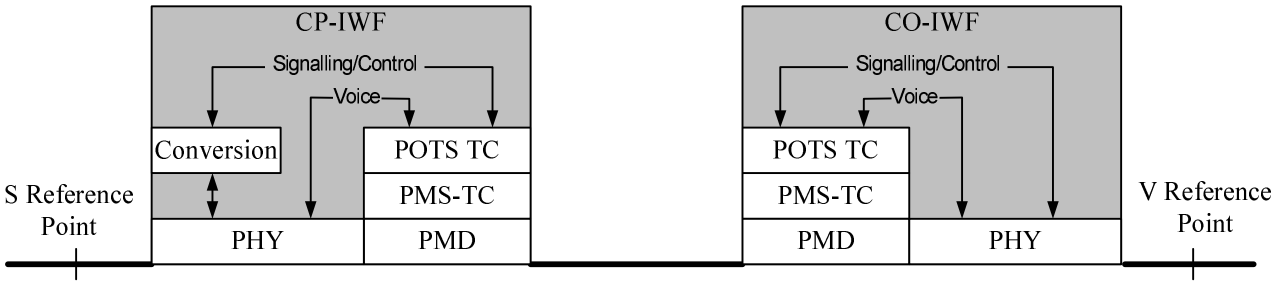


Figure B.2

The service model does not preclude the integration of the CP-IWF with other Customer-Premise functions.

B.3.2 ISDN over SDSL

The SDSL ISDN service, as defined by clause A.6 of TS 101 524 [17], provides the following required functions:

Transport

- ISDN data B-channels are mapped onto 64-kbit/s SDSL B-channels.
- ISDN D-channel signalling is mapped onto two 8-kbit/s Z-channels, or onto SDSL B-channels, if there are more than 3 D-channels.
- ISDN S-Bus control is mapped via ISDN eoc messages onto the SDSL eoc channel or onto the Fast eoc channel, depending on the number of supported ISDN BAs.

Protocol Handling

- ISDN B-channels are transported transparently.
- ISDN D-channel signalling is transported transparently.
- ISDN S-Bus control is handled by the CP-IWF and CO-IWF.

An example showing the functional relation to relevant reference points (with respect to the VoDSL Architectural Reference Model) is shown in figure B.3.

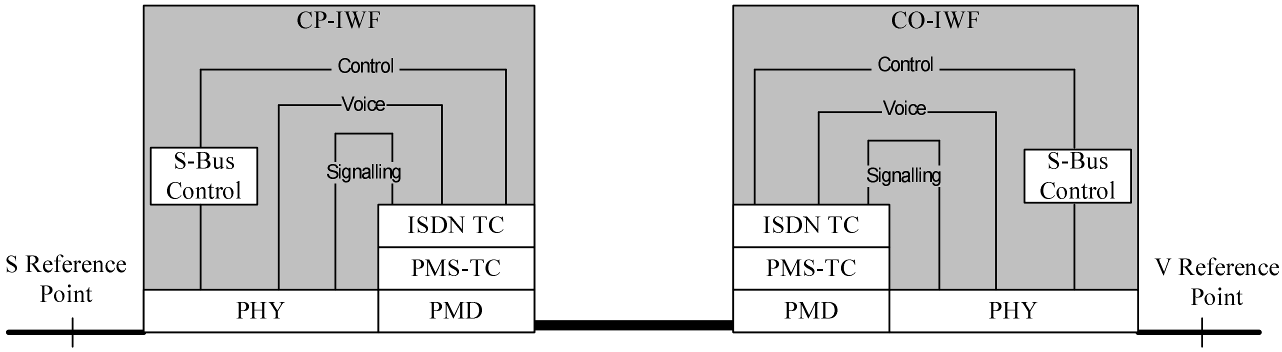


Figure B.3: SDSL ISDN Service Model

The CP-IWF provides S-Bus control: the conversion of ISDN Message Codes (as defined by TS 101 524 [17], clause A.6.7.2) to ISDN PHY commands (typically IOM®-2 Codes). IOM®-2 is a registered trademark of SIEMENS AG. This information is given for the convenience of users of the present document and does not constitute an endorsement by ETSI of the product named. Equivalent products may be used if they can be shown to lead to the same results.

The service model does not preclude the integration of the CP-IWF with other Customer-Premise functions.

The CO-IWF provides S-Bus control at the CO: it converts the ISDN Message Codes (as defined by TS 101 524 [17], clause A.6.7.2) to the ISDN Function Elements (FEs) from the ISDN Digital Section for basic access (defined in ETS 300 297 [21], clause 8.4.3) that are required to support the ETSI V5.1 interface (EN 300 324-1 [22]). The CO-IWF is located at the V1 reference point in figure 31 of EN 300 324-1 [22], where the S-Bus Control communicates with the AN Port-Status FSM.

The list of relevant FEs, taken from table 31 of ETS 300 297 [21], has been reproduced in table B.1; however, support of all the FEs from table 31 is not appropriate, since the Digital Section (DS) is provided by SDSL rather than ISDN basic rate access.

