ETSI WG TM6

(ACCESS TRANSMISSION SYSTEMS ON METALLIC CABLES)

Permanent Document

TM6(01)21 – rev 14 ~~– draft~~

Living List for Spectral Management SpM - part 2 creation of TR 101 830-2

This document is the living list of current issues connected with ETSI's spectral management report TR 101 830, part 2 (*Technical methods for performance evaluations*).
This work item is focussed on the creation of "Part 2", dedicated to calculation and measurement methods for evaluating what the performance of xDSL systems will be for various scenarios.
This draft has achieved "working group approval" during the ETSI-TM6 meeting of June 2004, but did not pass the official AbC-procedure (Approval by Correspondence) in august 2004. A new target date for "working group approval" is foreseen in June 2005. When the document passes a second voting, a first version of SpM part 2 will be published by ETSI somewhere in the fall of 2005. Issues that are (still) unsolved by that time are scheduled for a succeeding revision.
The issues related to the revision of "Part 1", or to the creation of "Part 3", are beyond the scope of this living list.

This is an interim living list, reflecting the status directly after the SpM-2 session during the ETSI-TM6 meeting, before the agreed content is moved into the draft.

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2. STUDY POINTS PART 2 (TECHNICAL METHODS FOR PERFORMANCE EVALUATIONS)

ED. NOTE. The study points, highlighted in color, can be considered as "solved". Please double check if TM6 can indeed agree on the associated text provided in this living list during the june meeting of TM6. According to schedule, the draft + agreed topics from the living list will be proposed for "working group approval" during that meeting in june

SP	Title	Owner	Status
2-1	~~*Spectral management aspects of non-stationary signals.*~~	~~*Reuven Franco (Tioga)*~~	Deleted
2-2	Basic model of input block	Ragnar Jonsson (Conexant)	Agreed
2-3	Basic model of 2-node crosstalk	Rob van den Brink (KPN)	Agreed
2-4	Generic detection models (*PAM, CAP/QAM, shifted-shannon*)	Rob van den Brink (KPN)	Agreed
	~~Transmitter/Disturber models - ADSL~~	Rosaria Persico (TI-labs)	split into 5.1+ 5.2
2-5.1	Transmitter/Disturber models - ADSL w/o DSslope@1.1MHz	Rosaria Persico (TI-labs)	Agreed
2-5.2	Study DS slope of ADSL template PSD at 1.1 MHz	Rosaria Persico (TI-labs)	PA agreed
2-6	Transmitter/Disturber models - SDSL	Rob van den Brink (KPN)	Agreed
2-7	Transmitter/Disturber models - HDSL-CAP/2	Rob van den Brink (KPN)	Agreed
2-8	Transmitter/Disturber models - HDSL-2B1Q	Rob van den Brink (KPN)	Agreed
2-9	Performance model for ETSI compliant SDSL	Marc Kimpe (Adtran)	Agreed
2-10	Performance model for ETSI compliant HDSL-CAP	Rob van den Brink (KPN)	Agreed
2-11	Transmitter/Disturber models - ISDN-2B1Q	Rob van den Brink (KPN)	Agreed
2-12	~~*Implementation loss values for PAM, CAP and DMT*~~	~~*Ragnar Jonsson (Conexant)*~~	deleted
2-13	~~*Method/Model for Crosstalk Cumulative Distribution, etc.*~~	~~*Jack Douglass (Paradyne)*~~	deleted
2-14	~~*Method/Model for Impairment Combination for multiple disturbers*~~	~~*Jack Douglass (Paradyne)*~~	deleted
2-15	~~*Method/Model for Loop Cumulative Distribution + Occurrence*~~	~~*Jack Douglass (Paradyne)*~~	deleted
2-16	~~*Method/Model for Network Model Coverage Score*~~	~~*Jack Douglass (Paradyne)*~~	deleted
2-17	Transmitter/Disturber models - ISDN-MMS43 (4B3T)	Marko Löffelholz (DTAG)	Agreed
2-18	Generic detection model for DMT	Tomas Nordstrom (FTW)	Agreed
2-19	Performance model for ETSI compliant ADSL (EC-variant)	Ragnar Jonsson (Conexant)	Agreed
2-20	Disturber model for line shared ISDN noise	Marko Loeffelholz (DTAG)	Agreed
2-21	Data collection of PSD measurements	Marcus Jonsson (TeliaSonera)	US
2-22	Improving the validity of receiver performance models	Tomas Nordström (FTW)	Prov Deleted Deleted
2-23	~~Performance model for ETSI compliant ADSL.FDD over POTS~~		Closed, è SP36
2-23.1	~~Performance model for ADSL.FDD over POTS, w/o bitloading~~		Closed, è SP36
2-23.2	~~Values for minimum and maximum bitloading~~		Closed, è SP36
2-24	~~Performance model for ETSI compliant ADSL.FDD over ISDN~~		Closed, è SP36
2-24.1	~~Performance model for ADSL.FDD over ISDN, w/o bitloading~~		Closed, è SP36
2-24.2	~~Values for minimum and maximum bitloading~~		Closed, è SP36
2-25	Performance model for ADSL 2 and ADSL2+	Laurent Cuvelier (Alcatel)	US move to new LL
2-26	Modelling sidelobe pick-up in DMT Receivers **Action 1:** provide literal text for generic model (Laurent) **Action 2:** extent specific (ADSL?) model with this mechanism	Laurent Cuvelier (Alcatel)	US Move to new LL
2-27	Additions to the scope of SpM-2	Angus Carrick	Agreed
2-28	Text for how to simulate power back-off	Tomas Nordstrom (FTW)	Agreed
2-29	Transmitter/disturber model for ADSL2 annex J & M	Robert Baldemair (Ericsson)	Agreed
2-30	Text for a more advanced description of bitloading modelling Remove current note, to be replaced in future by another descriuption	Tomas Nordstrom (FTW)	US Move to new LL
2-31	Out of band values for ISDN.2B1Q template	Infineon (Bernd Heise)	Prov deleted

