Alcatel
1000 ADSL
(Asymmetric Digital Subscriber Line)

and

7300 ASAM
(Advanced Services Access Manager)

Network Compatibility Disclosure Document

Interface Specification
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Contents

1. Preface

Alcatel's DSL Access Multiplexers include the 1000 ADSL and the second generation 7300 ASAM. These products constitute access systems for any ATM–based Broadband ISDN (BB–ISDN) switching fabric. Each system delivers narrowband services (POTS or ISDN) and broadband services (DSL) to subscribers over the widely installed single metallic pair subscriber loop base. The 7300 ASAM adds SHDSL and VDSL broadband service offerings.

This document specifies the DSL physical layer interfaces based on ANSI, ETSI, and ITU standards :

- ANSI Standard T1.413 [1] and T1.424/Trial Use [13], [14], [15]
- ETSI Technical Specification ETS 101 388 [2] and ETS 101 524 [10] and ETS 101 270 [11], [12]
- ITU-T Recommendation G.992.1[3], G.992.2[4] ,G.992.3 [5], G.992.4 [6], G.992.5 [7], G.994.1 [8] , G.991.2 [9].

Also annexes are added, describing:

- Annex A: G.994.1 Non-Standard Facilities;
- Annex B: ATM Layer Interoperability;
- Annex C: Ethernet Layer Interoperability.

This document provides the specification of the digital subscriber line interface. It refers to publicly available standards wherever possible. The xTU–C transmitter characteristics are described as they apply to the Alcatel 1000 ADSL and 7300 ASAM central office and remote (e.g. Remote Access Multiplexer and cabinet–based ASAM) equipment.

The majority of this document is relevant to both the 1000 ADSL and 7300 ASAM equipment, as applicable for providing ADSL services. Information is also included for ADSL2x, SHDSL and VDSL service capabilities, which are only supported by the 7300 ASAM.

The xTU–R transmitter requirements are specified with respect to interoperability with the Alcatel xTU–C. xTU–C characteristics and xTU–R requirements that may affect interoperability of the Alcatel xTU–C with an xTU–R are highlighted in this document.

1.1. Referenced Documents

The following documents are referenced:

[1] ANSI Standard T1.413-1998, “Network and Customer Installation Interfaces – Asymmetrical Digital Subscriber Line (ADSL) Metallic Interface”, publication by the ANSI.

[2] ETSI Technical Specification ETS 101 388 (RTS/TM-06025), “Access transmission systems on metallic access cables; Asymetric Digital Subscriber Line (ADSL)”, Version 1.3.1, Feb 2002

[3] ITU-T Recommendation G.992.1, *“Asymmetrical Digital Subscriber Line (ADSL) Transceivers”,* publication by the ITU-T, 1999.

[4] ITU-T Recommendation G.992.2, “*Splitterless Asymmetrical Digital Subscriber Line (ADSL) Transceivers*”, publication by the ITU-T, 1999.

[5]] ITU-T Recommendation G.992.3, “Asymmetrical Digital Subscriber Line (ADSL) Transceivers - 2 (ADSL2) ”, publication by the ITU-T, July 2002.

[6] ITU-T Recommendation G.992.4, “Splitterless Asymmetrical Digital Subscriber Line (ADSL) Transceivers - 2 (Splitterless ADSL2)”, publication by the ITU-T, July 2002

[7] ITU-T Recommendation G.992.5, “Asymmetrical Digital Subscriber Line (ADSL) Transceivers - Extended bandwidth ADSL2 (ADSL2plus) ”, publication by the ITU-T, Mai 2003

[8] ITU-T Recommendation G.994.1, “*Handshake Procedures for Asymmetrical Digital Subscriber Line (ADSL) Transceivers*”, publication by the ITU-T, 1999 and 2001.

[9] ITU-T Recommendation G.991.2, “*Single-Pair High Speed Digital Subscriber Line (SHDSL) Transceivers*”*,* publication by the ITU-T, 2001.

[10] ETSI Technical Specification ETS 101 524, “*Symmetric single pair high bit rate digital subscriber line (SDSL) transmission system on metallic local lines*”, version 1.1.2, August 2001.

[11] ETSI Technical Specification ETS 101 270-1, “Access transmission systems on metallc access cables; Very high speed Digital Subscriber Line (VDSL); Part 1 : Functional requirements", Version 2.0.9, May 2005

[12] ETSI Technical Specification ETS 101 270-2, “Access transmission systems on metallc access cables; Very high speed Digital Subscriber Line (VDSL); Part 2 : Transceiver specification", Version 2.0.7, May 2005

[13] ANSI Standard T1.424/Trial-Use, “Interface Between Networks and Customer Installations -- Very-high Speed Digital Subscriber Lines (VDSL) Metallic Interface ; Part 1 : Functional Requirements and Common Specification", T1E1.4/2002-031R2, Feb 2002.

[14] ANSI Standard T1.424/Trial-Use, “Interface Between Networks and Customer Installations -- Very-high Speed Digital Subscriber Lines (VDSL) Metallic Interface ; Part 2 : Technical Specification for a Single-Carrier Modulation (SCM) Transceiver", T1E1.4/2001-011R3, Nov 2001.

[15] ANSI Standard T1.424/Trial-Use, “Interface Between Networks and Customer Installations -- Very-high Speed Digital Subscriber Lines (VDSL) Metallic Interface ; Part 3 : Technical Specification of a Multi-Carrier Modulation Transceiver", T1E1.4/2002-099, Feb 2002.

[16] Draft ANSI Standard on ATM based Multi-Pair Bonding. T1E1.4/2003-334R2, February 2004

1.2. Acronyms

ADSL	Asymmetric Digital Subscriber Line
ADSLx	any ADSL variant (ADSL, ADSL2, ADSL2plus, READSL2)
ADSL2x	ADSL2 and its derivates (ADSL2, ADSL2plus, READSL2)
ASAM	Advanced Services Access Manager
ATM	Asynchronous Transfer Mode
ATU-C	ADSL Terminal Unit - Central Office
ATU-R	ADSL Terminal Unit - Remote
CBR	Constant Bit-Rate
CL	Cell Loss
CLP	Cell Loss Priority
CLR	Cell Loss Ratio
CPE	Customer Premises Equipment
DMT	Discrete Multi-Tone
DPM	Data-on-Pilot Modulation
GFC	Generic Flow Control
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunication Union - Telecom Sector
LPF	Low Pass Filter
NB	NarrowBand Servi ce
NSIF	Non-Standard Information Field
PABX	Private Automatic Branch Exchange
PAM	Pulse Amplitude Modulation
POTS	Plain Old Telephone Service
PSD	Power Spectral Density
QAM	Quadrature Amplitude Modulation

RM	Resource Management
SCM	Single-Carrier Modulation
SHDSL	Single-pair High-speed Digital Subscriber Line
STM	Synchronous Transfer Mode
STU-C	SHDSL Terminal Unit - Central Office
STU-R	SHDSL Terminal Unit -Remote
SVC	Switched Virtual Circuit
TCPAM	Trellis-Coded PAM
TU	Transceiver Unit
TU-C	TU at the central office end
TU-R	TU at the remote end
U-C	"U" Interface - Central Office
U-R	"U" Interface - Remote
VC	Virtual Circuit or Virtual Channel
VCI	Virtual Channel Identifier
VPI	Virtual Path Identifier
VP	Virtual Path
VTU-C	VDSL Terminal Unit - Central Office
VTU-R	VDSL Terminal Unit - Remote

2. Overview

The Alcatel 1000 ADSL and 7300 ASAM implement a new transport method for delivery of broadband information on ordinary subscriber twisted pairs. They use advanced modulation/signal processing techniques to allow high–speed digital communications between the ASAM and a DSL modem at the customer's premises (residential, SOHO or business). As well asymmetric/ADSLx [1000 ADSL and 7300 ASAM], symmetric/SHDSL [7300 ASAM, only], and very-high speed/VDSL [7300 ASAM] interfaces are available.

ADSLx and VDSL :

Figure 1 and Figure 2 show the general ADSLx and VDSL architectures, and their interfaces (depending on the usage of a NARROWBAND SERVICE (NB) SPLITTER at the entrance of the subscriber premises or not). The following main building blocks can be distinguished:

- ASAM with ADSLx/VDSL interface at the network side.
- ADSLx/VDSL Customer Premises Equipment (CPE) at the subscriber side.

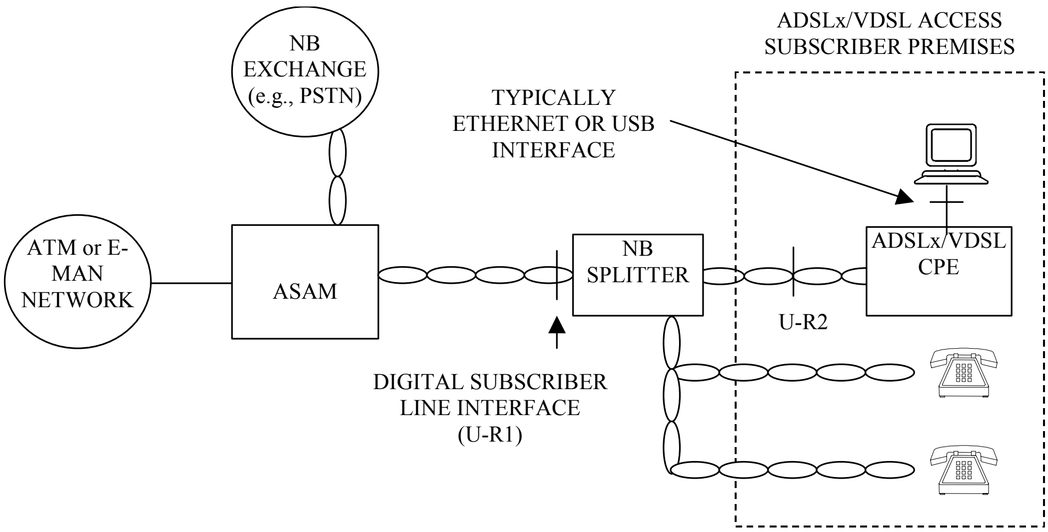

Figure 1 – ADSL Network Architecture (with POTS Splitter).