Table B.1: ISDN basic access Digital Section FEs relevant to interface V5.1 (modified from table 31 of ETS 300 297)

FE	Name	CO-IWF ET	Meaning at ET in LE
FE1	activate access	←	PH/MPH-AR
FE2	access activation initiated by user	→	MPH-AWI (awake indication)
FE3	DS activated	→	MPH-DSAI
FE4	access activated	→	PH/MPH-AI
FE5	deactivate access	←	MPH-DR
FE6	access deactivated	→	PH/MPH-DI
FE7	LOS/LFA on DS ***or loss of power in NT1***	failure in DS	not directly relevant
FE8	activate loopback 2	AN maintenance	not directly relevant
FE9	activate loopback 1 (Not supported)	AN maintenance	not directly relevant
FE10	activate loopback 1A (Not supported)	AN maintenance	not directly relevant
FE11	activate partially the DS (Not supported)	AN maintenance	not directly relevant
FE12	LOS/LFA at T reference point	AN management information	not directly relevant
FE13	deactivate T whilst keeping the DS partially activated (Not supported)	AN maintenance	not directly relevant

B.3.3 ETSI V5.1/V5.2 transported over SDSL

SDSL can provide the ETSI V5.1 (EN 300 324-1 [22]) and V5.2 (EN 300 347-1 [13]) interfaces by using the LAPV5 enveloped POTS/ISDN capability for the following functions, as specified by clause A.10 of TS 101 524 [17]:

Transport

- POTS PCM voice is mapped onto SDSL B-channels.
- ISDN data B-channels are mapped onto 64-kbit/s SDSL B-channels.
- ISDN D-channels are mapped onto two 8-kbit/s Z-channels, or onto SDSL B-channels, if there are more than 3 D-channels.
- POTS control and signalling messages are multiplexed together with ISDN control messages via LAPV5-DL.

NOTE: The payload sub-block ordering is defined in clause A.11.10 of TS 101 524 [17].

Protocol Handling

- ISDN B-channels are transported transparently.
- ISDN D-channel signalling is multiplexed with ISDN control and POTS signalling and control messages using the LAPV5 enveloped address function.

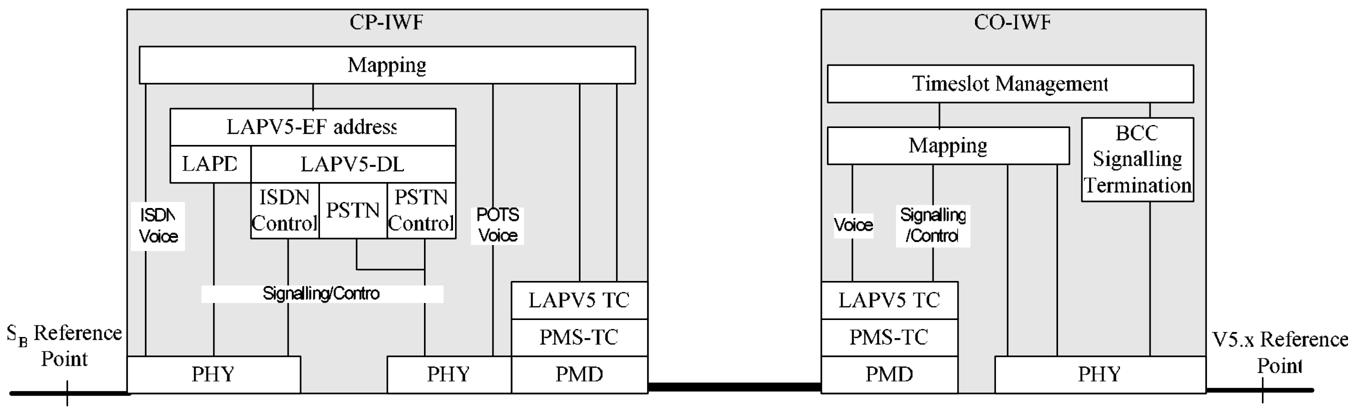


Figure B.4: SDSL LAPV5 enveloped POTS/ISDN Service Model

An example showing the functional relation to relevant reference points (with respect to the VoDSL Architectural Reference Model, clause 5) is shown in figure B.4. The PMD, PMS-TC and LAPV5 TC blocks belong to the SDSL physical layer.

The service model does not preclude the integration of the CP-IWF with other Customer Premise functions.

CP-IWF

The related protocol functions of the **CP-IWF** are:

1) **Mapping:** as described in TS 101 524 [17], clause A.10.

2) LAPV5-EF address: used to transport all ISDN- and POTS-related signalling and control information. The LAPV5-EF address is encapsulated in HDLC frames. The format is given in figure B.5.

