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From	James Bristow
Date	21 September 2021
Subject	xDSL, G.fast and fibre CPE WAN requirement library

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xDSL, G.fast and fibre CPE WAN requirement library

Scope	To list all wireline broadband access CPE requirements (xDSL, G.fast, fibre)
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Checklist of changes

Version	Date	Released by	Comments

Revisions

Version	Date	Released by	Comments

Release

Version	Date	Released by	Comments
0.10	09-03-2011	Damien Fragnière	Reviewed
0.42	30-08-2012	Jürg Ruprecht	Update and discussion within ACB
0.50	20-09-2012	Jürg Ruprecht	Update and discussion within DEV-PAD & NSB-ACB
0.60	15-10-2012	Jürg Ruprecht	Inclusion of feedback, update for ENT (Christoph Bruggmann), CWS (Cornel Kälin) and review with DEV-PAD (Daniel Ryter)
0.61		Jürg Ruprecht	Review with Yes Collaud (DEV-NTW-NSB-ACB)
0.62		Jürg Ruprecht	Review with Peter Ettlin
1.00		Jürg Ruprecht	ACB approval, open UL issues, especially IPv6
1.02		Jürg Ruprecht	Review with James Bristow (autosensing), Ulrich Menzi (vectoring), and Martin Gysi (UL with emphasis on IPv6); shows all changes in blue
1.04		Jürg Ruprecht	Removing changes in blue, duplication of UL requirements in MREQ and REQ, when necessary, differentiation between DP for operation and DP for development.
1.10		Jürg Ruprecht	Version approved by NSB-ACB on 01-11-2012
1.11		Jürg Ruprecht	Minor obvious defects corrected after 01-11-2012
1.14	08-01-2013	Jürg Ruprecht	Table 12, CPE datapump settings, Broadcom chipsets 6368, 63168 UL-DH-23: 5 / 6 commands: wait *64s* rather than 60s (Martin Gysi). AS-04, AS-05: New requirements
1.15	23-01-2013	Jürg Ruprecht	Table 18, significant update based on inputs of Stefan Alfaré
1.16	23-01-2013	Jürg Ruprecht	MREQ UL-GT-07 detailed with "3 CPE queues", and REQ UL-GT-09 added with "4 CPE queues". Requirements AS30 and AS-31 (interface trial duration) changed from 30s to 30-60s based on Stargate vendor input and agreement with James Bristow.
1.17	20-02-2013	Jürg Ruprecht	Update of Table 5 with newest Huawei Micro CAN specs based on Inputs of Christian Macherel. Requirement AS-11 changed to newly allow parallel interface tests on proposal of Stargate to increase speed. Extension of CAN types and settings in Table 5 (legacy CANs, for VDSL2, ADSL2+ and ADSL) and Table 6 (vectoring CANs, only VDSL2)..
1.18	23-01-2013	Jürg Ruprecht	Update of vectoring CAN specs..
1.19	18-03-2013	Jürg Ruprecht	Datapump recommendation for Broadcom 63168 and 63268 added.
1.20	17-04-2013	Jürg Ruprecht	Update of vectoring CAN specs based on inputs of Andreas Thöny.
1.21	31-05-2013	Jürg Ruprecht	L1-FI-02 "fibre standards" split into L1-FI-02 "100 Mb/s fibre standards" with clause 59 deleted and to Clause 58 added that the minimum average power of is -3dBm rather than -8dBm, as well as L1-FI-03 "1 Gb/s fibre standards" with clause 58 deleted, based on inputs of Yves Collaud.
1.22	13-06-2013	Jürg Ruprecht	<provisioning code> added to format in In requirement UL-DH-15. Differing between Broadcom POTS DPs A2pv6C038h.<DRV> for chipset 6368 and

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			A2pv6F038h.<DRV> for chipset 63168 in Table 12.
1.23	23-04-2014	Jürg Ruprecht	SDSL requirements, update of recommended datapumps in Table 12.
1.24	24-06-2014	Jürg Ruprecht	New surge suppressor requirement L1-GE-50, extension of dying gasp requirements with 90ms operation time after power loss.
1.25	01-09-2014	Jürg Ruprecht	Definition of SDSL actual bit rate reference bounds in Figure 4 and Table 17.
1.26	09-09-2014	Jürg Ruprecht	SDSL UL requirement UL-PS-07 in Section 5.1, update of VDSL2 FTTS and FTTC CANs in Table 6, and update of SDSL CAN in Table 9.
1.27	10-02-2015	Jürg Ruprecht	Change of CBU into ENT (Swisscom customer facing unit), conversion from Word 2003 (extension doc) into Word 2010 (extension docx).
1.28	09-03-2015	Jürg Ruprecht	Update of CAN settings in Table 5, Table 6 and Table 7.
2.00	23-03-2015	Jürg Ruprecht	Minor general updates and new G.fast requirements, all in red with yellow background markings, later changes with blue background markings, and newest change in green background markings (surge protection back to the original 6kV).
2.01	23-03-2015	Jürg Ruprecht	Changes to DHCP Option 60 requirements, : service provider ID, service ID, and provisioning code: – UL-DH-15 (RES): Unchanged. – UL-DH-16 (SME): New settings. – UL-DH-67 (CWS): Newly all empty.
2.02	15-10-2015	Jürg Ruprecht	Addition of VDSL2 requirement L1-V2-63 "VDSL2 immunity to G.fast reduced spectrum operation ".
2.03	16-11-2015	Jürg Ruprecht	Change of lower G.fast reduced spectrum operation from 19.6 MHz to 19.7 MHz.
2.04	10-12-2015	Jürg Ruprecht	Update of reference actual bit rate vs. reach plots and values in Sections 7.6 to 7.12. Update of autosensing process capture of Figure 5 in Section 7.14 by replacing "VDSL2" with "G.fast / VDSL2"; graph update pending. Update of Table 12, addition of Figure 1 and update of Table 8.
2.05	18-01-2016	Jürg Ruprecht	In requirement UL-DH-15, the 4th bullet point is changed from "MAC address" to "MAC OUI".
2.06	01-03-2016	Jürg Ruprecht	In requirement L1-GE-51, the title is changed from "xDSL / G.fast induction" to "xDSL / G.fast MELT requirement"; the requirement text remains unchanged. All G.fast reference curves updated as approved by the WAC-DSL board.
2.07	26-04-2016	Jürg Ruprecht	Addition of VDSL2 requirement L1-V2-64 "Activation of power holding mode" (only for Swisscom CPEs.
2.08	04-07-2016	Jürg Ruprecht	In requirement L1-GE-51, the "xDSL / G.fast MELT requirement" is left with 30nF for VDSL / ADSL2+ / ADSL and extended to 9nF for G.fast.
2.09	12-07-2016	Jürg Ruprecht	Addition of mandatory requirement L1-GE-16 that requires DP settings as listed in Table 12.
3.00	14.04.2020	James Bristow	- The following updates have been made: Addition of requirement REQ L1-FA-62 "G.fast out-of-band signal" and mandatory requirement MREQ L1-FA-68 "G.fast discontinuous operation (DO)". - Update of CPE datapump recommendations in Table 12. - Update of G.fast rate vs. reach curves in Figure 3 in Section 7.7. - Update of VDSL17a rate vs. reach curves in Figure 2 in Section 7.6. - Update of G.fast and VDSL17a rate vs. reach values in Table 13 in Section 7.9. - Update of VDSL and G.fast reference curves in Figure 2 and Figure 3 - Added XGS-PON Version 3.00 handed over to Cornel Kälin.
3.01	29.03.2021	James Bristow	Update XGS-PON requirements

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1 Introduction

1.1 Purpose

This document is a generic library of all potential requirements for wireline broadband access xDSL and fibre customer premises equipments (CPEs) with focus on the wide area network (WAN) side, except for the IPv6 requirements that cover both WAN and LAN issues. For a given CPE, a separate Excel compliancy sheet specifies the specific requirements for this CPE; the vendor must fill in this Excel compliancy sheet.

1.2 Scope

The scope of this document is to gather all requirements related only to the WAN interface of wireline broadband access xDSL and fibre CPEs. LAN interface issues are must be addressed separately, except IPv6 topics that are treated both in LAN and WAN aspects. Common issues of the LAN and the WAN interface must be treated as well separately such as

- TCP and IP throughputs,
- NAT / PAT,
- QoS,
- Layer 7 protocols like NTP and DNS,
- IGMP snooping and IGMP proxy, especially
  - IGMP snooping (join and leave) must support multi homing, and
  - IGMPv3 proxy must be enabled by default configuration,
- routing protocols such as RIP1 and RIP2.

1.3 Target readership, requirements of the reader

The document is intended to inform CPE vendors about all Swisscom xDSL and fibre CPE requirements. In the additional Excel compliancy sheet, the CPE vendors must comment the requirements dedicated for their CPE.

1.4 Requirement types, formulations and colour codes

Three types of requirements are used to answer the technical and commercial requirements:

- **Mandatory requirement (MREQ):** These requirements have to be fulfilled in any case. Neither workaround nor late delivery can be accepted.
- **Requirement (REQ):** These requirements have to be fulfilled. Workarounds or late deliveries may be acceptable.
- **Request for specification (RFS):** Swisscom requests information on how the vendor intends to fulfil a requirement or implement functionality, including roadmap information if applicable.

The requirement specifications are formulated as follows:

- **MREQ:** Formulation in a must form, e.g., "The CPE must comply with …".
- **REQ:** Formulation in a direct verbal form, e.g., "The CPE complies with …".

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- **RFS:** Formulation with a please statement, e.g., "Please specify …".

The same requirements may be an MREQ for some customer facing units (CFUs) and only a REQ for other CFUs, with the following Swisscom CFUs:

- Residential (RES)
- Small and Medium Enterprises (SME)
- Enterprise (ENT)
- Corporate Wholesale (CWS)

We then refer to an MREQ with a reference number between 1 and 49 and to a REQ with a reference number between 51 and 99, where <REQ number> = <MREQ number> + 50, i.e., for if the MREQ reference number is UL-DH-01, the corresponding REQ reference number is UL-DH-51. If the MREQ or the REQ is not used, the corresponding requirement is missing and its number is not used, but is reserved for eventual future needs.

The colour codes depicted in Table 1 are used to better distinguish between the requirement types.

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	Colour code
Mandatory requirement	Green = MREQ
Requirement	Red = REQ
Optional requirement	Not used
Request for specification	Yellow = RFS

Table 1: Colour codes to mark requirement types.

1.5 Level of compliance

In order to give more transparency to the answer provided by the CPE vendors, some levels of compliance are fixed and defined below for the MREQs, REQs and RFSs described in the technical requirements.

1.5.1 Clarifications on notation C, C1, NC1, NC2, NC3, NA for MREQ and REQ

The clarifications on notation C, C1, NC1, NC2, NC3, NA for MREQ and REQ are listed in Table 2. Note that the date for T1 (milestone 4.0) is defined in the covering letter. Note also that comments, compliancy and date have to be written directly in the respective field of the Excel compliancy sheet.

Abbr.	Notation	Explanation
C	Compliant	Feature is already commercially available at the date of the RFQ and / or the CPE vendor fully complies with the requirement. No clarification is allowed (cf. note below). If the CPE vendor wants to comment, the NCx alternative must be used. Note: Additional information providing further details, while not modifying the requirement is allowed. In the case of conflicting text, the requirement as formulated in this library takes precedence.
C1	Compliant for T1	Feature is not available at the date of the RFQ, but will be available in time for T1 delivery. No clarification is allowed (cf. note below). If the CPE vendor wants to comment, the NCx alternative must be used. Note: Additional information providing further details, while not modifying the requirement is allowed. In the case of conflicting text, the requirement as formulated in this library takes precedence.
NC1	Non-compliant	Feature will be supported, but not in time for the T1 delivery. The CPE vendor shall provide the date at which the feature is supported. A clarification is mandatory. When Swisscom cannot accept the date (since the time frame is not reasonable), and negotiations fail, then the declaration will be changed to NC3.
NC2	Non-compliant	Feature will not be supported, but an alternative feature is available. A clarification is mandatory, describing the alternative to the requirement as formulated in this library, including references to publications. The CPE vendor shall provide the date at which the feature is supported. When Swisscom cannot accept the date (since the time frame is not reasonable), and / or the proposed alternative is not acceptable, and negotiations fail, then the declaration will be changed to NC3.
NC3	Non-compliant	Feature is not and will not be available within a reasonable time frame.
NA	Not applicable	The required feature is not applicable or not relevant for the offered CPE. An explanation is required.

Table 2: Clarifications on notation C, C1, NC1, NC2, NC3, NA for MREQ and REQ.

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1.5.2 Clarifications on notation for RFS

The clarifications on notation for RFS are listed in Table 3. Note that comments have to be given directly in the vendor comment field of the Excel compliancy sheet.

Abbr.	Notation	Explanation
	Status: Committed	The feature is available at the latest by the date specified by Swisscom. The CPE vendor shall provide the date and a description, including references to publications.
	Status: Planned	The feature will be supported, but not in time. The CPE vendor shall provide the date at which the feature is supported and a description, including references to publications.
	Status: Not committed	The feature is not and will not be available within a reasonable time frame
NA	Not applicable	The feature is not applicable or not relevant for the systems offered. An explanation is required.

Table 3: Clarifications on notation for RFS.

1.5.3 Answers to the technical requirements

For all MREQs and REQs, a clear statement of compliance, i.e., C, C1, NC1, NC2, NC3 or NA, has to be made according to the definitions given in Table 2 of Section 1.5.1.

For all RFS, a detailed answer including dates (a period is unsatisfactory) and a clear statement, i.e., committed, planned, not committed or NA, has to be made according to the definitions given in Table 3 of Section 1.5.2.

All answers must be given in the separate Excel compliancy sheet (cf. example and explanations in Table 4).

Topic	Reference	General requirement type	Requirement title	CPE specific requirement type	Vendor comments	Compliancy	Date
General	L1-GE-01	MREQ	xDSL IP CAN interoperability	MREQ		C1	
	L1-GE-02	REQ	xDSL chipset	REQ		NC1	31-03-2012
	L1-GE-02	RFS	xDSL chipset model	RFS		Committed	
	L1-GE-10	MREQ	xDSL over POTS datapump	n/a			

Table 4: Extract from the Excel answer spread sheet, with the following columns:
- Topic: Referring to the respective section in the library (this document).
- Reference: Reference number in the library (this document).
- General requirement type: Requirement type in the library (this document); this requirement type is not necessarily relevant for the considered CPE and may be n/a.
- Requirement title: Requirement title in the library (this document); note that the full requirement text is not available in the separate Excel compliancy sheet and must be gathered from the library (this document).
- CPE specific requirement type: Requirement type that is relevant for the considered CPE.
- Vendor comments: Comments of the vendor, according to Table 2 and Table 3.
- Compliancy: Compliancy of the vendor, according to Table 2 and Table 3.
- Date: Date of the vendor, according to Table 2 and Table 3.

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1.6 Terms and abbreviations

6rd	IPv6 Rapid Deployment
ACS	Auto Configuration Server
ADSL	Asymmetric Digital Subscriber Line
ADSL2+	Asymmetric Digital Subscriber Line 2+
AF	Assured Forwarding
ALN	Active line noise
ATA	Analogue Terminal Adapter
ATM	Asynchronous Transfer Mode
AWGN	Additive Gaussian White Noise (i.e., thermal noise, referred to as Low Noise – LN)
BBCS	Broadband Connectivity Service
BOOTP	Bootstrap Protocol
BRAS	Broadband Remote Access Server
CAN	Copper Access Node (i.e., DSLAM)
CIS	Carrier Internet Service
CLI	Calling Line Identification (VoIP)
CLI	Command Line Interface
CO	Central Office (exchange)
CoC	Code of Conduct
CPE	Customer Premises Equipment
CS	Class Selector
CWS	Corporate Wholesale (Swisscom Customer Facing Unit)
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
DoS	Denial of Service
DP	Datapump
DS	Downstream
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer (i.e., CAN)
EE	Electrical Ethernet
EF	Expedited Forwarding
EFM	Ethernet in the first mile
ENT	Enterprise (Swisscom Customer Facing Unit)
ETSI	European Telecommunications Standards Institute
FAN	Fibre Access Node
G.fast	Fast Access to Subscriber Terminals
FDD	Frequency Division Duplex
FW	Firmware
G.INP	ITU implementation of INP in xDSL and G.fast by means of physical retransmission

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HN	High Noise (i.e., SPM3 noise)
HW	Hardware
IAD	Integrated Access Device
ICMP	Internet Control Message Protocol
ID	Identifier
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
IDC	Internet Distribution Core (i.e., peering between Swisscom residential IP+ and 3Play core)
INP	Impulse Noise Protection
IP	Internet Protocol (according to [RFC 791])
IPoE	IP over Ethernet
IPv4	Internet Protocol Version 4
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
ITU	International Telecommunication Union
LAN	Local Area Network
LATN	Line attenuation
LN	Low Noise (i.e., AWGN)
MAC	Medium Access Control
MREQ	Mandatory Requirement
MTU	Maximum Transmission Unit
NAT	Network Address Translation
NF	Non-Functional (Requirement)
NTP	Network Time Protocol
OLR	On-line reconfiguration
OLT	Optical Line Termination
ONT	Optical Network Termination
ONU	Optical Network Unit
OMCI	ONU management and control interface
OTT	Over The Top content
PAT	Port Address Translation
PON	Passive Optical Network
POTS	Plain Old Telephony Service
PPP	Point-to-Point Protocol
PPPoE	Point-to-Point Protocol over Ethernet
PTM	Packet Transfer Mode
PSD	Power Spectral Density
QLN	Quiet line noise
RES	Residential (Swisscom Customer Facing Unit)

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RFC	Request for Comments
RFS	Request For Specification
RIP	Routing Information Protocol
SATN	Signal attenuation
SDSL	Symmetric Digital Subscriber Line
SIP	Session Initiation Protocol
SPM3	Spectrum Management 3 noise, Swisscom specific noise type taking inter copper line interference into account (referred to as High Noise – HN)
SME	Small and Medium Enterprises (Swisscom Customer Facing Unit)
SRA	Seamless Rate Adaptation
SW	Software
TCP	Transmission Control Protocol
TDD	Time Division Duplex
TR	Technical Recommendation
TV	Television
UDP	User Datagram Protocol
US	Upstream
VCI	Virtual Circuit Identifier
VDSL2	Very-High-Bit-Rate Digital Subscriber Line 2
VLAN	Virtual Local Area Network
VoD	Video on Demand
VoIP	Voice over IP
VPI	Virtual Path Identifier
WAN	Wide Area Network
WLAN	Wireless LAN
xDSL	Generic term covering various DSL techniques such as ADSL, ADSL2, ADSL2+, VDSL or SDSL
XGS-PON	10 (X) Gigabit Symmetric PON

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1.7 Referenced documents

[1] ETSI TS 101 271 V1.1.1 (2009-01), Access Terminals Transmission and Multiplexing (ATTM), Access transmission system on metallic pairs, Very High Speed digital subscriber line system (VDSL2) [ITU-T Recommendation G.993.2 modified].