In the case of Figure 1, a NB splitter is located at the entrance of the customer premises. A POTS splitter is used for operation of ADSLx/VDSL above POTS. An ISDN splitter is used for operation of ADSLx/VDSL above ISDN.

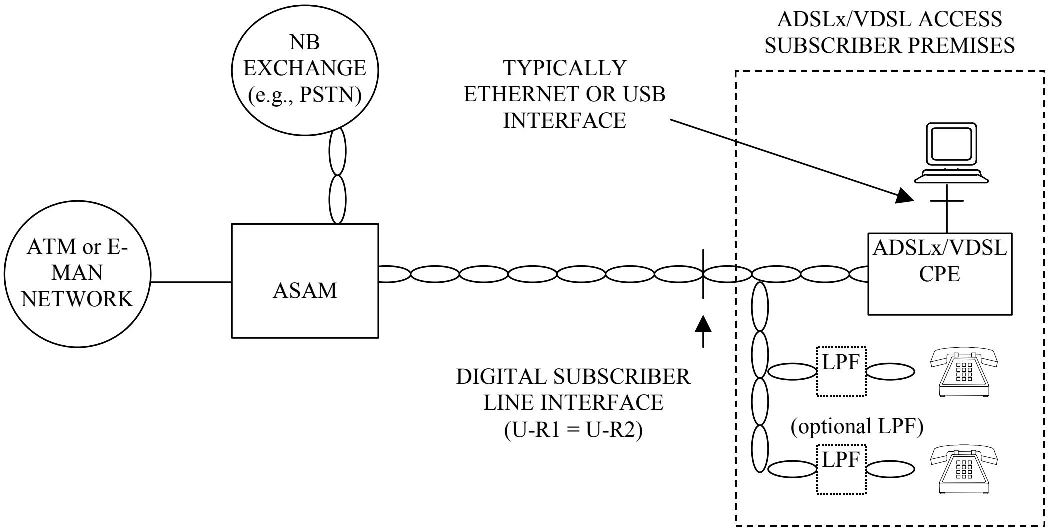

Figure 2 – Splitterless ADSL Network Architecture (without POTS SPLITTER).

In the case of Figure 2, no NB SPLITTER is used at the entrance of the subscriber premises. Low Pass Filters (LPF) may be used instead to shield phone sets (or other voice band appliances) from interfering with the ADSLx/VDSL signal. Depending on the phone set characteristics, the absence of such LPF may have a severe impact on the achievable ADSLx/VDSL data rate.

SHDSL :

Figure 3 shows the general SHDSL architectures and interfaces. The following main building blocks can be distinguished:

- ASAM with SHDSL interface at the network side.
- SHDSL Customer Premises Equipment (CPE) at the subscriber side.

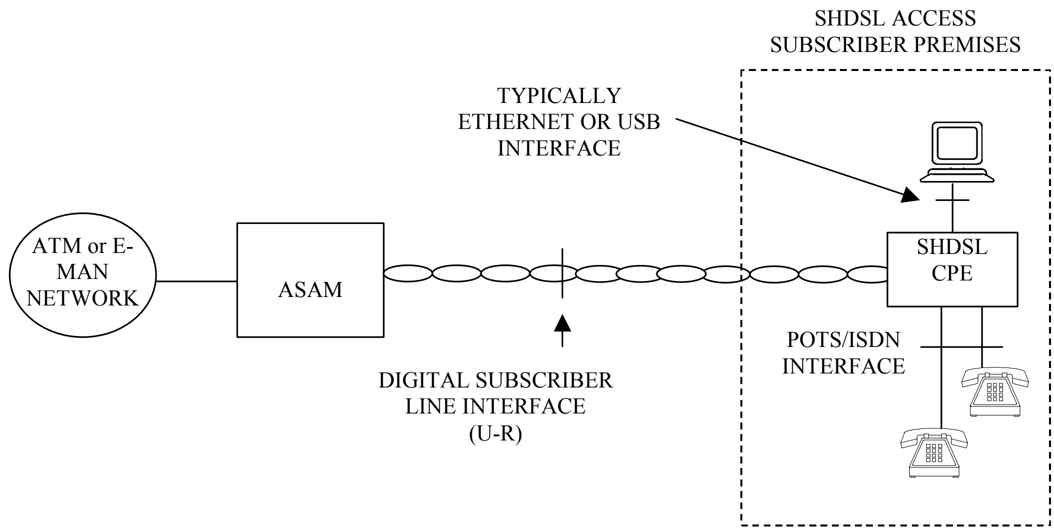

Figure 3 – SHDSL Network Architecture.

In the case of Figure 3, the SHDSL CPE is shown with example data and voice services. Alternatively, more business-oriented interfaces may be provided, e.g., PABX interconnect.

3. DSL Interface Characteristics

3.1. ADSLx above POTS frequency spectrum usage

The Digital Subscriber Line (DSL) interface carries the normal Plain Old Telephone Service (POTS) frequencies multiplexed with the upstream and downstream ADSLx signals. The interface connects the ATU–R (in the CPE) to the ATU-C (in the ASAM) via the copper access network. Normal subscriber line wire is used for the connection.

The upstream and downstream signals are DMT modulated. A (qualitative) view of the DMT power spectrum density (PSD) used in the ADSLx modem is shown in Figure 4.

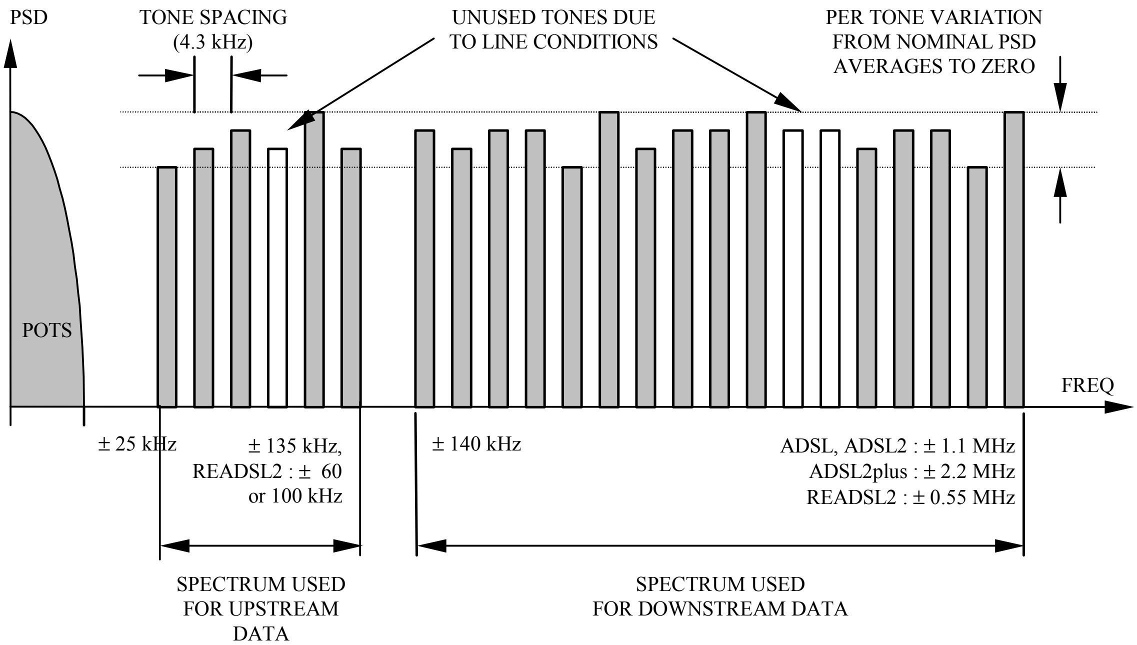

Figure 4 - DMT Spectrum Used in ADSLx Modem

3.2. ADSLx over ISDN frequency spectrum usage

The Digital Subscriber Line (DSL) interface carries the normal Integrated Services Digital Network (ISDN) signal frequencies multiplexed with the upstream and downstream ADSLx signals. The interface connects the ATU–R (in the CPE) to the ATU-C (in the ASAM) via the copper access network. Normal subscriber line wire is used for the connection.

The upstream and downstream signals are DMT modulated. A (qualitative) view of the DMT power spectrum density (PSD) used in the ADSLx modem is shown in Figure 5.

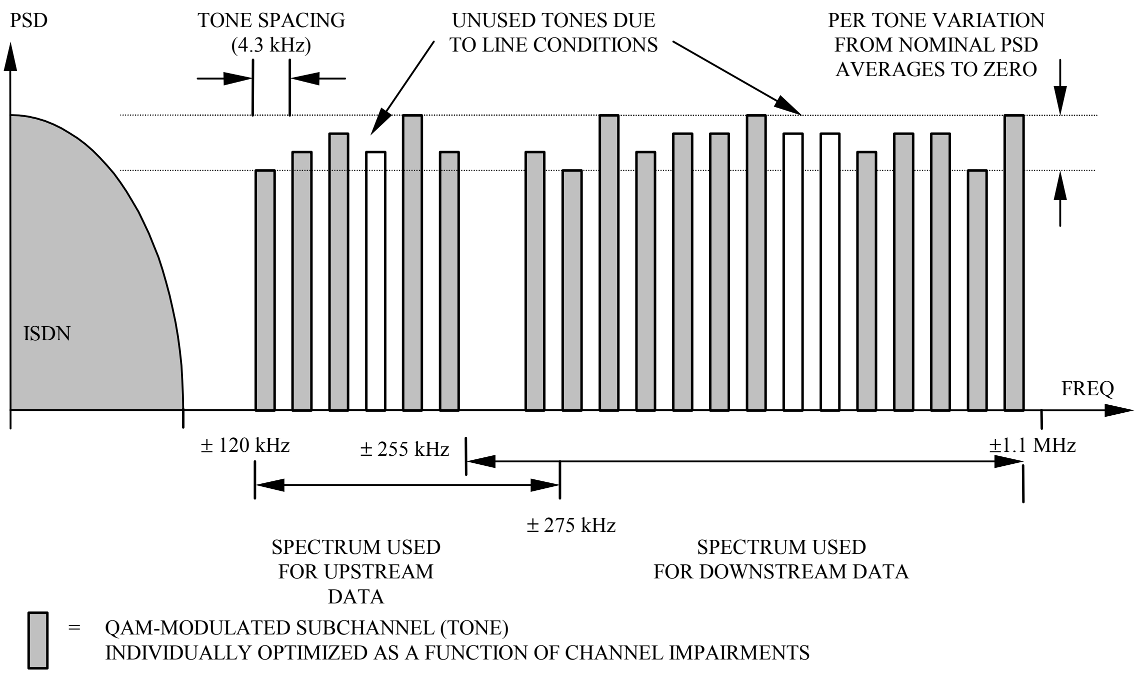

Figure 5 - DMT Spectrum Used in ADSLx above ISDN Modem

3.3. SHDSL frequency spectrum usage

NOTE: The SHDSL service offering applies to the 7300 ASAM only.