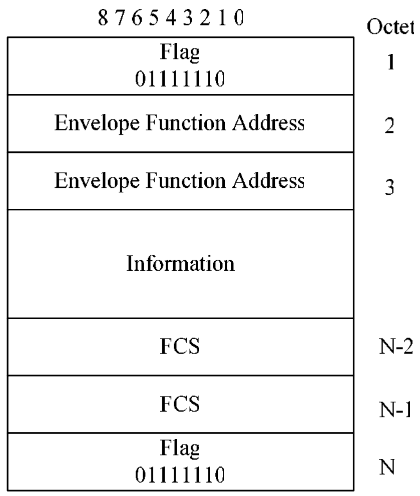


Figure B.5: LAPV5-EF frame structure

3) **LAPD:** to be implemented as follows: D-channel frames received from the ISDN user ports are passed, after processing by the CP-IWF frame relay function, to the Envelope function for transmission on the LAPV5 TC. The EFaddr associated with the port is passed as a parameter. The processed frame is mapped into the envelope information field of the envelope function of the communications channel selected in accordance with V5.1, clause 8.45.1 of EN 300 324-1 [22]. When frames are received by the LAPV5-EF sublayer from the CO-IWF, and if the V5DLaddr lies within the range reserved for ISDN user port identification (as defined in clause 9.2.2.2 of EN 300 324-1 [22]), the envelope information field and the EFaddr is passed to the CP-IWF frame relay function for additional processing and transmission towards the ISDN user port.

4) **LAPV5-DL (data link) sublayer:** used for peer-to-peer exchanges of information between the AN and the LE, employing frames conforming to the formats defined in figure B.6. Two format types are shown:

   1) format A for frames without information field; and

   2) format B for frames containing an information field.

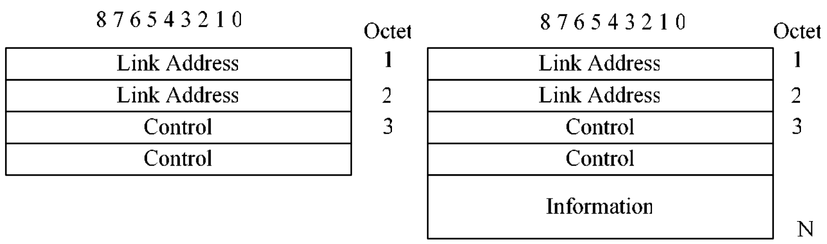


Figure B.6: LAPV5-DL frame structures

5) **ISDN Port Control:** user port status indication is based on the defined split of responsibilities between the AN and the LE. Only status information of the user port that has relevance to call control should influence the state machine in the LE via the V5.1 interface. Port tests, e.g. loop back operation, are ordinarily the responsibility of the AN, but with LAPV5 TC these function are located in the CP-IWF. Performance of loop backs is no longer required, as they are apply to the ISDN physical layer which no longer exists. Tests which interfere with the service are only to be performed when the port is "Blocked", either due to failure or due to request of, and by permission of, the LE. The function elements relevant to the CP-IWF are shown in table B.2, selected from table 31 of EN 300 324-1 [22]).

Table B.2: ETS 300 297 set of function elements with relevance to interface V5.1 (modified from table 31 of EN 300 324-1)

FE	Name	DS ET	Meaning at ET in LE
FE1	activate access	←	PH/MPH-AR
FE2	access activation initiated by user	→	MPH-AWI (awake indication)
FE3	DS activated	→	MPH-DSAI
FE4	access activated	→	PH/MPH-AI
FE5	deactivate access	←	MPH-DR
FE6	access deactivated	→	PH/MPH-DI
FE7	LOS/LFA on DS ***or loss of power in NT1***	failure in DS	not directly relevant
FE8	activate loopback 2	AN maintenance	not directly relevant
FE9	activate loopback 1 (Not supported)	AN maintenance	not directly relevant
FE10	activate loopback 1A (Not supported)	AN maintenance	not directly relevant
FE11	activate partially the DS (Not supported)	AN maintenance	not directly relevant
FE12	LOS/LFA at T	AN management information	not directly relevant
FE13	deactivate T whilst keeping DS partially activated (Not supported)	AN maintenance	not directly relevant

6) **POTS Port Control:** user port status indication is based on the defined split of responsibilities between the CP-IWF and the LE. Only status information of the user port that has relevance to call control should influence the state machine in the LE via the V5.1 interface. Port tests, e.g. line tests, are no longer required because the access link is replaced by SDSL. Tests which interfere with the service are only to be performed when the port is "Blocked", either due to failure or due to request of, and by permission of, the LE. The function elements relevant to the CP-IWF are shown in table B.3, taken from table 37 of EN 300 324-1 [22]. The MPH-primitives towards the management function are shown in table B.4, taken from table 39 of EN 300 324-1 [22]. See also figure B.4.