			Deleted
2-32	Out of band values for SDSL template	Infineon (Michael Horvat)	PA Agreed
	~~*VDSL templates based on ETSI standards*~~		Split into 33.1 and 33.2
2-33.1	VDSL1 templates based on ETSI standards, whose integral does **not** exceed the total aggregate power constraint	Alcatel (Danny Van Bruyssel)	PA Agreed
2-33.2	VDSL1 templates based on ETSI standards, whose integral exceeds the total aggregate power constraint In case multiple templates can fulfill the requirements (beyond the simple one defined in VDSL1 specification)	Alcatel (Danny Van Bruyssel)	US agreed
2-34	Out of band values for ADSL templates **Action 1:** verify for Alcatel solutions (Laurent) **Action 2:** verify for Infineon/siemens solutions (Bernd) (-120?) **Action 3:** verify for Texas Instruments solutions (Neal)	Alcatel (Danny Van Bruyssel)	US Deleted (keep current values)
2-35	Out of band values for HDSL.CAP/2 template Solution: (Add note: out of band noise may be lower then specified in the model)	Schmid Telecom (Marc Laeser)	~~PA~~ Agreed
2-36	ADSL.FDD performance model (over POTS & ISDN)	Conexant (Ragnar Jonsson)	~~PA~~ Agreed
2-37	Performance model for HDSL.2B1Q	Swisscom (Andreas Thöny)	~~PA~~ agreed
2-38	Collecting public available cable models	DTAG (Marko Löffelholz)	~~US~~ agreed
2-39	Restructuring Clause 5	Telecom Italia (Rosaria Persico)	~~ProvDelete~~ delete
2-40	Text for sub-clauses 8.1 to 8.3	Telecom Italia (Rosaria Persico)	~~ProvDelete~~ delete
2-41	Compiling available text for sub-clauses on multi node crosstalk	Infineon (Michael Horvat)	US Merge with SP2-44
2-42	Describing the scenarios (without calculation results) identified within the European Simulation Platform (2004)	Swisscom (Andreas Thöny)	~~PA~~ Agreed
2-43	Revising scope, or inclusion of chapter dedicated to measurements	DTAG (Marko Löffelholz)	~~ProvDelete~~ delete
2-44	Calculation methods for distributed cable tree topologies	Czech Telecom (Milan Meninger)	US, move to new LL