The Digital Subscriber Line (DSL) interface carries the upstream and downstream SHDSL signals. The downstream and upstream signals use the same frequency band. The frequency bandwidth depends on the data rate provided. Typically, the (3 dB down) bandwidth is the data rate divided by 6 (e.g., 384 kHz at 2.304 Mbit/s). The interface connects the STU–R (in the CPE) to the STU-C (in the ASAM) via the copper access network. Normal subscriber line wire is used for the connection.

The upstream and downstream signals are 16-TCPAM modulated. A view of the PAM power spectrum density (PSD) used in the SHDSL modem is shown in Figure 6. It shows how the bandwidth used by the SHDSL signal scales with the data rate.

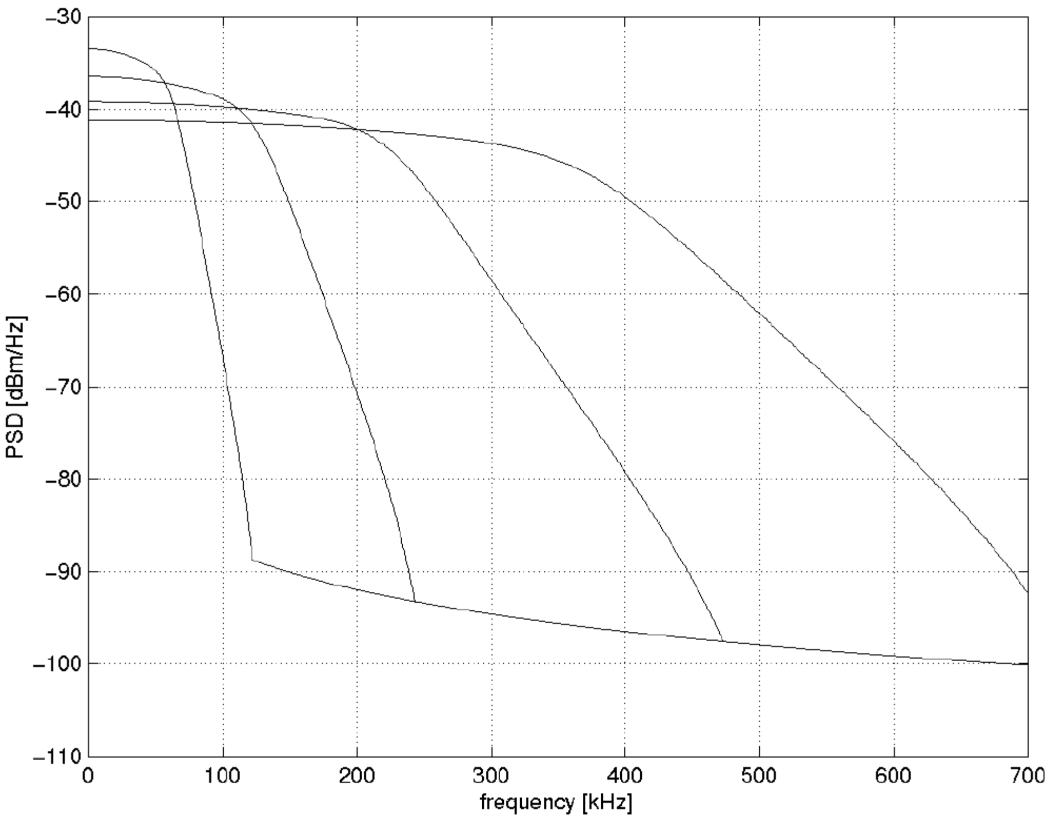

Figure 6 – SHDSL Spectra for data rates 384, 768, 1536 and 2304 kbit/s.

3.4. VDSL frequency spectrum usage

The Digital Subscriber Line (DSL) interface carries the normal Plain Old Telephone Service (POTS) or Integrated Services Digital Network (ISDN) signal frequencies multiplexed with the upstream and downstream VDSL signals. The interface connects the VTU–R (in the CPE) to the VTU-C (in the ASAM) via the copper access network. Normal subscriber line wire is used for the connection.

The upstream and downstream signals are DMT modulated. A (qualitative) view of the DMT power spectrum density (PSD) used in the VDSL modem is shown in Figure 7.

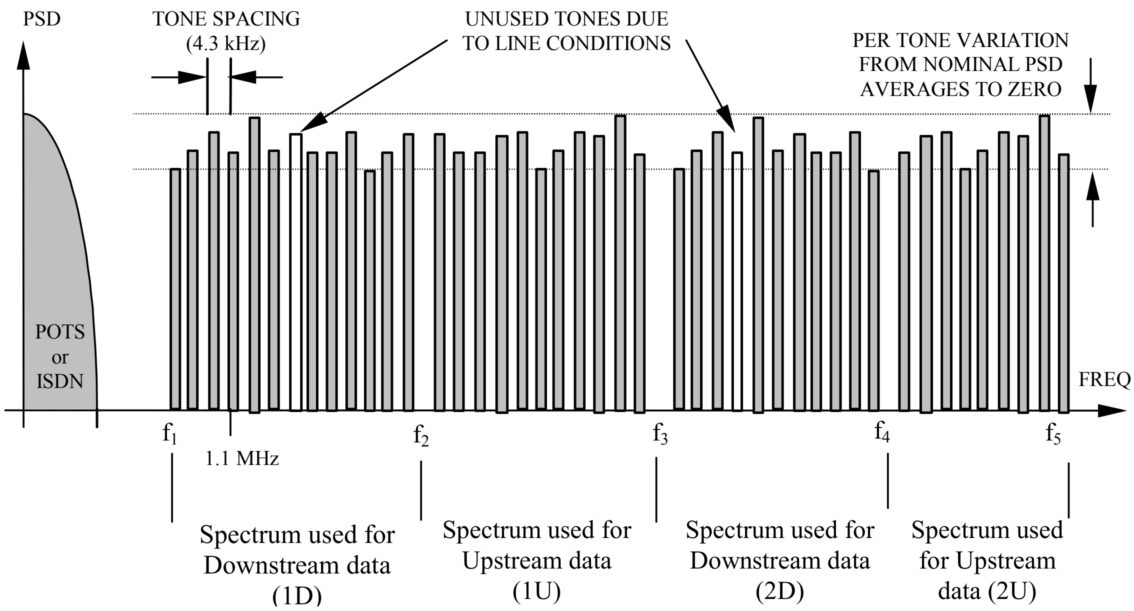

Figure 7 - DMT Spectrum Used in VDSL Modem

Following parameters depend on the used bandplan, standard, and mix with or without ADSL in same cable :

- the start frequence of the 1D band : 0.138 or 1.1 MHz.
- the usage of second upstream band (2U)
- the start and stop frequencies of the downstream and upstream bands :

	f_1[MHz]	f_2[MHz]	f_3[MHz]	f_4[MHz]	f_5[MHz]
998 bandplan	0.138	3.75	5.20	8.50	12.00
997 bandplan	0.138	3.00	5.10	7.05	12.00

3.5. DSL Interfaces available at the ASAM

Supported DSL standards

		ADSL							SHDSL		VDSL				
		ANSI	ETSI	ITU.T					ITU.T	ETSI	ETSI		ANSI		
		T1.413 Issue 2 *ANSI-ADSL* [1]	ETS 101 388 *Euro-ISDN* [2]	G.992.1 *G.dmt ADSL* [3]	G.992.2 G.lite *ADSL-lite* [4]	G.992.3 G.dmt.bis *ADSL2* [5]	G.992.5 *ADSL2plus* [7]	G.992.4 G.lite.bis *ADSL2-lite* [6]	G.991.2 G.shdsl [9]	ETS 101 524 [10]	ETS 101 270-1 [11]	ETS 101 270-2 [12]	T1.424 Part 1 [13]	T1.424 Part 2 *SCM-VDSL* [14]	T1.424 Part 3 *DMT-VDSL* [15]
	main body	POTS overlay	POTS and ISDN overlay								functional requirements	transceiver requirements	functional requirements	transceiver requirements	transceiver requirements
Annex	A			POTS overlay				POTS overlay	Region 1 : North America						handshake
Annex	B			ISDN overlay	POTS overlay, overlap US/DS	ISDN overlay			Region 2 : Europe						FMT
Annex	C		ISDN overlay of T1.413 based modems	ADSL over Japanese TCM-ISDN					Region 3 : with TCM-ISDN						8.625 KHz spacing
Annex	H			Symmetrical ADSL over Japanese TCM-ISDN											
Annex	I			ADSLplus over TCM-ISDN		All Digital Mode, split tone #32									
Annex	J					All Digital Mode, split tone #64									
Annex	L					READSL2									
Annex	M					POTS overlay with Extended Upstream									

The Alcatel 1000 ADSL and 7300 ASAM support the following DSL operating modes (colored in Table 1. Only those annexes are listed which contribute to signal behaviour on the line.