Table B.3: Set of function elements of interface V5.1 (from table 37 of EN 300 324-1)

FE	Name	AN LE	Description
FE201	Unblock	←	request or acknowledgement
FE202	Unblock	→	request or acknowledgement
FE203	Block	←	Command
FE204	Block	→	Command
FE205	block request	→	Request

Table B.4: Set of management primitives in the AN relevant to V5.1 (from table 39 of EN 300 324-1)

Primitive	FSM Management	Description
MPH-UBR	→	Unblock request
MPH-UBR	←	Unblock request
MPH-UBI	←	Unblock indication
MPH-BI	→	block command
MPH-BI	←	block command
MPH-BR	→	block request

7) **PSTN:** CP-IWF is to support the AN functionality from EN 300 324-1 [22] which includes the PSTN protocol (clause 13.3), general message format (clause 13.4) and PSTN call control (clause 13.5).

As shown in figure B.6, the CP-IWF is to support two PHY layers at the S_B reference point. The conversion function is to provide the multiplexing/de-multiplexing of the ISDN D-channel and ISDN control from/to the ISDN PHY.

CO-IWF

The related protocol functions of the **CO-IWF** are:

1) **Mapping**: this function is described in EN 300 324-1 [22], clause A.10.

2) **Timeslot Management**: it includes the following functions specified by EN 300 347-1 [13]:

   - Control Protocol: to take individual bearer channels (user ports for POTS or ISDN) out of service, or to return them to service; primarily for maintenance and testing purposes.

   - Protection Protocol: to control the switchover of communications channels carrying the V5 message protocols (including the D-channels) from a failed to a back-up physical link.

   - Link Control Protocol: to manage the physical links that make up the V5 interface; including auditing a link's identity, or taking one out of service.

3) **Bearer Channel Connection (BCC):** This a specific protocol feature of EN 300 347-1 [13] which allows the LE to instruct the AN to dynamically allocate bearer channels, either singly or in multiples, on demand. This function is only required if the interface between the CO-IWF and the LE is V5.2.

Figure B.4 indicates the point at which compliance to the V5.1/V5.2 interface is applicable, for the signalling and control.

B.3.4 Lifeline Voice Service over SDSL using Dynamic Rate Repartitioning

In most configurations and normal operation, the broadband-data interface of the SDSL transceiver will provide both the voice and the data services. However, in the event of a local power failure, it is also possible to operate an SDSL transceiver in a lower-power mode which can be sustained by line power on an emergency basis, and which will support voice for lifeline service. This procedure depends on specified optional capabilities in the SDSL standard.

The procedure is as follows: When a power failure occurs, the SDSL system will:

- Transmit an indication of the use of line powering from the Central Office.
- Switch into a lower-power mode of operation that provides service to an emergency telephone.
- Initiate a DRR procedure that sets up the possibility of a CVoDSL connection between the emergency telephone and the PSTN, through the Access Node. (This assumes that the SDSL system is operating in Dual-Bearer mode type 1.)

The SDSL system will draw power from the CO through the line, as would an ISDN system in emergency operation. It can provide lifeline voice service based upon either POTS or ISDN basic access.

When changing into the lower-power mode, it is acceptable that ongoing telephone calls are dropped on all phone lines with the exception of at least one line, designated as the lifeline interface(s). However, when changing back into normal mode, reconfiguration of the bearers should not result in a dropped call; if necessary, the DRR operation should be held until the call is finished.

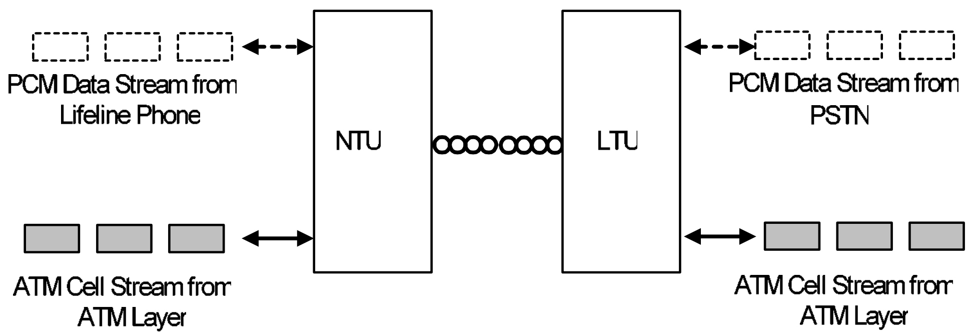


Figure B.7: Dual-Bearer Application supporting ATM Data and Lifeline Voice

Figure B.7 illustrates that the lifeline phone is supported over the SDSL line in Dual-Bearer mode type 1 (STM + Broadband). In the lifeline application, the PCM data stream will be carried only during a power failure, as otherwise the bandwidth will be dedicated to ATM cells.

Local power failure is to be detected by the Management and Control entity and indicated by setting the *ps* bit, as described in clause 10.2.8 "Loss of Local Power" of ITU-T Recommendation I.411 [2]. The LTU should provide the remote feeding power, as prescribed in clause 13.4 "Feeding Power from the LTU" of ITU-T Recommendation I.411 [2]. The Management and Control entity initiates the DRR procedure, resulting in a change of the framing, as shown below in figure B.8.

