

TR-252

xDSL Protocol-Independent Management Model

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Executive Summary

TR-252 specifies a protocol-independent management model for ADSL, ADSL2, ADSL2plus and VDSL2 containing the parameters described in the ITU-T Recommendation G.997.1. The model is based on an earlier model specified in Broadband Forum TR-129 with the configuration part of the model replaced by the Vector of Profiles model specified in TR-165 plus new parameters defined in a more recent version of G.997.1. Parameters are also included from ITU-T Recommendation G.997.1 Amendment 1 for the management of retransmission and vectoring and ITU-T Recommendation G.997.1 Amendments 2, 3 and 4 and Corrigendum 2.

1 Purpose and Scope

1.1 Purpose

The purpose of this Technical Report is to provide a management model for ADSL, ADSL2, ADSL2plus and VDSL2 based on the parameters described in the ITU-T Recommendation G.997.1 [1], its Amendments 1, 2, 3 and 4 ([10], [11], [12] and [13]) and Corrigendum 2 [14]. The management model is independent of any protocol.

1.2 Scope

This Technical Report places into an object model all the parameters specified in G.997.1 for:

- Configuration Management
- Status Monitoring
- Performance Management including thresholds
- Test / Diagnostics
- Inventory data

Although most of the parameters in G.997.1 apply to ADSL [2, 3], ADSL2 [4, 5], ADSL2plus [6] and VDSL2 [7] there are some that only apply to one or more of the transmission technologies. This report provides a unified model so that any of the technologies may be managed using it. The applicability of a parameter to a technology is defined in G.997.1. Parameters are also included for the management of retransmission [8] and vectoring [9]. The model contains only the parameters in the version of G.997.1 listed in the references [1] and in G.997.1 Amendments 1, 2, 3 and 4 ([10], [11], [12] and [13]) and Corrigendum 2 [14].

2 References and Terminology

2.1 Conventions

In this Technical Report, several words are used to signify the requirements of the specification. These words are always capitalized. More information can be found in RFC 2119.

MUST	This word, or the term “REQUIRED”, means that the definition is an absolute requirement of the specification.
MUST NOT	This phrase means that the definition is an absolute prohibition of the specification.
SHOULD	This word, or the term “RECOMMENDED”, means that there could exist valid reasons in particular circumstances to ignore this item, but the full implications need to be understood and carefully weighed before choosing a different course.
SHOULD NOT	This phrase, or the phrase "NOT RECOMMENDED" means that there could exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications need to be understood and the case carefully weighed before implementing any behavior described with this label.
MAY	This word, or the term “OPTIONAL”, means that this item is one of an allowed set of alternatives. An implementation that does not include this option MUST be prepared to inter-operate with another implementation that does include the option.

2.2 References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

Document	Title	Source	Year
[1] G.997.1	<i>Physical layer management for Digital Subscriber Line (DSL) Transceivers</i>	ITU-T	2009/04
[2] G.992.1	<i>Asymmetric digital subscriber line (ADSL) transceivers</i>	ITU-T	1999/06

[3]	G.992.2	<i>Splitterless asymmetric digital subscriber line (ADSL) transceivers</i>	ITU-T	1999/06
[4]	G.992.3	<i>Asymmetric digital subscriber line transceivers 2 (ADSL2)</i>	ITU-T	2009/04
[5]	G.992.4	<i>Splitterless asymmetric digital subscriber line transceivers 2 (ADSL2)</i>	ITU-T	2002/07
[6]	G.992.5	<i>Asymmetric digital subscriber line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)</i>	ITU-T	2009/01
[7]	G.993.2	<i>Very high speed digital subscriber line 2 (VDSL2)</i>	ITU-T	2006/02
[8]	G.998.4	<i>Improved impulse noise protection for DSL transceivers</i>	ITU-T	2010/06
[9]	G.993.5	<i>Self-FEXT cancellation (vectoring) for use with VDSL2 transceivers</i>	ITU-T	2010/04
[10]	G.997.1 Amendment 1	<i>Physical layer management for digital subscriber line (DSL) transceivers: Amendment 1: Management of ITU-T G.998.4, G.993.5 and receiver referred virtual noise of ITU-T G.993.2</i>	ITU-T	2010/06
[11]	G.997.1 Amendment 2	<i>Physical layer management for digital subscriber line (DSL) transceivers: Amendment 2: New channel initialization policies</i>	ITU-T	2010/11
[12]	G.997.1 Amendment 3	<i>Physical layer management for digital subscriber line (DSL) transceivers: Amendment 3</i>	ITU-T	2011/06
[13]	G.997.1 Amendment 4	<i>Physical layer management for digital subscriber line (DSL) transceivers: Amendment 4</i>	ITU-T	2011/12
[14]	G.997.1 Corrigendum 2	<i>Physical layer management for digital subscriber line (DSL) transceivers: Corrigendum 2</i>	ITU-T	2011/10
[15]	TR-129	<i>Protocol-Independent Management Model for Next Generation DSL Technologies</i>	BBF	2006
[16]	TR-165	<i>Vector of Profiles</i>	BBF	2009

2.3 Definitions

The following terminology is used throughout this Technical Report.

FTTx.	Summarises FTTB, FTTC and FTTK
Vector of Profiles	A set of N independent profiles, each profile containing a unique set of DSL modem configuration parameters and the value of each vector index referencing specific values of the parameters.
xDSL	Summarizes the DSL types ADSL (G.992.1/G.992.2), ADSL2 (G.992.3/G.992.4), ADSL2plus (G.992.5) and VDSL2 (G.993.2).

2.4 Abbreviations

This Technical Report uses the following abbreviations:

DPBO	Downstream Power Back-Off
DS	Downstream
DSLAM	Digital Subscriber Line Access Multiplexer
EMS	Element Management System
FEXT	Far End Crosstalk
FTTB	Fibre To The Building
FTTC	Fibre To The Cabinet
FTTK	Fibre To The Kerb
INP	Impulse Noise Protection
NEXT	Near End Crosstalk
NMS	Network Management System
PSD	Power Spectral Density
RFI	Radio Frequency Interference
SNR	Signal to Noise Ratio
US	Upstream
UPBO	Upstream Power Back-Off
VN	Virtual Noise
VoP	Vector of Profiles

3 Technical Report Impact

3.1 Energy Efficiency

TR-252 has no impact on energy efficiency.

3.2 IPv6

TR-252 has no impact on IPv6.

3.3 Security

TR-252 has no impact on security.

3.4 Privacy

TR-252 has no impact on privacy.

4 xDSL Managed Object Model

This specification is based on the managed objects listed in ITU-T Recommendation G.997.1 [1], its Amendments up to and including Amendment 4 and Corrigendum 2. The object model in this specification only specifies the structure of the managed objects, the detailed parameter definitions and their access mode (read-only vs read-write) is specified in references [1-14].

Figure 1 illustrates notations used in this specification for illustrating the object model.