Table 1 – supported DSL operating modes (in green)

The TU-C characteristics and the TU-R requirements to inter-operate with the TU-C are described in separate sections for each of these operating modes.

Operating Mode Selection Mechanism for ADSLx

Depending on the supported operating modes by the ATU-R, the ATU-C will give priorities according to following list, assuming the operator allowed all supported operating modes to be executed :

1. G.992.5 (ADSL2plus), Annex M
2. G.992.3 (ADSL2), Annex M
3. G.992.5 (ADSL2plus), Annex A or B (exclusive)
4. G.992.3 (ADSL2), Annex A or L (*), or B (exclusive)
5. G.992.1 (ADSL), Annex A or B (exclusive)
6. G.992.2 (ADSL-lite), Annex A
7. T.413 (ANSI-ADSL) or ETS 101 388 Annex C (exclusive)

(*) When the ATU-R supports as well G.992.3 Annex L (READSL2), then priority selection between Annex A and Annex L is configurable by operator, and based on optimising the downstream or the upstream bitrate.

4. ADSL above POTS: T1.413

The ANSI Standard T1.413-1998 is also known as T1.413 Issue 2 or ***ANSI-ADSL***

4.1. General

The U-C interface is compliant with T1.413 [1], unless explicitly stated in this section.

The U-R interface shall be compliant with T1.413 [1].

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with sections 4.2.2, 5.2, and 6.2 of T1.413 [1].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with sections 4.3.2, 5.2, and 7.2 of T1.413 [1].

4.2. Transport capacity

The transport capacity of the ATU–C complies with section 5.2 of T1.413 [1]. It supports downstream transmission at all multiples of 32 kb/s up to a net data rate of 6.144 Mb/s, and upstream reception at all multiples of 32 kb/s up to a net data rate of 640 kb/s upstream.

The transport capacity of the ATU–R shall comply with section 5.2 of T1.413 [1]. It shall support downstream reception at all multiples of 32 kb/s up to a net data rate of 6.144 Mb/s, and upstream transmission at all multiples of 32 kb/s up to a net data rate of 640 kb/s.

The maximum downstream transport capacity of the ATU–C implementation is 255 x 32 = 8160 kb/s (total data rate). The actual downstream transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 32 kb/s.

4.3. Framing Modes

The framing modes supported by the ATU-C are compliant with T1.413 [1], with the exception of the support of framing mode 0. The bit stuffing mechanism that may be activated in framing mode 0 provides data rate decoupling. The same functionality is achieved through ATM Idle Cell insertion. Other framing mode 0 functionality is also provided in framing mode 1. Framing mode 1 is supported by the ATU-C. Not supporting framing mode 0 does not affect interoperability with an ATU–R compliant with T1.413 [1]. However, interoperability with a (non T1.413 compliant) ATM–over–STM ATU–R is not assured (see T1.413 [1] section 6.2.4).

4.4. Network Timing Reference

The ATU-C inserts the Network Timing Reference in the ADSL frame, as specified in T1.413 [1]. The ATU-R may recover the Network Timing Reference from that information.

NOTE – On the 1000 ADSL Platform, the ATU-C does not insert the Network Timing Reference. The NTR bit in C-MSG1 is always coded "0". The downstream indicator bits 23–20 are always coded "1111".

4.5. Data on Pilot Subcarrier 64

The T1.413 standard specifies that no data shall be carried on the downstream pilot (tone 64). However, the ability to modulate data bits on the downstream pilot can be enabled through the vendor ID field of the CPE. If this additional functionality is enabled, the ATU-R may consider tone 64 as a regular data-carrying tone.

5. ADSL above POTS: G.992.1 Annex A

The ITU-T Recommendation G.992.1 is also known as ***G.dmt***.

5.1. General

The U-C interface is compliant with G.992.1 Annex A [3] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.1 Annex A [3] (including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with sections 5.1.2, 6.2, and 7.2 of G.992.1 [3].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with sections 5.2.2, 6.2, and 8.2 of G.992.1 [3].

5.2. Transport capacity

The transport capacity of the ATU–C complies with section 6.2 of G.992.1[3]. It supports downstream transmission at all multiples of 32 kb/s up to a net data rate of 6.144 Mb/s, and upstream reception at all multiples of 32 kb/s up to a net data rate of 640 kb/s upstream.

The transport capacity of the ATU–R shall comply with section 6.2 of G.992.1 [3]. It shall support downstream reception at all multiples of 32 kb/s up to a net data rate of 6.144 Mb/s, and upstream transmission at all multiples of 32 kb/s up to a net data rate of 640 kb/s.

The maximum downstream transport capacity of the ATU–C implementation is 255 x 32 = 8160 kb/s (total data rate). The actual downstream transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 32 kb/s.

5.3. Framing Modes

The framing modes supported by the ATU-C are compliant with G.992.1[3], with the exception of the support of framing mode 0. The bit stuffing mechanism that may be activated in framing mode 0 provides data rate decoupling. The same functionality is achieved through ATM Idle Cell insertion. Other framing mode 0 functionality is also provided in framing mode 1. Framing mode 1 is supported by the ATU-C. Not supporting framing mode 0 does not affect interoperability with an ATU–R compliant with G.992.1 [3]. However, interoperability with a (non G.992.1 compliant) ATM–over–STM ATU–R is not assured (see G.992.1 [3] section 7.2.4).

5.4. Network Timing Reference

The ATU-C inserts the Network Timing Reference in the ADSL frame, as specified in G.992.1 [3]. The ATU-R may recover the Network Timing Reference from that information.

NOTE – On the A1000 ADSL Hardware Platform, the ATU-C does not insert the Network Timing Reference. The NTR bit in C-MSG1 is always coded "0". The downstream indicator bits 23–20 are always coded "1111".

5.5. Data on pilot subcarrier 64

The ITU-T Recommendation G.992.1 specifies that no data shall be carried on the downstream pilot (tone 64). However, the ATU-C has the ability to modulate data bits on the downstream pilot (See Annex A : non-standard facilities). If this additional functionality is enabled, the ATU-R may consider tone 64 as a regular data-carrying tone (i.e., $b_i \leq$ Ndownmax and -14.5 dB $\leq g_i \leq +2.5$ dB in R-B&G table and in subsequent bit swaps).

6. ADSL lite above POTS: G.992.2 Annex A

The ITU-T Recommendation G.992.2 is also known as ***G.lite.***

6.1. General

The U-C interface is compliant with G.992.2 Annex A [4] (including G.994.1[8]).

The U-R interface shall be compliant with G.992.2 Annex A [4] (including G.994.1[8]).

6.2. Transport capacity

The transport capacity of the ATU–C complies with section 5 of G.992.2 [4]. It supports downstream transmission at all multiples of 32 kb/s up to a net data rate of 1.536 Mb/s, and upstream reception at all multiples of 32 kb/s up to a net data rate of 512 kb/s upstream.

The transport capacity of the ATU–R shall comply with section 5 of G.992.2 [4]. It shall support downstream reception at all multiples of 32 kb/s up to a net data rate of 1.536 Mb/s, and upstream transmission at all multiples of 32 kb/s up to a net data rate of 512 kb/s.

The maximum downstream transport capacity of the ATU–C implementation is 255 x 32 = 8160 kb/s (total data rate). The actual downstream transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 32 kb/s.

6.3. Network Timing Reference

The ATU-C inserts the Network Timing Reference in the ADSL frame, as specified in G.992.2 [4]. The ATU-R may recover the Network Timing Reference from that information.

NOTE – On the A1000 ADSL Hardware Platform, the ATU-C does not insert the Network Timing Reference. The NTR bit in C-MSG1 is always coded "0". The downstream indicator bits 23–20 are always coded "1111".

6.4. Data on pilot subcarrier 64

The ITU-T Recommendation G.992.2 specifies that no data shall be carried on the downstream pilot (tone 64). However, the ATU-C has the ability to modulate data bits on the downstream pilot (see Annex A : non-standard facilities). If this additional functionality is enabled, the ATU-R may consider tone 64 as a regular data-carrying tone (i.e., bi ≤ Ndownmax and –14.5 dB ≤ gi ≤ +2.5 dB in R-B&G table and in subsequent bit swaps).

7. ADSL2 above POTS: G.992.3 Annex A

The ITU-T Recommendation G.992.3 is also known as ***G.dmt.bis or ADSL2***

7.1. General

The U-C interface is compliant with G.992.3 Annex A [5] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.3 Annex A [5](including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with Annex K2 of G.992.3 [5].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with Annex K2 of G.992.3 [5].

7.2. Transport capacity

The transport capacity of the ATU–C complies with section K2.7 of G.992.3 [5]. It supports downstream transmission up to a net data rate of 8 Mb/s, and upstream reception up to a net data rate of 800 kb/s upstream.

The transport capacity of the ATU–R shall comply with section K2.7 of G.992.3 [5]. It shall support downstream reception up to a net data rate of 8 Mb/s, and upstream transmission up to a net data rate of 800 kb/s.

The actual transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 4 kb/s.

7.3. Supported options

The ATU-C complies with following optional features of G.992.3 [5] :

- Section K2, support of net data rate above 8 Mbit/s in downstream direction, and above 800 kbit/s in upstream direction
- Section 6.3, number of enabled TPS-TC frame bearers = 1
- Section 7, number of enabled latency path functions in PMS-TC = 1
- Section 8.13.3.1.11, the ATU-C takes into account the spectrum shaping on the 3 indicated subcarriers when determining the required upstream power cutback value.
- Section 8.15, loop diagnostics
-

The ATU-C does not support following optional features of G.992.3 [5] :

- Section 8.14, short initialization sequence
- Section 8.17 and 9.5, L2 mode
- Section 9.4.1.8, Clear EOC
- Section 9.5, orderly shutdown to L3 mode
- Section 10.2, Seamless Rate Adaptation (SRA)
- Section K2.7, IMA in ATM TPS-TC

8. Extended Reach ADSL2 above POTS: G.992.3 Annex L

The ITU-T Recommendation G.992.3 Annex L is also known as ***READSL2***

8.1. General

The U-C interface is compliant with G.992.3 Annex L [5] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.3 Annex L [5](including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with section 7.1 and Annex K2 of G.992.3 [5].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with section 7.1 and Annex K2 of G.992.3 [5].