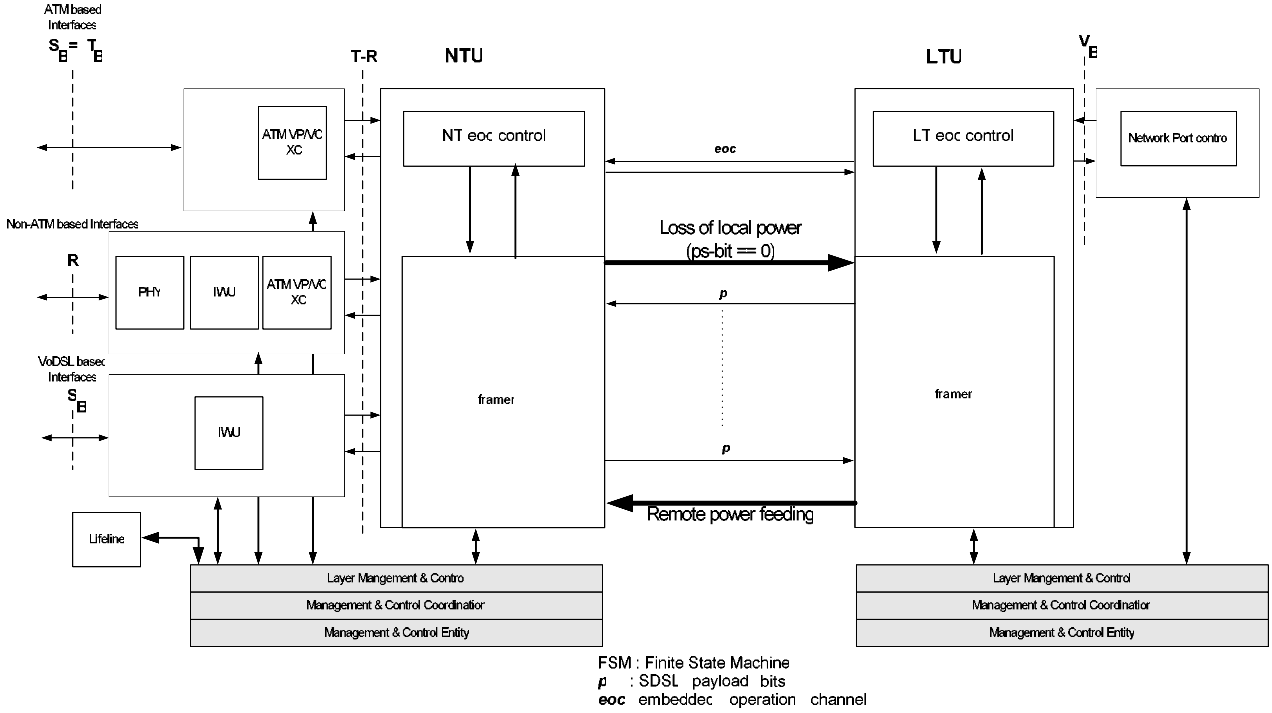


Figure B.8: Dual-Bearer Architecture with Lifeline support

B.3.4.1 Lifeline ISDN Example

ISDN lifeline service is defined in TS 101 524 [17], clause A.6.4.

As a result of the DRR operation, the SDSL framing would change to shift some of the ATM bandwidth to the lifeline CVoDSL service. An example is shown below.

In the example of figure B.9 during normal operation, the frame has:

- 1 Z-bit for the DRR channel: this assignment will not be changed.
- 2 Z-bits for ISDN signalling: this assignment can be fixed, or it can be dynamically allocated, using an Activation/Deactivation procedure using the S-Bus control, carried over the SDSL eoc channel. Although the transceiver is operating in the Dual-Bearer TPS-TC STM + Broadband mode, no B-channels are being used for voice.
- (n) ATM bytes mapped onto the B-channels (B_1 - B_n): this assignment can be dynamically allocated.