[2] ETSI TS 101 388 V1.4.1 (2007-08), Access Terminals Transmission and Multiplexing (ATTM), Access transmission systems on metallic access cables, Asymmetric Digital Subscriber Line (ADSL) - European specific requirements, [ITU-T Recommendation G.992.1 modified].

[3] ETSI TS 105 388 V1.1.1 (2008-04), Transmission and Multiplexing (TM), Access transmission systems on metallic access cables, Asymmetric Digital Subscriber Line (ADSL2plus) - European specific requirements, [ITU-T Recommendation G.992.5 modified]

[4] IEEE 802.3-2008, IEEE standard for information technology, specific requirements, part 3, carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

[5] IEEE 802.3ah-2004, 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, amendment media access control, parameters, physical layers and management, parameters for subscriber access networks.

[6] ITU-T G.992.1 (07/99), Asymmetric digital subscriber line (ADSL) transceivers, including Corrigendum 1 (11/01) and Amendment 1 (03/03).

[7] ITU-T G.992.5 (01(09), Asymmetric digital subscriber line (ADSL) transceivers – extended bandwidth ADSL2 (ADSL2plus), including Corrigendum 1 (11/10).

[8] ITU-T G.993.2 (12/11), Very high speed digital subscriber line transceivers 2 (VDSL2), including Corrigendum 1 (06/12) and Erratum 1 (09/12.

[9] ITU-T G.993.5 (04/10), Self-FEXT cancellation (vectoring) for use with VDSL2 transceivers, including Corrigendum 1 (06/11), Amendment 1 (12/11) and Corrigendum 2 (06/12).

[10] ITU-T G.994.1(06/12), Handshake procedures for digital subscriber line (DSL) transceivers.

[11] ITU-T G.996.2 (05/09) Single-ended line testing for digital subscriber lines (DSL), including Amendment 2 (04/12).

[12] ITU-T G.997.1 (06/12), Physical layer management for digital subscriber line (DSL) transceivers.

[13] ITU-T G.998.4 (06/10), Improved impulse noise protection for DSL transceivers, including Corrigendum 2 (04/11), Amendment 1 (06/11), Corrigendum 3 (12/11), Amendment 2 (04/12) and Corrigendum 4.

[14] Broadband Forum, TR-069, CPE WAN Management Protocol, Issue 1, Amendment 4, July 2011, Protocol Version 1.3.

[15] ITU T G.991.2, (12/2003), Single-pair high-speed digital subscriber line, (SHDSL) transceivers.

[16] ITU-T G.998.2, (12/2007), Ethernet-based multi-pair bonding, Amendment 2.

[17] ETSI TS 101 524 V1.5.1 (2010-08), Symmetric single pair high bitrate, Digital Subscriber Line (SDSL), [ITU-T Recommendation G.991.2 (2005), modified].

[18] IEEE EFM (IEEE 802.3-2004), 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.

[19] ETSI EN 61000-6-1, Electromagnetic Compatibility (EMC) – Part 6.1: Generic standards – Immunity standard for residential, commercial and light-industrial environments.

[20] ITU-T K.21, Resistibility of telecommunication equipment installed in customer premises to over voltages and over currents.

[21] ITU-T G.9700, (04/2014), Fast access to subscriber terminals (G.fast) – Power spectral density specification.

[22] ITU-T G.9701, (12/2014), Fast Access to Subscriber Terminals (G.fast) – Physical layer specification.

[23] ITU-T G.9701 Amendment 1, Draft Fast Access to Subscriber Terminals (G.fast) – Physical layer specification.

[24] ITU-T G.997.2, Draft new Recommendation ITU-T G.997.2, Physical layer management for G.fast transceivers.

[25] ITU G.9807.1 10-Gigabit-capable symmetric passive optical network (XGS-PON)

[26] ITU-T G.988 ONU management and control interface (OMCI) specification

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[27] BBF Certification - TP-247 Issue 4: G-PON & XG-PON & XGS-PON ONU Conformance Test Plan (04/2020)

[28] Recommendation ITU-T Supplement 49: Rogue optical network unit (ONU) considerations (09/2020)

[29] SFF-8472: Management Interface for SFP+

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2 WAN layer 1

2.1 WAN layer 1 general

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "xDSL", "POTS", "ISDN" and, for the datapump definitions, also "DP generation: Operation" or "DP generation: Development" appear in the respective requirement title if applicable. The specific requirement determination rules are the same for the whole "WAN layer 1 general" section.

Note further that the requirements in this section apply to G.fast, VDSL2, ADSL2+ and ADSL, but not to SDSL.

Reference	Requirement
L1-GE-01 MREQ	xDSL / G.fast IP CAN interoperability The CPE must interoperate with the IP CANs as depicted in Table 5 to Table 8 of Section 7.1 in the Annex.
L1-GE-02 REQ	xDSL / G.fast chipset The CPE is based on a Broadcom chipset.
L1-GE-03 RFS	xDSL / G.fast chipset model Please specify the chipset model.
L1-GE-10 REQ	xDSL over POTS datapump The CPE must operate with the xDSL over POTS datapump of the respective chipset model of the generation "operation" as defined in Table 12 of Section 7.4 in the Annex.
L1-GE-11 REQ	xDSL over ISDN datapump The CPE must operate with the xDSL over ISDN datapump of the respective chipset model of the generation "operation" as defined in Table 12 of Section 7.4 in the Annex.
L1-GE-14 REQ	G.fast datapump The CPE must operate with the G.fast datapump of the respective chipset model of the generation "operation" as defined in Table 12 of Section 7.4 in the Annex.
L1-GE-16 MREQ	Datapump settings The CPE datapump settings must be as listed in Table 12 of Section 7.4 in the Annex.
L1-GE-20 MREQ	xDSL / G.fast CPE inventory information (vendor ID) The CPE must communicate the vendor ID (i.e., the ID of the vendor of the chipset), i.e.: • xDSL: The xTU-R vendor ID as specified in ITU-T G.997.1 [12], Section 7.4.2. • G.fast: The FTU-R vendor ID as specified in ITU-T G.997.2 [24], Section 7.13.1.2. I.e., the concatenation of the following 3 substrings: • The T.35 country code (country identification, 2 octets) of the country of the chipset vendor. • The T.35 provider code (vendor identification, 4 octets) of the chipset vendor. • Any information (2 octets). *Example:* 0xB5004244434D0000, where • B500 is the T.35 country code of the United States, • 4244434D is the ASCII code of BDCM that is the abbreviation of Broadcom, and • 0000 is any information of the chipset vendor.
L1-GE-21	xDSL / G.fast CPE inventory information (system vendor ID)

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Reference	Requirement
MREQ	The CPE must communicate the system vendor ID (i.e., the ID of the vendor of the CPE), i.e.: • xDSL: The xTU-R system vendor ID as specified in ITU-T G.997.1 [12], Section 7.4.4. • G.fast: The FTU-R system vendor ID as specified in ITU-T G.997.2 [24], Section 7.13.2.2. I.e., the concatenation of the following 3 substrings: • The T.35 country code (country identification, 2 octets) of the country of the CPE vendor. • The T.35 provider code (vendor identification, 4 octets) of the CPE vendor. • Any information (2 octets). *Example:* 0x5900504242530000, where • 5900 is the T.35 country code of Italy, • 50424253 is the ASCII code of PBBS that is the abbreviation of Pirelli Broadband Systems, and • 0000 is any information of the CPE vendor.
L1-GE-22 MREQ	xDSL / G.fast CPE inventory information (version number) The CPE must communicate the version number (i.e., further chipset information), i.e.: • xDSL: The xTU-R version number as specified in ITU-T G.997.1 [12], Amendment 2 (11/2007), Section 7.4.6. • G.fast: The FTU-R version number as specified in ITU-T G.997.2 [24], Section 7.13.1.4. I.e., a string with at most 16 ASCII characters containing the following 2 substrings separated by a space: • xTU-R or FTU-R chipset firmware (i.e., datapump) version for xDSL or G.fast, respectively. • xTU-R or FTU-R chipset model for xDSL or G.fast, respectively. *Example:* Ap6v38q.24j 68, where • Ap6v38q.24j is the code of the chipset firmware (i.e., datapump) of A2pv6C038q.d24j, and • 68 is the code of the chipset model of 6368.
L1-GE-23 MREQ	xDSL / G.fast CPE inventory information (serial number) The CPE must communicate the serial number (i.e., further system, i.e., CPE, information), i.e.: • xDSL: The xTU-R version number as specified in ITU-T G.997.1 [12], Amendment 2 (11/2007), Section 7.4.8. • G.fast: The FTU-R version number as specified in ITU-T G.997.2 [24], Section 7.13.2.4. I.e., a string with at most 32 ASCII characters containing the following 3 substrings separated by a space: • System serial number, • system model, and • system firmware version. *Example:* 09001X0121276 V226N1W 61400, where • 09001X0121276 is the system (i.e., CPE) serial number, and • V226N1W is the code of the system (i.e., CPE) model of V226N1. • 61400 is the code of the system (i.e., CPE) firmware 6.14.00.

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Reference	Requirement
L1-GE-50 MREQ	xDSL / G.fast surge suppression The CPE must comply with the surge suppression basis protection [19] [20], i.e., 6kV. Note that 2kV has been proven not to be enough in the Swisscom Starlite xDSL pilot.
L1-GE-51 MREQ	xDSL / G.fast MELT requirement The copper WAN interface • must induce at least 30nF between wire a and wire b in VDSL2 / ADSL2+ / ADSL mode, • must induce at least 9nF between wire a and wire b in G.fast mode, and • must not induce any DC voltage, any AC voltage, any copper fault such as poor insulation, short circuit, capacitance unbalance to ground, capacitance leakage to ground, etc.

2.2 WAN layer 1 G.fast

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the term "G.fast" appears in the respective requirement title if applicable. The specific requirement determination rules are the same for the whole "WAN layer 1 G.fast" section.

Reference	Requirement
L1-FA-01 MREQ	G.fast basic standards The CPE must comply with the relevant G.fast standards including up-to-date amendments and corrigenda, i.e.: • ITU-T G.9700 [21] • ITU-T G.9701 [22] • ITU-T G.9701 Amendment 1 [23] • ITU-T G.997.2 [24]
L1-FA-10 MREQ	G.fast (profile 106a) PSD masks The CPE must comply with the G.fast (profile 106a) PSD mask according to ITU-T G.9701 [22].
L1-FA-20 REQ	Basic actual aggregate bit rate vs. reach performance for full G.fast (profile 106a) spectrum For full G.fast (profile 106a) spectrum, i.e., for 2.2 – 106 MHz, and vectoring enabled, the CPE performs better than the reference aggregate bit rate (= US + DS bit rate) vs. reach performance in the presence of low noise (cf. Section 7.9) for the CANs in Section 7.1. that support G.fast.
L1-FA-21 REQ	Basic actual aggregate bit rate vs. reach performance for G.fast (profile 106a) spectrum above the VDSL2 band For G.fast (profile 106a) spectrum above the VDSL2 band up to 106 MHz, and vectoring enabled, the CPE performs better than the reference aggregate bit rate (= US + DS bit rate) vs. reach performance in the presence of low noise (cf. Section 7.9) for the CANs in Section 7.1. that support G.fast.
L1-FA-40 REQ	G.fast attainable bit rate The CPE supports the provision of an attainable bit rate value according to ITU-T G.9701 [22], Section 11.4.1.1.2.
L1-FA-43 REQ	G.fast attainable bit rate accuracy The CPE provides an attainable bit rate value that differs by at most 5% from the actual net data rate when not limited by the configuration. Please specify the respective performance of the CPE.
L1-FA-44 REQ	G.fast attainable expected throughput The CPE supports the provision of an attainable expected throughput value according to ITU-T

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Reference	Requirement
	G.9701 [22], Section 11.4.1.1.4.
L1-FA-45 REQ	G.fast attainable expected throughput accuracy The CPE provides an attainable expected throughput value that differs by at most 5% from the actual bit rate when not limited by the configuration. Please specify the respective performance of the CPE.
L1-FA-46 REQ	G.fast error-free throughput The CPE supports for measurement of error-free throughput and count of error-free bits passed according to ITU-T G.9701 Amendment 1 [23] and ITU-T G.997.2 [24].
L1-FA-47 REQ	G.fast bit swapping The CPE provides bit swapping on each carrier to zero. Each carrier, even with zero bit loading, reloads bits when noise disappears on that carrier, either without adding noise to other carriers, or after adding noise to other carriers.
L1-FA-50 REQ	G.fast improved impulse noise protection The CPE supports impulse noise protection according to ITU-T G.9701 [22].
L1-FA-51 REQ	G.fast on-line reconfiguration (OLR) The CPE supports all on-line reconfiguration (OLR) types according to ITU-T G.9701 [22], Section 13.1.3.
L1-FA-53 REQ	G.fast dying gasp The CPE supports dying gasp according to ITU-T G.9701 [22], Section 11.3.3.2, even when the CPE is fully loaded, i.e., if all Ethernet ports and all other LAN devices such as WiFi are used with maximum capacity. Specifically, after power loss, a minimum operation time of 90ms shall be guaranteed in order to transmit at least 3 flpr indicator transmissions.
L1-FA-62 REQ	G.fast out-of-band signal For a G.fast start frequency above the VDSL2 band with a starting frequency of at least 19.7 MHz, the CPE G.fast out-of-band signal must suffice the spectrum mask of ITU G.9700 [21] Section 7.2.1.2 Figure 7-3 with f_{tr1} = 19.7 MHz and Figure 7-4 with f_{tr2} = 106 MHz and Δf_{th} = 20 MHz.
L1-FA-64 REQ	G.fast DS / US ratio The CPE supports flexible ratios between downstream and upstream user data rates between 9:1 and 1:1 (as set by the CO).
L1-FA-65 REQ	G.fast start frequency The CPE supports a flexible G.fast start frequency, e.g., 2.2 MHz or 17.6 MHz (as set by the CO).
L1-FA-66 REQ	G.fast test parameters Support for HLOG, QLN, ALN, LATN and SATN according to ITU-T G.9701 Amendment 1 [23] and ITU-T G.997.2 [24].
L1-FA-68 MREQ	G.fast discontinuous operation (DO) The CPE supports discontinuous operation according to ITU-T G.9701 [22].

2.3 WAN layer 1 VDSL2

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "VDSL2", "POTS" or "ISDN" appear in the respective requirement title if applicable. The specific requirement determination rules are the same for the whole "WAN layer 1 VDSL2" section.

Reference	Requirement

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Reference	Requirement
L1-V2-01 MREQ	VDSL2 basic standards The CPE must comply with the relevant VDSL2 standards including up-to-date amendments and corrigenda up to date, i.e.: • ITU-T G.993.2 [8] • ETSI TS 101 271 [1] • ITU-T G.993.5 [9] • ITU-T G.997.1 [12]
L1-V2-02 REQ	VDSL2 additional standards The CPE complies with the relevant VDSL2 additional standards including amendments and corrigenda up to date, i.e.: • ITU-T G.994.1 [10] • ITU-T G.996.2 [11] • ITU-T G.998.4 [13]
L1-V2-10 MREQ	VDSL2 profile 35b "super vectoring" capability (applicable to StarX CPEs / ADB CBV2 only) The CPE hardware, i.e., its analogue front-end, must be capable to support VDSL2 profile 35b "super vectoring" operation.
L1-V2-11 RFS	VDSL2 profile 35b "super vectoring" PSD masks (applicable to StarX CPEs / ADB CBV2 only) Please specify whether the CPE complies with the VDSL2 profile 35b "super vectoring" according to ITU-T G.993.2 [8] with the limit PSD mask options (to be defined). If the CPE complies, please specify the respective bit rate vs. reach performance of the CPE.
L1-V2-14 MREQ	VDSL2 over POTS (profile 17a) PSD masks The CPE must comply with the VDSL2 over POTS (profile 17a) PSD mask according to ITU-T G.993.2 [8], Annex B, including the extended US0 band with the limit PSD mask option, i.e., 998ADE17-M2x-M (B8-17).
L1-V2-15 MREQ	VDSL2 over ISDN (profile 17a) PSD masks The CPE must comply with the VDSL2 over ISDN (profile 17a) PSD mask according to ITU-T G.993.2 [8], Annex B, with the limit PSD mask option, i.e., 998ADE17-M2x-B (B8-12).
L1-V2-16 MREQ	VDSL2 over POTS (profile 8b) PSD masks The CPE must comply with the VDSL2 over POTS (profile 8b) PSD mask according to ITU-T G.993.2 [8], Annex B, including the extended US0 band with the limit PSD mask option, i.e., 998-M2x-M (B8-5).
L1-V2-17 MREQ	VDSL2 over ISDN (profile 8b) PSD masks The CPE must comply with the VDSL2 over ISDN (profile 8b) PSD mask according to ITU-T G.993.2 [8], Annex B, with the limit PSD mask option, i.e., 998-M2x-B (B8-6).
L1-V2-20 REQ	Basic actual bit rate vs. reach performance for VDSL2 over POTS (profile 17a) The CPE performs better than the VDSL2 over POTS (profile 17a) reference bit rate vs. reach performance in the presence of low and high noise, respectively (cf. Section 7.11), for the CANs in Section 7.1. that support VDSL2. If the respective CAN contains a VDSL2 over ISDN (profile 17a) board, the respective VDSL2 over ISDN (profile 17a) reference bit rate vs. reach curves are applicable (cf. Sections 7.10 and 7.12).
L1-V2-21 REQ	Basic actual bit rate vs. reach performance for VDSL2 over ISDN (profile 17a) The CPE performs better than the VDSL2 over ISDN (profile 17a) reference bit rate vs. reach performance in the presence of low and high noise, respectively (cf. Sections 7.10 and 7.12), for the CANs in Section 7.1. that support VDSL2.