8.2. Transport capacity

The transport capacity of the ATU–C complies with section K2.7 of G.992.3 [5]. It supports downstream transmission up to a net data rate of 8 Mb/s, and upstream reception up to a net data rate of 800 kb/s upstream.

The transport capacity of the ATU–R shall comply with section K2.7 of G.992.3 [5]. It shall support downstream reception up to a net data rate of 8 Mb/s, and upstream transmission up to a net data rate of 800 kb/s.

The actual transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 4 kb/s.

8.3. Supported options

The ATU-C does not support following optional features of G.992.3 Annex L [5]:

- Section L1.2, downstream overlapped spectrum reach-extended operation

9. ADSL2plus above POTS: G.992.5 Annex A

The ITU-T Recommendation G.992.5 is also known as ***ADSL2plus***

9.1. General

The U-C interface is compliant with G.992.5 Annex A [7] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.5 Annex A [7] (including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with section 7.1 of G.992.5 [7].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with section 7.1 of G.992.5 [7].

9.2. Transport capacity

The transport capacity of the ATU–C complies with section K of G.992.5 [7]. It supports downstream transmission up to a net data rate of 16 Mb/s, and upstream reception up to a net data rate of 800 kb/s upstream.

The transport capacity of the ATU–R shall comply with section K of G.992.5 [7]. It shall support downstream reception up to a net data rate of 16 Mb/s, and upstream transmission up to a net data rate of 800 kb/s.

The actual transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 4 kb/s.

9.3. Supported options

The ATU-C complies with following optional features of G.992.5 [7] (besides the supported G.992.3 optional features, see section 7.3) :

- Section K, support of net data rate above 16 Mbit/s in downstream direction, and above 800 kbit/s in upstream direction
- Section 8.13.5.1.4, support of 14^{th} order PRMB in C-MEDLEY.

The ATU-C does not support following optional features of G.992.5 [7] (besides the G.992.3 optional features, see section 7.3) :

- <none>

10. ADSL2 above POTS with extended upstream bandwidth : G.992.3 Annex M

The ITU-T Recommendation G.992.3 is also known as ***G.dmt.bis or ADSL2***

10.1. General

The U-C interface is compliant with G.992.3 Annex M [5] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.3 Annex M [5](including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with Annex K2 of G.992.3 [5].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with Annex K2 of G.992.3 [5].

10.2. Transport capacity

The transport capacity of the ATU–C complies with section K2.7 of G.992.3 [5]. It supports downstream transmission up to a net data rate of 8 Mb/s, and upstream reception up to a net data rate of 800 kb/s upstream.

The transport capacity of the ATU–R shall comply with section K2.7 of G.992.3 [5]. It shall support downstream reception up to a net data rate of 8 Mb/s, and upstream transmission up to a net data rate of 800 kb/s.

The actual transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 4 kb/s.

10.3. Supported options

The ATU-C complies with following optional features of G.992.3 [5] :

- Section K2, support of net data rate above 8 Mbit/s in downstream direction, and above 800 kbit/s in upstream direction
- Section 6.3, number of enabled TPS-TC frame bearers = 1
- Section 7, number of enabled latency path functions in PMS-TC = 1
- Section 8.13.3.1.11, the ATU-C takes into account the spectrum shaping on the 3 indicated subcarriers when determining the required upstream power cutback value.
- Section 8.15, loop diagnostics

- Section M2.2. : PSD Mask « EU56 » is supported

The ATU-C does not support following optional features of G.992.3 [5] :
- Section 8.14, short initialization sequence
- Section 8.17 and 9.5, L2 mode
- Section 9.4.1.8, Clear EOC
- Section 9.5, orderly shutdown to L3 mode
- Section 10.2, Seamless Rate Adaptation (SRA)
- Section K2.7, IMA in ATM TPS-TC
- Section M2.2 : all other than "EU56" PSD masks

11. ADSL2plus above POTS with extended upstream bandwidth : G.992.5 Annex M

The ITU-T Recommendation G.992.5 is also known as ***ADSL2plus***

11.1. General

The U-C interface is compliant with G.992.5 Annex M [7] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.5 Annex M [7] (including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with section 7.1 of G.992.5 [7].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with section 7.1 of G.992.5 [7].

11.2. Transport capacity

The transport capacity of the ATU–C complies with section K of G.992.5 [7]. It supports downstream transmission up to a net data rate of 16 Mb/s, and upstream reception up to a net data rate of 800 kb/s upstream.

The transport capacity of the ATU–R shall comply with section K of G.992.5 [7]. It shall support downstream reception up to a net data rate of 16 Mb/s, and upstream transmission up to a net data rate of 800 kb/s.

The actual transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 4 kb/s.

11.3. Supported options

The ATU-C complies with following optional features of G.992.5 [7] (besides the supported G.992.3 optional features, see section 7.3) :

- Section K, support of net data rate above 16 Mbit/s in downstream direction, and above 800 kbit/s in upstream direction
- Section 8.13.5.1.4, support of 14th order PRMB in C-MEDLEY.
- Section M2.2. : PSD Mask « EU56 » is supported

The ATU-C does not support following optional features of G.992.5 [7] (besides the G.992.3 optional features, see section 7.3) :

- Section M2.2 : all other than "EU56" PSD masks

12. ADSL above ISDN: G.992.1 Annex B

The ITU-T Recommendation G.992.1 is also known as G.dmt.

12.1. General

The U-C interface is compliant with G.992.1 Annex B [3] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.1 Annex B [3] (including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with sections 5.1.2, 6.2, and 7.2 of G.992.1 [3].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with sections 5.2.2, 6.2, and 8.2 of G.992.1 [3].

12.2. Transport capacity

The transport capacity of the ATU–C complies with section 6.2 of G.992.1 [3]. It supports downstream transmission at all multiples of 32 kb/s up to a net data rate of 6.144 Mb/s, and upstream reception at all multiples of 32 kb/s up to a net data rate of 640 kb/s upstream.

The transport capacity of the ATU–R shall comply with section 6.2 of G.992.1 [3]. It shall support downstream reception at all multiples of 32 kb/s up to a net data rate of 6.144 Mb/s, and upstream transmission at all multiples of 32 kb/s up to a net data rate of 640 kb/s.

The maximum downstream transport capacity of the ATU–C implementation is 255 x 32 = 8160 kb/s (total data rate). The actual downstream transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 32 kb/s.

12.3. Framing Modes

The framing modes supported by the ATU-C are compliant with G.992.1 [3], with the exception of the support of framing mode 0. The bit stuffing mechanism that may be activated in framing mode 0 provides data rate decoupling. The same functionality is achieved through ATM Idle Cell insertion. Other framing mode 0 functionality is also provided in framing mode 1. Framing mode 1 is supported by the ATU-C. Not supporting framing mode 0 does not affect interoperability with an ATU–R compliant with G.992.1 [3]. However, interoperability with a (non G.992.1 compliant) ATM–over–STM ATU–R is not assured (see G.992.1 [3] section 7.2.4).

12.4. Network Timing Reference

The ATU-C inserts the Network Timing Reference in the ADSL frame, as specified in G.992.1 [3]. The ATU-R may recover the Network Timing Reference from that information.

NOTE – On the Standard Density Hardware Platform, the ATU-C does not insert the Network Timing Reference. The NTR bit in C-MSG1 is always coded “0”. The downstream indicator bits 23–20 are always coded “1111”.

13. ADSL above ISDN: ETS 101 388 Annex C

The ETS 101 388 Annex C Technical Specification is an adaptation of the ANSI ADSL over POTS Standard T1.413-1998 [1] for the transport of ADSL over ISDN.

13.1. General

The U-C interface is compliant with ETS 101 388 Annex C [2], unless explicitly stated in this section.

The U-R interface shall be compliant with ETS 101 388 Annex C [2].

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with ETS 101 388 Annex C [2], which references sections 4.2.2, 5.2, and 6.2 of T1.413 [1].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with ETS 101 388 Annex C [2], which references sections 4.3.2, 5.2, and 7.2 of T1.413 [1].

13.2. Transport capacity

The transport capacity of the ATU–C complies with ETS 101 388 Annex C [2], which references section 5.2 of T1.413 [1]. It supports downstream transmission at all multiples of 32 kb/s up to a net data rate of 6.144 Mb/s, and upstream reception at all multiples of 32 kb/s up to a net data rate of 640 kb/s upstream.

The transport capacity of the ATU–R shall comply with ETS 101 388 Annex C [2], which references section 5.2 of T1.413 [1]. It shall support downstream reception at all multiples of 32 kb/s up to a net data rate of 6.144 Mb/s, and upstream transmission at all multiples of 32 kb/s up to a net data rate of 640 kb/s.

The maximum downstream transport capacity of the ATU–C implementation is 255 x 32 = 8160 kb/s (total data rate). The actual downstream transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 32 kb/s.

13.3. Framing Modes

The framing modes supported by the ATU-C are compliant with ETS 101 388 Annex C [2], which references T1.413 [1], with the exception of the support of framing mode 0. The bit stuffing mechanism that may be activated in framing mode 0 provides data rate decoupling. The same functionality is achieved through ATM Idle Cell insertion. Other framing mode 0 functionality is also provided in framing mode 1. Framing mode 1 is supported by the ATU-C. Not supporting framing mode 0 does not affect interoperability with an ATU–R compliant with ETS 101 388 Annex C [2]. However, interoperability with a (non ETS 101 388 Annex C [2] compliant) ATM-over-STM ATU–R is not assured (see ETS 101 388 Annex C [2], which references T1.413 [1] section 6.2.4).