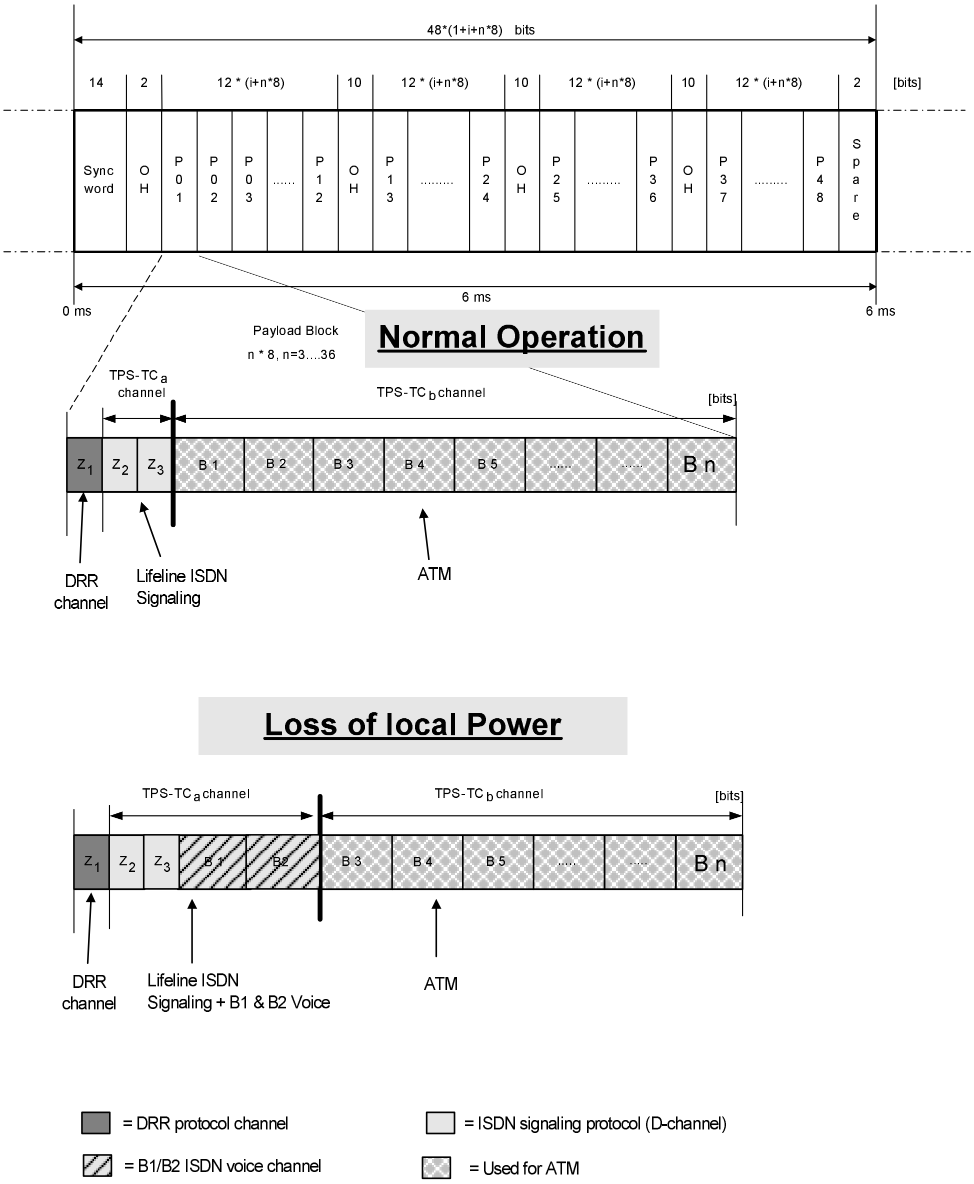


Figure B.9: SDSL Dual-Bearer TPS-TC Framing with Lifeline ISDN

After the loss of local power, the DRR procedure gives the following framing, for this example:

- 1 Z-bit for the DRR channel.
- 2 Z-bits for ISDN signalling.
- 2 B-channels for carrying the ISDN B1 and B2 channels over the SDSL in the TPS-TC_a. (In the lifeline mode of ISDN, only one B-channel can be used.)
- (n – 2) ATM bytes mapped onto the B-channels (B_1 - B_n). Because this is a lifeline condition, in this case the ATM layer will be inactive above layer 1, and the ATM bytes will be only idle cells produced by the ATM TPS-TC of the SDSL NTU/LTU.

As a result of this procedure, the SDSL-based NTU will be able to meet the power-dissipation restrictions of clause 13.5 of TS 101 524 [17] while continuing to transmit the lifeline ISDN signalling and voice data.

B.3.4.2 Lifeline POTS Example

POTS lifeline service is defined in TS 101 524 [17], clause A.7.2.

As a result of the DRR operation, the SDSL framing would change to shift some of the ATM bandwidth to the lifeline CVoDSL service. An example is shown below.

In the example of figure B.10, during normal operation after start-up, the frame has:

- 1 Z-bit for the DRR channel: this assignment will not be changed.
- 1 Z-bit for POTS signalling: this assignment will not be changed.
- (n) ATM bytes mapped onto the B-channels (B_1 - B_n): this assignment can be dynamically allocated. Although the transceiver is operating in the Dual-Bearer TPS-TC STM + Broadband mode, no B-channels are being used for voice.