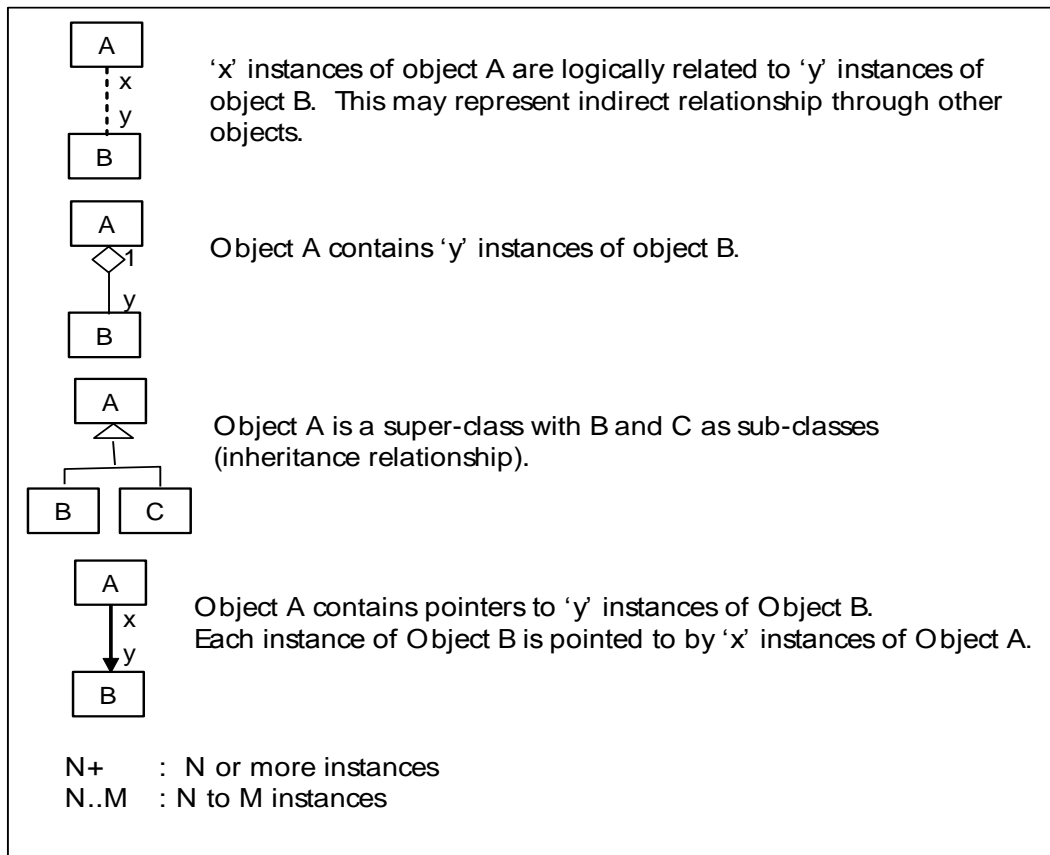
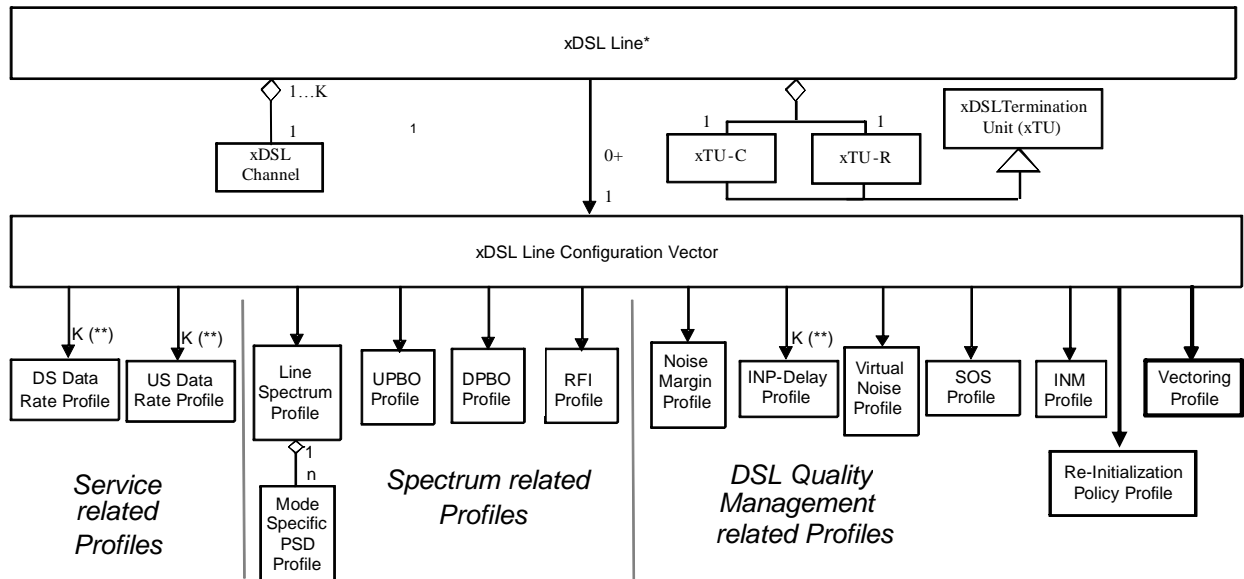


Figure 1/TR-252 – Notation

5 Object Model for xDSL Configuration Management

The principle of the object model for the configuration parameters is known as Vector of Profiles (VoP) which was first developed in Broadband Forum TR-165. In VoP the configuration parameters are divided into independent sets or profiles which are addressed by a vector of pointers. The model in this Technical Report supersedes that in TR-165. Figure 2 shows the individual profiles which contain the parameters listed below. The parameter names are taken from G.997.1 and its amendments which give the parameter definitions.



* Note: in direct attachment method mode, the xDSL Line is equal to the xDSL Line Configuration Vector.

K = maximum number of channels = 4

** Note: these are Channel related profiles, each instance of which is identified by a Channel Number

"n" is number of xDSL transmission modes enabled in the XTSE configuration parameter

Figure 2/TR-252 - Managed object model: configuration management

5.1 xDSL Line

The xDSL Line object represents an individual physical transmission line and its associated parameters and states.

The following attributes MUST be supported by the xDSL Line object:

- xDSL Line Identifier

- Pointer to xDSL Line Configuration Vector
- Pointer to xDSL Line Threshold Template
- Power Management State Forced (PMSF)
- Loop Diagnostics Mode Forced
- Automode Cold Start Forced
- xDSL Transmission System
- Power Management State
- Initialization Success/Failure Cause
- Update request flag for near-end test parameters (UPDATE-TEST-NE)
- Update request flag for far-end test parameters (UPDATE-TEST-FE)

5.2 xDSL Channel

The xDSL Channel object represents an individual logical transmission channel over the xDSL Line and its associated parameters and states.

The following attributes **MUST** be supported by the xDSL Channel object:

- Channel Number (Numeric ID for a channel in a Line – 1 to K)

5.3 xDSL Termination Unit (xTU)

An xDSL Termination Unit object represents an xDSL Modem at either end of the xDSL Line. The xTU object only represents a super-class that cannot be instantiated. It has two sub-classes that are instantiated - xTU-C (central office modem), and an xTU-R (Remote modem). The xDSL Line is always terminated by an xTU-C at the central office (or at a cabinet) and an xTU-R at the remote subscriber location.

The following attributes **MUST** be supported for xDSL Termination Units:

- xTU Identifier (xTU-C or xTU-R)
- xTU G.994.1 Vendor ID
- xTU System Vendor ID
- xTU Version Number
- xTU Serial Number
- xTU Self-Test Result
- xTU xDSL Transmission System Capabilities
- Current 15-minute Interval Elapsed Time (0 to 900 sec)
- Number of previous 15-minute Intervals (0 to N)
- Number of previous invalid 15-minute Intervals (0 to N)
- Current 1-day Interval Elapsed Time (0 to 86400 sec)
- Number of previous 1-day Intervals (0 to M)

- Number of previous invalid 1-day intervals (0 to M)

5.4 xDSL Line Configuration Vector

The xDSL Line Configuration Vector object represents a possible complete xDSL line configuration either in the form of a combination of configuration profiles or referring to a combination of configuration profiles.

The xDSL Line Configuration Vector identifier is a numeric scalar whose interpretation is according to the implemented VoP attachment method (see Appendix I):

- In ‘direct’ attachment mode the xDSL Line Configuration Vector identifier is the same as the xDSL Line identifier. Each xDSL line is directly associated with its own instance of xDSL Line Configuration VoP .
- In ‘indirect’ attachment mode the xDSL Line Configuration Vector identifier is a simple ordered number. Each xDSL line is associated with a single xDSL Line Configuration VoP instance, identified by a unique xDSL Line Configuration Vector identifier. Note that zero or more xDSL lines may be associated with each xDSL Line Configuration VoP instance.

The xDSL Line Configuration Vector object MUST contain the following read/write parameters:

- xDSL Line Configuration Vector Identifier
- Pointer to Upstream Data Rate Profile for Channel Number 1
- Pointer to Downstream Data Rate Profile for Channel Number 1
- Pointer to INP Delay Profile for Channel Number 1
- Pointer to Upstream Data Rate Profile for Channel Number 2
- Pointer to Downstream Data Rate Profile for Channel Number 2
- Pointer to INP Delay Profile for Channel Number 2
- Pointer to Upstream Data Rate Profile for Channel Number 3
- Pointer to Downstream Data Rate Profile for Channel Number 3
- Pointer to INP Delay Profile for Channel Number 3
- Pointer to Upstream Data Rate Profile for Channel Number 4
- Pointer to Downstream Data Rate Profile for Channel Number 4
- Pointer to INP Delay Profile for Channel Number 4
- Pointer to Line Spectrum Profile
- Pointer to Noise Margin Profile
- Pointer to Virtual Noise Profile
- Pointer to UPBO Profile
- Pointer to DPBO Profile
- Pointer to RFI Profile
- Pointer to SOS Profile
- Pointer to INM Profile
- Pointer to Vectoring Profile

- Pointer to the Re-initialization Policy Profile

5.5 Service related profiles

The service related profiles contain the parameters for configuration of data rates for individual channels. There will be a separate data rate profile for each of the upstream and downstream channels. The number of possible channels varies with the type of DSL. For ADSL and VDSL2 there can be up to two in each direction and for ADSL2 and ADSL2plus there can be up to four in each direction. Thus to cover all possibilities there will be 8 pointers in the xDSL Line Configuration Vector for data rate profiles. If less than the maximum number of channels is to be used then the pointers corresponding to non-required channels MUST be set to a null value (0).