13.4. Network Timing Reference

The ATU-C inserts the Network Timing Reference in the ADSL frame, as specified in ETR 101 388 Annex C [2] (referencing T1.413 [1]). The ATU-R may recover the Network Timing Reference from that information.

NOTE – On the Standard Density Hardware Platform, the ATU-C does not insert the Network Timing Reference. The NTR bit in C-MSG1 is always coded “0”. The downstream indicator bits 23–20 are always coded “1111”.

14. ADSL2 above ISDN: G.992.3 Annex B

The ITU-T Recommendation G.992.3 is also known as ***G.dmt.bis or ADSL2***

14.1. General

The U-C interface is compliant with G.992.3 Annex B [5] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.3 Annex B [5](including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with Annex K2 of G.992.3 [5].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with Annex K2 of G.992.3 [5].

14.2. Transport capacity

The transport capacity of the ATU–C complies with section K2.7 of G.992.3 [5]. It supports downstream transmission up to a net data rate of 8 Mb/s, and upstream reception up to a net data rate of 800 kb/s upstream.

The transport capacity of the ATU–R shall comply with section K2.7 of G.992.3 [5]. It shall support downstream reception up to a net data rate of 8 Mb/s, and upstream transmission up to a net data rate of 800 kb/s.

The actual transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 4 kb/s.

14.3. Supported options

The ATU-C complies with following optional features of G.992.3 [5] :

- Section K2, support of net data rate above 8 Mbit/s in downstream direction, and above 800 kbit/s in upstream direction
- Section 6.3, number of enabled TPS-TC frame bearers = 1
- Section 7, number of enabled latency path functions in PMS-TC = 1
- Section 8.13.3.1.11, the ATU-C takes into account the spectrum shaping on the 3 indicated subcarriers when determining the required upstream power cutback value.
- Section 8.15, loop diagnostics
-

The ATU-C does not support following optional features of G.992.3 [5] :

- Section 8.14, short initialization sequence
- Section 8.17 and 9.5, L2 mode
- Section 9.4.1.8, Clear EOC
- Section 9.5, orderly shutdown to L3 mode
- Section 10.2, Seamless Rate Adaptation (SRA)
- Section K2.7, IMA in ATM TPS-TC

15. ADSL2plus above ISDN: G.992.5 Annex B

The ITU-T Recommendation G.992.5 is also known as ***ADSL2plus***

15.1. General

The U-C interface is compliant with G.992.5 Annex B [7] (including G.994.1[8]), unless explicitly stated in this section.

The U-R interface shall be compliant with G.992.5 Annex B [7] (including G.994.1 [8]).

The U–C interface is an ATM cell–based interface. The ATU–C is configured for ATM transport and complies with section 7.1 of G.992.5 [7].

The U–R interface shall be an ATM cell–based interface. The ATU–R shall be configured for ATM transport and shall comply with section 7.1 of G.992.5 [7].

15.2. Transport capacity

The transport capacity of the ATU–C complies with section K of G.992.5 [7]. It supports downstream transmission up to a net data rate of 16 Mb/s, and upstream reception up to a net data rate of 800 kb/s upstream.

The transport capacity of the ATU–R shall comply with section K of G.992.5 [7]. It shall support downstream reception up to a net data rate of 16 Mb/s, and upstream transmission up to a net data rate of 800 kb/s.

The actual transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the ATU-R. The ADSL system overhead depends on the modem configuration and can be as low as 4 kb/s.

15.3. Supported options

The ATU-C complies with following optional features of G.992.5 [7] (besides the supported G.992.3 optional features, see section 7.3) :

- Section K, support of net data rate above 16 Mbit/s in downstream direction, and above 800 kbit/s in upstream direction
- Section 8.13.5.1.4, support of 14^{th} order PRMB in C-MEDLEY.

The ATU-C does not support following optional features of G.992.5 [7] (besides the G.992.3 optional features, see section 7.3) : <none>

16. ADSLx bonding: T1E1.4/2003-334R2

16.1. General

ATM Multi-Pair Bonding is compliant to T1E1.4/2003-334R2 [[16]],

16.2. Supported options

The ATU-C complies with following optional features of T1E1.4/2003-334R2 [[16]] :

- Section 5.1 : both 8 bit and 12 bit SID supported
- Max number of supported lines in bonding group = 2

The ATU-C does not support following optional features of T1E1.4/2003-334R2 [[16]] :

- Support of bonding groups with more than 2 lines

17. SHDSL: G.991.2 Annex A

The ITU-T Recommendation G.991.2 is also known as G.shdsl.
NOTE: The SHDSL service offering applies to the 7300 ASAM only.

17.1. General

The U-C interface is compliant with G.991.2 Annex A [5], unless explicitly stated in this section. The G.991.2 Annex A operating mode is activated through the G.994.1 Handshake Procedure [8].

The U-R interface shall be compliant with G.991.2 Annex A [9].

The U–C interface is an ATM cell–based interface. The STU–C is configured for ATM transport and complies with section E.9 of G.991.2 [9].

The U–R interface shall be an ATM cell–based interface. The STU–R shall be configured for ATM transport and shall comply with section E.9 of G.991.2 [9].

17.2. Transport capacity

The transport capacity of the STU–C complies with section 5 of G.991.2 [9]. It supports symmetric data rates at all multiples of 64 kbit/s, from 192 kbit/s up to a net data rate of 2.304 Mbit/s. The data rate may be fixed or limited to within a range of data rates through the Central Office MIB.

The transport capacity of the STU–R shall comply with section 5 of G.991.2 [9]. It shall support one or more symmetric data rates at multiples of 64 kbit/s, from 192 kbit/s up to a net data rate of 2.304 Mbit/s.

17.3. Network Timing Reference

The STU-C operates in synchronous mode. The SHDSL frame period and symbol clock is locked to the network clock. The STU-R may recover the Network Timing Reference from either the SHDSL frame period or the SHDSL symbol clock.

18. SHDSL: G.991.2 Annex B

Operation according to G.991.2 Annex B [9] is identical to operation according to ETSI SDSL ETS 101 524 [10]. Both operating modes are activated in exactly the same way through G.994.1 Handshake Procedures [8]. Therefore, the STU-R cannot distinguish the two operating modes. The STU-R interface requirements are identical for both operating modes and described from G.991.2 Annex B perspective below.

18.1. General

The U-C interface is compliant with G.991.2 Annex B [9], unless explicitly stated in this section. The G.991.2 Annex B operating mode is activated through the G.994.1 Handshake Procedure [8].

The U-R interface shall be compliant with G.991.2 Annex B [9].

The U–C interface is an ATM cell–based interface. The STU–C is configured for ATM transport and complies with section E.9 of G.991.2 [9].

The U–R interface shall be an ATM cell–based interface. The STU–R shall be configured for ATM transport and shall comply with section E.9 of G.991.2 [9].

18.2. Transport capacity

The transport capacity of the STU–C complies with section 5 of G.991.2 [9]. It supports symmetric data rates at all multiples of 64 kbit/s, from 192 kbit/s up to a net data rate of 2.304 Mbit/s. The data rate may be fixed or limited to within a range of data rates through the Central Office MIB.

The STU-C also supports the symmetric data rate of 2.312 Mbit/s for transport of the 2048 kbit/s E1 service over AAL1 ATM. When configured in this mode, the STU-C advertises a single data rate in the G.994.1 handshake [8], indicating ATM mode with n=36 and i=1.

The transport capacity of the STU–R shall comply with section 5 of G.991.2 [9]. It shall support one or more symmetric data rates at multiples of 64 kbit/s, from 192 kbit/s up to a net data rate of 2.312 Mbit/s.

18.3. Network Timing Reference

The STU-C operates in synchronous mode. The SHDSL frame period and symbol clock are locked to the network clock. The STU-R may recover the Network Timing Reference from either the SHDSL frame period or the SHDSL symbol clock.

19. VDSL : ETS 101 524 & T1.424

19.1. General

The U-C interface is compliant with

- ETS 101 270 –1 [11]
- ETS 101 270 –2 [12]
- T1.424 Part 1 [13]
- T1.424 Part 3 [15]

unless explicitly stated in this section.

The U-R interface shall be compliant with

- ETS 101 270 –1 [11]
- ETS 101 270 –2 [12]
- T1.424 Part 1 [13]
- T1.424 Part 3 [15]

The U–C interface is an ATM cell–based interface. The VTU–C is configured for ATM transport and complies with Section 6.2.1 of ETS 101 270 –2 [12] and Section 9.1.2 of T1.424 Part 1 [13].

The U–R interface shall be an ATM cell–based interface. The VTU–R shall be configured for ATM transport and shall with Section 6.2.1 of ETS 101 270 –2 [12] and Section 9.1.2 of T1.424 Part 1 [13].

19.2. Transport capacity

The transport capacity of the VTU–C complies with section 6 of T1.424 Part 1 [13].
It supports transmission up to a net data rate of 22/3, 6/6, and 13/13 Mbit/s for respectively downstream and upstream.
The transport capacity of the VTU–R shall comply with section 6 of T1.424 Part 1 [13].
It shall support transmission up to a net data rate of 22/3, 6/6, and 13/13 Mbit/s for respectively downstream and upstream.

The actual transport capacity depends upon the line characteristics measured at modem initialization and the implementation limitations of the VTU-R.

19.3. Supported features

The VTU-C does not support following features :

- Network Timing Reference : Section 6.1.5 of ETS 101 270 –2 [12] and Section 9.3.5.5.4 of T1.424 Part 3[15].
- VDSL Overhead Control (VOC) : Section 7.4 of ETS 101 270 –2 [12] and Section 10.7 of T1.424 Part 3[15].
- VDSL Embedded Operation Channel (EOC): Section 7.6 of ETS 101 270 –2 [12]and Section 10.6 of T1.424 Part 1[13].
- Handshake procedure : Section 8.2.3. of ETS 101 270 –2 [12] and Annex A of T1.424 Part 3[15].