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Reference	Requirement
L1-V2-22 REQ	Basic actual bit rate vs. reach performance for VDSL2 over POTS (profile 8b) The CPE performs better than the VDSL2 over POTS (profile 8b) reference bit rate vs. reach performance in the presence of low and high noise, respectively (cf. Section 7.11), for the CANs in Section 7.1. that support VDSL2.
L1-V2-23 REQ	Basic actual bit rate vs. reach performance for VDSL2 over ISDN (profile 8b) The CPE performs better than the VDSL2 over ISDN (profile 8b) reference bit rate vs. reach performance in the presence of low and high noise, respectively (cf. Section 7.11), for the CANs in Section 7.1. that support VDSL2.
L1-V2-30 MREQ	VDSL2 vectoring hardware readiness The CPE must be hardware ready for VDSL2 vectoring according to ITU-T G.993.5 [9].
L1-V2-40 REQ	VDSL2 attainable bit rate basic method The CPE supports the provision of an attainable bit rate value complying with the basic method attndr_method = 0 according to ITU-T G.993.2 [8], Section 11.4.1.1.7.1.
L1-V2-41 REQ	VDSL2 attainable bit rate improved method 1 The CPE supports the provision of an attainable bit rate value complying with the improved method attndr_method = 1 according to ITU-T G.993.2 [8], Section 11.4.1.1.7.2.
L1-V2-42 REQ	VDSL2 attainable bit rate improved method 2 The CPE supports the provision of an attainable bit rate value complying with the improved method attndr_method = 2 according to ITU-T G.993.2 [8], Section 11.4.1.1.7.2.
L1-V2-43 REQ	VDSL2 attainable bit rate accuracy The CPE provides an attainable bit rate value that differs by at most 5% from the actual bit rate when not limited by the configuration. Please specify the respective performance of the CPE.
L1-V2-44 REQ	VDSL2 synchronization time in non-vectoring mode The CPE provides a synchronization time in the order of 45 seconds or less including xDSL auto detection in non-vectoring mode.
L1-V2-45 REQ	VDSL2 synchronization time in vectoring mode The CPE provides a synchronization time in the order of 120 seconds or less including xDSL auto detection in vectoring mode.
L1-V2-46 REQ	VDSL2 basic bit swapping The CPE provides bit swapping on each carrier to zero. Each carrier, even with zero bit loading, reloads bits when noise disappears on that carrier without adding noise to other carriers, either without adding noise to other carriers, or after adding noise to other carriers.
L1-V2-47 REQ	VDSL2 basic stability The CPE provides a long term stability proven by the following test: With a fixed profile, G.INP = OFF and SRA = OFF, the synchronisation is not lost for a noise margin of only 2dB in the presence of AWGN.
L1-V2-50 REQ	VDSL2 improved impulse noise protection The CPE supports improved impulse noise protection according to ITU-T G.998.4 [13].
L1-V2-51 REQ	VDSL2 seamless rate adaptation (SRA) The CPE supports seamless rate adaptation (SRA) according to ITU-T G.993.2 [8].
L1-V2-52 MREQ	VDSL2 simultaneous G.INP and SRA in vectoring mode The CPE supports G.INP and SRA simultaneously in vectoring mode.

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Reference	Requirement
L1-V2-53 REQ	VDSL2 dying gasp The CPE supports dying gasp according to ITU-T G.993.2 [8] even when the CPE is fully loaded, i.e., if all Ethernet ports and all other LAN devices such as WiFi are used with maximum capacity. Specifically, after power loss, a minimum operation time of 90ms shall be guaranteed in order to transmit at least 3 flpr indicator transmissions.
L1-V2-62 REQ	VDSL2 out-of-band signal For a G.fast start frequency above the VDSL2 band with a starting frequency of at least 19.7 MHz, the CPE VDSL2 out-of-band signal above at least 19.7 MHz must be below the low noise level of -130 dBm/Hz (cf. Section 7.5.1).
L1-V2-63 REQ	VDSL2 immunity to G.fast reduced spectrum operation The CPE provides sufficient spectrum isolation from G.fast reduced spectrum operation at 19.7 MHz and above in adjacent lines of the same quad so that the VDSL2 stability is not compromised by these lines.
L1-V2-64 REQ	Activation of power holding mode (CFUs: RES, SME, ENT only) The CPE provides power holding mode that can be activated via a CLI command in order to allow a PSD test according to Broadband Forum technical requirement 115 (BBF TR-115) in Section 5.7.1. "PSD Mask Test" referred to as Mode of Procedure (4), i.e., MOP4.

2.4 WAN layer 1 ADSL2+

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "ADSL2+", "POTS" or "ISDN" appear in the respective requirement title if applicable. The specific requirement determination rules are the same for the whole "WAN layer 1 ADSL2+" section.

Reference	Requirement
L1-AP-01 MREQ	ADSL2+ standards (1st part) The CPE must comply with the relevant ADSL2+ standards including up-to-date amendments and corrigenda up to date, i.e.: • ITU-T G.992.5 [7] • ITU-T G.997.1 [12] • ETSI TS 105 388 [3]
L1-AP-02 REQ	ADSL2+ standards (2nd part) The CPE complies with the relevant ADSL2+ standards including amendments and corrigenda up to date, i.e.: • ITU-T G.994.1 [10] • ITU-T G.996.2 [11] • ITU-T G.998.4 [13]
L1-AP-10 MREQ	ADSL2+ over POTS PSD mask The CPE must comply with the ADSL2+ over POTS PSD mask according to ITU-T G.992.5 [7], Annex A, with the limit PSD mask options for non-overlapped spectrum operation of ITU-T G.992.5 [7], Annex A, Sections A.1.3 and A.2.2.
L1-AP-11 MREQ	ADSL2+ over ISDN PSD mask The CPE must comply with the ADSL2+ over ISDN PSD mask according to ITU-T G.992.5 [7], Annex B with the limit PSD mask options for non-overlapped spectrum operation of ITU-T G.992.5 [7], Annex B, according to Sections B1.3 and B.2.2.

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Reference	Requirement
L1-AP-20 REQ	Basic actual bit rate vs. reach performance for ADSL2+ over POTS The CPE performs better than the ADSL2+ over POTS reference bit rate vs. reach performance in the presence of low and high noise, respectively (cf. Section 7.11) for the CANs in Section 7.1. that support ADSL2+.
L1-AP-21 REQ	Basic actual bit rate vs. reach performance for ADSL2+ over ISDN The CPE performs better than the ADSL2+ over ISDN reference bit rate vs. reach performance in the presence of low and high noise, respectively (cf. Section 7.12) for the CANs in Section 7.1. that support ADSL2+.
L1-AP-40 REQ	ADSL2+ attainable bit rate basic method The CPE supports the provision of an attainable bit rate value complying with the basic VDSL2 method attndr_method = 0 as defined for VDSL2 in ITU-T G.993.2 [8], Section 11.4.1.1.7.1.
L1-AP-41 REQ	ADSL2+ attainable bit rate improved method 1 The CPE supports the provision of an attainable bit rate value complying with the improved VDSL2 method attndr_method = 1 as defined for VDSL2 in ITU-T G.993.2, [8], Section 11.4.1.1.7.2.
L1-AP-42 REQ	ADSL2+ attainable bit rate improved method 2 The CPE supports the provision of an attainable bit rate value complying with the improved VDSL2 method attndr_method = 1 as defined for VDSL2 in ITU-T G.993.2 [8], Section 11.4.1.1.7.2.
L1-AP-43 REQ	ADSL2+ attainable bit rate accuracy The CPE provides an attainable bit rate value that differs by at most 5% from the actual bit rate when not limited by the configuration. Please specify the respective performance of the CPE.
L1-AP-44 REQ	ADSL2+ synchronization time The CPE provides a synchronization time in the order of 45 seconds or less including xDSL auto detection.
L1-AP-46 REQ	ADSL2+ bit swapping The CPE provides bit swapping on each carrier to zero. Each carrier, even with zero bit loading, reloads bits when noise disappears on that carrier without adding noise to other carriers, either without adding noise to other carriers, or after adding noise to other carriers.
L1-AP-47 REQ	ADSL2+ stability The CPE provides a long term stability proven by the following test: With a fixed profile, G.INP = OFF and SRA = OFF, the synchronisation is not lost for a noise margin of only 2dB in the presence of AWGN.
L1-AP-50 REQ	ADSL2+ improved impulse noise protection The CPE supports improved impulse noise protection according to ITU-T G.998.4 [13].
L1-AP-51 REQ	ADSL2+ seamless rate adaptation (SRA) The CPE supports online reconfiguration according to ITU-T G.992.5 [7].
L1-AP-53 REQ	ADSL2+ dying gasp The CPE supports dying gasp according to ITU-T G.992.5 [7] even when the CPE is fully loaded, i.e., if all Ethernet ports and all other LAN devices such as WiFi are used with maximum capacity. Specifically, after power loss, a minimum operation time of 90ms shall be guaranteed in order to transmit at least 3 flpr indicator transmissions.

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2.5 WAN layer 1 ADSL

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "ADSL", "POTS" or "ISDN" appear in the respective requirement title if applicable. The specific requirement determination rules are the same for the whole "WAN layer 1 ADSL" section.

Reference	Requirement
L1-AD-01 MREQ	ADSL standards (1st part) The CPE must comply with the relevant ADSL standards including up-to-date amendments and corrigenda up to date, i.e.: • ITU-T G.992.1 [6] • ITU-T G.997.1 [12] • ETSI TS 101 388 [2]
L1-AD-02 REQ	ADSL standards (2nd part) The CPE complies with the relevant ADSL standards including amendments and corrigenda up to date, i.e.: • ITU-T G.994.1 [10] • ITU-T G.996.2 [11]
L1-AD-10 MREQ	ADSL over POTS PSD mask The CPE must comply with the ADSL over POTS PSD mask according to [ITU-T G.992.1 [6], Annex A, with the limit PSD mask options of ITU-T G.992.1 [6], Annex A, Sections A.1.3 and A.2.4.
L1-AD-11 MREQ	ADSL over ISDN PSD mask The CPE must comply with the ADSL over ISDN PSD mask according to ETSI TS 101 388 [2] with the limit PSD mask options for FDD, i.e., non-overlapped spectrum operation, of ETSI TS 101 388 [2], Section 4.2.2.
L1-AD-20 REQ	Basic actual bit rate vs. reach performance for ADSL over POTS The CPE complies perform better than the ADSL over POTS reference bit rate vs. reach performance in the presence of low and high noise, respectively (cf. Section 7.11) for the CANs in Section 7.1. that support ADSL.
L1-AD-21 REQ	Basic actual bit rate vs. reach performance for ADSL over ISDN The CPE complies perform better than the ADSL over ISDN reference bit rate vs. reach performance in the presence of low and high noise, respectively (cf. Section 7.12) for the CANs in Section 7.1 that support ADSL.
L1-AD-40 REQ	ADSL attainable bit rate basic method The CPE supports the provision of an attainable bit rate value complying with the basic VDSL2 method attndr_method = 0 as defined for VDSL2 in ITU-T G.993.2 [8], Section 11.4.1.1.7.1.
L1-AD-41 REQ	ADSL attainable bit rate improved method 1 The CPE supports the provision of an attainable bit rate value complying with the improved VDSL2 method attndr_method = 1 as defined for VDSL2 in ITU-T G.993.2 [8], Section 11.4.1.1.7.2.
L1-AD-42 REQ	ADSL attainable bit rate improved method 2 The CPE supports the provision of an attainable bit rate value complying with the improved VDSL2 method attndr_method = 1 as defined for VDSL2 in ITU-T G.993.2 [8], Section 11.4.1.1.7.2.
L1-AD-43 REQ	ADSL attainable bit rate accuracy The CPE provides an attainable bit rate value that differs by at most 5% from the actual bit rate when not limited by the configuration. Please specify the respective performance of the CPE.

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Reference	Requirement
L1-AD-44 REQ	ADSL synchronization time The CPE provides a synchronization time in the order of 45 seconds or less including xDSL auto detection.
L1-AD-46 REQ	ADSL bit swapping The CPE provides bit swapping on each carrier to zero. Each carrier, even with zero bit loading, reloads bits when noise disappears on that carrier without adding noise to other carriers, either without adding noise to other carriers, or after adding noise to other carriers.
L1-AD-47 REQ	ADSL stability The CPE provides a long term stability proven by the following test: With a fixed profile, G.INP = OFF and SRA = OFF, the synchronisation is not lost for a noise margin of only 2dB in the presence of AWGN.
L1-AD-53 REQ	ADSL dying gasp The CPE supports dying gasp according to ITU-T G.992.5 [7] even when the CPE is fully loaded, i.e., if all Ethernet ports and all other LAN devices such as WiFi are used with maximum capacity. Specifically, after power loss, a minimum operation time of 90ms shall be guaranteed in order to transmit at least 3 flpr indicator transmissions.

2.6 WAN layer 1 SDSL

Reference	Requirement
L1-SD-01 MREQ	SDSL basic standards The CPE must comply with the relevant SDSL standards including up-to-date amendments and corrigenda up to date, i.e.: • ITU-T G.991.2 [15] • ITU-T G.998.2 [16] • ETSI TS 101 524 [17] • IEEE EFM (IEEE 802.3-2004) [18]
L1-SD-14 MREQ	SDSL PSD masks The CPE must comply with the SDSL according to ITU-T G.991.2 [15], Annex B and G.
L1-SD-20 REQ	Basic actual bit rate vs. reach performance for SDSL The CPE performs better than the SDSL Annex B/G two wire reference bit rate vs. reach performance in the presence of low and high noise (using ETSI 0.4mm cables), respectively (cf. Section 7.7, Figure 4, and Section 7.13, Table 17).
L1-SD-44 REQ	SDSL synchronization time The CPE provides a synchronization time below 60 seconds or less.
L1-SD-47 REQ	SDSL basic stability The CPE provides a long term stability proven by the following test: With a fixed profile, the synchronisation is not lost for a noise margin of only 1dB in the presence of AWGN.
L1-SD-48 REQ	SDSL bonding The CPE supports Ethernet in the first mile (EFM) bonding on 4, 6 and 8 wires. The synchronization must not be lost if one or more wires are removed apart from one wire pair that must remain.
L1-SD-53 REQ	SDSL dying gasp The CPE supports dying gasp according to ITU-T G.991.2 [15] even when the CPE is fully loaded, i.e., if all Ethernet ports and all other LAN devices such as WiFi are used with maximum capacity.

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Reference	Requirement
	Specifically, after power loss, a minimum operation time of 90ms shall be guaranteed in order to transmit at least 3 flpr indicator transmissions.

2.7 WAN layer 1 1000Base-BX

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "Fibre" or "fibre" appear in the respective requirement title if applicable. The specific requirement determination rules are the same for the whole "WAN layer 1 fibre" section.

Reference	Requirement
L1-FI-01 MREQ	Fibre - supported FANs The CPE must interoperate with the FANs as depicted in Table 10 of Section 7.2 in the Annex.
L1-FI-02 REQ	100 Mb/s fibre standard The CPE must comply with the relevant optical standards including up-to-date amendments and corrigenda up to date, i.e.: • IEEE 802.3 [4], Clause 37. • IEEE 802.3 [4], 100Base-BX10-U, Clause 58, except the value indicated in Table 5 "100BASE-BX10 receive characteristics": Instead of average receive power of at least -8dBm, at least -3dBm are required.
L1-FI-03 MREQ	1 Gb/s fibre standard The CPE must comply with the relevant optical standards including up-to-date amendments and corrigenda up to date, i.e.: • IEEE 802.3 [4], Clause 37. • IEEE 802.3 [4], 1000Base-BX10-U, Clause 59.
L1-FI-10 REQ	Fibre LC/PC connector interface The CPE provides an optical transceiver that allows for LC/PC (IEC 61754-20 Ed2.0) and F3000/PC (pr. IEC 61754-28).
L1-FI-11 MREQ	Fibre laser protection The CPE must provide a non-removable protective lid to protect its laser transceiver for reasons of safety and against impurities.
L1-FI-12 REQ	Fibre laser detection The CPE provides a LED indicating the detection of a laser beam coming from the FAN (only a layer 1 function for laser detection). *Note: Swisscom requires this in order to provide a fast problem detection in case of malfunction (the customer reports to the hotline) and on request of the regulator (it is advantageous detect laser presence despite only laser class 1 (1M) is used).*
L1-FI-14 RFS	Fibre layer 1 management Does the CPE support EFM OAM features? Please specify if any.

2.8 WAN layer 1 XGS-PON

The following requirements apply to the ONT, which may be integrated into the CPE.