DS Data Rate Profile

The downstream data rate profile MUST contain the following parameters:

- Minimum Data Rate downstream
- Minimum Reserved Data Rate downstream
- Maximum Data Rate downstream
- Rate Adaptation Ratio downstream
- Minimum Data Rate in low power state downstream
- Maximum Bit Error Ratio downstream
- Data Rate Threshold Upshift downstream
- Data Rate Threshold Downshift downstream
- Minimum SOS Data Rate (MIN-SOS-DR) downstream
- Minimum Expected Throughput for retransmission (MINETR_RTX) downstream
- Maximum Expected Throughput for retransmission (MAXETR_RTX) downstream
- Maximum Net Data Rate for retransmission (MAXNDR_RTX) downstream
- Target net data rate (TARGET_NDR) downstream
- Target Expected Throughput for retransmission (TARGET_ETR) downstream

US Data Rate Profile

The upstream data rate profile MUST contain the following parameters:

- Minimum Data Rate upstream
- Minimum Reserved Data Rate upstream
- Maximum Data Rate upstream
- Rate Adaptation Ratio upstream
- Minimum Data Rate in low power state upstream
- Maximum Bit Error Ratio upstream
- Data Rate Threshold Upshift upstream
- Data Rate Threshold Downshift upstream
- Minimum SOS Data Rate (MIN-SOS-DR) upstream

- Minimum Expected Throughput for retransmission (MINETR_RTX) upstream
- Maximum Expected Throughput for retransmission (MAXETR_RTX) upstream
- Maximum Net Data Rate for retransmission (MAXNDR_RTX) upstream
- Target net data rate (TARGET_NDR) upstream
- Target Expected Throughput for retransmission (TARGET_ETR) upstream

5.6 Spectrum related profiles

Line Spectrum Profile

The Line Spectrum Profile contains the parameters that are mainly set during the service delivery phase, independently for upstream and downstream. They are combined into one profile as the number of different combinations is expected to be rather low. The Line Spectrum profile MUST contain the following parameters:

- xTU Transmission System Enabling (XTSE)
- Power Management State Enabling (PMode)
- L0-TIME
- L2-TIME
- L2-ATPR
- L2-ATPRT
- CARMASK downstream
- CARMASK upstream
- VDSL2-CARMASK
- Minimum Overhead Rate Upstream (MSGMIN upstream)
- Minimum Overhead Rate Downstream (MSGMIN downstream)
- VDSL2 Profiles Enabling (PROFILES)
- VDSL2 US0 PSD Masks Enabling (US0MASK)
- Optional Cyclic Extension Flag (CEFLAG)
- Retransmission MODE (RTX_MODE) upstream
- Retransmission MODE (RTX_MODE) downstream

The Line Spectrum Profile includes configuration parameters that are independent of the specific transmission mode(s) enabled in the XTSE configuration parameter. However, there are configuration parameters where their setup depends on a transmission mode. Therefore, each Line Spectrum Profile is also associated with one or more Mode Specific PSD Profiles. When the xDSL Line Configuration Vector refers to a Line Spectrum Profile it also implicitly refers to all Mode Specific PSD Profiles associated with it.

Mode Specific PSD Profile

The Line Spectrum Profile includes a configuration parameter (XTSE) that enables one or more transmission modes in the same profile. While all other parameters in the Line Spectrum Profile are independent of the enabled transmission mode(s) there are other configuration parameters where their setup depends on a transmission mode. Those parameters are covered by the Mode Specific PSD Profile. When the xDSL Line Configuration Vector refers to a Line Spectrum

Profile it also implicitly refers to all Mode Specific PSD Profiles associated with it. Each transmission mode enabled in a Line Spectrum Profile is covered by one and only one of the Mode Specific PSD Profiles contained in that Line Spectrum Profile.

The Mode Specific PSD Profile MUST contain the parameters that define the downstream and upstream PSDs for a specific xDSL mode.

- xDSL mode (possible values from the list in paragraph 7.3.1.1.1/G.997.1)
- Downstream Maximum Nominal Power Spectral Density (MAXNOMPSD downstream)
- Upstream Maximum Nominal Power Spectral Density (MAXNOMPSD upstream)
- Downstream Maximum Nominal Aggregate Transmit Power (MAXNOMATP downstream)
- Upstream Maximum Nominal Aggregate Transmit Power (MAXNOMATP upstream)
- Upstream Maximum Aggregate Receive Power (MAXRXPWR upstream)
- Downstream PSD Mask (PSDMASK downstream)
- Upstream PSD mask selection
- Upstream PSD Mask (PSDMASK upstream)
- VDSL2 Limit PSD Masks and bandplans enabling (LIMITMASK)
- VDSL2 US0 Disabling (US0DISABLE)
- VDSL2 PSD Mask Class Selection (CLASSMASK)

UPBO Profile

The UPBO Profile MUST contain all the parameters related to upstream power back-off:

- Upstream Power Back-Off electrical loop length (UPBOKL)
- Force CO-MIB electrical loop length (UPBOKLF)
- Upstream Power Back-Off reference PSD per band (Band number, UPBOPSD-pb parameters a and b)
- Reference electrical length per band (Band number, UPBOKLREF-pb)
- Alternative Electrical Length Estimation Mode (AELE-MODE)
- UPBO Electrical Length Threshold Percentile (UPBOELMT)

DPBO Profile

The electrical length of the cable from the CO to the cabinet at the FTTx site is applied, on a site, card or port basis during the network creation phase; it needs to be enforced on each DSL line of the site to guarantee spectral compatibility. To avoid a huge amount of profile combinations it should be separated from all other spectrum related parameters. The DPBO profile MUST contain the following parameters:

- Downstream Power Back-Off E-side Electrical Length (DPBOESEL)
- Downstream Power Back-Off assumed Exchange PSD mask (DPBOEPSD)
- Downstream Power Back-Off E-side Cable Model (DPBOESCMA, DPBOESCMB and DPBOESCMC)
- Downstream Power Back-Off Minimum Usable Signal (DPBOMUS)

- Downstream Power Back-Off span Minimum Frequency (DPBOFMIN)
- Downstream Power Back-Off span maximum frequency (DPBOFMAX)

RFI Profile

RFI notches are necessary when radio services may be disturbed during operation, or to protect DSL Lines from RFI, therefore this parameter should be separated from all other profiles. The RFI profile MUST contain the following parameter:

- RFIBANDS

Vectoring Profile

The Vectoring mechanism is defined by ITU-T Recommendation G.993.5 [9] as an optional technique. The Vectoring Profile contains part of the Vectoring mechanism's related configuration parameters while the rest of the parameters are located in the DS data rate profile and in the US data rate profile.. If Vectoring is being used then the xDSL Line Configuration vector instance MUST include a pointer to a selected Vectoring Profile instance. Otherwise, the xDSL Line Configuration vector instance MUST include the null value (0).