Study point for future revision

2-45	Transmitter/disturber model for POTS signals	Peter Reusens (LEA)	US
2-46			
2-47			

The current agreed procedure for changing the status of living list items is in Annex A of TM6 working methods.

Part 2 study points

SP 2-1. Spectral management rules for non-stationary signals.

It was observed that the combined impairment from modems that are rapidly switching on and off over a period of time is much more destructive to ADSL then when these modems are continuously transmitting their signals. This is identified as "non stationary noise". The effect of non-stationary transmission in general on ADSL modems has not been fully understood. Is it a performance issue, related to the way a victim xDSL modem is implemented, or is it a spectral management issue that requires a way to bound the amount of non-stationary behaviour of signals that are injected into the Local Loop Wiring.
This study point is dedicated to the analysis of the impact of non-stationary crosstalkers on legacy systems, and to find a way to model and bound the amount of non stationary noise.
Status: Deleted
Related Contributions:

- *002t24, Helsinki 2000, Impact of non-stationary crosstalk on legacy ADSL modems - Orckit*
- *003t52, Vienna - Alcatel*
- *003t53, Vienna 2000, Stationarity requirements for spectral compatibility - Tioga*
- *004t25, TD26,TD35,TD53, Montreux 2000 - Alcatel*

SP 2-2. Basic model of input block.

Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One of them is the evaluation of SNR, as interim result of an xDSL performance model (receiver). This study point explores possible improvements to the calculation blocks proposed in TD35 (021t35) of the Torino meeting, dedicated to the input block and the associated echo loss model.
Related Contributions:

- *021t35, Torino 2002 - Model of basic input block, within xDSL receivers - KPN*

SP 2-3. Basic model of 2-node crosstalk.

Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One of them is the evaluation of crosstalk noise levels in a scenario, in the special case that all disturbers are virtually co-located at no more than 2 nodes. This study point explores possible improvements to the calculation block proposed in TD36 (021t36) of the Torino meeting.
Related Contributions:

- *021t36, Torino 2002 - Generic crosstalk models for two-node co-location - KPN*

SP 2-4. Generic Detection models. (PAM, CAP/QAM, Shifted Shannon)

Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One of them is the evaluation of the performance (in terms of noise margin or max bitrate) when a received signal is deteriorated by noise. Models for PAM and CAP/QAM and a line code independent ("Shifted Shannon") model have been proposed. This study point explores possible improvements of the proposed models.
Related Contributions:

- *022t35, Sophia 2002 - Generic detection models for performance modelling - KPN*

SP 2-5. Transmitter/Disturber models for ADSL

Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One of them is the evaluation of the expected signal levels of the "modem under study" as well as modems acting as disturber for the "modem under study". The PSD ***masks*** from "part 1" cover worst *case values* and are too pessimistic for this purpose and related to some resolution bandwidth. Performance modelling requires the definition of PSD ***templates*** representing *expected* values, being independent from any resolution bandwidth.