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Reference	Requirement
L1-XG-01 MREQ	XGS-PON - supported NGFANs The ONT must interoperate with the NGFAN as depicted in Table 11 of Section 7.3 in the Annex.
L1-XG-02 MREQ	XGS-PON fibre standard The ONT must comply with ITU G.9807.1 [25] including up-to-date amendments and corrigenda.
L1-XG-03 MREQ	XGS-PON fibre standard - Encryption The ONT must support • Encryption of unicast downstream • Encryption of unicast upstream • Encryption of OMCC (OMCI)
L1-XG-04 MREQ	XGS-PON fibre standard - FEC The ONT must support FEC in both up and downstream directions.
L1-XG-05 MREQ L1-XG-06 MREQ	XGS-PON fibre standard - OMCI The ONT must support OMCI (ITU G.988 [26] incl. amendments and corrigenda) XGS-PON fibre standard – Serial Number The ONT shall have a unique identifier (SN) passed to the OLT according to OMCI standard
L1-XG-07 MREQ	XGS-PON fibre standard – ONT identification The ONT must support at least the following identification fields: • ONU-G Vendor ID • ONU-G Version • ONU2-G Equipment ID • ONU Software Image Version The ONT must pass the following information, in the above fields: • ONT vendor • ONT model • ONT HW version • ONT FW version
L1-XG-08 REQ	XGS-PON fibre standard – ONT extended identification The ONT shouldsupport at least the following identification fields: • ONU-G Version • ONU2-G Equipment ID The ONT must pass the following information, in the above fields: • ONT Chipset FW version • ONT XGS-PON SFP laser model (when a pluggable XGS-PON SFP laser is used)
L1-XG-09 MREQ	XGS-PON dying gasp The ONT must support dying gasp
L1-XG-10 MREQ	XGS-PON BBF The ONT must pass the BBF.247i4 [27] certification and the information in Section 7.16 must be supplied to Swisscom.

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Reference	Requirement
L1-XG-11 REQ	XGS-PON GEM ports The ONT should support 16 GEM port-IDs
L1-XG-12 REQ	XGS-PON Alloc-IDs The ONT should support 8 Alloc-IDs
L1-XG-13 MREQ	XGS-PON Rogue ONT mitigation ONT must not violate the correct and secure operation of the PON-tree where it is attached to.
L1-XG-14 MREQ	XGS-PON Rogue ONT self-isolation ONT must support rogue ONT self-detection and self-isolation: The ONT must have the capability to monitor its own behaviour and autonomously turn off the laser if a fault condition is detected, e.g. detect if it transmits light outside of assigned timeslots and if so, disable the laser.
L1-XG-15 MREQ	XGS-PON Emergency Stop State ONT must switch off the laser and go to Emergency Stop State (O7) after it receives a Disable_Serial_Number PLOAM message [25]. If an ONT has been isolated by the OLT with the Disable_Serial_Number PLOAM message, the laser must stay turned off even after a reboot/power cycle.
L1-XG-16 MREQ	XGS-PON SFP+ whitelist on host For ONT which are composed of a host (e.g. a residential gateway) and a pluggable XGS-PON transceiver (SFP+), the host must only enable the transmitter of XGS-PON SFP+ for which it passed BBF.247 certification [27] i.e. the host must have a whitelist of allowed XGS-PON SFP+ and must not enable unknown SFP+.
L1-XG-17 MREQ	XGS-PON SFP+ rogue prevention XGS-PON SFP+ must not emit rogue signals if plugged into arbitrary hosts (including devices that have no XGS-PON functionality or capability). E.g. this can be achieved by XGS-PON SFP+ that support soft TX_disable control (see [29], table 9-11, A2h 110, bit 6) where the default is set to '1' i.e. the laser of the SFP+ is disabled and is only enabled if the host explicitly enables it by setting the corresponding bit to '0' via I2C.

3 WAN electrical Ethernet

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "Electrical Ethernet" or "electrical Ethernet" appear in the respective requirement title if applicable. The specific requirement determination rules are the same for the whole "WAN electrical Ethernet" section.

Reference	Requirement
EE-01 REQ	Electrical Ethernet standards The CPE complies with the relevant electrical Ethernet standards including up-to-date amendments and corrigenda up to date, i.e.: • IEEE 802.3 [4].
EE-02 MREQ	Electrical Ethernet interface The CPE must support an electrical Ethernet interface.

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4 WAN autosensing

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "xDSL", "G.fast", "Fibre", "fibre", "Electrical Ethernet", "electrical Ethernet", "DHCP", "PPP" appear in the respective requirement title if applicable. The specific requirement determination rules are not the same for the whole "WAN autosensing" section.

Reference	Requirement
AS-01 MREQ	xDSL / G.fast / fibre / electrical Ethernet autosensing (CFUs: RES, CWS only) The CPE supports autosensing of xDSL / G.fast and either fibre or electrical Ethernet, if applicable, as depicted for the whole autosensing process in the flow chart of Figure 5 in Section 7.14.
AS-02 MREQ	xDSL / G.fast autosensing The CPE supports autosensing of G.fast, VDSL2, ADSL2+ and ADSL, if applicable, as depicted for the whole autosensing process in the flow chart of Figure 5 in Section 7.14. I.e., the CPE recognizes the respective CAN port configuration and thereby autosense between G.fast, VDSL2, ADSL2+ and ADSL.
AS-03 MREQ	DHCP / PPP autosensing (CFUs: RES, CWS only) The CPE supports autosensing of DHCP and PPP, if applicable, as depicted for the whole autosensing process in the flow chart of Figure 5 in Section 7.14.
AS-04 MREQ	DHCP / PPP autosensing after choice of DHCP (CFUs: RES, CWS only) The CPE shall not send PPP packets once a DHCP session has been established.
AS-05 MREQ	DHCP / PPP autosensing after choice of PPP (CFUs: RES, CWS only) The CPE shall not send DHCP packets once a PPP session has been established.
AS-10 REQ	Interface trial order with xDSL / G.fast priority over fibre / Electrical Ethernet The CPE tries first the last active WAN interface in operation, if applicable, i.e., xDSL / G.fast or either fibre or electrical Ethernet, if applicable. If this interface trial is not successful or if it is the first one after factory reset, it tries repetitively xDSL / G.fast and either fibre or Electrical Ethernet (in this order) until the WAN interface is successfully established.
AS-11 REQ	Interface trial order with fibre / Electrical Ethernet priority over xDSL / G.fast The CPE tries first the last active WAN interface in operation, if applicable, i.e., xDSL / G.fast or either fibre or electrical Ethernet, if applicable. If this interface trial is not successful or if it is the first one after factory reset, it tries either in parallel either fibre or Electrical Ethernet and xDSL / G.fast, or repetitively either fibre or Electrical Ethernet and xDSL / G.fast (in this order) until the WAN interface is successfully established.
AS-20 MREQ	Configuration download and shutdown unused interface for xDSL / G.fast / fibre / electrical Ethernet The CPE, once it has decided for the WAN interface (xDSL / G.fast, either fibre or electrical Ethernet), loads the configuration for it and deactivates the unused interface.
AS-21 REQ	Alternative interface trial and preference for xDSL / G.fast / fibre / electrical Ethernet If the CPE is in xDSL / G.fast operation, it performs either fibre or electrical Ethernet trials at least every 24 hours; if it detects either a fibre or an electrical Ethernet signal, it changes to this interface. Conversely, if the CPE is already either in fibre or electrical Ethernet operation, it does neither trial nor change back to xDSL / G.fast operation.
AS-30 REQ	Interface trial duration for xDSL / G.fast The CPE tries to detect xDSL / G.fast handshake within a range of 30 - 60 seconds. If not successful, it tries to detect either the fibre or the electrical Ethernet interface, if applicable.
AS-31 REQ	Interface trial duration for fibre / electrical Ethernet The CPE tries to detect either the fibre or the electrical Ethernet interface within a range of

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Reference	Requirement
	30 - 60 seconds. If not successful, it tries to detect xDSL / G.fast handshake, if applicable.

5 WAN upper layer

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "CFU specific", "RES", "SME", "ENT" and "CWS" appear in the respective requirement title if applicable. Additionally, because the same requirement may be used as MREQ and REQ for different CFUs, we refer to an MREQ with a reference number between 1 and 49 and to a REQ with a reference number between 51 and 99, where <REQ number> = <MREQ number> + 50, i.e., if the MREQ reference number is UL-DH-01, the corresponding REQ reference number is UL-DH-51. If the MREQ or the REQ is not used, the corresponding requirement is missing and its number is not used, but is reserved for eventual future needs. The specific requirement determination rules are the same for the whole "WAN upper layer" section.

All upper layer requirements apply to CPEs with G.fast, VDSL2, ADSL2+, ADSL, Fibre and Electrical Ethernet. For SDSL CPEs, please refer to Christoph Bruggmann, Swisscom, for further information.

5.1 WAN upper layer protocol stacks

Reference	Requirement
UL-PS-01 MREQ	PPPoE over ADSL / ADSL2+ protocol stack The following protocol stack for PPPoE over ADSL / ADSL2+ must be supported: IP PPP RFC 2516 (PPPoE) 802.3 Ethernet RFC 2684 LLC / SNAP ATM AAL5 ADSL / ADSL2+
UL-PS-02 MREQ	PPPoE over VDSL2 protocol stack (CFU specific: SME, ENT, CWS only) The following protocol stack for PPPoE over VDSL2 must be supported: IP PPP RFC 2516 (PPPoE) 802.3 Ethernet VDSL2
UL-PS-03 MREQ	DHCP over ADSL / ADSL2+ protocol stack (CFU specific: RES, SME, CWS only) The following protocol stack for DHCP over ADSL / ADSL2+ must be supported (DHCP) (UDP) IP 802.3 Ethernet RFC 2684 LLC / SNAP ATM AAL5 ADSL / ADSL2+
UL-PS-04 MREQ	DHCP over VDSL2 protocol stack (CFU specific: RES, SME, CWS only) The following protocol stack for DHCP over VDSL2 must be supported (DHCP) (UDP)

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Reference	Requirement
	IP 802.3 Ethernet VDSL2
UL-PS-05 MREQ	PPP over fibre / electrical Ethernet protocol stack (CFU specific: SME, ENT, CWS only) The following protocol stack for PPP over either fibre or electrical Ethernet must be supported IP PPP RFC 2516 (PPPoE) 802.3 Ethernet / 802.1q (currently VLAN tag 11, configurable for future applications)
UL-PS-06 MREQ	DHCP over fibre / electrical Ethernet protocol stack (CFU specific: RES, SME, CWS only) The following protocol stack for DHCP over either fibre or electrical Ethernet must be supported (DHCP) (UDP) IP 802.3 Ethernet / 802.1q (currently VLAN tag 10, configurable for future applications)
UL-PS-07 MREQ	IPoE over SDSL protocol stack (CFU specific: ENT only) The following protocol stack for IPoE over SDSL must be supported: IP 802.3 Ethernet SDSL

5.2 WAN upper layer DHCP

Reference	Requirement
UL-DH-01 MREQ	General DHCP support (CFU specific: RES, SME only) The CPE must be able to acquire IP network settings by automatic configuration using Dynamic Host Configuration Protocol (DHCP) RFC 2131. The CPE must support a DHCP client. This must include support for the following standards: • IETF RFC 3396 (Dynamic Host Configuration Protocol), • IETF RFC 2132 (DHCP options and BOOTP vendor extensions) • IETF RFC 2939 (Procedure for defining new DHCP options and message types)
UL-DH-51 REQ	General DHCP support (CFU specific: CWS only) The CPE is able to acquire IP network settings by automatic configuration using Dynamic Host Configuration Protocol (DHCP) RFC 2131. The CPE supports a DHCP client. This includes support for the following standards: • IETF RFC 3396 (Dynamic Host Configuration Protocol), • IETF RFC 2132 (DHCP options and BOOTP vendor extensions) • IETF RFC 2939 (Procedure for defining new DHCP options and message types)
UL-DH-02 MREQ	DHCP IP network information (CFU specific: RES, SME only) The CPE must be able to obtain IP network information dynamically on its connection to the broadband interface using DHCP. This information must include IP address, IP Net Mask, IP Subnet, IP Gateway Address, primary and secondary DNS addresses.
UL-DH-52 REQ	DHCP IP network information (CFU specific: CWS only) The CPE is able to obtain IP network information dynamically on its connection to the broadband

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Reference	Requirement
	interface using DHCP. This information includes IP address, IP Net Mask, IP Subnet, IP Gateway Address, primary and secondary DNS addresses.
UL-DH-03 MREQ	Length of the DHCP options (CFU specific: RES, SME only) All DHCP options together must have a maximum length of 180 bytes.
UL-DH-53 REQ	Length of the DHCP options (CFU specific: CWS only) All DHCP options together have a maximum length of 180 bytes.
UL-DH-04 MREQ	DHCP option 12 "host name" (CFU specific: RES, SME only) The CPE must support DHCP option 12 (host name) according to RFC 2132.
UL-DH-54 REQ	DHCP option 12 "host name" (CFU specific: CWS only) The CPE supports DHCP option 12 (host name) according to RFC 2132.
UL-DH-55 REQ	DHCP option 15 "domain name" (CFU specific: RES, SME, CWS only) The CPE supports DHCP option 15 (domain name) according to RFC 2132.
UL-DH-56 REQ	DHCP option 43 "vendor specific information" (CFU specific: RES, SME, CWS only) The CPE supports DHCP option 43 (vendor specific information) according to RFC 2132. The reference ISP requested implementation of only two encapsulated vendor specific option numbers "1" (URL of the Auto Configuration Server – ACS) and "2" (provisioning code) are required as in TR-069.
UL-DH-07 MREQ	DHCP option 50 "requested IP address" (CFU specific: RES, SME only) The CPE must support DHCP option 50 (requested IP address) according to RFC 2132.
UL-DH-57 REQ	DHCP option 50 "requested IP address" (CFU specific: CWS only) The CPE supports DHCP option 50 (requested IP address) according to RFC 2132.
UL-DH-08 MREQ	DHCP option 51 "lease time" (CFU specific: RES, SME only) The CPE must support DHCP option 51 (lease time) according to RFC 2132.
UL-DH-09 MREQ	DHCP option 53 "DHCP message type" (CFU specific: RES, SME only) The CPE must support DHCP option 53 (message type) according to RFC 2132.
UL-DH-10 MREQ	DHCP option 53 "DHCP message type", force renew message (CFU specific: RES, SME only) The CPE must support force renew according to RFC 3203 (DHCP reconfigure extension). The CPE must accept this command only from the original DHCP server IP address. RFC 3203 mandates the use of DHCP authentication based on RFC 3118 (authentication for DHCP messages). The authentication for force renew packets must be based on Section 4 (configuration token) of RFC 3118 (cf. also requirement "DHCP option 90").
UL-DH-11 MREQ	DHCP option 54 "server identifier" (CFU specific: RES, SME only) The CPE must support DHCP option 54 (server identifier) according to RFC 2132.
UL-DH-61 REQ	DHCP option 54 "server identifier" (CFU specific: CWS only) The CPE supports DHCP option 54 (server identifier) according to RFC 2132.
UL-DH-62 REQ	DHCP option 55 "parameter request list" (CFU specific: RES, SME, CWS only) The CPE supports DHCP option 55 (parameter request list) according to RFC 2132.
UL-DH-13 MREQ	DHCP option 58 "renewal time T1" (CFU specific: RES, SME only) The CPE must support DHCP option 58 (lease renewal time T1) according to RFC 2132.
UL-DH-63	DHCP option 58 "renewal time T1" (CFU specific: CWS only)

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Reference	Requirement
REQ	The CPE supports DHCP option 58 (lease renewal time T1) according to RFC 2132.
UL-DH-14 MREQ	DHCP option 59 "rebinding time T2" (CFU specific: RES, SME only) The CPE must support DHCP option 59 (lease renewal time T2) according to RFC 2132.
UL-DH-64 REQ	DHCP option 59 "rebinding time T2" (CFU specific: CWS only) The CPE supports DHCP option 59 (lease renewal time T2) according to RFC 2132.
UL-DH-15 MREQ	DHCP option 60 "vendor class identifier" (CFU specific: RES only) The CPE must support DHCP option 60 (vendor class identifier) according to RFC 2131. The following CPE identifiers must be sent at the beginning of the DHCP option 60 field in this order in the correct format (see below) separated by commas: • *Service provider ID (6 Bytes):* Default setting must be 100008 • *Service ID (4 Bytes)*: Default setting must be 0001 • *Provisioning code (36 Bytes)*: Written by Auto Configuration Server (ACS) via TR-069 according to RFC 4122 For all applications, further CPE identifiers must be sent in the DHCP option 60 field separated by commas, e.g.: • Vendor name • MAC OUI • CPE model • SW release • CPE serial number The format of the option 60 string as part of the DHCP request must then be: <service provider ID>,<service ID>,<provisioning code >,<device ID>,<vendor name>, <MAC OUI>,<model>,<running firmware version>,<serial number> These parameters are separated by a single comma (ASCII 44), without a space.
UL-DH-16 MREQ	DHCP option 60 "vendor class identifier" (CFU specific: SME only) The CPE must support DHCP option 60 (vendor class identifier) according to RFC 2131. The following CPE identifiers must be sent at the beginning of the DHCP option 60 field in this order in the correct format (see below) separated by commas: • *Service provider ID (6 Bytes):* Default setting must be empty or 100008, according to special agreement. • *Service ID (4 Bytes):* Default setting must be empty or 0001, according to special agreement. • *Provisioning code (36 Bytes):* Written by Auto Configuration Server (ACS) via TR-069 according to RFC 4122, or according to special agreement. For all applications, further CPE identifiers may be sent in the DHCP option 60 field separated by commas, e.g.: • Vendor name • MAC address • CPE model • SW release • CPE serial number The format of the option 60 string as part of the DHCP request must then be: <service provider ID>,<service ID>,<device ID>,<vendor name>,<MAC OUI>,<model>, <running firmware version>,<serial number> These parameters are separated by a single comma (ASCII 44), without a space.