The Vectoring Profile MUST contain the following parameters:

- Vectoring frequency-band control upstream (VECTOR_BAND_CONTROL_{us})
- Vectoring frequency-band control downstream (VECTOR_BAND_CONTROL_{ds})
- FEXT Cancellation Line Priorities upstream (FEXT_CANCEL_PRIORITY_{us})
- FEXT Cancellation Line Priorities downstream (FEXT_CANCEL_PRIORITY_{ds})
- FEXT cancellation enabling/disabling upstream (FEXT_CANCEL_ENABLE_{us})
- FEXT cancellation enabling/disabling downstream (FEXT_CANCEL_ENABLE_{ds})
- Downstream requested XLIN subcarrier group size (XLINGREQ_{ds})
- Upstream requested XLIN subcarrier group size (XLINGREQ_{us})

5.7 DSL Quality Management related profiles

SNR Margin Profile

Noise margins are important for line robustness and need to be configured independently from other spectrum related parameters to reduce the amount of combinations. These parameters may be adjusted because of the changed disturber's impact while data rates aren't changed. The SNR Margin profile MUST contain the following parameters:

- Downstream Minimum Noise Margin (MINSNRM_{ds})
- Upstream Minimum Noise Margin (MINSNRM_{us})
- Downstream Target Noise Margin (TARSNRM_{ds})
- Upstream Target Noise Margin (TARSNRM_{us})
- Downstream Maximum Noise Margin (MAXSNRM_{ds})
- Upstream Maximum Noise Margin (MAXSNRM_{us})
- Downstream Signal-to-Noise Ratio Mode (SNRMODE_{ds})
- Upstream Signal-to-Noise Ratio Mode (SNRMODE_{us})

- Downstream Rate Adaptation Mode (RA-MODEds)
- Upstream Rate Adaptation Mode (RA-MODEus)
- Downstream Upshift Noise Margin (RA-USNRMds)
- Upstream Upshift Noise Margin (RA-USNRMus)
- Downstream Downshift Noise Margin (RA-DSNRMds)
- Upstream Downshift Noise Margin (RA-DSNRMus)
- Downstream Minimum Time Interval for Upshift Rate Adaptation (RA-UTIMEds)
- Upstream Minimum Time Interval for Upshift Rate Adaptation (RA-UTIMEus)
- Downstream Minimum Time Interval for Downshift Rate Adaptation (RA-DTIMEds)
- Upstream Minimum Time Interval for Downshift Rate Adaptation (RA-DTIMEus)

INP-Delay Profile

The INP-Delay profile contains INP-Delay parameters for each pair of upstream and downstream channels. To cover all possibilities there will be 4 pointers in the xDSL Line Configuration Vector for INP-Delay Profiles. If less than the maximum number of channels is to be used then the pointers corresponding to non-required channels MUST be set to a null value (0).

The reason for separating the INP-Delay Profile from the Data Rates Profile is to provide different robustness and delay behaviour for services like online gaming, voice and video. These parameters may be adjusted because of changed disturber's impact while data rates aren't changed, as they are set at the service delivery phase. The INP-Delay profile MUST contain the following parameters:

- Force framer setting for impulse noise protection (FORCEINP) downstream
- Minimum Impulse Noise Protection (INPMIN) downstream
- Minimum Impulse Noise Protection 8 kHz (INPMIN8) downstream
- Maximum Interleaving Delay downstream
- Maximum delay for retransmission (DELAYMAX_RTX) downstream
- Minimum delay for retransmission (DELAYMIN_RTX) downstream
- Minimum impulse noise protection against SHINE for retransmission (INPMIN_SHINE_RTX) downstream
- Minimum impulse noise protection against SHINE for retransmission 8khz (INPMIN8_SHINE_RTX) downstream
- SHINERATIO_RTX downstream
- Minimum impulse noise protection against REIN for Retransmission (INPMIN_REIN_RTX) downstream
- Minimum impulse noise protection against REIN for Retransmission 8 khz (INPMIN8_REIN_RTX) downstream
- REIN Inter-arrival Time for Retransmission (IAT_REIN_RTX) downstream
- Force framer setting for impulse noise protection (FORCEINP) upstream
- Minimum Impulse Noise Protection (INPMIN) upstream
- Minimum Impulse Noise Protection 8 kHz (INPMIN8) upstream
- Maximum Interleaving Delay upstream
- Maximum delay for retransmission (DELAYMAX_RTX) upstream
- Minimum delay for retransmission (DELAYMIN_RTX) upstream
- Minimum impulse noise protection against SHINE for retransmission (INPMIN_SHINE_RTX) upstream

- Minimum impulse noise protection against SHINE for retransmission 8khz (INPMIN8_SHINE_RTX) upstream
- SHINERATIO_RTX upstream
- Minimum impulse noise protection against REIN for Retransmission (INPMIN_REIN_RTX) upstream
- Minimum impulse noise protection against REIN for Retransmission 8khz (INPMIN8_REIN_RTX) upstream
- REIN Inter-arrival Time for Retransmission (IAT_REIN_RTX) upstream
- Maximum Delay Variation (DVMAX)
- Channel Initialization Policy Selection (CIPOLICY)
- MAXDELAYOCTET split parameter (MDOSPLIT)

Virtual Noise Profile

The Virtual Noise Profile MUST contain the virtual noise PSDs:

- Downstream Virtual Noise (VNds)
- Upstream Virtual Noise (VNus)
- Far End Crosstalk Transmitter Referred Virtual Noise (FEXT TXREFVNdS)
- Near End Crosstalk Transmitter Referred Virtual Noise (NEXT TXREFVNdS)
- Downstream Virtual Noise Scaling Factor (TXREFVNSFdS)
- Upstream Virtual Noise Scaling Factor (RXREFVNSFuS)

A Virtual Noise PSD is not used if the corresponding SNRMODE parameter is set to 1. If set to 4 the Virtual Noise together with the scaling factor is enabled. The SNRMODE parameters for upstream and downstream are in the SNR Margin Profile

SOS Profile

The SOS Profile provides the parameters to configure the optional procedure for on-line reconfiguration of the Physical Media Dependent (PMD) sub-layer in VDSL2 operation mode.

If the SOS procedure is not utilized the relevant profile pointer within the xDSL Line Configuration Vector instance MUST be set to a null value (0).

The SOS Profile MUST contain the following parameters:

- Downstream SOS time Window (SOS-TIME-ds)
- Upstream SOS Time Window (SOS-TIME-us)
- Downstream Minimum Percentage of Degraded Tones (SOS-NTONES-ds)
- Upstream Minimum Percentage of Degraded Tones (SOS-NTONES-us)
- Downstream Minimum Number of normalized CRC anomalies (SOS-CRC-ds)
- Upstream Minimum Number of normalized CRC anomalies (SOS-CRC-us)
- Downstream Maximum Number of SOS (MAX-SOS-ds)
- Upstream Maximum Number of SOS (MAX-SOS-us)
- Downstream SNR Margin Offset of ROC (SNRMOFFSET-ROC-ds)
- Upstream SNR Margin Offset of ROC (SNRMOFFSET-ROC-us)
- Downstream Minimum INP of ROC (INPMIN-ROC-ds)
- Upstream Minimum INP of ROC (INPMIN-ROC-us)

Note that there is a relationship between the parameters in the SOS profile and the Noise Margin profile, because the Rate Adaptation Mode parameters are part of the Noise Margin profile.

INM Profile

Impulse Noise Monitoring (INM) is not required for modem operation but is a capability for the measurement of Impulse Noise. The INM Profile includes the option to control an INM function on the receive direction in the xTU. A downstream Impulse Noise Monitor applies to the xTU-R; an upstream Impulse Noise Monitor applies to the xTU-C.

If INM is not implemented, the relevant profile pointer within the xDSL Line Configuration Vector instance **MUST** be set to a null value (0).

The INM profile **MUST** contain the following parameters:

- INM Inter Arrival Time Offset (INMIATO) downstream
- INM Inter Arrival Time Step (INMIATS) downstream
- INM Cluster Continuation value (INMCC) downstream
- INM Equivalent INP Mode (INM_INPEQ_MODE) downstream
- INM Inter Arrival Time Offset (INMIATO) upstream
- INM Inter Arrival Time Step (INMIATS) upstream
- INM Cluster Continuation value (INMCC) upstream
- INM Equivalent INP Mode (INM_INPEQ_MODE) upstream

Re-initialization Policy Profile

The re-initialization policy allows control of the DSL re-initialize based on the error performance of the line.

If re-initialization policy is not implemented, the relevant profile pointer within the xDSL Line Configuration Vector instance **MUST** be set to a null value (0).

The re-initialization policy profile **MUST** contain the following parameters:

- Downstream Re-Initialization Policy Selection (RIPOLICYds)
- Upstream Re-Initialization Policy Selection (RIPOLICYus)
- Downstream REINIT_TIME_THRESHOLDds
- Upstream REINIT_TIME_THRESHOLDus

6 Object model for xDSL Status Monitoring

Figure 3 shows the object model relating to xDSL Line status monitoring.

