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ADSL2+ over POTS
User To Network Interface specification

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0. Document history

Every update of this document results in a complete new version with new version number and release date.

Version	Date	Main or important changes since previous version
1.0	20 June 2005	<ul style="list-style-type: none">Initial version

1. Scope

The goal of this document is to provide the technical specifications of the User To Network Interface (UNI) for ADSL2+ equipment to be connected to the Belgacom network.

As ADSL2+ may provide a variety of bearer channels in conjunction with other services, this document deals with the ADSL2+ service on the same pair with POTS services.

The UNI technical specifications for the ADSL2+ service, mentioned in this document, are based on the currently relevant international specifications and recommendations for ADSL2+ equipment (see references).

2. References

- [1] ITU-T G.992.5 Recommendation *“Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)”*
- [2] ITU-T G.994.1 Recommendation *“Handshake procedures for digital subscriber line (DSL) transceivers”*
- [3] ITU-T G.997.1 Recommendation *“Physical layer management for Digital Subscriber Line (ADSL) transceivers”*
- [4] ETSI TS 101 952-1-1 (Version 1.2.1) Technical Specification *“Generic specification of the low pass part of DSL over POTS splitters including dedicated annexes for specific xDSL variants”*
- [5] ETSI TS 101 952-1-2 (Version 1.1.1) Technical Specification *“Specification of the high pass part of ADSL/POTS splitters”*

3. Definitions and abbreviations

3.1. Abbreviations

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

ATM	Asynchronous Transfer Mode
CP	Customer's Premise
CO	Central Office
DMT	Discrete Multi-Tone
DSL	Digital Subscriber Line (also named Copper Access Line or Local Loop)
DSLAM	Digital Subscriber Line Access Multiplexer
EMC	ElectroMagnetic Compatibility
ISDN	Integrated Services Digital Network
LT	Line Termination
NT	Network Termination (at the customer premise end of the line)
OAM	Operations, Administration and Maintenance
POTS	Plain Old Telephony Service
TE	Terminal Equipment
UNI	User Network Interface
ADSL2+	Asymmetric Digital Subscriber Line with Extended bandwidth
ATU-C	ADSL2+ Transceiver Unit - Central Office side
ATU-R	ADSL2+ Transceiver Unit - Remote side

3.2. Definitions

For the purposes of the present document, the following terms and definitions apply:

downstream: transmission in the direction of LT towards NT (network to customer premise)

upstream: transmission in the direction of NT towards LT (customer premise to network)

Central Office: Central Office side is intended to designate the operator side of the DSL that contains the DSLAM equipment.

4. System reference model

Figure 1 shows the reference model used for ADSL2+ [1].

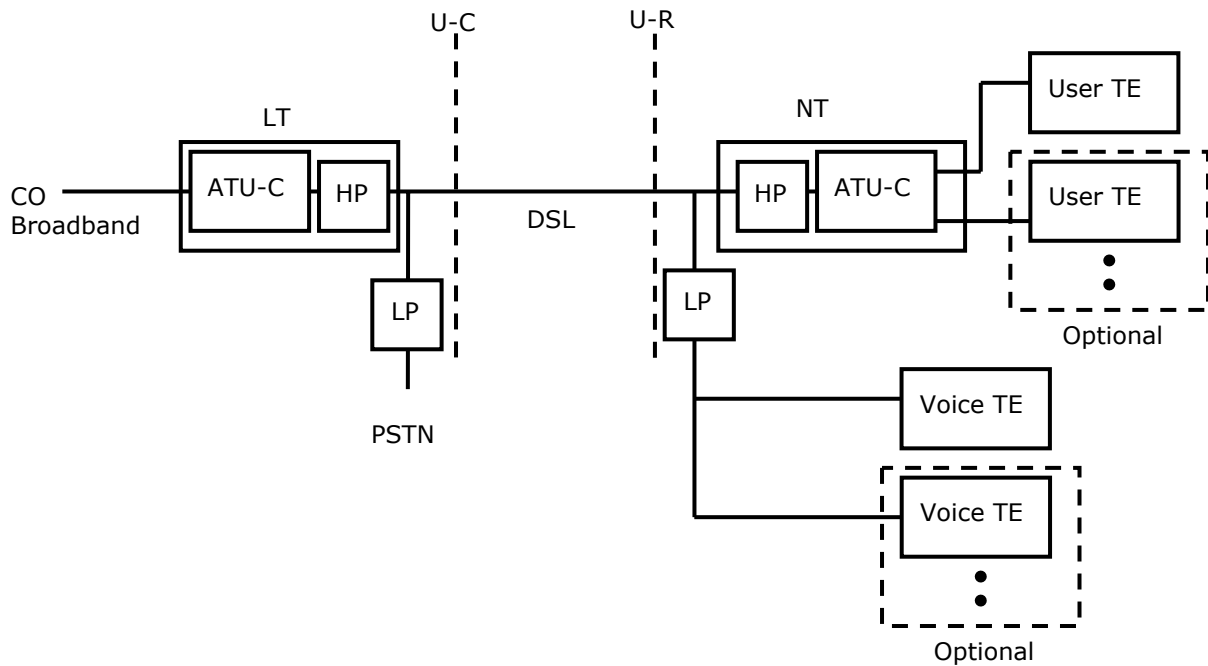


Figure 1: General reference model

A Digital Subscriber Lines Access Multiplexer (DSLAM) holding ADSL2+ Line termination (LT) cards is placed at central office (CO) side. From the DSLAM, the Digital Subscriber Lines (DSL), consisting in unscreened twisted metallic access wire-pairs, are used to convey the broadband (ADSL2+) and narrowband (POTS) signals to and from the customer's premises (CP).