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Reference	Requirement
UL-DH-67 REQ	DHCP option 60 "vendor class identifier" (CFU specific: CWS only) The CPE supports DHCP option 60 (vendor class identifier) according to RFC 2131. The following CPE identifiers is sent at the beginning of the DHCP option 60 field in this order in the correct format (see below) separated by commas: • *Service provider ID (6 Bytes):* Default setting is empty. • *Service ID (4 Bytes):* Default setting is empty. • *Provisioning code (36 Bytes):* Default setting is empty. For all applications, further CPE identifiers may be sent in the DHCP option 60 field separated by commas, e.g.: • Vendor name • MAC address • CPE model • SW release • CPE serial number The format of the option 60 string as part of the DHCP request is then: <service provider ID>,<service ID>,<device ID>,<vendor name>,<MAC OUI>,<model>, <running firmware version>,<serial number> These parameters are separated by a single comma (ASCII 44), without a space.
UL-DH-68 REQ	DHCP option 61 "client identifier" (CFU specific: RES, SME, CWS only) The CPE supports DHCP option 61 (client identifier) according to RFC 2132.
UL-DH-19 MREQ	DHCP option 90 "authentication information" (CFU specific: RES, SME only) The CPE must support DHCP option 90 (authentication information) according to RFC 3118.
UL-DH-69 REQ	DHCP option 90 "authentication information" (CFU specific: CWS only) The CPE supports DHCP option 90 (authentication information) according to RFC 3118.
UL-DH-70 REQ	DHCP option 121 "static route" (CFU specific: RES, SME, CWS only) The CPE supports DHCP option 121 (static route) according to RFC 3442. The CPE is able to learn at least 4 static routes.
UL-DH-71 REQ	6rd configuration "6rd DHCPv4 option 212" (CFU specific: RES, CWS only) The CPE supports the 6rd DHCPv4 option 212 for 6rd configuration according to RFC 5969.
UL-DH-72 REQ	DHCP exception handling (CFU specific: CWS only) There may be some cases where the CPE cannot connect to the DHCP server at start-up due to e.g. DHCP server down or network failure. If the DHCP server connectivity is restored afterwards, a way is needed for the CPE to get an IP address from the server (DHCP requests timeout may already be reached).

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Reference	Requirement
UL-DH-23 MREQ	DHCP back-off algorithm (CFU specific: RES, SME, CWS only) The back-off algorithm must be not too aggressive. Therefore, the following settings are required: • *1 discover command sent:* Wait 4s • *2 discover commands sent:* Wait 8s • *3 discover commands sent:* Wait 16s • *4 discover commands sent:* Wait 32s • *5 discover commands sent:* Wait 64s • *6 discover commands sent:* Wait 64s → do not stop Additionally, the following settings must be required: • *Discover commands:* Every discover command has a new X-ID (RFC 2131). • *X-ID*: X-ID remains constant until DHCP release. • *Renew retries:* Every 5 minutes until rebind • *Rebind retries:* Every 5 minutes until lease expires
UL-DH-24 MREQ	DHCP request in state rebinding (CFU specific: RES, SME only) If CPE must be in state REBINDING and starts sending a DHCPREQUEST, the destination MAC address must be a broadcast address (0x FF FF FF FF FF FF).
UL-DH-74 REQ	DHCP request in state rebinding (CFU specific: CWS only) If CPE is in state REBINDING and starts sending a DHCPREQUEST, the destination MAC address is a broadcast address (0x FF FF FF FF FF FF).

5.3 WAN upper layer other issues

Reference	Requirement
UL-GT-01 MREQ	IPv4 routing The CPE must support IPv4 routing according to RFC 1812.
UL-GT-02 MREQ	Static routes (CFU specific: RES, SME, ENT only) The CPE must support static routes beside the standard NAT / PAT.
UL-GT-52 REQ	Static routes (CFU specific: CWS only) The CPE supports static routes beside the standard NAT / PAT.
UL-GT-03 MREQ	Bridge mode (CFU specific: SME only) The CPE must support bridge mode according to RFC 1483.
UL-GT-53 REQ	Bridge mode (CFU specific: ENT, CWS only) The CPE supports bridge mode according to RFC 1483.
UL-GT-04 MREQ	General VPI / VCI settings for ADSL / ADSL2+ (CFU specific: RES, SME, CWS only) It must be possible to set a default VPI / VCI value of 8 / 35 for both protocols PPPoE and DHCP, when operating in ADSL or ADSL2+ mode.
UL-GT-05 MREQ	Special VPI / VCI settings for ADSL / ADSL2+ (CFU specific: ENT only) It must be possible to set a default VPI / VCI value of 8 / 35 for PPPoE (BBCS) or 1 / 40 for IPoE (CIS), when operating in ADSL or ADSL2+ mode.
UL-GT-06 MREQ	PPPoE max payload tag The CPE must support a PPPoE max-payload tag such that a 1500 Byte payload on PPPoE can be

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Reference	Requirement
	sent.
UL-GT-09 MREQ	DSCP to 802.1p mapping (4 CPE queues) The CPE must support the creation of an 802.1p tag based on a configurable mapping from DSCP in upstream VLANs with 4 CPE queues (see Section 7.15, Table 18 in the Annex).
UL-GT-08 MREQ	TR-069 management protocol (CFU specific: RES, SME only) The CPE must support the TR-069 management protocol according to Broadband Forum, TR-069 [14].
UL-GT-58 REQ	TR-069 management protocol (CFU specific: CWS only) The CPE supports the TR-069 management protocol according to Broadband Forum, TR-069 [14].
UL-GT-09 MREQ	Port forwarding via TR-069 and Web UI (CFU specific: RES, SME only) The CPE must support NAT / PAT network and protocol address translation according to RFC 1631. Port forwarding rules must be configurable via TR-069 and Web user interface (UI).
UL-GT-59 REQ	Port forwarding via TR-069 and Web UI (CFU specific: CWS only) The CPE supports NAT / PAT network and protocol address translation according to RFC 1631. Port forwarding rules are configurable via TR-069 and Web user interface (UI).
UL-GT-10 MREQ	Port forwarding via CLI (CFU specific: RES, SME, ENT only) The CPE must support NAT / PAT network and port address translation according to RFC 1631. Port forwarding rules must be configurable via CLI user interface.
UL-GT-60 REQ	Port forwarding via CLI (CFU specific: CWS only) The CPE supports NAT / PAT network and port address translation according to RFC 1631. Port forwarding rules are configurable via CLI user interface.
UL-GT-11 MREQ	WAN to LAN port mirroring (CFU specific: RES, SME only) The CPE must support WAN to LAN port mirroring such that, for testing purposes, network traces from the WAN side can be captured through a LAN port.
UL-GT-61 REQ	WAN to LAN port mirroring (CFU specific: CWS only) The CPE supports WAN to LAN port mirroring such that, for testing purposes, network traces from the WAN side can be captured through a LAN port.
UL-GT-12 MREQ	VLAN on fibre / electrical Ethernet The CPE must allow for the configuration of a VLAN on either the fibre or the electrical Ethernet WAN interface.

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6 WAN and LAN upper layer

Note that the specific requirements of a given CPE are automatically determined in the separate Excel compliancy sheet if and only if the terms "CFU specific", "RES", "SME", "ENT" and "CWS" appear in the respective requirement title if applicable. Additionally, because the same requirement may be used as MREQ and REQ for different CFUs, we refer to an MREQ with a reference number between 1 and 49 and to a REQ with a reference number between 51 and 99, where <REQ number> = <MREQ number> + 50, i.e., if the MREQ reference number is UL-DH-01, the corresponding REQ reference number is UL-DH-51. If the MREQ or the REQ is not used, the corresponding requirement is missing and its number is not used, but is reserved for eventual future needs. The specific requirement determination rules are the same for the whole "WAN and LAN upper layer" section.

6.1 WAN and LAN IPv6

Reference	Requirement
UL-I6-51 REQ	IPv6 routing The CPE supports IPv6 routing according to RFC 2460.
UL-I6-02 MREQ	General requirements (CFU specific: RES only) The CPE must support the general requirements according to RFC 6204, Section 4.1, in particular with G-1 through G-5.
UL-I6-52 REQ	General requirements (CFU specific: CWS only) The CPE supports the general requirements according to RFC 6204, Section 4.1, in particular with G-1 through G-5.
UL-I6-03 MREQ	6rd transition mechanism (CFU specific: RES only) The CPE must support 6rd functionality and at least one 6rd virtual interface according to RFC 5969.
UL-I6-53 REQ	6rd transition mechanism (CFU specific: CWS only) The CPE supports 6rd functionality and at least one 6rd virtual interface according to RFC 5969.
UL-I6-04 MREQ	6rd configuration "default" routed IPv4 connection (CFU specific: RES only) The CPE must support • TR-069 for 6rd configuration and • enabling and disabling of 6rd on the "default" routed IPv4 connection using TR-69 according to RFC 5969.
UL-I6-54 REQ	6rd configuration "default" routed IPv4 connection (CFU specific: CWS only) The CPE supports • TR-069 for 6rd configuration and • enabling and disabling of 6rd on the "default" routed IPv4 connection using TR-69 according to RFC 5969.
UL-I6-05 MREQ	6rd no multicast (CFU specific: RES only) If 6rd must be operational on the IPv6 CPE, the CPE does not send multicast data on any 6rd tunnel according to RFC 5969.
UL-I6-55 REQ	6rd no multicast (CFU specific: CWS only) If 6rd is operational on the IPv6 CPE, the CPE does not send multicast data on any 6rd tunnel according to RFC 5969.

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Reference	Requirement
UL-I6-06 MREQ	6rd pre-provisioning (CFU specific: RES only) The CPE must be pre-provisioned with the Swisscom specific 6rd parameters: • 6rdPrefix 2a02:1200::/28 • 6rdPrefixLen /28 • IPv4MaskLen of 0, i.e., the full 32 bits of the IPv4 address must be used to calculate the IPv6 prefix • 6rd.swisscom.com, i.e., the 6rd border relay must be predefined as a DNS name • The 6th feature must be disabled by default The CPE must allow changes to these parameters by TR-069.
UL-I6-07 MREQ	LAN requirements (CFU specific: RES only) The CPE must comply with the LAN requirements according to RFC 6204, L-1 to L-14 (in particular with L-13), and LAN.ADDRESSv6.(1, 2, 6-9) of WT-124i3, with the following detailed definition: • *LAN interface:* The definition of a LAN interface in RFC 6204 must be understood as a virtual interface of a router, not the physical interfaces of built-in Ethernet / WLAN bridge of the CPE. • *L-8:* The IPv6 CE router must support a stateless DHCPv6 server according to RFC 3736 on its LAN interfaces, announcing the IPv6 address of the local DNS server. • *L-9:* The M flag must be set to 0 and the O flag must be set to 1. • *L-12:* Not applicable.
UL-I6-57 REQ	LAN requirements (CFU specific: CWS only) The CPE complies with the LAN requirements according to RFC 6204, L-1 to L-14 (in particular with L-13), and LAN.ADDRESSv6.(1, 2, 6-9) of WT-124i3, with the following detailed definition: • *LAN interface:* The definition of a LAN interface in RFC 6204 is understood as a virtual interface of a router, not the physical interfaces of built-in Ethernet / WLAN bridge of the CPE. • *L-8:* The IPv6 CE router supports a stateless DHCPv6 server according to RFC 3736 on its LAN interfaces, announcing the IPv6 address of the local DNS server. • *L-9:* The M flag is set to 0 and the O flag is set to 1. • *L-12:* Not applicable.
UL-I6-08 MREQ	Advertisement on LAN side (CFU specific: RES only) The first /64 of the generated 6rd prefix must be advertised on the LAN interface, the remaining /64's may later be used to attach additional IPv6 routers.
UL-I6-58 REQ	Advertisement on LAN side (CFU specific: CWS only) The first /64 of the generated 6rd prefix is advertised on the LAN interface, the remaining /64's may later be used to attach additional IPv6 routers.
UL-I6-09 MREQ	MTU settings (CFU specific: RES only) • The CPE must advertise an MTU of 1472 bytes by using the MTU option in router advertisements according to RFC 4861. • The MTU option must be configurable by TR-069.
UL-I6-59 REQ	MTU settings (CFU specific: CWS only) • The CPE advertises an MTU of 1472 bytes by using the MTU option in router advertisements according to RFC 4861. • The MTU option is configurable by TR-069.

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Reference	Requirement
UL-I6-10 MREQ	DNS local server and non-local queries (CFU specific: RES only) • For local DNS queries for configuration, the CPE must include a DNS server to handle local queries according to draft-ietf-v6ops-ipv6-6204-bis-11. • Non-local queries must be forwarded unchanged to a DNS server obtained via TR 069 (IPv4 or IPv6) or, if not available, via DHCPv4, according to draft-ietf-v6ops-ipv6-6204-bis-11.
UL-I6-60 REQ	DNS local server and non-local queries (CFU specific: CWS only) • For local DNS queries for configuration, the CPE includes a DNS server to handle local queries, according to draft-ietf-v6ops-ipv6-6204-bis-11. • Non-local queries are forwarded unchanged to a DNS server obtained via TR 069 (IPv4 or IPv6) or, if not available, via DHCPv4, according to draft-ietf-v6ops-ipv6-6204-bis-11.
UL-I6-11 MREQ	Naming services (CFU specific: RES only) The CPE must support IPv6 (AAAA) records in its DNS server according to RFC 3596 and must allow these records to be queried using IPv4 transport according to RFC 3901.
UL-I6-61 REQ	Naming services (CFU specific: SME, ENT, CWS only) The CPE supports IPv6 (AAAA) records in its DNS server according to RFC 3596 and allows these records to be queried using IPv4 transport according to RFC 3901.
UL-I6-12 MREQ	DNS implementation RFC 1034 (CFU specific: RES only) The CPE must provide a DNS implementation fully compliable with RFC 1034.
UL-I6-62 REQ	DNS implementation RFC 1034 (CFU specific: SME, ENT, CWS only) The CPE provides a DNS implementation fully compliable with RFC 1034.
UL-I6-13 MREQ	DNS implementation RFC 1035 (CFU specific: RES only) The CPE must provide a DNS implementation fully compliable with RFC 1035.
UL-I6-63 REQ	DNS implementation RFC 1035 (CFU specific: SME, ENT, CWS only) The CPE provides a DNS implementation fully compliable with RFC 1035.
UL-I6-14 MREQ	General security issues (CFU specific: RES only) The CPE must support functionality sufficient for implementing the set of recommendations according to RFC 6092, Section 4, with the following detailed specifications: • The CPE must support a stateless filter as described in REC-1 to REC-10 of RFC 6092. • The CPE must implement an IPv6 stateful firewall; this firewall complies with REC 12, REC-14 to REC-49 of RFC 6204, and must offer the modes of operation mentioned in REC-11. • The stateful firewall state (enabled/disabled) must be configurable through TR-069. • Note that REC-13 must be already available through TR-069. • The CPE must comply with REC-50 with the exception of TR-069.
UL-I6-64 REQ	General security issues (CFU specific: SME, CWS only) The CPE supports functionality sufficient for implementing the set of recommendations according to RFC 6092, Section 4, with the following detailed specifications: • The CPE supports a stateless filter as described in REC-1 to REC-10 of RFC 6092. • The CPE implements an IPv6 stateful firewall; this firewall complies with REC 12, REC-14 to REC-49 of RFC 6204, and offers the modes of operation mentioned in REC-11. • The stateful firewall state (enabled/disabled) is configurable through TR-069. • Note that REC-13 is already available through TR-069. • The CPE complies with REC-50 with the exception of TR-069.

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Reference	Requirement
UL-I6-15 MREQ	Ingress filtering security issues (CFU specific: RES only) The IPv6 CE router must support ingress filtering according to RFC 2827.
UL-I6-65 REQ	Ingress filtering security issues (CFU specific: CWS only) The IPv6 CE router supports ingress filtering according to RFC 2827.
UL-I6-16 MREQ	Denial of service prevention (CFU specific: RES only) • The device must provide protection against remotely exploitable DoS attacks, in particular against the Neighbour Discovery DoS attack according to RFC 3756, Section 4.3.2. • The protection against the Neighbour Discovery DoS attack may restrict access to the LAN link to registered nodes, so that packets going to a LAN address that have never been seen before do not trigger neighbour solicitation messages, but are silently dropped. Other methods may be used.
UL-I6-66 REQ	Denial of service prevention (CFU specific: CWS only) • The device provides protection against remotely exploitable DoS attacks, in particular against the Neighbour Discovery DoS attack according to RFC 3756, Section 4.3.2. • The protection against the Neighbour Discovery DoS attack may restrict access to the LAN link to registered nodes, so that packets going to a LAN address that have never been seen before do not trigger neighbour solicitation messages, but are silently dropped. Other methods may be used.
UL-I6-17 MREQ	Supported TR-69 parameters (CFU specific: RES only) The CPE must support the following TR-69 parameters for IPv6: • 6rd 4-tuplet • 6rd boolean on-off • IPv4 DNS • IPv6 DNS • IPv6 MTU • RA prefix information option lifetimes Example from Broadband Forum Document PD-193, 181-9 (default values indicated): • *IPv6rd.boolean:* True • *IPv6rd.BorderRelayIPv4Address:* 193.5.122.254 • *IPv6rd.SPIPv6Prefix:* 2a02:1200::/28 • *IPv6rd.IPv4PrefixLength:* 0

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Reference	Requirement
UL-I6-67 REQ	Supported TR-69 parameters (CFU specific: CWS only) The CPE supports the following TR-69 parameters for IPv6: • 6rd 4-tuplet • 6rd boolean on-off • IPv4 DNS • IPv6 DNS • IPv6 MTU • RA prefix information option lifetimes Example from Broadband Forum Document PD-193, 181-9 (default values indicated): • *IPv6rd.boolean:* True • *IPv6rd.BorderRelayIPv4Address:* 193.5.122.254 • *IPv6rd.SPIPv6Prefix:* 2a02:1200::/28 • *IPv6rd.IPv4PrefixLength:* 0
UL-GT-18 MREQ	IPv6 firewall rules via TR-069 and Web UI (CFU specific: RES only) IPv6 firewall rules must be configurable via TR-069 and Web user interface (UI).
UL-GT-19 MREQ	IPv6 firewall rules via CLI (CFU specific: RES only) IPv6 firewall rules must be configurable via CLI user interface.
UL-GT-20 MREQ	IPv6 over PPP (CFU specific: SME, ENT only) The CPE must support IPv6 over PPP according to RFC 5072.