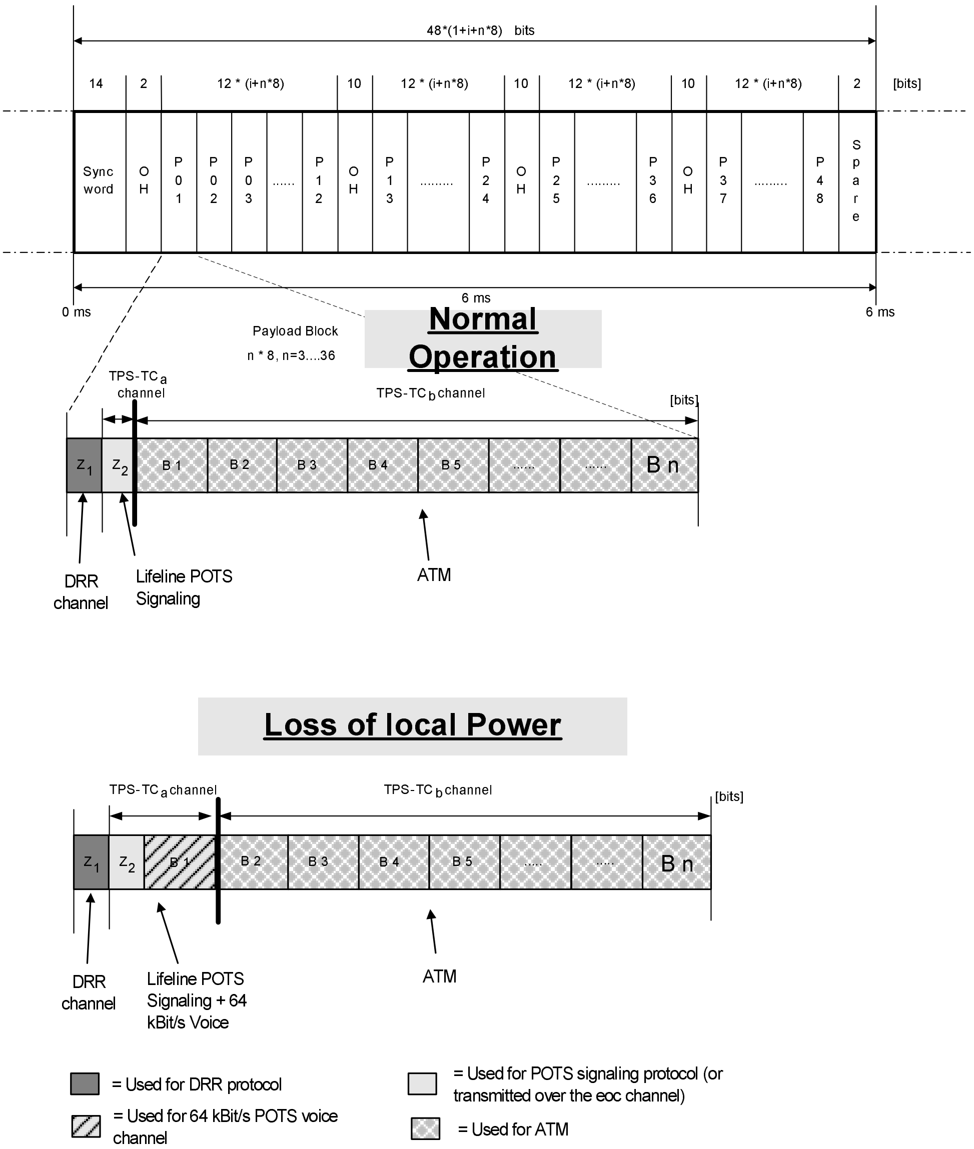


Figure B.10: SDSL Dual-Bearer TPS-TC Framing with Lifeline POTS

After the loss of local power, the DRR procedure gives the following framing, for this example:

- 1 Z-bit for the DRR channel.
- 2 Z-bits for POTS signalling.
- 1 B-channels for carrying the 64-kb/s POTS channel over the SDSL in the TPS-TC_a.
- (n – 1) ATM bytes mapped onto the B-channels (B_1 - B_n). Because this is a lifeline condition, in this case the ATM layer will be inactive above layer 1, and the ATM bytes will be only idle cells produced by the ATM TPS-TC of the SDSL NTU/LTU.

As a result of this procedure, the SDSL-based NTU will be able to meet the power-dissipation restrictions of clause 13.5 of TS 101 524 [17] while continuing to transmit the lifeline POTS signalling and voice data.

B.4 Channelized Voice over VDSL

For further study.

Annex C: Voice over Internet Protocol (VoIP)

The VoIP approach uses the Internet Protocol (IP) as the Network layer to transport voice. Figure C.1 shows how VoIP is carried over ATM, in terms of the OSI layer model.