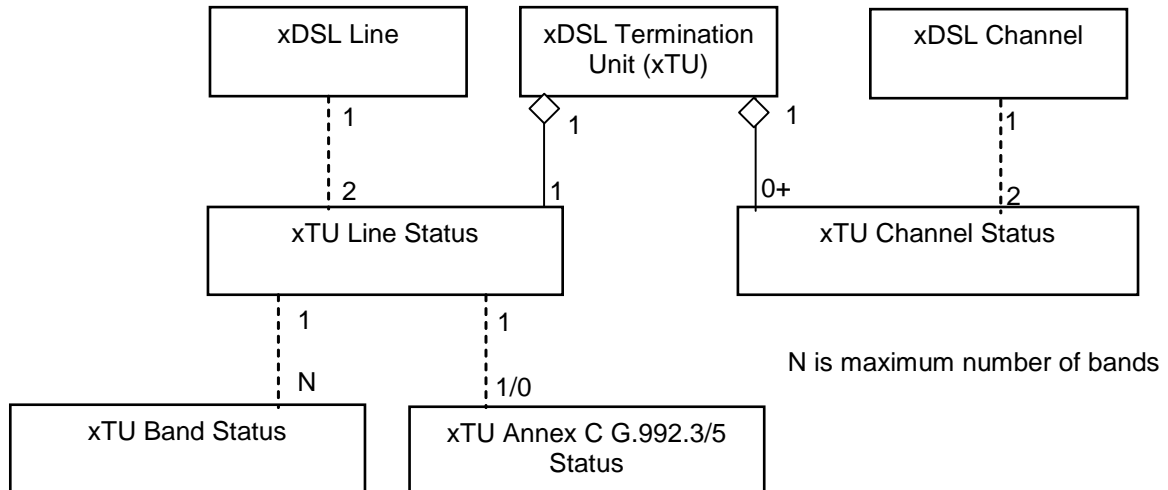


Figure 3/TR-252 - Managed object model: xDSL status monitoring

6.1 xTU Line Status

The xTU Line Status object represents current line status / measurements at a particular xTU.

The following attributes **MUST** be supported for the xTU Line Status object:

- xTU Current Status (Near-End Failures for xTU-C/ Far-End Failures for xTU-R)
NOTE - Line Init (LINIT) Failure is reported by both xTU-C and xTU-R
NOTE - Should include Loss of Signal Quality condition per RFC 2662.
- Last State Transmitted (Downstream for xTU-C / Upstream for xTU-R)
- Signal-to-Noise Ratio Margin (SNRMds for xTU-R / SNRMus for xTU-C)
- Actual Signal-To-Noise Ratio mode (ACTSNRMODEds for xTU-R / ACTSNRMODEus for xTU-C)
- Maximum Attainable Data Rate (ATTNDRds for xTU-C / ATTNDRus for xTU-R)
- Actual Power Spectrum Density (ACTPSDds for xTU-C / ACTPSDus for xTU-R)
- Actual Aggregate Transmit Power (ACTATPds for xTU-R / ACTATPus for xTU-C)
- VDSL2 Profile
- VDSL2 Limit PSD Mask and Bandplan
- VDSL2 US0 PSD Mask
- VTU-O Estimated Upstream Power Back-Off Electrical Loop Length (UPBOKLE)
- VTU-R Estimated Upstream Power Back-Off Electrical length (UPBOKLE-R)

- Trellis Use (TRELLISds /TRELLISus)
- Actual Cyclic Extension (ACTUALCE)
- Actual Downstream Rate Adaptation Mode (ACT-RA-MODEds)
- Actual Upstream Rate Adaptation Mode (ACT-RA-MODEus)
- UPBO Downstream receiver signal level threshold (RXTHRSHds)
- UPBO Upstream receiver signal level threshold (RXTHRSHus)
- Downstream Actual impulse noise protection of ROC (ACTINP-ROC-ds)
- Upstream Actual impulse noise protection of ROC (ACTINP-ROC-us)
- Downstream Actual SNR Margin of ROC (SNRM-ROC-ds)
- Upstream Actual SNR Margin of ROC (SNRM-ROC-us)
- Date/time-stamping of near-end test parameters (STAMP-TEST-NE)
- Date/time-stamping of far-end test parameters (STAMP-TEST-FE)
- Date/time-stamping of last successful downstream OLR operation (STAMP-OLR-ds)
- Date/time-stamping of last successful upstream OLR operation (STAMP-OLR-us)
- VCE ID (VCE_ID)
- VCE port index (VCE_port_index)
- Actual Downstream RIPOLICY (ACTRIPOLICYds)
- Actual Upstream RIPOLICY (ACTRIPOLICYus)
- Downstream XLIN subcarrier group size (XLINGds)
- Upstream XLIN subcarrier group size (XLINGus)
- Retransmission used downstream (RTX_USED ds)
- Retransmission used upstream (RTX_USED us)

6.1.1 xTU Band Status

The xTU Band Status object represents current band status / measurements at a particular xTU.

The following attributes MUST be supported for the xTU Band Status object:

- Band number (1, N)
- Line Attenuation per band (LATNds for xTU-R / LATNus for xTU-C)
- Signal Attenuation per band (SATNds for xTU-R / SATNus for xTU-C)
- Signal-to-Noise Ratio Margin per band (SNRMpbds for xTU-R / SNRMpbus for xTU-C)
- VTU-O Estimated Upstream Power Back-Off Electrical length per band (UPBOKLE-pb)
- VTU-R Estimated Upstream Power Back-Off Electrical length per band (UPBOKLE-R-pb)

6.1.2 xTU Channel Status

The xTU Channel Status object represents current channel status / measurements at a particular xTU.

The following attributes **MUST** be supported for the xTU Channel Status object:

- Actual Data Rate (Downstream for xTU-C / Upstream for xTU-R)
- Previous Data Rate (Downstream for xTU-C / Upstream for xTU-R)
- Actual Delay (Downstream for xTU-C / Upstream for xTU-R)
- Actual Impulse Noise Protection (ACTINP)
- Impulse Noise Protection Report (INPREPORT)
- Actual size of Reed-Solomon codeword (NFEC)
- Actual number of Reed-Solomon redundancy bytes (RFEC)
- Actual number of bits per symbol (LSYMB)
- Actual interleaving depth (INTLVDEPTH)
- Actual interleaving block length (INTLVBLOCK)
- Actual Latency Path (LPATH)
- Actual net data rate downstream (ACTNDR ds)
- Actual net data rate upstream (ACTNDR us)
- Actual impulse noise protection against REIN downstream (ACTINP_REIN ds)
- Actual impulse noise protection against REIN upstream (ACTINP_REIN us)

6.1.3 xTU Annex C G.992.3,5 Status

The xTU Annex C G.992.3,5 Status object represents current measurements at a particular xTU.

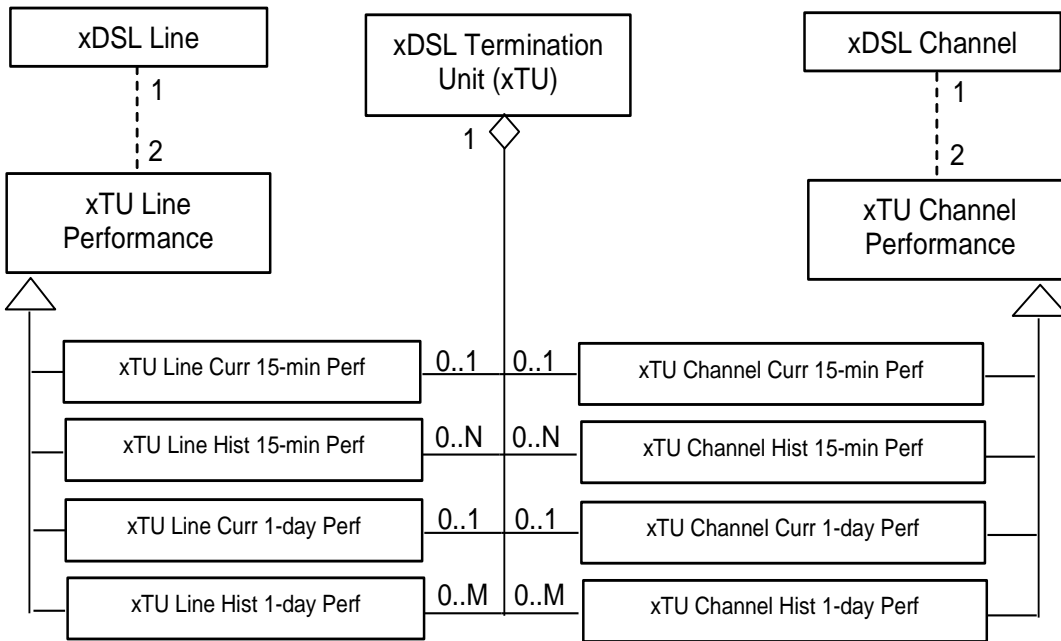
The following attributes **MUST** be supported for the xTU Annex C G.992.3,5 Status object:

- FEXT Downstream Signal-to-Noise Ratio Margin (FEXT SNRMds)
- NEXT Downstream Signal-to-Noise Ratio Margin (NEXT SNRMds)
- FEXT Upstream Signal-to-Noise Ratio Margin (FEXT SNRMus)
- NEXT Upstream Signal-to-Noise Ratio Margin (NEXT SNRMus)
- FEXT Downstream Maximum Attainable Data Rate (FEXT ATTNDRds)
- NEXT Downstream Maximum Attainable Data Rate (NEXT ATTNDRds)
- FEXT Upstream Maximum Attainable Data Rate (FEXT ATTNDRus)
- NEXT Upstream Maximum Attainable Data Rate (NEXT ATTNDRus)
- FEXT Downstream Actual Power Spectral Density (FEXT ACTPSDds)
- NEXT Downstream Actual Power Spectral Density (NEXT ACTPSDds)
- FEXT Upstream Actual Power Spectral Density (FEXT ACTPSDus)
- NEXT Upstream Actual Power Spectral Density (NEXT ACTPSDus)
- FEXT Downstream Actual Aggregate Transmit Power (FEXT ACTATPds)
- NEXT Downstream Actual Aggregate Transmit Power (NEXT ACTATPds)

- FEXT Upstream Actual Aggregate Transmit Power (FEXT ACTATP_{us})
- NEXT Upstream Actual Aggregate Transmit Power (NEXT ACTATP_{us})

7 Object model for xDSL Performance Management

Figure 4 shows the object model relating to xDSL Line performance management.



N : Maximum number of 15-min intervals supported

M : Maximum number of 1-day intervals supported

Figure 4/TR-252- Managed object model: xDSL performance management

7.1 xTU Line Performance

The xTU Line Performance object represents line performance related data for a given xTU. It is only a super-class that cannot be instantiated. It supports following sub-classes that are instantiated:

- xTU Line Current 15-min Performance
- xTU Line History 15-min Performance
- xTU Line Current 1-day Performance
- xTU Line History 1-day Performance

The following attributes **MUST** be supported for the xTU Line Performance object:

- Interval Number (0 for current; 1..N/M for previous/history intervals)

- Interval Status (valid – Data is valid and complete; invalid – Data is invalid or incomplete)
- Forward Error Correction Seconds - Line (FECS-L/LFE)
- Errored Seconds – Line (ES-L/LFE)
- Severely Errored Seconds – Line (SES-L/LFE)
- Loss of Signal Seconds – Line (LOSS-L/LFE)
- Unavailable Seconds – Line (UAS-L/LFE)
- Full Initializations **
- Failed Full Initializations **
- Short Initializations **
- Failed Short Initializations **
- Loss-of-power interruption count (LPR_INTRPT) **
- Host-Reinit interruption count (HRI_INTRPT) **
- Spontaneous interruption count (SPONT_INTRPT) **
- Near-end (xTU-C) Impulse Noise Performance Monitoring Counters
- INM INPEQ histogram 1..17 (INMINPEQ_{1..17}-L)
- INM IAT histogram 0..7 (INMIAT_{0..7}-L) INM total measurement (INMME-L) Far-end (xTU-R) Impulse Noise Performance Monitoring Counters
 - INM INPEQ histogram 1..17 (INMINPEQ_{1..17}-LFE)
 - INM IAT histogram 0..7 (INMIAT_{0..7}-LFE)
- INM total measurement (INMME-LFE) Near-end Successful SOS count (SOS SUCCESS NE)
 - Far-end Successful SOS count (SOS SUCCESS FE)
 - Near-end "lefr" defects seconds
 - Far-end "lefr" defects seconds
 - Near-end Error-free bits
 - Far-end Error-free bits
 - Near-end Minimum error-free throughput (MINEFTR NE)
 - Far-end Minimum error-free throughput (MINEFTR FE)

NOTE - Object instances associated with the xTU-C use the xxx-L version of the parameter while those associated with the xTU-R use xxx-LFE version of the parameter.

** These parameters apply only to instances of the object associated with the xTU-C.

Instances of this object are supported for each xTU (xTU-C or xTU-R) for the current and previous N 15-minute intervals, as well as for current and previous M 1-day intervals.

7.2 xTU Channel Performance

The xTU Channel Performance object represents channel performance related data for a particular channel associated with a particular xTU. It is only a super-class that cannot be instantiated. It supports following sub-classes that are instantiated:

- xTU Channel Current 15-min Performance
- xTU Channel History 15-min Performance
- xTU Channel Current 1-day Performance
- xTU Channel History 1-day Performance

The following attributes **MUST** be supported for the xDSL Channel Performance object:

- Interval Number (0 for current; 1..N/M for previous/history intervals)
- Interval Status (valid – Data is valid and complete; invalid – Data is invalid or incomplete)
- Code Violations – Channel (CV-C/CFE)
- Forward Error Corrections – Channel (FEC-C/CFE)

NOTE - Object instances associated with the xTU-C use the xxx-C version of the parameter while those associated with the xTU-R use xxx-CFE version of the parameter.

Instances of this object are supported for each channel associated with each xTU (xTU-C or xTU-R) for the current and previous N 15-minute intervals, as well as for current and previous M 1-day intervals.

8 Object model for xDSL Performance Threshold Management

Figure 5 shows the object model relating to xDSL Line performance threshold management.

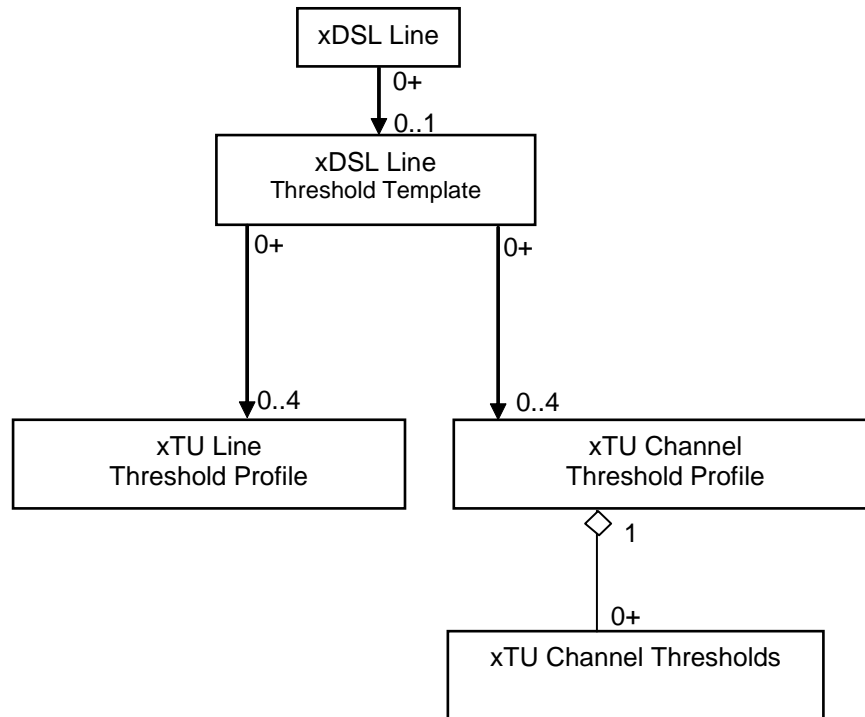


Figure 5/TR-252 - Managed object model: xDSL performance threshold management

8.1 xDSL Line Threshold Template

The xDSL Line Threshold Template object represents a complete set of performance monitoring thresholds for an xDSL Line.