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7 Annex

7.1 CAN types and settings

The CPE must interoperate with the IP CAN types as listed in Table 5, Table 6 (VDSL2, ADSL2+ and ADSL), Table 7 (only VDSL2), Table 8 (G.fast and VDSL2) and Table 9 (only SDSL) below.

	Huawei CAN
Types	Standard: MA5600T (CO) Option: MA5603T (CO, if MA5600T is not available)
Boards	VDMF
Firmware	R15: MA5600V800R015C00 SPH105
Chipset vendors	Broadcom
Chipset FW	10.09.05

	Alcatel Lucent ISAM
Types	Standard: ISAM 7302 (CO) Option: ISAM 7330 (CO, if ISAM 7302 is not available)
Boards	POTS: NVLT-C ISDN: NVLT-D
Firmware	4.5.03r : R4.5.03r (Build 45.582)
Chipset vendors	Ikanos (CO5)
Chipset FW	8.10.7_6.7.3.6

Table 5: Central Office (CO) legacy CAN types and configurations for VDSL2, ADSL2+ and ADSL application.

	Huawei CAN
Types	MA5603T (FTTC)
Boards	VCMM
Firmware	R15: R15 (V800R015C00SPH102)
Chipset vendors	Broadcom
Chipset FW	10.9.10
Mode	In vectoring mode (VDSL2 only)

Table 6: Fibre to the Curb (FTTC) vectoring CAN types and configurations for VDSL2, ADSL2+ and ADSL application.

	Huawei Micro CANs (VDSL2)
Types	Standard: MA5611S-AE48 (FTTB) and MA5611S-DE16 (FTTS) Options: MA5611S-DE48 (FTTS) and MA5611S-AE16 (FTTB) (if MA5611S-AE48 (FTTS) or MA5611S-DE16 are not available, respectively)
Boards	HS3BVDMM
Firmware	R15 (MA5611S-DE16): V800R015C00HP2005 R15 (MA5611S-DE48): V800R015C00SPC203 R15 (MA5611S-AE16): V800R015C00HP2005 R15 (MA5611S-AE48): V800R015C00SPC203
Chipset vendors	Broadcom
Chipset FW	10.9.10
Mode	In vectoring mode (VDSL2 only)

Table 7: Fibre to the Street (FTTS) and Fibre to the Building (FTTB) vectoring CAN types and configurations for VDSL2 only application.

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	Huawei Micro CAN (G.fast and VDSL2)
Types	Standard: MA5811S-AE48 (FTTB) and MA5811S-DE16 (FTTS) Options: MA5811S-DE48 (FTTS) and MA5811S-AE16 (FTTB) (if MA5811S-AE48 (FTTS) or MA5811S-DE16 are not available, respectively)
Boards	HS35FDEM
Firmware	R16 (MA5811S-DE16): V800R016C10SPC112 R16 (MA5811S-DE48): To be defined. R16 (MA5811S-AE16): To be defined. R16 (MA5811S-AE48): To be defined.
Chipset vendors	Broadcom
Chipset FW	11.2.22
Mode	In vectoring mode (VDSL2 and G.fast)

Table 8: Fibre to the Street (FTTS) and Fibre to the Building (FTTB) G.fast / VDSL2 CAN types and configurations for G.fast and VDSL2 only application.

	Alcatel Lucent ISAM
Types	ISAM7356
Boards	NSLT-B
Firmware	4.5.03: 4.5.03 (build 45.443)
Chipset vendors	Lantiq
Chipset FW	SOCRATES-4e PEF 24628 E V1.2

Table 9: CAN types and configurations for SDSL only application.

7.2 FAN types and settings

The CPE must interoperate with the FAN types as listed in Table 10 below.

	Alcatel Lucent
Models	ISAM 7302
Boards	NELT-B
Firmware	4.5.03 (build 45.572, latest)
SFP	3FE66131AA

Table 10: FAN types, boards, firmwares, chipset vendors, chipset types & proxies.

7.3 NGFAN types and settings

The CPE must interoperate with the NGFAN types as listed in Table 11below.

	Huawei
Models	MA5800
Boards	H901FLHF H902XSHF
Firmware	V100R020C10
SFP	Hisense LTF7218

Table 11: NGFAN types, boards, firmwares, chipset vendors, chipset types & proxies.

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7.4 CPE datapumps

The CPE must operate with one of the datapumps and settings as listed in Table 12 below.

Supported access technologies

	xDSL over POTS, VDSL2 over ISDN	ADSL, ADSL2+, VDSL2 over ISDN	G.fast
Supported access technologies	POTS: ADSL, ADSL2+, VDSL2 profiles 8b and 17a. ISDN: VDSL2 profiles 8b and 17a, via enabling of ISDN sync tone in US0 band (optional for POTS).	ISDN: ADSL, ADSL2+, VDSL2 profiles 8b and 17a.	G.fast profile 106a, full and reduced spectrum.
Not supported access technologies	ISDN: ADSL, ADSL2+, since the resulting US0 bands would be too small.	POTS: ADSL, ADSL2+, VDSL2 profiles 8b and 17a.	Any other G.fast access technology.

DP recommendations

Chipset vendor	Chipset model	xDSL over POTS, VDSL2 over ISDN		ADSL, ADSL2+, VDSL2 over ISDN		G.fast	
		Datapump	Driver	Datapump	Driver	Datapump	Driver
Broadcom	6368	A2pv6C038q	Free choice	B2pvC038r1	Free choice	n/a	n/a
	63168	A2pv6F038q	Free choice	B2pvF038r1	Free choice	n/a	n/a
	63381	A2pvl041g	d26c	No recommendation	No recommendation	n/a	n/a
	63138	A2pvbH042m	d26m	No recommendation	No recommendation	AfH042p1	d26m
	63138	A2pvfbH043j2	d26u	No recommendation	No recommendation	A2pvfbH043j2	d26u
	63138	A2pvfbH043j2	d26u	No recommendation	No recommendation	A2pvfbH043j2	d26u
	63158	tbd	tbd	No recommendation	No recommendation	tbd	tbd
Lantiq	VRX288/268	5.7.4.3.0.7	n/a	No recommendation	n/a	No recommendation	n/a
	VRX318/518	7.9.0.C.1.7	n/a	No recommendation	n/a	No recommendation	n/a
Metanoia	MT5321	n/a	n/a	n/a	n/a	8811r039	n/a
Huawei	HN8255Ws	n/a	n/a	n/a	n/a	n/a	n/a

DP setting recommendations

	xDSL over POTS, VDSL2 over ISDN		ADSL, ADSL2+, VDSL2 over ISDN		G.fast	
	US	DS	US	DS	US	DS
Physical retransmission	On	On	On	On	On	On
G.INP	On	On	On	On	n/a	n/a
SRA	On	On	On	On	On	On
Vectoring	On	On	On	On	On	On
Bit swap	On	On	On	On	On	On
Monitoring tones	On		On		On	
A43 sync tone set	Toggle A43/B43		n/a		Toggle A43/B43	
B43 synctone set	Toggle A43/B43		On		Toggle A43/B43	
A43C sync tone set	Off		Off		Off	
B43C synctone set	Off		Off		Off	
V43 sync tone set	Dynamic On		Dynamic On		n/a	

Table 12: Recommended CPE datapumps and CPE datapump settings, where n/r denotes "no recommendation", n/a denotes "not applicable" and V43 = **Dynamic On** denotes V43 = **On** for Ikanos CO chipset and V43 = **Off** for Broadcom CO chipset.

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CPE datapump sync tone settings vs spectral band occupancy is shown in Figure 1 below.

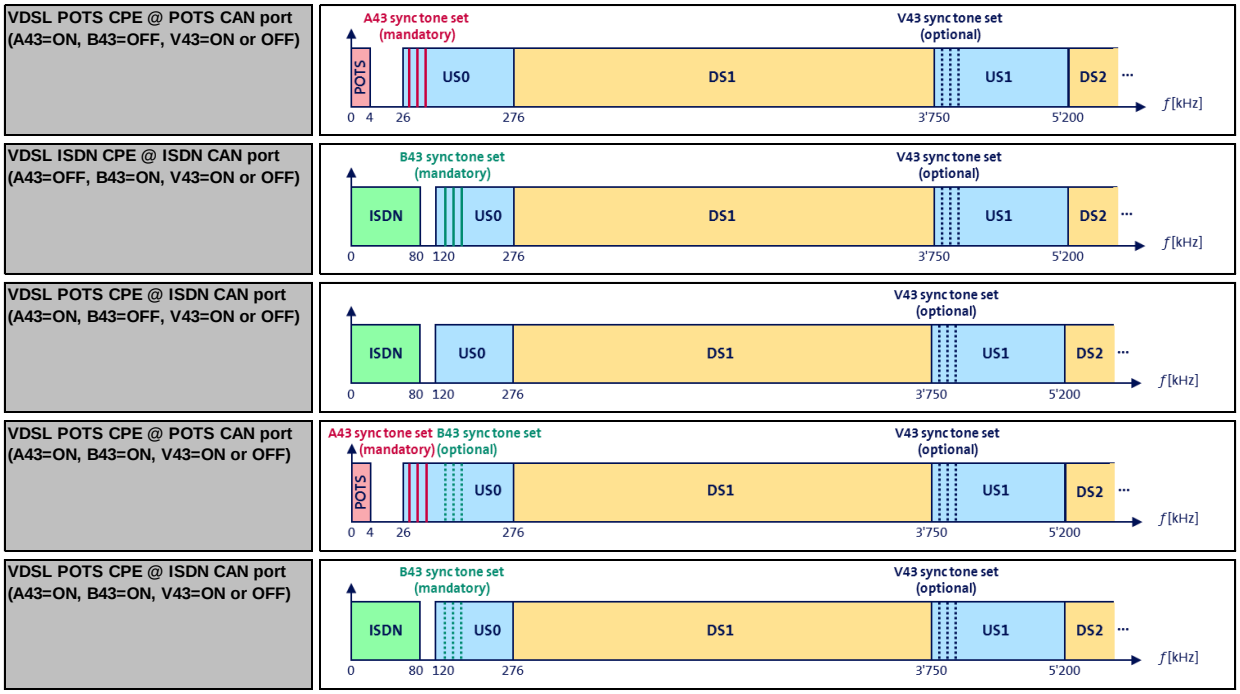

Figure 1: CPE datapump sync tone settings vs spectral band occupancy.

7.5 Noise definitions

7.5.1 Low noise

Additive Gaussian white noise (AWGN) with –130dBm/Hz, also referred to as white noise.

7.5.2 High noise

Swisscom specific noise, also referred to as Spectrum Management 3 (SpM3, for VDSL2, ADSL2+, and ADSL) and Spectrum Management 4 (SpM4, for SDSL) noise related to an assumed cable fill, i.e., an assumed number of xDSL users in adjacent copper cables that cause interference to the considered cable. Special noise files in Spirent simulator format are available in the files

Noise_SCS_Lab_6_4.zip (SpM3) and

Noise_SCS_SpM4.zip (SpM4),

with the example naming

Noise_SCS_Lab_6_4_CO_TP100_050m_xtk.dat (SpM3) and

Noise_SpM4wSDSL_2MHz_CO_HDSL_ETSI_0.4_0050m_xtk.dat (SpM4),

where

- *6_4* refers to Version 6.4,
- *CO* refers to Central Office side, as opposed to *CUST* that in turn refers to CUSTomer side,
- *TP100* refers to performance values applying to TP100 cable type,

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- *HDSL_ETSI_0.4* refers to performance values applying to the HDSL ETSI 0.4mm cable type,
- *0050m* refers to a distance of 50m, and
- *2MHz* refers to the fact that the line simulator (SPIRENT DLS 400HE PE04) is only specified up to 2 MHz.

The file contents are e.g.

```
$ver<1.1.1>
$dist<ref>
$clk<100 MHz>
$data<begin>
10000  -101.5393331
20000  -97.75068257
30000  -96.39145299
```

where, e.g.,

- 10000 refers to the frequency in [kHz] and
- 101.539333144901 refers to the noise power spectral density (PSD) in [dBm/Hz].

Note that the up- and downstream have to be measured separately, i.e., the noise must not be added on both sides at the same time.

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7.6 xDSL reference bit rate vs. reach performance: Low noise and high noise curves

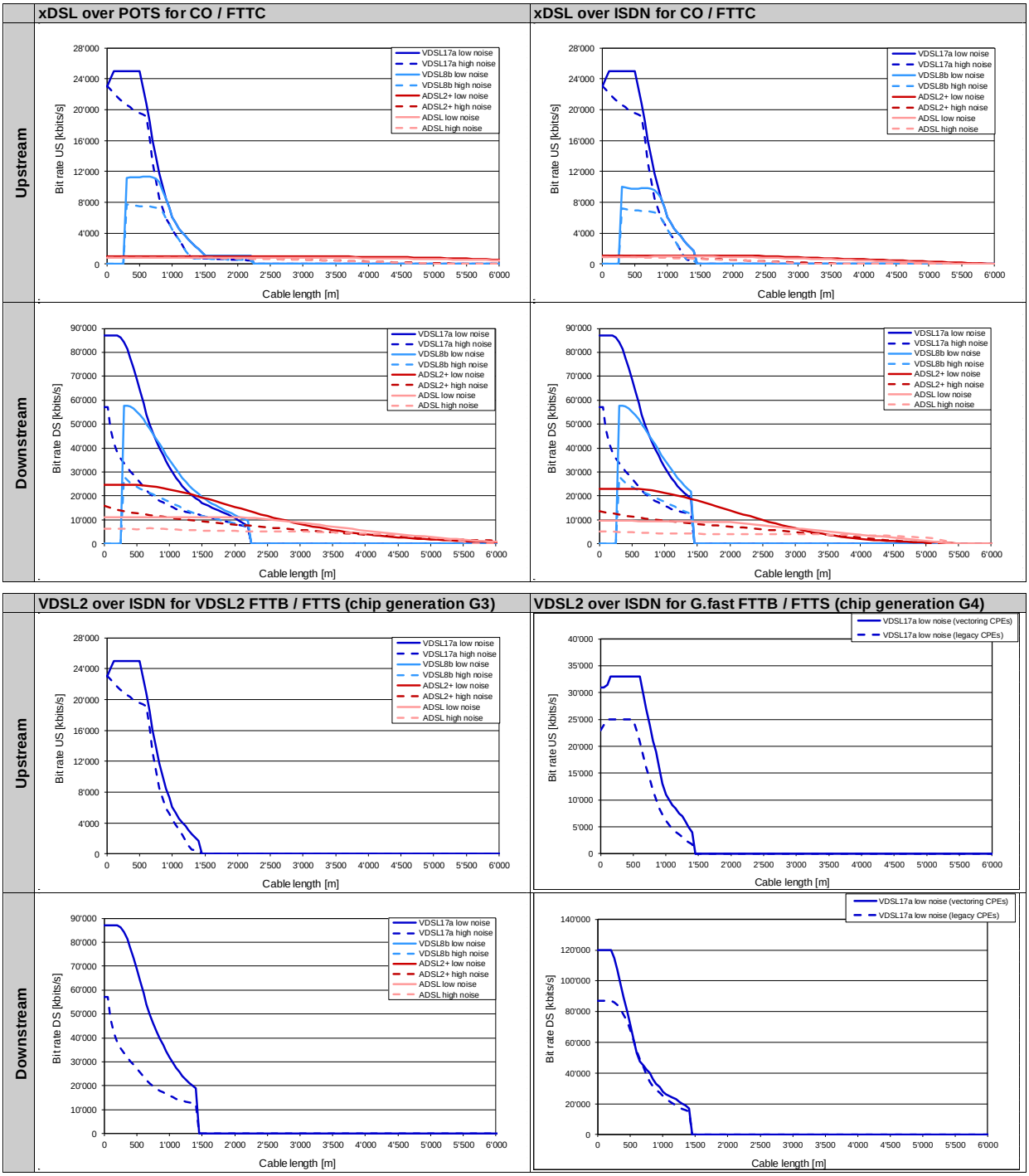

Figure 2: xDSL over POTS reference bit rate performance curves; for numeric values, cf. Sections 7.9 to 7.12.

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7.7 xDSL and G.fast reference bit rate vs. reach performance: Low noise, self noise and self noise with bridged tap curves

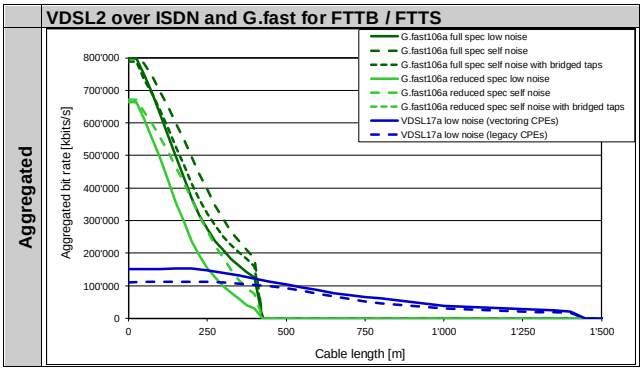

Figure 3: VDSL2 over ISDN and G.fast reference bit rate performance curves; for numeric values, cf. Section 7.9.