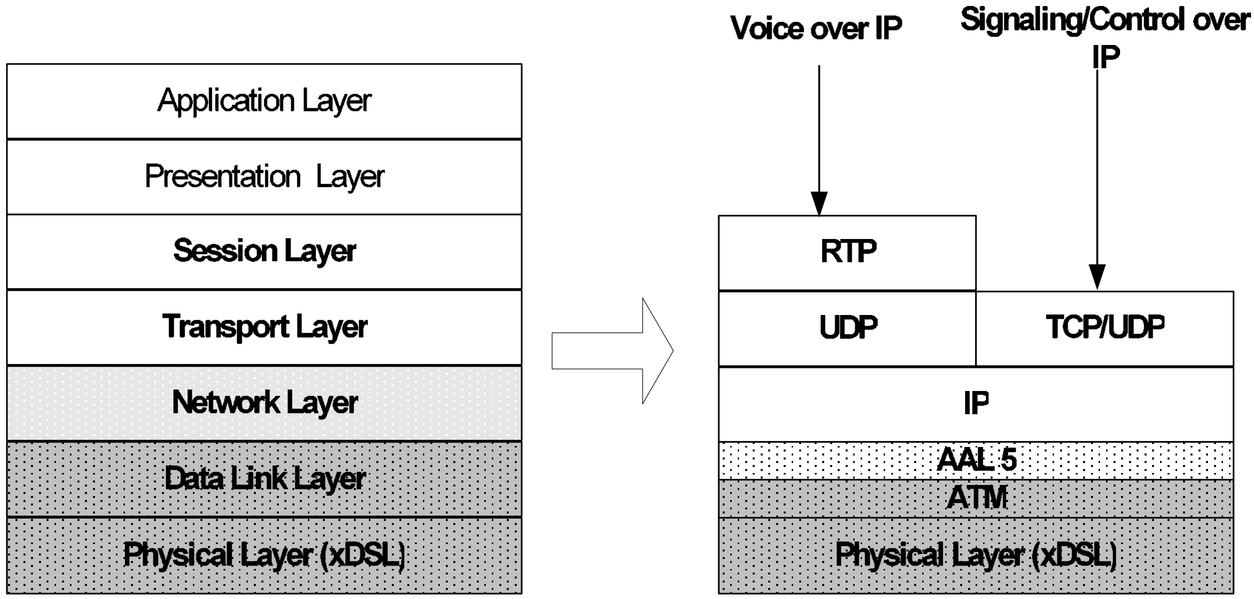
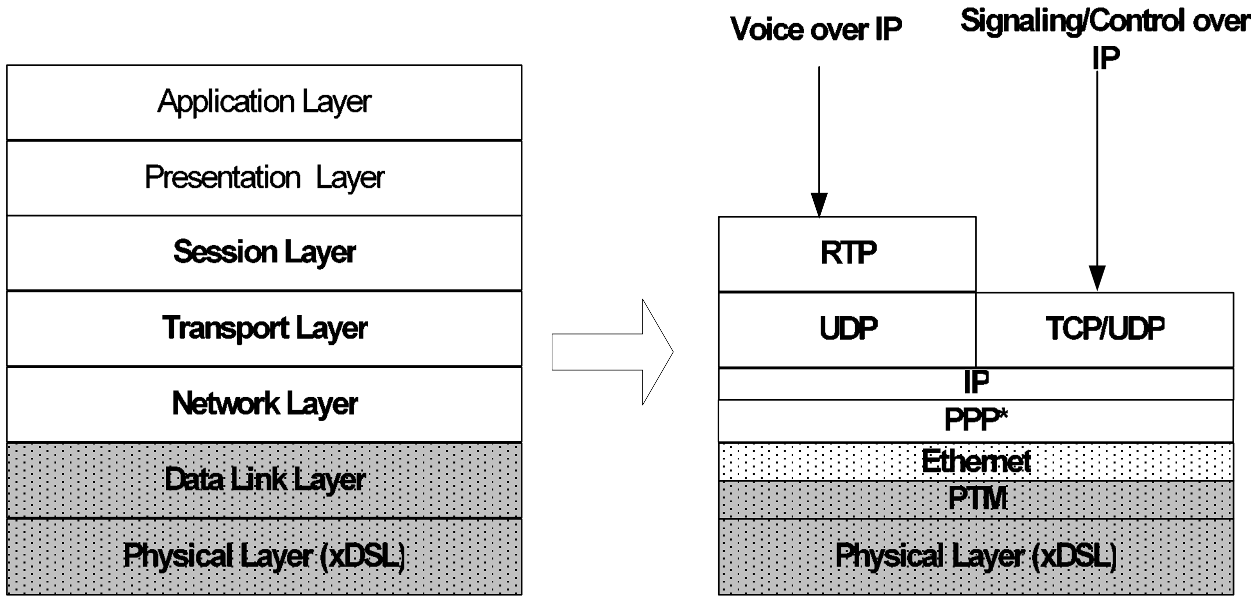


Figure C.1: VoIP OSI Layer Relations

Conversely, figure C.2 shows how VoIP is carried over Ethernet.



NOTE: * PPP is not necessarily needed.

Figure C.2: VoIP OSI Layer Relations

The transport of voice streams and call-related signalling and control are carried using different transport-layer functions. The interaction of the ATM and ATM Transmission Convergence layers (ATM-TC) for the different xDSL technologies are specific for each technology, and are specified in the respective ETSI standards. The Packet Transport Mode (PTM) is a generic packet-based transmission system; an example implementation is IEEE 802.3ah [15] (EFM).

The provision of lifeline voice service in a VoIP scenario raises issues that need further study. It is expected that work underway in the DSL Forum will provide recommendations on this matter.

History

Document history		
V1.1.1	March 2005	Publication