The following attributes **MUST** be supported by the xDSL Line Threshold Template object:

- Template Name
- Pointer to the xTU-C 15-min Line Threshold Profile
- Pointer to the xTU-C 1-day Line Threshold Profile
- Pointer to the xTU-R 15-min Line Threshold Profile
- Pointer to the xTU-R 1-day Line Threshold Profile
- Pointer to the xTU-C 15-min Channel Threshold Profile
- Pointer to the xTU-C 1-day Channel Threshold Profile
- Pointer to the xTU-R 15-min Channel Threshold Profile
- Pointer to the xTU-R 1-day Channel Threshold Profile

8.2 xTU Line Threshold Profile

The xTU Line Threshold Profile object represents a set of performance monitoring thresholds for an xDSL Line at a particular xTU.

The following attributes **MUST** be supported by the xTU Line Threshold Profile object:

- Profile Name
- Forward Error Correction Seconds - Line Threshold (FECS-L/LFE)
- Errored Seconds – Line Threshold (ES-L/LFE)
- Severely Errored Seconds – Line Threshold (SES-L/LFE)
- Loss of Signal Seconds – Line Threshold (LOSS-L/LFE)
- Unavailable Seconds – Line Threshold (UAS-L/LFE)
- Full Initializations Threshold **
- Failed Full Initializations Threshold **
- Short Initializations Threshold **
- Failed Short Initializations Threshold **
- Spontaneous Interruption Count (SPONT_INTRPT) Thresholds (24-hour interval) **
- "lefr" defect threshold (LEFTR_THRESH)

NOTE - Object instances associated with the xTU-C use the xxx-L version of the threshold while those associated with the xTU-R use xxx-LFE version of the threshold.

** These thresholds apply only to instances of the object associated with the xTU-C.

8.3 xTU Channel Threshold Profile

The xTU Channel Threshold Profile object is a logical-container of performance monitoring thresholds for all channels associated with an xDSL Line at a particular xTU.

The following attribute **MUST** be supported by the xTU Channel Threshold Profile object:

- Profile Name

8.4 xTU Channel Thresholds

The xTU Channel Thresholds object represents a set of performance monitoring thresholds for a particular channel associated with an xDSL Line at a particular xTU.

The following attributes **MUST** be supported by the xTU Channel Thresholds object:

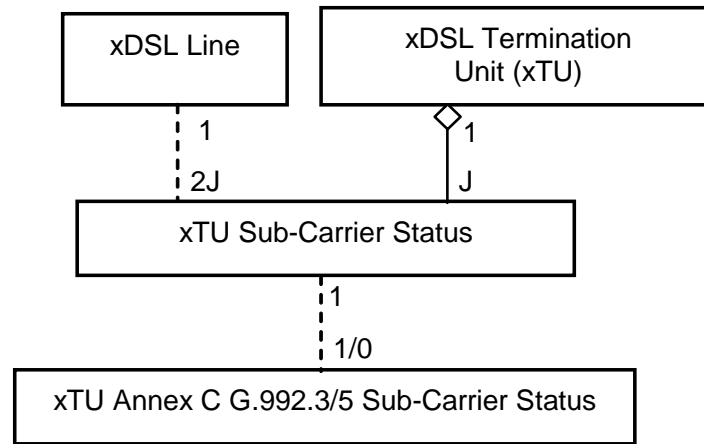
- Channel Number
- Code Violations – Channel Threshold (CV-C/CFE)

- Forward Error Corrections – Channel Threshold (FEC-C/CFE)

NOTE - Object instances associated with the xTU-C use the xxx-C version of the threshold while those associated with the xTU-R use xxx-CFE version of the threshold.

9 Object model for xDSL Testing / Diagnostics

Figure 6 shows the object model relating to detailed xDSL Line testing / diagnostics.



J : Maximum number of Sub-Carriers supported

Figure 6/TR-252 - Managed object model: xDSL testing/diagnostics

9.1 xTU Sub-Carrier Status

The xTU Sub-Carrier Status object represents current detailed status / measurements relating to a particular sub-carrier in an xDSL Line at a particular xTU.

The following attributes **MUST** be supported for the xTU Sub-Carrier Status object:

- Sub-Carrier Number (1..J)
- Channel Characteristics Function Linear Representation Scale (HLINSCds / HLINSCus)
- H(f) linear subcarrier group size (HLINGds / HLINGus)
- Channel Characteristics Function Linear Representation (HLINpsds / HLINpsus)
- Channel Characteristics Function Logarithmic Measurement Time (HLOGMTds / HLOGMTus)
- H(f) logarithmic subcarrier group size (HLOGGds / HLOGGus)
- Channel Characteristics Function Logarithmic Representation (HLOGpsds / HLOGpsus)
- Quiet Line Noise PSD Measurement Time (QLNMTds / QLNMTus)
- QLN(f) subcarrier group size (QLNGds / QLNGus)
- Quiet Line Noise PSD (QLNpsds / QLNpsus)

- Signal-to-Noise Ratio Measurement Time (SNRMTds / SNRMTus)
- SNR(f) subcarrier group size (SNRGds / SNRGus)
- Signal-to-Noise Ratio (SNRpsds / SNRpsus)
- Bits Allocation (BITSpsds / BITSpsus)
- Gains Allocation (GAINSpds / GAINSpus)
- Transmit Spectrum Shaping (TSSpsds / TSSpsus)
- MEDLEY Reference PSD (MREFPSDds / MREFPSDus)

NOTE - Object instances associated with the xTU-C use the xxxds version of the parameter while those associated with the xTU-R use xxxus version of the parameter.

9.1.1 xTU Annex C G.992.3/5 Sub-Carrier Status

The xTU Annex C G.992.3/5 Sub-Carrier object represents current detailed status / measurements relating to a particular sub-carrier in an xDSL Line at a particular xTU.

The following attributes MUST be supported for the xTU Annex C G.992.3/5 Sub-Carrier Status object:

- Sub-Carrier Number (1..J)
- FEXT Downstream QLN(f) (FEXT QLNpsds)
- NEXT Downstream QLN(f) (NEXT QLNpsds)
- FEXT Upstream Quiet Line Noise PSD Measurement Time (FEXT QLNMtUs)
- NEXT Upstream Quiet Line Noise PSD Measurement Time (NEXT QLNMtUs)
- FEXT Upstream QLN(f) (FEXT QLNpsus)
- NEXT Upstream QLN(f) (NEXT QLNpsus)
- FEXT Downstream Quiet Line Noise PSD Measurement Time (FEXT SNRMTds)
- NEXT Downstream Quiet Line Noise PSD Measurement Time (NEXT SNRMTds)
- FEXT Downstream SNR Measurement Time (FEXT SNRMTds)
- NEXT Downstream SNR Measurement Time (NEXT SNRMTds)
- FEXT Downstream SNR(f) (FEXT SNRpsds)
- NEXT Downstream SNR(f) (NEXT SNRpsds)
- FEXT Upstream SNR Measurement Time (FEXT SNRMTus)
- NEXT Upstream SNR Measurement Time (NEXT SNRMTus)
- FEXT Upstream SNR(f) (FEXT SNRpsus)
- NEXT Upstream SNR(f) (NEXT SNRpsus)
- FEXT Downstream Bits Allocation (FEXT BITSpsds)
- NEXT Downstream Bits Allocation (NEXT BITSpsds)
- FEXT Upstream Bits Allocation (FEXT BITSpsus)
- NEXT Upstream Bits Allocation (NEXT BITSpsus)
- FEXT Downstream Gains Allocation (FEXT GAINSpds)
- NEXT Downstream Gains Allocation (NEXT GAINSpds)
- FEXT Upstream Gains Allocation (FEXT GAINSpus)

- NEXT Upstream Gains Allocation (NEXT GAINSpSus)
- FEXT Downstream Transmit Spectrum Shaping (FEXT TSSpsds)
- NEXT Downstream Transmit Spectrum Shaping (NEXT TSSpsds)
- FEXT Upstream Transmit Spectrum Shaping (FEXT TSSpsus)
- NEXT Upstream Transmit Spectrum Shaping (NEXT TSSpsus)
- Downstream XLIN scale (XLINSCds)
- Downstream XLIN subcarrier group size (XLINGds)
- Downstream XLIN bandedges (XLINBANDSds)
- Downstream FEXT coupling (XLINpsds)
- Upstream XLIN scale (XLINSCus)
- Upstream XLIN subcarrier group size (XLINGus)
- Upstream XLIN bandedges (XLINBANDSsus)
- Upstream FEXT coupling (XLINpsus),

Appendix I. Possible Implementation Approaches for VoP

I.1 Introduction

Section 5 defines a Vector of Profiles (VoP) for xDSL line configuration. This informative appendix describes two possible alternatives for implementing the VoP and associating it with DSL lines, a *direct attachment* of a VoP to each DSL line and an *indirect attachment* of a VoP to each DSL line.