7.8 SDSL reference bit rate performance: Graphs

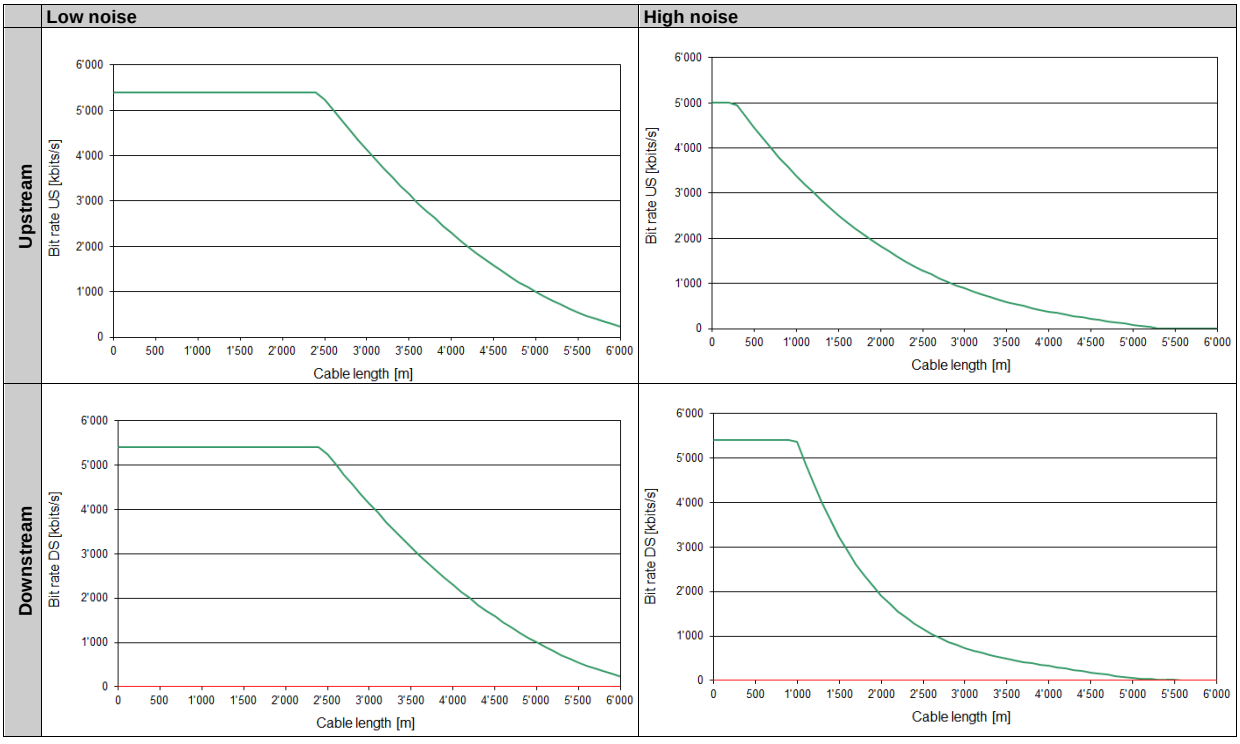

Figure 4: SDSL reference bit rate performance; for numeric values, cf. Section 7.13.

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7.9 G.fast and VDSL2 over ISDN reference actual bit rate vs. reach (FTTB and FTTS, G4): Numeric values

G.fast length [m]	G.fast 106a full spectrum low noise aggregated rate	G.fast 106a full spectrum self noise aggregated rate	G.fast 106a full spectrum self noise BT aggregated rate	G.fast 106a reduced spectrum low noise aggregated rate	G.fast 106a reduced spectrum self noise aggregated rate	G.fast 106a reduced spectrum self noise BT aggregated rate	VDSL length [m]	VDSL2 17a vectored low noise [kb/s] US	VDSL2 17a vectored low noise [kb/s] DS	VDSL2 17a legacy high noise [kb/s] US	VDSL2 17a legacy high noise [kb/s] DS
0	797'206	807'645	789'036	663627	670629	n/a	**0**	31'000	120'000	23'000	87'191
25	797'206	807'645	789'036	663627	670629	n/a	**50**	31'000	120'000	24'000	87'191
50	749'012	782'861	734'255	612149	635348	n/a	**100**	31'500	120'000	25'000	87'191
75	691'618	743'605	689'740	550872	596743	n/a	**150**	33'000	120'000	25'000	87'163
100	629'167	697'393	639'507	493663	556890	n/a	**200**	33'000	120'000	25'000	86'993
125	561'142	649'343	584'115	424005	512567	n/a	**250**	33'000	115'000	25'000	86'136
150	498'471	598'902	526'863	355894	464739	n/a	**300**	33'000	107'000	25'000	84'330
175	431'117	548'785	471'443	297671	415984	n/a	**350**	33'000	98'000	25'000	81'533
200	369'057	495'473	414'537	237624	364939	n/a	**400**	33'000	89'000	25'000	77'848
225	316'998	443'559	365'127	193141	315481	n/a	**450**	33'000	80'000	25'000	73'479
250	274'266	394'543	319'991	153914	268345	n/a	**500**	33'000	71'000	25'000	67'700
275	237'613	345'774	284'763	125466	222555	n/a	**550**	33'000	62'000	22'896	61'300
300	210'230	305'325	251'245	99117	186286	n/a	**600**	33'000	53'000	20'792	54'500
325	183'057	266'242	225'802	79455	150058	n/a	**650**	30'000	47'500	18'444	49'000
350	161'659	237'501	201'573	59948	116282	n/a	**700**	27'000	45'000	16'096	43'700
375	141'977	209'526	181'625	40882	93206	n/a	**750**	24'000	42'000	13'948	38'400
400	124'860	185'037	158'243	30882	75059	n/a	**800**	21'000	40'000	11'800	34'200
425	0	0	0	0	0	n/a	**850**	19'000	36'000	10'116	31'245
450	0	0	0	0	0	n/a	**900**	16'000	33'000	8'432	29'108
475	0	0	0	0	0	n/a	**950**	13'000	31'000	7'260	27'088
500	0	0	0	0	0	n/a	**1'000**	11'000	28'000	6'088	25'096
525	0	0	0	0	0	n/a	**1'050**	10'000	26'000	5'336	23'370
550	0	0	0	0	0	n/a	**1'100**	9'000	25'000	4'584	21'644
575	0	0	0	0	0	n/a	**1'150**	8'500	24'000	4'084	20'283
600	0	0	0	0	0	n/a	**1'200**	7'500	23'000	3'584	18'923
625	0	0	0	0	0	n/a	**1'250**	7'000	21'500	3'072	17'802
650	0	0	0	0	0	n/a	**1'300**	6'000	20'000	2'560	16'680
675	0	0	0	0	0	n/a	**1'350**	5'000	19'000	2'132	15'789
700	0	0	0	0	0	n/a	**1'400**	4'000	17'000	1'704	14'898
725	0	0	0	0	0	n/a	**1'450**	0	0	0	0
750	0	0	0	0	0	n/a	**1'500**	0	0	0	0

Table 13: G.fast reduced spectrum low noise, self noise and self noise with bridged taps (only applicable for G.fast 106a full spectrum) as well as VDSL2 over ISDN low noise reference actual bit rates vs. reach performances for FTTB and FTTS with G4 CO chipset (G.fast and VDSL2) for vectored and legacy CPEs; for graphs cf. Figure 3 in Section 7.7.

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7.10 xDSL over ISDN reference actual bit rate vs. reach (FTTB and FTTS, G3): Numeric values

VDSL length	VDSL2 17a low noise [kb/s]		VDSL2 17a high noise [kb/s]	
[m]	US	DS	US	DS
0	23'000	87'191	23'055	57'269
50	24'000	87'191	22'601	57'269
100	25'000	87'191	22'147	48'218
150	25'000	87'163	21'747	42'240
200	25'000	86'993	21'348	38'290
250	25'000	86'136	20'999	35'591
300	25'000	84'330	20'649	33'591
350	25'000	81'533	20'351	31'923
400	25'000	77'848	20'052	30'363
450	25'000	73'479	19'804	28'796
500	25'000	68'676	19'555	27'187
550	22'896	63'699	19'357	25'556
600	20'792	58'786	19'159	23'948
650	18'444	54'129	16'215	22'422
700	16'096	49'860	13'270	21'031
750	13'948	46'042	10'911	19'814
800	11'800	42'671	8'552	18'786
850	10'116	39'682	7'236	17'936
900	8'432	36'967	5'921	17'227
950	7'260	34'402	5'195	16'601
1'000	6'088	31'872	4'470	15'986
1'050	5'336	29'680	3'814	15'310
1'100	4'584	27'488	3'158	14'597
1'150	4'084	25'760	2'433	14'209
1'200	3'584	24'032	1'707	13'821
1'250	3'072	22'608	1'102	13'464
1'300	2'560	21'184	497	13'107
1'350	2'132	20'052	477	12'769
1'400	1'704	18'920	458	12'432
1'450	0	0	0	0
1'500	0	0	0	0

Table 14: VDSL2 over ISDN low and high noise reference actual bit rates vs. reach performances for FTTB and FTTS with G3 CO chipset (VDSL2 only); for graphs cf. Figure 2 in Section 7.6.

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7.11 xDSL over POTS reference actual bit rate vs. reach (CO and FTTC): Numeric values

VDSL length	VDSL2 17a low noise [kb/s]		VDSL2 17a high noise [kb/s]		VDSL2 8b low noise [kb/s]		VDSL2 8b high noise [kb/s]		ADSL length	ADSL2+ low noise [kb/s]		ADSL2+ high noise [kb/s]		ADSL low noise [kb/s]		ADSL high noise [kb/s]	
[m]	US	DS	US	DS	US	DS	US	DS	[m]	US	DS	US	DS	US	DS	US	DS
0	23'055	57'269	23'055	57'269	0	0	0	0	0	950	24'558	925	15'962	776	11'155	794	6'353
50	22'601	57'269	22'601	57'269	0	0	0	0	100	950	24'558	925	14'967	776	11'155	794	6'301
100	22'147	48'218	22'147	48'218	0	0	0	0	200	950	24'558	925	14'193	776	11'155	793	6'249
150	21'747	42'240	21'747	42'240	0	0	0	0	300	950	24'558	925	13'639	776	11'155	793	6'198
200	21'348	38'290	21'348	38'290	0	0	0	0	400	950	24'555	925	13'205	776	11'155	792	6'172
250	20'999	35'591	20'999	35'591	0	0	0	0	500	950	24'534	925	12'788	776	11'155	792	6'146
300	20'649	33'591	20'649	33'591	11'183	57'570	7'728	28'098	600	950	24'388	925	12'388	776	11'155	791	6'338
350	20'351	31'923	20'351	31'923	11'227	57'708	7'651	26'736	700	950	24'131	924	12'005	776	11'155	791	6'531
400	20'052	30'363	20'052	30'363	11'235	57'321	7'590	25'606	800	950	23'775	921	11'636	776	11'155	790	6'377
450	19'804	28'796	19'804	28'796	11'236	56'488	7'539	24'653	900	950	23'332	917	11'282	776	11'155	790	6'224
500	19'555	27'187	19'555	27'187	11'255	55'284	7'500	23'830	1'000	950	22'813	910	10'940	776	11'155	789	6'095
550	19'357	25'556	19'357	25'556	11'293	53'778	7'472	23'100	1'100	950	22'229	903	10'611	776	11'155	789	5'966
600	19'159	23'948	19'159	23'948	11'335	52'031	7'453	22'431	1'200	950	21'590	893	10'294	776	11'155	788	5'860
650	16'215	22'422	16'215	22'422	11'342	50'100	7'434	21'801	1'300	950	20'904	883	9'987	776	11'155	787	5'754
700	13'270	21'031	13'270	21'031	11'259	48'035	7'397	21'190	1'400	950	20'181	871	9'690	776	11'155	785	5'668
750	10'911	19'814	10'911	19'814	11'026	45'882	7'309	20'585	1'500	950	19'428	858	9'402	776	11'155	783	5'583
800	8'552	18'786	8'552	18'786	10'591	43'680	7'125	19'978	1'600	950	18'652	843	9'123	776	11'155	767	5'516
850	7'236	17'936	7'236	17'936	9'511	41'464	6'776	19'362	1'700	950	17'861	828	8'852	776	11'155	750	5'448
900	5'921	17'227	5'921	17'227	8'432	39'265	5'921	18'737	1'800	950	17'061	812	8'588	776	11'155	734	5'397
950	5'195	16'601	5'195	16'601	7'260	37'108	5'195	18'101	1'900	950	16'258	794	8'331	776	11'155	718	5'345
1'000	4'470	15'986	4'470	15'986	6'088	35'013	4'470	17'458	2'000	950	15'456	776	8'079	776	11'119	702	5'306
1'050	3'814	15'310	3'814	15'310	5'336	32'999	3'814	16'810	2'100	950	14'660	757	7'834	776	11'083	685	5'268
1'100	3'158	14'597	3'158	14'597	4'584	31'077	3'158	16'163	2'200	950	13'875	737	7'593	776	10'896	668	5'240
1'150	2'433	14'209	2'433	14'209	4'084	29'259	2'433	15'521	2'300	950	13'105	716	7'357	776	10'709	650	5'212
1'200	1'707	13'821	1'707	13'821	3'584	27'550	1'707	14'891	2'400	950	12'352	695	7'126	776	10'483	632	5'192
1'250	1'238	13'464	1'238	13'464	3'172	25'953	1'238	14'276	2'500	950	11'619	673	6'898	776	10'258	614	5'172
1'300	768	13'107	768	13'107	2'760	24'470	768	13'684	2'600	950	10'910	651	6'674	776	9'996	595	5'158
1'350	749	12'769	749	12'769	2'332	23'098	749	13'117	2'700	950	10'226	628	6'453	776	9'734	576	5'144
1'400	729	12'432	729	12'432	1'904	21'834	729	12'580	2'800	950	9'569	605	6'236	776	9'441	556	5'133
1'450	710	12'102	710	12'102	1'504	20'671	710	12'075	2'900	950	8'940	582	6'021	776	9'149	536	5'122
1'500	691	11'772	691	11'772	1'104	19'602	691	11'772	3'000	950	8'340	558	5'808	776	8'832	516	5'112
1'550	671	11'446	671	11'446	1'104	18'620	671	11'446	3'100	950	7'770	534	5'605	776	8'516	495	5'101
1'600	652	11'120	652	11'120	1'104	17'713	652	11'120	3'200	950	7'231	510	5'404	776	8'185	474	5'020
1'650	636	10'790	636	10'790	1'104	16'873	636	10'790	3'300	950	6'722	486	5'205	776	7'854	452	4'939
1'700	621	10'460	621	10'460	1'104	16'089	621	10'460	3'400	947	6'244	461	5'009	776	7'516	430	4'854
1'750	601	10'127	601	10'127	1'104	15'369	601	10'127	3'500	943	5'795	437	4'814	776	7'179	408	4'768
1'800	582	9'793	582	9'793	1'104	14'650	582	9'793	3'600	938	5'376	413	4'622	775	6'844	386	4'676
1'850	570	9'448	570	9'448	1'104	13'988	570	9'448	3'700	932	4'986	388	4'432	773	6'508	363	4'584
1'900	559	9'102	559	9'102	1'104	13'325	559	9'102	3'800	926	4'623	364	4'244	763	6'181	339	4'483
1'950	543	8'753	543	8'753	1'104	12'695	543	8'780	3'900	919	4'287	340	4'058	754	5'854	315	4'382
2'000	528	8'404	528	8'404	1'104	12'064	528	8'457	4'000	911	3'976	316	3'876	743	5'541	291	4'268
2'050	516	8'051	516	8'051	1'104	11'456	516	8'215	4'100	903	3'689	293	3'696	732	5'227	267	4'155
2'100	504	7'698	504	7'698	1'104	10'848	504	7'973	4'200	893	3'423	270	3'518	720	4'930	241	4'028
2'150	493	7'341	493	7'341	1'104	10'276	493	7'724	4'300	883	3'179	247	3'345	708	4'633	216	3'901
2'200	481	6'984	481	6'984	1'104	9'704	481	7'475	4'400	872	2'953	224	3'175	695	4'353	190	3'757
2'250	0	0	0	0	0	0	0	0	4'500	860	2'743	202	3'008	683	4'074	164	3'613
2'300	0	0	0	0	0	0	0	0	4'600	846	2'549	180	2'846	670	3'812	138	3'449
2'350	0	0	0	0	0	0	0	0	4'700	832	2'368	159	2'689	657	3'550	111	3'286
2'400	0	0	0	0	0	0	0	0	4'800	817	2'198	139	2'537	644	3'303	84	3'101
2'450	0	0	0	0	0	0	0	0	4'900	801	2'037	118	2'390	631	3'057	56	2'916
2'500	0	0	0	0	0	0	0	0	5'000	784	1'884	99	2'250	618	2'823	28	2'680
2'550	0	0	0	0	0	0	0	0	5'100	766	1'736	80	2'116	605	2'590	0	2'440
2'600	0	0	0	0	0	0	0	0	5'200	747	1'592	61	1'989	591	2'368	0	2'151
2'650	0	0	0	0	0	0	0	0	5'300	726	1'451	44	1'870	578	2'146	0	1'804
2'700	0	0	0	0	0	0	0	0	5'400	705	1'310	27	1'760	564	1'935	0	1'428
2'750	0	0	0	0	0	0	0	0	5'500	682	1'168	10	1'659	550	1'723	0	1'052
2'800	0	0	0	0	0	0	0	0	5'600	658	1'055	0	1'568	535	1'524	0	0
2'850	0	0	0	0	0	0	0	0	5'700	633	941	0	1'487	520	1'324	0	0
2'900	0	0	0	0	0	0	0	0	5'800	607	827	0	1'418	502	1'142	0	0
2'950	0	0	0	0	0	0	0	0	5'900	580	714	0	1'362	485	961	0	0
3'000	0	0	0	0	0	0	0	0	6'000	551	600	0	1'318	463	807	0	0

Table 15: xDSL over POTS low and high noise reference actual bit rates vs. reach performances for CO and FTTC; for graphs cf. Figure 2 in Section 7.6.

