SHDSL

(Single-pair High-speed Digital Subscriber Line)

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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	23 JAN 2002	• First version.

1. Preface

The goal of this document is to provide the technical specifications of the User to Network Interface (UNI) for SHDSL equipment to be connected to the Proximus ATM network.

The technology SHDSL mentioned in this document is indicated in the ITU-T standard as the G.SHDSL recommendation whereas in the ETSI standard as the SDSL recommendation.

The technical specifications for the SHDSL technology, mentioned in this document, are based on the currently relevant international ITU-T recommendations for SHDSL equipment namely:

∗ The ITU-T G.991.2 Recommendation and amendment [see References: 1];
∗ The ITU-T G.994.1 Recommendation [see References: 2]

2. System reference model

The system reference model for the SH*DSL* technology has been made in figure 1; it illustrates the functional blocks required to provide an SHDSL technology.

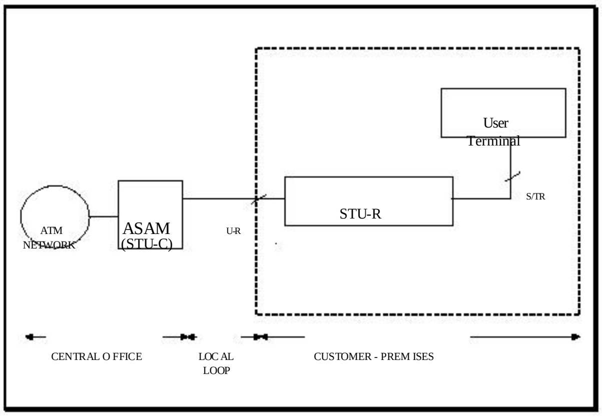


Fig. 1 : System reference model for SHDSL technology

The following main-building blocks can be distinguished:

- ***ASAM*** : the ATM Subscriber Access Multiplexer (including the SHDSL transceiver unit at the central office; i.e. network operator);
- ***U*-R**: The loop interface U-R carries the upstream and downstream SHDSL signals. The upstream and downstream SHDSL signals are TC-PAM16 modulated.
- ***STU-C*** : The SHDSL transceiver unit at the Central office side
- ***STU-R*** : The SHDSL transceiver unit at the customer side (Remote end)

3. General description

The U-R-interface connects the STU-R to the ASAM (with STU-C) via the copper access network. A normal subscriber line wire is used for this connection. Physically, the UNI-connection point is situated on the point **U-R** of the system reference model (see fig 1).

The sub-paragraphs mentioned below describe the STU-C functionalities and the requirements for the STU-R in order to establish a SHDSL - connection. **Only Line code TC-PAM16, Symmetrical PSD - ANNEX B (European version) is applicable**

The characteristics of the local loop are described in annex A of this document.
The distance restrictions are described in annex B of this document.

3.1. Transport capacity

The transport capacity complies with section 5 of ITU-T Recommendation G.991.2. The transport capacity of the STU-C supports symmetrical data rates from 192 kbit/s to 2312 kbit/s in increments of 8 kbit/s. By consequence, the transport capacity of the connected STU-R has to compatible with this.

The Proximus STU-C supports only the specific European requirements (see Annex B of the ITU- T Recommendation).
The Proximus STU-C supports only the two wire operational mode - Symmetrical spectrum.

3.2. Physical Media Dependent (PMD)

Regarding the Physical Media Dependent, the STU-C complies with section 6 of ITU-T Recommendation G.991.2. The STU-R shall comply with section 6 of ITU-T Recommendation G.991.2.

The STU-C Power Back off option is always set in the default mode. The STU-R Power Back off must be set between the Default and the Maximum power back off.

Estimated power loss (dB)	Maximum power back-off (dB)	Default power back-off (dB)
EPL ≥6	31	0
5≤ EPL <6	31	12
4≤ EPL <5	31	34
3≤ EPL <4	31	56
2≤ EPL <3	31	
1≤ EPL <2	31	
0≤ EPL <1	31	

3.3. Physical Media-Specific Transmission convergence layer (PMS-TC)

Regarding the PMS-TC functional characteristics, the STU-C complies with section 7 of ITU-T Recommendation G.991.2. The STU-R shall comply with section 7 of ITU-T Recommendation G.991.2.