At the CP side, the ADSL2+ NT block (Network Termination) contains the remote ADSL2+ transceiver unit (ATU-R) and the High-Pass filter (HP). The POTS Terminal Equipment (TE) is connected on the POTS port of a Splitter that includes a Low-Pass filter (LP). The ADSL2+ NT can be connected directly to the DSL termination point or via the ADSL2+ port of the splitter.

At the CO side, the DSLAM contains the ADSL2+ Transceiver Unit (ATU-C), the ADSL2+ splitter and High-Pass filter (HP) functionalities and the backhaul to the optical network.

5. UNI specification

5.1. User to Network Interface U_R

The User to Network Interfaces (UNI) U_R is the Digital Subscriber Line Termination point into the Customer's Premise where the splitter and the NT can be connected.

U_R interface carries the POTS service multiplexed in frequency division multiplexing mode with the ADSL2+ upstream and downstream signal.

5.2. Transmission characteristics

ATU-R shall comply with ITU-T G.992.5 main body and Annex A [1].

ATU-R shall support non-overlapped spectrum when ATU-C complies with downstream PSD described in Annex A §1.3.

ATU-R shall support all D_p and S_p values defined as optional or mandatory within §7 of ITU-T G.992.5 [1], where D_p stands for interleaving depth in latency path #p and S_p is the number of PMD symbols over which the FEC data Frames, in latency path #p, spans.

5.3. Handshaking

ATU-R shall support ADSL2+ handshaking procedure described within ITU-T G.994.1 [2]

5.4. Management

ATU-R shall support management functionalities described within ITU-T G.997.1 [3]

5.5. Splitters and filters

Although ETSI technical specification defines an optional high pass filter into the splitter, it is common ADSL practice that the high pass filter is included into the network termination equipment and that the splitter contains only the low pass filter. The same practice may apply to ADSL2+, this document will only specify the filter functionality and not exact location.

The low pass filter shall comply with ETSI TS 101 952-1-1 [4] for ADSL2+ options. At least option A within [4] shall be supported but it is preferable that both options A & B are supported.

The high pass filter shall comply with ETSI TS 101 952-1-1 [5] and requirements of [5] applying over a frequency band up to 1104 kHz shall be met over a frequency band up to 2208 kHz.

ANNEX A : Local loop characteristics

A telecom cable consists of a number of *cores* surrounded by a layer of insulating material. The cores of such a cable are always grouped in *pairs* of *conductors*.

Cables in the local network are designed so as to ensure optimum transmission and guarantee minimum mechanical resistance. For this reason, the description of cables below consists of a section dealing with electrical characteristics and one dealing with mechanical characteristics.

Mechanical characteristics

- The conductors of a local cable are round, full wires consisting of 98%–99% pure electrolytic copper.
- A conductor is isolated by a layer of synthetic material (usually polyethylene).
- Most conductors have a 0.5 mm or 0.6 mm diameter with a maximum negative variance of 0.01 mm and a positive variance of 0.03 mm.
- The set of conductors is covered by a waterproof extruded cable sheath (usually polyethylene). Under normal circumstances, the cable is also longitudinally waterproof.
- The cable cores are arranged in a specific manner. The two conductors (e.g. of a telephone circuit) must be arranged symmetrically in relation to all other conductors. For this reason, conductors are twisted and placed in coaxial cylindrical layers (*a basic unit consists, for example, of four conductors twisted around one another and from which two telephone circuits can be created; a cross section shows that these four conductors form the corners of a square. The conductors located on two opposite angular points form a pair*).

Electrical characteristics

- Since the signals to be transmitted are changeable electrical voltages, the cable conductor must be a good transmission medium for electrical signals. The important elements are defined for a unit length of one kilometer and are called primary electrical parameters of a conductor. These parameters are kilometer resistance R, kilometer inductance L, kilometer capacity C and kilometer leakance G.

◆ kilometer resistance R

- * Kilometer resistance is the initial resistance of a one kilometer conductor pair that is looped at the remote end; the value of this parameter is therefore the resistance of a conductor with a length of two kilometers.
 - ⇒ R is 180 Ohm for a conductor diameter of 0.5 mm (at 20°C);
 - ⇒ R is 123 Ohm for a conductor diameter of 0.6 mm (at 20°C).
- * It should be noted that due to the skin effect, the alternating current resistance is higher than the direct current resistance indicated above.

◆ kilometer inductance L

- * In a symmetrical pair cable, conductors forming a pair lie very close to one another; kilometer inductance L is therefore very low (approx. 0.5 mH per kilometer).

◆ kilometer capacity C

- * The capacity between two conductors of the same pair can be measured when the rest of the cable conductors are connected to each other and to an equipotential point of a measuring device. The nominal value of kilometer capacity C is situated between 38.5 nF/km and 50 nF/km at 800 Hz.

◆ kilometer leakance G

- * Kilometer leakance G depends on the frequency concerned and kilometer capacity C. Theoretically, kilometer leakance may be considered as negligible.
- * G can roughly be calculated with the help of the following formula, in which k has a value between 0.005 and 0.02 (ω = pulsation in rad/s):

$$G = k \cdot \omega \cdot C$$

- The insulation resistance of each conductor in relation to the rest of the conductors (and any shielding) is at least 5,000 M Ω /km.