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7.12 xDSL over ISDN reference actual bit rate vs. reach (CO and FTTC): Numeric values

VDSL length	VDSL2 17a low noise [kb/s]		VDSL2 17a high noise [kb/s]		VDSL2 8b low noise [kb/s]		VDSL2 8b high noise [kb/s]		ADSL length	ADSL2+ low noise [kb/s]		ADSL2+ high noise [kb/s]		ADSL low noise [kb/s]		ADSL high noise [kb/s]	
[m]	US	DS	US	DS	US	DS	US	DS	[m]	US	DS	US	DS	US	DS	US	DS
0	23'000	87'191	23'055	57'269	0	0	0	0	0	1'100	23'100	1'061	13'704	921	9'693	912	5'263
50	24'000	87'191	22'601	57'269	0	0	0	0	100	1'100	23'100	1'058	13'170	922	9'672	904	5'176
100	25'000	87'191	22'147	48'218	0	0	0	0	200	1'100	23'100	1'051	12'671	923	9'651	895	5'090
150	25'000	87'163	21'747	42'240	0	0	0	0	300	1'100	23'100	1'039	12'203	924	9'630	887	5'004
200	25'000	86'993	21'348	38'290	0	0	0	0	400	1'100	23'100	1'025	11'765	926	9'599	872	4'895
250	25'000	86'136	20'999	35'591	0	0	0	0	500	1'100	23'056	1'006	11'354	928	9'567	858	4'786
300	25'000	84'330	20'649	33'591	10'013	57'570	7'192	28'098	600	1'100	22'902	985	10'968	929	9'536	841	4'696
350	25'000	81'533	20'351	31'923	9'935	57'708	7'094	26'736	700	1'100	22'647	961	10'606	931	9'505	824	4'605
400	25'000	77'848	20'052	30'363	9'849	57'321	7'023	25'606	800	1'100	22'301	935	10'264	932	9'474	805	4'532
450	25'000	73'479	19'804	28'796	9'785	56'488	6'976	24'653	900	1'100	21'872	906	9'941	934	9'442	786	4'458
500	25'000	68'676	19'555	27'187	9'761	55'284	6'943	23'830	1'000	1'100	21'371	875	9'635	936	9'411	765	4'399
550	22'896	63'699	19'357	25'556	9'780	53'778	6'915	23'100	1'100	1'100	20'804	843	9'344	937	9'380	744	4'340
600	20'792	58'786	19'159	23'948	9'826	52'031	6'887	22'431	1'200	1'100	20'181	809	9'067	939	9'348	721	4'294
650	18'444	54'129	16'215	22'422	9'870	50'100	6'857	21'801	1'300	1'100	19'508	774	8'802	940	9'317	698	4'248
700	16'096	49'860	13'270	21'031	9'869	48'035	6'821	21'190	1'400	1'100	18'794	738	8'547	942	9'286	673	4'213
750	13'948	46'042	10'911	19'814	9'772	45'882	6'774	20'585	1'500	1'100	18'045	701	8'301	944	9'255	647	4'178
800	11'800	42'671	8'552	18'786	9'531	43'680	6'694	19'978	1'600	1'100	17'268	664	8'062	939	9'223	620	4'152
850	10'116	39'682	7'236	17'936	9'110	41'464	6'537	19'362	1'700	1'100	16'470	626	7'830	934	9'192	593	4'126
900	8'432	36'967	5'921	17'227	8'493	39'265	5'921	18'737	1'800	1'100	15'656	588	7'603	928	9'161	564	4'107
950	7'260	34'402	5'195	16'601	7'291	37'108	5'195	18'101	1'900	1'099	14'833	551	7'380	922	9'129	534	4'089
1'000	6'088	31'872	4'470	15'986	6'088	35'013	4'470	17'458	2'000	1'096	14'005	513	7'160	915	9'020	498	4'076
1'050	5'336	29'680	3'814	15'310	5'336	32'999	3'814	16'810	2'100	1'091	13'178	476	6'941	908	8'800	465	4'063
1'100	4'584	27'488	3'158	14'597	4'584	31'077	3'158	16'163	2'200	1'082	12'357	439	6'724	885	8'574	423	4'053
1'150	4'084	25'760	2'433	14'209	4'084	29'259	2'433	15'521	2'300	1'061	11'546	403	6'507	862	8'300	385	4'044
1'200	3'584	24'032	1'707	13'821	3'584	27'550	1'707	14'891	2'400	1'037	10'750	367	6'290	839	7'978	340	4'036
1'250	3'072	22'608	1'102	13'464	3'072	25'953	1'102	14'276	2'500	1'011	9'971	333	6'073	817	7'719	295	4'028
1'300	2'560	21'184	497	13'107	2'560	24'470	497	13'684	2'600	984	9'214	299	5'853	794	7'460	248	4'020
1'350	2'132	20'052	477	12'769	2'132	23'098	477	13'117	2'700	957	8'481	267	5'632	771	7'202	201	4'013
1'400	1'704	18'920	458	12'432	1'704	21'834	458	12'580	2'800	929	7'776	236	5'409	748	6'943	152	4'003
1'450	0	0	0	0	0	0	0	0	2'900	901	7'100	206	5'183	725	6'684	103	3'993
1'500	0	0	0	0	0	0	0	0	3'000	872	6'457	178	4'955	702	6'425	52	3'979
1'550	0	0	0	0	0	0	0	0	3'100	843	5'847	151	4'724	679	6'166	0	3'966
1'600	0	0	0	0	0	0	0	0	3'200	814	5'272	125	4'491	657	5'907	0	3'946
1'650	0	0	0	0	0	0	0	0	3'300	785	4'734	101	4'255	634	5'649	0	3'927
1'700	0	0	0	0	0	0	0	0	3'400	756	4'233	79	4'017	611	5'390	0	3'900
1'750	0	0	0	0	0	0	0	0	3'500	726	3'769	58	3'777	588	5'131	0	3'873
1'800	0	0	0	0	0	0	0	0	3'600	697	3'344	39	3'535	565	4'872	0	3'837
1'850	0	0	0	0	0	0	0	0	3'700	668	2'956	22	3'291	542	4'613	0	3'800
1'900	0	0	0	0	0	0	0	0	3'800	639	2'605	6	3'047	515	4'355	0	3'753
1'950	0	0	0	0	0	0	0	0	3'900	610	2'290	0	2'803	490	4'096	0	3'705
2'000	0	0	0	0	0	0	0	0	4'000	581	2'010	0	2'560	465	3'837	0	3'645
2'050	0	0	0	0	0	0	0	0	4'100	553	1'764	0	2'318	434	3'578	0	3'584
2'100	0	0	0	0	0	0	0	0	4'200	524	1'549	0	2'078	403	3'319	0	3'508
2'150	0	0	0	0	0	0	0	0	4'300	496	1'365	0	1'841	372	3'061	0	3'432
2'200	0	0	0	0	0	0	0	0	4'400	468	1'207	0	1'609	341	2'802	0	3'340
2'250	0	0	0	0	0	0	0	0	4'500	439	1'073	0	1'382	310	2'543	0	3'247
2'300	0	0	0	0	0	0	0	0	4'600	412	961	0	1'161	279	2'284	0	3'136
2'350	0	0	0	0	0	0	0	0	4'700	384	866	0	949	248	2'025	0	3'024
2'400	0	0	0	0	0	0	0	0	4'800	356	785	0	746	217	1'767	0	2'893
2'450	0	0	0	0	0	0	0	0	4'900	328	713	0	553	186	1'508	0	2'761
2'500	0	0	0	0	0	0	0	0	5'000	300	647	0	373	155	1'249	0	2'513
2'550	0	0	0	0	0	0	0	0	5'100	271	581	0	207	124	990	0	2'250
2'600	0	0	0	0	0	0	0	0	5'200	243	510	0	57	93	731	0	1'850
2'650	0	0	0	0	0	0	0	0	5'300	214	429	0	0	62	472	0	1'346
2'700	0	0	0	0	0	0	0	0	5'400	185	332	0	0	0	0	0	0
2'750	0	0	0	0	0	0	0	0	5'500	155	213	0	0	0	0	0	0
2'800	0	0	0	0	0	0	0	0	5'600	125	65	0	0	0	0	0	0
2'850	0	0	0	0	0	0	0	0	5'700	93	0	0	0	0	0	0	0
2'900	0	0	0	0	0	0	0	0	5'800	62	0	0	0	0	0	0	0
2'950	0	0	0	0	0	0	0	0	5'900	29	0	0	0	0	0	0	0
3'000	0	0	0	0	0	0	0	0	6'000	0	0	0	0	0	0	0	0

Table 16: xDSL over ISDN low and high noise reference actual bit rates vs. reach performances for CO and FTTC; for graphs cf. Figure 2 in Section 7.6.

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7.13 SDSL Annex B/G low & high noise reference bit rate performance: Numeric values

Length	Low noise [kb/s]		High noise [kb/s]		Length	Low noise [kb/s]		High noise [kb/s]	
[m]	US	DS	[m]	US	[m]	US	DS	US	US
0	5'400	5'400	5'000	5'400	3'100	3'923	3'923	823	672
100	5'400	5'400	5'000	5'400	3'200	3'721	3'721	760	620
200	5'400	5'400	5'000	5'400	3'300	3'524	3'524	701	573
300	5'400	5'400	4'947	5'400	3'400	3'333	3'333	646	530
400	5'400	5'400	4'696	5'400	3'500	3'147	3'147	594	490
500	5'400	5'400	4'454	5'400	3'600	2'966	2'966	545	454
600	5'400	5'400	4'222	5'400	3'700	2'791	2'791	499	419
700	5'400	5'400	3'998	5'400	3'800	2'621	2'621	456	387
800	5'400	5'400	3'784	5'400	3'900	2'456	2'456	416	356
900	5'400	5'400	3'578	5'400	4'000	2'297	2'297	378	325
1'000	5'400	5'400	3'380	5'358	4'100	2'143	2'143	343	296
1'100	5'400	5'400	3'191	4'852	4'200	1'995	1'995	309	267
1'200	5'400	5'400	3'010	4'388	4'300	1'851	1'851	277	238
1'300	5'400	5'400	2'836	3'965	4'400	1'713	1'713	247	210
1'400	5'400	5'400	2'670	3'579	4'500	1'581	1'581	218	182
1'500	5'400	5'400	2'512	3'227	4'600	1'454	1'454	190	155
1'600	5'400	5'400	2'361	2'909	4'700	1'332	1'332	164	129
1'700	5'400	5'400	2'217	2'620	4'800	1'215	1'215	138	105
1'800	5'400	5'400	2'079	2'359	4'900	1'104	1'104	113	81
1'900	5'400	5'400	1'949	2'125	5'000	998	998	88	61
2'000	5'400	5'400	1'824	1'914	5'100	897	897	64	42
2'100	5'400	5'400	1'706	1'725	5'200	802	802	39	28
2'200	5'400	5'400	1'594	1'556	5'300	712	712	0	17
2'300	5'400	5'400	1'488	1'405	5'400	628	628	0	12
2'400	5'400	5'400	1'387	1'271	5'500	548	548	0	12
2'500	5'247	5'247	1'292	1'152	5'600	475	475	0	0
2'600	5'013	5'013	1'202	1'046	5'700	406	406	0	0
2'700	4'784	4'784	1'117	953	5'800	343	343	0	0
2'800	4'561	4'561	1'037	870	5'900	285	285	0	0
2'900	4'343	4'343	961	796	6'000	232	232	0	0
3'000	4'130	4'130	890	730	-	-	-	-	-

Table 17: SDSL Annex B/G low and high noise reference bit rate performance; for graphs cf. Figure 4 in Section 7.7.

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7.14 Autosensing process

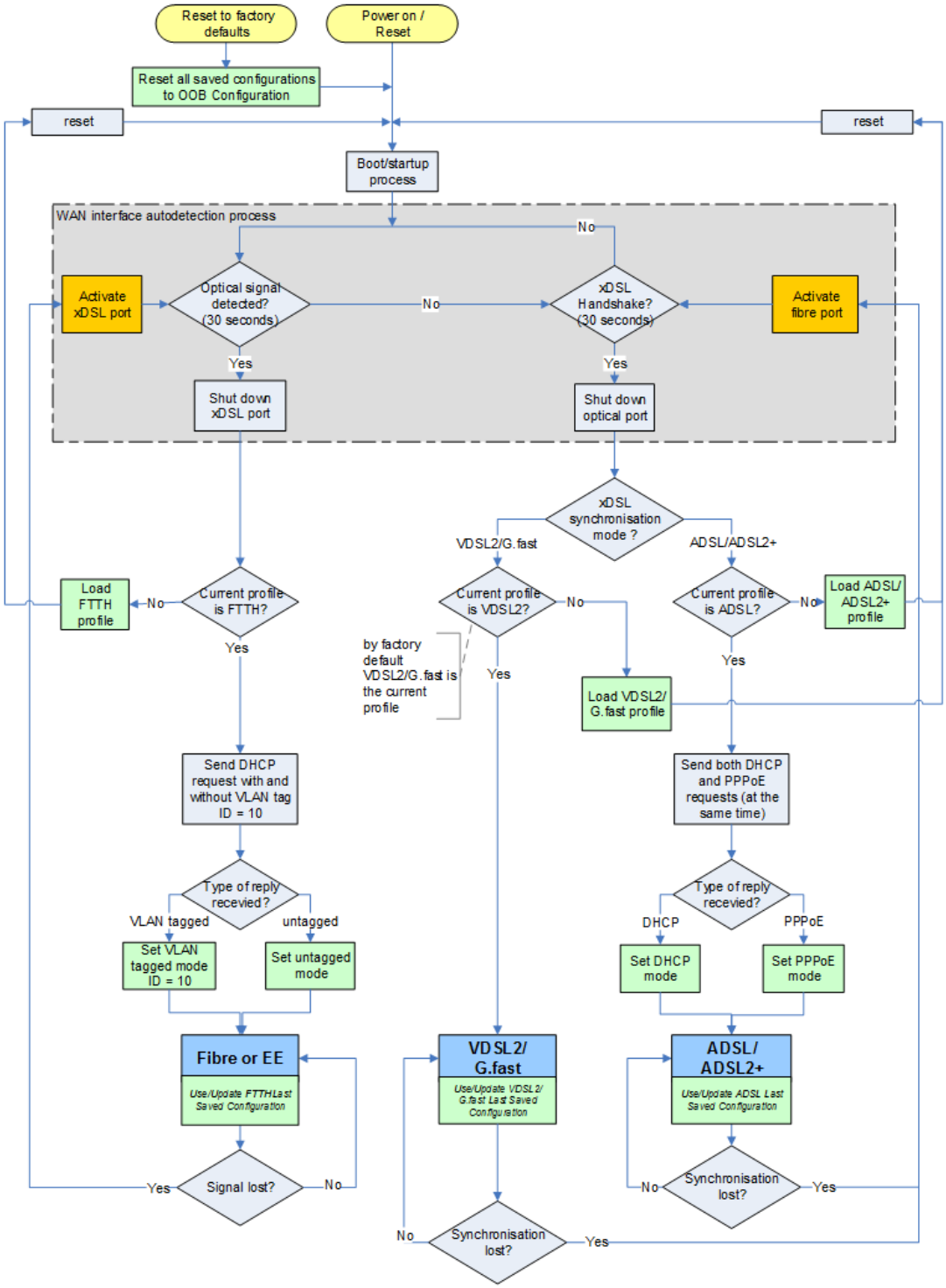

Figure 5: Autosensing process, where EE is used to abbreviate electrical Ethernet.

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7.15 DSCP to 802.1p mapping

The required mapping from DSCP (xDSL, fibre) to 802.1p (fibre only) is listed in Table 18.

DSCP	802.1p	Service	CPE with	
			3 queues	4 queues
0	0	3P Internet (TV Air, OTT)	Q0	Q0
AF11	1	3P zapping (unicast, UDP) TV Air (only in IDC) Replay TV	Q1	Q1
AF31	3	3P VoD (unicast, TCP)	Q1	Q1
AF41	2 (downstream) 4 or n/a (upstream)	3P TV (multicast)	Q1	Q2
	4	3P VoIP Videoconference signalling	Q1	Q2
EF	5	3P VoIP 3P video conferencing	Q3	Q3
n/a	n/a	Control	Q3	Q3

Table 18: DSCP to 802.1p mapping, with 3 CPE queues (Q0, Q1, Q3) and 4 CPE queues (Q0, Q1, Q2, Q3).

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7.16 XGS-PON ONT Information

The ONT supplier must report the following information in written form to Swisscom whenever there is a change in one of the fields:

Item	Description
ONT Full Vendor Name	The full name of the ONT vendor
ONT Vendor ID	The vendor ID is a maximum of 4 characters. Example ABCD
ONT model	
ONT HW version	
ONT Software Version	Main software version running on the ONT
ONT PON Serial Number format/encoding	How the serial number is formatted on the ONT
ONT PON Serial number labeling	Is the PON serial number printed on the label on the outside of the ONT
ONT Type	GatewayHost & separate SFP+, Gateway with interagted optics, SFP ONU (integrate MAC)
ONT Chipset Vendor	The name of the chipset vendor. Example Broadcom
ONT Chipset model	The model number of the PON chipset. Example Broadcom 63158
ONT Chipset firmware version ONT Chipset firmware version	The version of the firmware provided by the chipset vender
SFP Vendor*	The vendor of the SFP
SFP Model*	The model number of the SFP

Table 19: Required ONT information

*Only applicable for pluggable XGS-PON SFP (without MAC)

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