3.4. Transmission Protocol Specific Transmission Convergence layer (TPS-TC)

Regarding the TPS-TC functional characteristics, the STU-C complies with section 8 Annex E9 (TPS-TC for ATM Transport) of ITU-T Recommendation G.991.2. The STU-R shall comply with section 8 Annex E9 of ITU-T Recommendation G.991.2.

The Proximus STU-C supports only the two-wire mode.

3.5. Maintenance

Regarding the maintenance, the STU-C complies with section 9 Annex E9.4 of ITU-T Recommendation G.991.2. The STU-R shall comply with section 9 Annex E9.4 of ITU-T Recommendation G.991.2.

3.6. Clock Architecture

Regards the clocking the STU-C complies with section 10 of ITU-T Recommendation G.991.2. The STU-R shall comply with the clocking described in section 10.

The Proximus STU-C is in the Clock Synchronization configuration 3a (Transmit data clock or network reference clock).

3.7. Electrical Characteristics

The electrical characteristics of the STU-C comply with section 11 of ITU-T Recommendation G.991.2. The STU-R shall comply with of ITU-T Recommendation G.991.2.

Only Line code TC-PAM16, Symmetrical PSD - ANNEX B (European version) is applicable.

3.8. Conformance Testing

The behaviour against Micro-Interruptions of the STU-C complies with section 12 of ITU-T Recommendation G.991.2. The STU-R shall comply with of ITU-T Recommendation G.991.2.

4. References

[1] ITU-T Recommendation G.991.2, *Single-pair High-speed Digital Subscriber Line (SHDSL) Transceivers.*

[2] ITU-T Recommendation G.994.1, *Handshake Procedures*

ANNEX A : Local loop characteristics

A telecoms 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.

    ♦ <u>kilometer resistance R</u>

    ∗ 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.

    ♦ <u>kilometer inductance L</u>

    ∗ 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).

♦ <u>kilometer capacity C</u>

∗ 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.

♦ <u>kilometer leakance G</u>

∗ Kilometer leakance G depends on the frequency concerned and kilometer capacity C. Theoretically, kilometer leakancy may be considered as negligible.

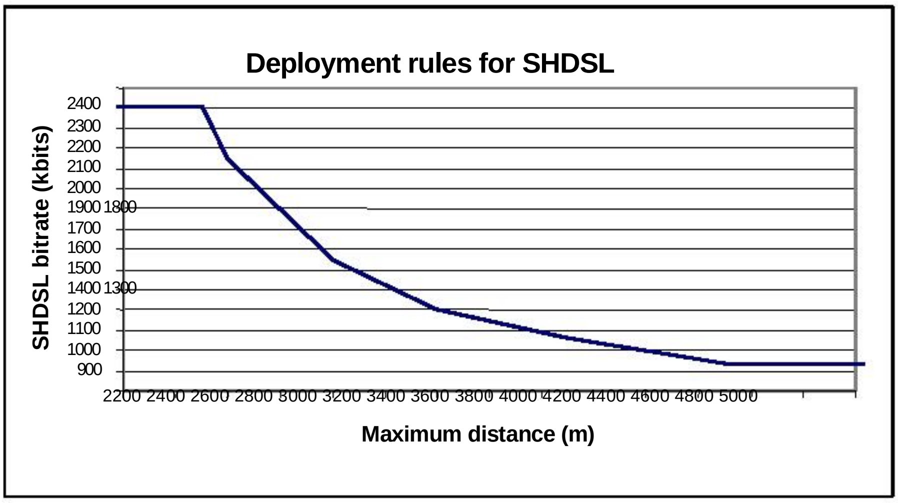
∗ G can roughly be calculated with the help of the following formula, in which k has a value between 0.005 and 0.02 (ω = pulsation in rad/s):

$$G = k . \omega . C$$

- The insulation resistance of each conductor in relation to the rest of the conductors (and any shielding) is at least 5 GΩ/km (Specified value when ordering cable lengthes).

ANNEX B: SHDSL Distance Restrictions

The following distance restrictions for SHDSL two-wire have to be respected for the SHDSL systems:



The following table gives the x-y data of this graph:

Bitrate (kbits)	Distance (m)
2312	2500
2048	2600
1552	3000
1300	3400
1160	3900
1033	4500
≤ 1032	No limit

Note: this curve is subject to evolution, and has to be considered as starting point for the deployment of the first SHDSL systems.