Annex A: ADSL non-standard facilities

A.1 Vendor information

The ATU-C uses one of following parameter sets in G.994.1 :

A/ ATU-C of type “SGST”

COUNTRY CODE	BELGIUM	
VENDOR CODE	‘ALCB’	(ALCatel Bell)

B/ ATU-C of type “BDCM”

COUNTRY CODE	USA	
VENDOR CODE	‘BDCM’	(BroaDCoM)

The vendor specific information is coded according to the NPAR/SPAR tree structure as defined in G.994.1 [8] for the Standard Information Field, with codepoints defined below.

A.2 Non-standard facilities

A.2.1 Data on pilot subcarrier 64

For the ATU-C with vendor code “ALCB”:

Negotiation of the pilot subcarrier 64 modulation happens through the DPM codepoint in the NSIF field of the G.994.1 handshaking. See section A.3 G.994.1 NSIF codepoints for details on the DPM codepoint

If the DPM codepoint is set in the CL message, the ATU-C supports modulation of data on the downstream pilot subcarrier 64 (transmitter function). Otherwise, the ATU-C does not. The default setting is DPM=0.

The ATU-R may set the DPM codepoint in the CLR message to indicate it supports modulation of data on the downstream pilot subcarrier 64 (receiver function).

The DPM codepoint shall be set in the MS message if and only if both the last exchanged CL and CLR messages have set DPM=1. If the DPM codepoint is set in the MS message, the ATU-R may request a bi>0 for downstream subcarrier 64 (during initialization or through bit swap). In that case, the ATU-C transmits subcarrier 64 as a data subcarrier.

For the ATU-C with vendor code “BDCM” :

If the ATU-R requests a bitloading of subcarrier 64 in R-B&G message or in bitswap messages, then the ATU-C will set up the corresponding bi and gi value on subcarrier 64.

A.3 G.994.1 NSIF codepoints

Non-standard information field – {NPar(1)} coding

NPar(1)s Octet 1/1	8	7	6	5	4	3	2	1
Reserved	x	x	x	x	x	x	x	1
Reserved	x	x	x	x	x	x	1	x
Reserved	x	x	x	x	x	1	x	x
Reserved	x	x	x	x	1	x	x	x
Reserved	x	x	x	1	x	x	x	x
Reserved	x	x	1	x	x	x	x	x
Reserved	x	1	x	x	x	x	x	x
No parameters in this octet	x	0	0	0	0	0	0	0

Non-standard information field – {SPar(1)} coding

SPar(1)s Octet 1/1	8	7	6	5	4	3	2	1
G.992.1 – Annex A	x	x	x	x	x	x	x	1
Reserved	x	x	x	x	x	x	1	x
Reserved	x	x	x	x	x	1	x	x
G.992.2 – Annex A/B	x	x	x	x	1	x	x	x
Reserved	x	x	x	1	x	x	x	x
Reserved	x	x	1	x	x	x	x	x
Reserved	x	1	x	x	x	x	x	x
No parameters in this octet	x	0	0	0	0	0	0	0

Non-standard information field – G.992.1 Annex A {NPar(2)} coding – Octet 1

NPar(1)s Octet 1/1	8	7	6	5	4	3	2	1
Reserved	x	x	x	x	x	x	x	1
Reserved	x	x	x	x	x	x	1	x
Reserved	x	x	x	x	x	1	x	x
Reserved	x	x	x	x	1	x	x	x
Reserved	x	x	x	1	x	x	x	x
Reserved	x	x	1	x	x	x	x	x
No parameters in this octet	x	x	0	0	0	0	0	0

Non-standard information field – G.992.1 Annex A {NPar(2)} coding – Octet 2

NPar(2)s Octet 2/2	8	7	6	5	4	3	2	1
Reserved	x	x	x	x	x	x	x	1
Reserved	x	x	x	x	x	x	1	x
DPM	x	x	x	x	x	1	x	x
Reserved	x	x	x	x	1	x	x	x
Reserved	x	x	x	1	x	x	x	x
Reserved	x	x	1	x	x	x	x	x
No parameters in this octet	x	x	0	0	0	0	0	0

Non-standard information field – G.992.2 Annex A {NPar(2)} coding – Octet 1

NPar(1)s Octet 1/1	8	7	6	5	4	3	2	1
Reserved	x	x	x	x	x	x	x	1
Reserved	x	x	x	x	x	x	1	x
Reserved	x	x	x	x	x	1	x	x
Reserved	x	x	x	x	1	x	x	x
Reserved	x	x	x	1	x	x	x	x
Reserved	x	x	1	x	x	x	x	x
No parameters in this octet	x	x	0	0	0	0	0	0

Non-standard information field – G.992.2 Annex A {NPar(2)} coding – Octet 2

NPar(2)s Octet 2/2	8	7	6	5	4	3	2	1
Reserved	x	x	x	x	x	x	x	1
Reserved	x	x	x	x	x	x	1	x
DPM	x	x	x	x	x	1	x	x
Reserved	x	x	x	x	1	x	x	x
Reserved	x	x	x	1	x	x	x	x
Reserved	x	x	1	x	x	x	x	x
No parameters in this octet	x	x	0	0	0	0	0	0

Annex B: ATM Layer Interoperability

This annex is published by Alcatel to provide a technical description of the ATM layer of the user network interface. It is intended as a guideline for third–party ATM systems to successfully inter-operate with the ASAM.

For describing the ATM interoperability, the ATM reference model is used to specify the various aspects. It is assumed the reader is familiar with this model and its terminology.

All features are supported in both upstream and downstream directions unless otherwise stated.

B.1 Referenced Documents

[ITU–T-I.361] ITU-T Recommendation I.361 ISDN Overall Network Aspects and Functions (11/95). B–ISDN ATM Layer Specification.

[ITU–T-I.371] ITU-T Recommendation I.371 ISDN Traffic Control and Congestion Control (08/96). B–ISDN ATM Layer Specification.

[ITU–T–I.432] ITU-T Recommendation I.432.1 - B–ISDN User-Network Interface - Physical Layer Specification: General Characteristics, August 1996.

[ITU–T–I.610] ITU-T Recommendation I.610 - B–ISDN Operation and Maintenance Principles and Functions (11/95).

[ITU–T–I.731] ITU-T Recommendation I.731- B–ISDN Types and general characteristics of ATM equipment (03/96).

[ITU–T–I.732] ITU-T Recommendation I.732- B–ISDN Functional characteristics of ATM equipment (03/96).

[ATMF-3.1] ATM Forum AF–UNI–0010.002 - ATM User-Network Interface Specification V3.1.

[ATMF-Traffic] ATM Forum AF–TM–0056.000 - Traffic Management Specification Version 4.0.

[ATMF-ILMI] ATM Forum AF-ILMI-0065.000 - Integrated Local Management Interface (ILMI) Specification Version 4.0

The base documents for ATM layer specifications are [ITU–T-I.731], [ITU–T-I.732], [ITU-T-I.361] and [ATMF-3.1].

B.2 PMD & TC Layers

The functions listed below are typically Physical Medium Dependent and Transmission Convergence Sub-layer functions:

- Cell Stream mapping/de-mapping
- Cell Delineation
- Payload Scrambling
- HEC Processing
- Cell Rate Decoupling

These functions interact directly with the underlying xDSL layer, which is almost independent of the processing of ATM cells. Therefore, this specific interoperability information is described in the documents referenced in the xDSL interface description.

B.3 ATM Cell Header Format

Cell Format

The ATM cell format is compliant with Recommendation [ITU-T-I.361].

This implies the cell structure complies with the generic ATM cell structure as defined in [ITU-T-I.361] Clause 2.1: Cell Structure.

The cell header coding scheme is of type ITU public **UNI** and complies with [ITU-T-I.361] Clause 2.2: Cell header format and encoding at UNI.

GFC Field

The GFC field coding is compliant with [ITU-T-I.361] Clause 2.2.2: Generic Flow Control field. Currently it is assumed that most CPE equipment connected to the ASAM acts as "uncontrolled equipment". According to [ITU-T-I.361] this implies:

- downstream: cells sourced by the ASAM will have their GFC bits set to 0;
- no action shall be taken by ASAM on GFC field settings of received cells, moreover, non-zero GFC bits shall be forced to zero for cells "in transit".

Routing field (VPI & VCI field)

The 24 bit routing field consists of 8 bits VPI and 16 bits VCI which is compliant with [ITU-T-I.361] UNI format.

For PVC's VPI values can range from 0 to 255 and VCI values from 0 to 65535. The actual number of bits in the VPI and VCI fields used for routing, are configured compliant with the rules defined in [ITU-T-I.361] Clause 2.2.3: Routing field (VPI/VCI).

VPI Field & VCI Field - Reserved VPI/VCI values

When processing cell headers, the ASAM takes the pre-assigned cell header values listed below into account:

- the pre-assigned cell header values for use by the physical layer at the UNI, [ITU-T-T.361] Table 1;
- the combinations of pre-assigned VPI, VCI, PTI and CLP values at the UNI [ITU-T-T.361] Table 2;

any VPI / VCI 3 or 4 : OAM F4 flow cell

Other pre-assigned VPI/VCI values are not supported : cells with these headers that are received, are discarded and the ASAM will not source them.

PTI Field

The PTI field encoding/decoding is compliant to [ITU-T-I.361].

PTI field bit assignment:

- EFCI bit;
- AUU bit;
- F5 cells;
- RM cells;
- reserved cells.

AUU bit (**A**TM **U**ser to ATM **U**ser bit): the ASAM leaves the AUU bit untouched because it is AAL5 unaware.