In either case, the assumption is that the DSLAM is required to allocate memory for storing all instances of the profiles that the management system (i.e., EMS and/or NMS) defines as well as the information regarding the configuration of each DSL line.

I.2 Direct Attachment of VoP to DSL Line

With this approach there are two layers in implementing the VoP. One layer includes the tables for all profiles that are part of the VoP. The management system creates instances of those profiles as needed and removes instances of profiles when no longer required. The other layer is the VoPs and, according to this approach, each DSL line directly points to all profile instances that construct the configuration VoP it uses. This is realized by implementing, for each DSL line, a number of managed objects that are profile pointers. When the management system wishes to set a configuration for the DSL line or modify the configuration of a DSL line, it directly accesses and modifies the relevant pointers in the set of managed objects belonging to that DSL line.

Figure 7 illustrates the method of direct attachment of profiles to DSL lines, where each one of the L lines directly points to instances from V profile pools.

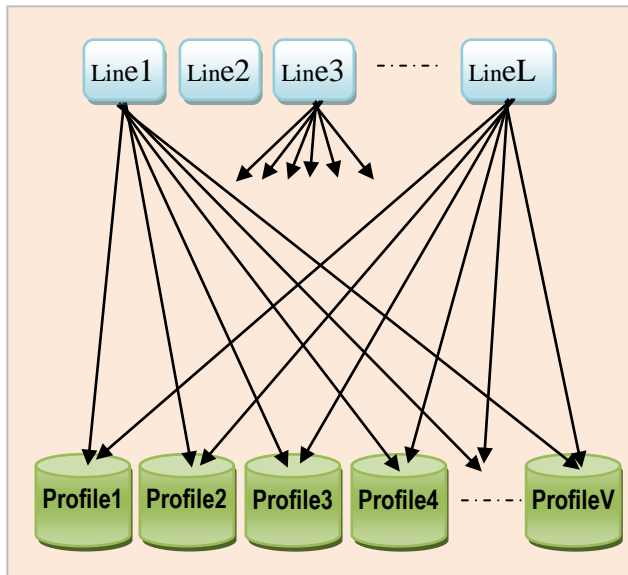


Figure 7/TR-252 - Direct attachment of VoP to DSL Lines

The memory consumption for storing configuration information in the direct attachment model is:

$L \times V$ where:

- V is the number profile indices in the VoP, and
- L is the number of DSL lines in the DSLAM; each is assigned a set of profile indices

In addition, $\sum_{p=1}^{p=V} (N_p \times P_p)$ memory locations are needed for the profile storage where:

- N_p is the number of parameters in profile p and P_p is the number of different p profiles.

Note that $(L \times V)$ is $\leq \prod_{p=1}^{p=V} P_p$ as in practice the management system does not use every potential combination of the p profiles.

I.3 Indirect Attachment of VoP to DSL Line

With this approach there are three layers in implementing the VoP. One layer includes the tables for all profiles that are part of the VoP. This layer is identical to the one implemented according to the direct attachment approach. The second layer is a VoP table with a profile pointer per each profile in the VoP. The management system creates instances of VoPs when needed (i.e., for configuring one or more DSL lines) and removes instances of VoPs when no longer required. The third layer is the association of each DSL line with a VoP. This is realized by a single managed object, a VoP identifier, implemented for each DSL line. When the management system wishes to configure a specific DSL line or modify the configuration of a specific DSL line, it creates a new VoP and writes its identifier in the VoP identifier of that specific DSL line. If the required VoP already exist in memory, then the management system only need to write its identifier in the VoP identifier of the specific DSL line.

Figure 8 illustrates the method of indirect attachment of profiles to DSL lines, where there are V profile pools and one VoPs pool and each one of the L lines directly points to an instance of VoP.

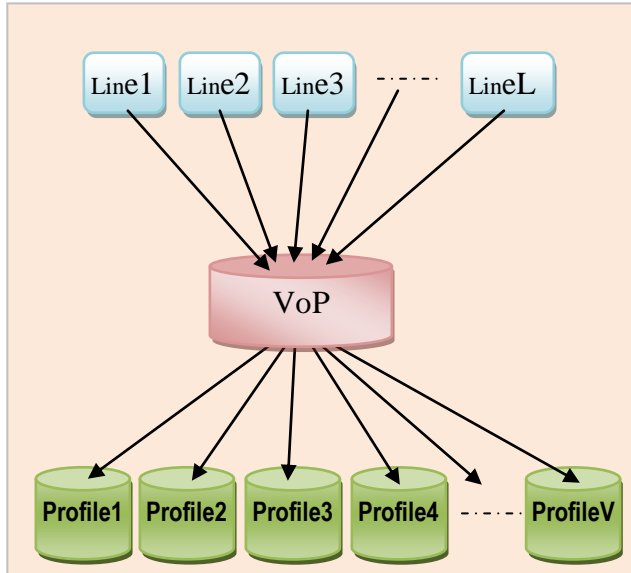


Figure 8/TR-252 - Indirect attachment of VoP to DSL Lines

The memory consumption for storing configuration information in the indirect attachment model is:

$P_V \times V + L$ where:

- P_V is the number of different VoPs stored in memory,
- V is the number profile indices in each VoP, and
- L is the number of DSL lines in the DSLAM; each is assigned one VoP index

In addition, $\sum_{p=1}^{p=V} (N_p \times P_p)$ memory locations are needed for the profile storage where:

- N_p is the number of parameters in profile p and P_p is the number of different p profiles.

Note that P_V is $\leq \prod_{p=1}^{p=V} P_p$ as in practice the management system does not use every potential combination of the p profiles.

I.4 Comparison of Direct and Indirect Attachment Approaches

I.4.1 Ease of Operation

I.4.1.1 First Setup

The *direct attachment* approach requires that each DSL line will be assigned its own set of V pointers, and that requires V 'WRITE' operations (V is the number of profiles pointers in the VoP) while configuring each DSL line.

With the *indirect attachment* approach if the management system already uses the same configuration for any other DSL line in the DSLAM, it simply associates the new DSL line with the same VoP identifier. That requires a single 'WRITE' operation. Only if the DSL line is the first to use the specific configuration planned for it then creating the VoP and associating the DSL line with the new VoP requires V+1 'WRITE' operations.

I.4.1.2 Configuration Changes

The *direct attachment* approach allows the management system to modify a specific component of any DSL line configuration at the DSLAM by simply changing the involved profile pointer in the VoP which is attached to the affected DSL line. This can be performed with a single 'WRITE' operation.

The *indirect attachment* always replaces a VoP identifier with another VoP identifier. So, if the management system does not already use the modified configuration for any other DSL line in the DSLAM, it should first create a new VoP and then associate the affected line with the new VoP identifier. If the VoP with the modified configuration already exist then the operation is simply changing the VoP identifier associated with the affected DSL line. So, the cost of configuration changes in this case is one or (V+1) 'WRITE' operations, depending on whether or not there is a need to create a new VoP.

I.4.1.3 VoP Maintenance

In the *indirect attachment* approach, the management system is required to determine from time to time what VoPs are being used by the DSLAM and remove unused VoPs from the DSLAM's memory. Such an operation is irrelevant in *direct attachment* approach.

It should be noted that in all three of the above operations additionally the indirect attachment approach needs comparisons to be performed to identify matching profiles.

I.4.2 Memory Consumption

From I.2 and I.3 above it is clear that the memory consumption for storing the configuration profiles is the same no matter what attachment approach is selected. The difference between the two approaches is on higher layers, where only profile indices are involved.

The memory required for storing the VoPs with the *direct attachment* approach is constant, i.e., number of pointers in the VoP multiplied by the number of lines in the DSLAM. This makes the

direct attachment optimized for the case where each DSL line in the DSLAM has a different configuration.

The *indirect attachment*, however, stores each VoP only once. So, when M lines share the same configuration VoP_x only one copy of VoP_x is stored in the DSLAM's memory, instead of M copies in the other approach. This makes the *indirect attachment* optimized for the case in which a significant number of lines in the DSLAM have identical configuration.

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