EFCI bit (**E**xplicit **F**orward **C**ongestion **I**ndication): EFCI marking is performed in the ASAM in case of congestion.

OAM F5 cell indication bits:

- if the ASAM is configured as VP cross connect, the F5 cells are treated in a transparent manner independently of downstream or upstream direction;
- if the ASAM is configured as VC cross connect, F5 cells are accepted and sourced by ASAM.

VC RM Cell indication bits:

- if the ASAM is configured as VP cross connect, the VC RM cells are treated in a transparent manner independently of downstream or upstream direction;
- if the ASAM is configured as VC cross connect, VC RM cells are silently discarded in both downstream and upstream direction;
- the ASAM will not source VC RM cells itself.

VC reserved cell indication bits:

- if the ASAM is configured as VP cross connect, the VC reserved cells are treated in a transparent manner independently of downstream or upstream direction;
- if the ASAM is configured as VC cross connect, VC reserved cells are silently discarded in both downstream and upstream direction;
- the ASAM will not source VC reserved cells itself.

B.4 Traffic Control & Congestion Control

The ASAM implements VP/VC UPC at the UNI to detect violations of negotiated traffic parameters and reacts appropriately to protect the QoS of other VPCs/VCCs.

If the ASAM is configured as a VP cross-connect, VP UPC can be performed on each VP connection.

If the ASAM is configured as a VC cross-connect, VC UPC can be performed on each VC connection.

Via configuration management following service classes can be configured:

- UBR .1 (with MCR)
- CBR.1
- rt-VBR.1
- nrt-VBR.1
- nrt-VBR.2
- nrt-VBR.3
- GFR.1
- GFR.2

Whether traffic is conforming with the configured service class is checked via the GCRA algorithm which is defined in [ITU-T-I.371] and [ATMF-Traffic].

CLP Field

In downstream direction, the CLP bit setting is left untouched. In upstream, depending on the service class that is configured, the CLP bit is checked and modified according to the UPC rules. For UBR no policing is performed.

B.5 OAM Flows

[ITU-T-I.610] specifies procedures for various OAM flows.

LB cells :

- The ASAM supports generation and passive loopback of segment or end-to-end F4 and of segment or end-to-end F5 LB cells at the UNI for cross-connected VP and VC connections. LB cells are only sourced towards the CPE upon explicite operator command.

AIS/RDI cells :

- The ASAM is transparent for end-to-end F4 / F5 AIS and RDI cells at the UNI for cross-connected VP and VC connections.
- The ASAM is transparent, within a segment, for segment F4 / F5 AIS or RDI cells at the UNI for cross-connected VP and VC connections.
- The ASAM does not source end-to-end or segment F4 / F5 AIS or RDI cells.

CC cells :

- The ASAM is transparent for end-to-end F4 / F5 CC cells at the UNI for cross-connected VP and VC connections.
- The ASAM is transparent, within a segment, for segment F4 / F5 CC cells at the UNI for cross-connected VP and VC connections.
- The ASAM does not source end-to-end or segment F4 / F5 CC cells.

PM cells :

- The ASAM is transparent for end-to-end F4 / F5 PM cells at the UNI for cross-connected VP and VC connections.
- The ASAM is transparent, within a segment, for segment F4 / F5 PM cells at the UNI for cross-connected VP and VC connections.
- The ASAM does not source end-to-end or segment F4 / F5 PM cells.

B.6 ILMI

The ASAM supports automatic configuration of the CPE, compliant to [ATMF-ILMI]. The configuration entails

- ATM Interface attributes
- Virtual Path attributes
- Virtual Circuit attributes

that can be retrieved by the CPE from the ASAM.

The auto-configuration is restricted to the ATM layer; service layer information cannot be retrieved.

Annex C: Ethernet Layer Interoperability

This annex is only applicable for an ASAM equipped with an Ethernet northbound interface.

This annex is published by Alcatel to provide a technical description of the Ethernet layer of the user network interface. It is intended as a guideline for third–party Ethernet systems to successfully inter-operate with the ASAM.

An ASAM equipped with an Ethernet northbound interface needs to terminate the ATM VCC from the user network interface, segment or reassemble the AAL5-frame and encapsulate/decapsulate the Ethernet frames. The corresponding protocol stack at the user network interface is shown in the next figure.

anything	
Ethernet	Ethernet II, IEEE 802.3
LLC-SNAP	RFC 2684
AAL5	ITU-T I.363
ATM	ITU-T I.361
xxx	Any Transport Layer, e.g. ADSL

The Transport Layer and ATM interface specifications for an ASAM with Ethernet network interface follow the generic ASAM interface specifications given in the preceding chapters. The following subsections will describe the AAL5, LLC-SNAP and Ethernet specifications at the user network.

C.1 Referenced Documents

[ITU–T-I.363.5] ITU-T Recommendation I.363.5 ISDN Overall network aspects and functions – Protocol layer requirements (08/96). B–ISDN ATM Adaptation Layer Specification: Type 5 AAL.

[RFC2684] Request For Comments 2684. Multiprotocol Encapsulation over ATM Adaptation Layer 5.

[IEEE802.3] IEEE Std 802.3™-2002 IEEE Standard for 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

[IEEE802.1Q] IEEE Std 802.1Q-1998 IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks

[IEEE802.1ad] IEEE P802.1ad/D2.0 Draft Standard for Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks – Amendment 4: Provider Bridges

[RFC2131] Request For Comments 2131 Dynamic Host Configuration Protocol.

[RFC3046] Request For Comments 3046 DHCP Relay Agent Information Option

C.2 AAL5 layer

The ASAM implements the AAL5 according to [ITU–T-I.363.5] with a "null" SSCS sublayer.

The CPE shall send AAL5-frames with maximum CPCS-SDU size of 1536 bytes. The CPE shall also be able to receive AAL5-frames with a CPCS-SDU size up to 1532 bytes. Note that the CPCS-SDU size includes possible LLC/SNAP encapsulation, VLAN- and Ethernet headers. It does not include the AAL5-padding nor AAL5-trailer.

C.3 LLC-SNAP layer

The ASAM implements the LLC-SNAP "Bridged" encapsulation according to [RFC2684]. It is able to receive encapsulated Ethernet frames with or without FCS. When sending frames, the ASAM always applies the Ethernet encapsulation without FCS. The ASAM does not support any other encapsulation method such as the LLC-SNAP "Routed" encapsulation or the VC-multiplexing method.

When sending frames, the CPE shall apply the LLC-SNAP encapsulation type for Bridged Ethernet/802.3 PDUs. I.e. the CPE shall use the following LLC-SNAP encoding:

LLC-SNAP header from CPE to ASAM	
RFC2684 header field	**Value**
LLC (Logical Link Control)	0xAA-AA-03
OUI (Organisationally Unique Identifier)	0x00-80-C2
PID (Protocol Identifier)	0x00-01 if the Ethernet FCS is present 0x00-07 if the Ethernet FCS is absent
PAD (padding)	0x00-00

The CPE shall at least be able to receive frames with the LLC-SNAP encapsulation type for Bridged Ethernet/802.3 PDUs with absent Ethernet FCS. I.e. the CPE shall use the following LLC-SNAP encoding:

LLC-SNAP header from ASAM to CPE	
RFC2684 header field	**Value**
LLC (Logical Link Control)	0xAA-AA-03
OUI (Organisationally Unique Identifier)	0x00-80-C2
PID (Protocol Identifier)	0x00-07 if the Ethernet FCS is absent
PAD (padding)	0x00-00

C.3 Ethernet layer

The ASAM allows both the Ethernet II and the IEEE802.2/802.3 frame formats except for DHCP relay messages, see section C.4). Both types follow the IEEE 802.3 MAC-frame layout according to [IEEE802.3]. The CPE shall not send any other but these EthernetII/802.3 frame types. An obvious exception is that the Ethernet FCS may be absent, as discussed in the previous section on LLC/SNAP encapsulation.

Optionally, one VLAN-header according to [IEEE802.1Q] may be present on the interface between ASAM and CPE. If the CPE is sending VLAN-tagged frames, then it must also be able to receive VLAN-tagged frames. Otherwise, the CPE is not required to receive VLAN-tagged frames.

Optionally, two VLAN-headers according to [IEEE802.1ad] may be present on the interface between ASAM and CPE. If the CPE is sending dual VLAN tagged frames, then it must also be able to receive dual VLAN tagged frames. Otherwise, the CPE is not required to receive dual VLAN-tagged frames. Preceding the S-VLAN tag of these dual VLAN tagged frames, the CPE shall use the same value for the 802.1Q Service Tag Type as the value configured in the ASAM.

If the traffic from the CPE is switched in the ASAM by means of a QoS-aware VLAN cross-connection, then the CPE shall not multicast or flood the frames to more than one upstream VC.

C.4 DHCP relay

ASAM supports the functionality of DHCP relay agent. When the DHCP relay agent is enabled, the user shall not send out a DHCP message in IEEE 802.3 MAC frame, since this mode is not supported by ASAM.

The ASAM only accepts DHCP messages originated directly from DHCP client. The DHCP relay agent at user side is not supported, so all DHCP messages, already relayed by another relay agent near to the user, is dropped. In another words, the ASAM shall be the first DHCP relay agent on the way from DHCP client to DHCP server.

The ASAM does not support fragmented DHCP messages. If a fragmented DHCP message is received, the ASAM will drop the first fragment, and forward transparently the remained fragments.

The DHCP client shall send out DHCP messages, in which the ‘chaddr’ field shall be the MAC address of length of 6 bytes. The DHCP client shall not send out unicast DHCP messages with “ciaddr”=0.

For DHCP messages encapsulated in IPsec packets, the ASAM forwards them transparently. If the DHCP relay agent is enabled, the user shall not send out this kind of packet.

The ASAM can also support the function of option 82. If option 82 is enabled, the ASAM considers all user ports as distrusted ports, that means all DHCP messages with option 82 received from the user side will be dropped. The concept of trusted port is not supported by the ASAM.

End of document