Related Contributions:

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*
- *022t22, Sophia 2002 - FSAN noise models are too pessimistic for SpM - Alcatel*
- *022t23, Sophia 2002 - PSD of ADSL is too pessimistic in FSAN noise models - Alcatel*
- *023t43, Praha 2002 - Defining Xtalk noise models by measuring ADSL transceivers - Alcatel*
- *031t11, Sophia 2003 - Realistic noise model of ADSL for spectral management - Alcatel*
- *031t23, Sophia 2003 - Transmitter models for ADSL modems - KPN/TNO*
- *031w19, Sophia 2003 - Measurement of actual ADSL products - various vendors*
- *034t38, Sophia 2003 - Transmitter models for ADSL - Alcatel*

This study point has been split-up into SP 2-5.1 and SP2-5.1, and is therefore closed

SP 2-5.1 Transmitter/Disturber models - ADSL without downstream slope @ 1.1MHz

Most of the details of the ADSL templates have been solved, except for a few numbers near 1.1 MHz. This study point is dedicated to the solved issues, and is therefore closed

SP 2-5.2 Transmitter/Disturber models - Downstream slope @ 1.1MHz of ADSL template

Most of the details of the ADSL templates have been solved, except for a few numbers near 1.1 MHz. This study point is dedicated to the numbers that are to define the downstream slope near 1.1 MHz.

- *041t33, Sophia 2004 - Unrealistic steep slopes in proposed ADSL SpM templates - Ericsson*
- *041t34, Sophia 2004 - Problems with current templates in ADSL2 J/M evaluations - Ericsson*
- *043t33, Zürich 2004 - Proposal to complete PSD template of ADSL - TNO*
- *043t35, Sophia 2004 – ADSL PSD Template and PSD measurements - Infineon*
- *051w21, Sophia, feb 2005 – Results of Ad Hoc on ADSL slope near 1.1MHz – Rapporteur*

SP 2-6. Transmitter/Disturber models for SDSL

Similar to SP 2-5, but dedicated to SDSL systems

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*
- *032t14, Reykjavik 2003 - Example of 2B1Q HDSL and SDSL PSDs – Siemens*
- *044t30, Sophia 2004 – SDSL PSD Measurements - Infineon*

SP 2-7. Transmitter/Disturber models for HDSL-CAP/2

Similar to SP 2-5, but dedicated to two-pair HDSL-CAP systems

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*

SP 2-8. Transmitter/Disturber models for HDSL-2B1Q

Similar to SP 2-5, but dedicated to HDSL-2B1Q systems

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*
- *031t20, Sophia 2003 - Example 2B1Q HDSL PSDs - Keymile*
- *031t21, Sophia 2003 - Proposal on HDSL.2B1Q/2 Transmitter signal models - KE*
- *031t22, Sophia 2003 - Transmitter models for ISDN & HDSL-2B1Q modems - KPN/TNO*
- *032t14, Reykjavik 2003 - Example of 2B1Q HDSL and SDSL PSDs - Siemens*

- *033t05, Sophia 2003 - Realistic template of HDSL.2B1Q/2 in out of band range - Swisscom*
- *033t06, Sophia 2003 - Measurements and model for HDSL.2B1Q/2 transceivers - Siemens*
- *034t41, Sophia 2003 - Measurements of out-of-band PSD of HDSL.2B1Q/2 - KE*

SP 2-9. Performance model for ETSI compliant SDSL

Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. Among them are models that predict the performance (noise margin, or bitrate) of xDSL receivers, when the received signal is disturbed by noise. This study point is dedicated to models that predict 6 dB noise margin under all stress conditions specified by the ETSI SDSL standard, for various bitrates, noise models and testloops. Models of SDSL modems that outperform (or underperform) the ETSI standard requirements are beyond the scope of this study point.

- *023t32, Praha 2002 - Receiver performance model for ETSI compliant SDSL - KPN*
- *024t37, Darmstadt 2002 - Parameters for SDSL performance model - Conexant / Adtran*

SP 2-10. Performance model for ETSI compliant HDSL-CAP

Similar to SP 2-9, but dedicated to HDSL-CAP systems. This means predicting 6 dB noise margin under all stress conditions specified by the ETSI HDSL standard.

- *023t33, Praha 2002 - Receiver performance model for ETSI compliant HDSL/CAP - KPN*

SP 2-11. Transmitter/Disturber models for ISDN-2B1Q

Similar to SP 2-5, but dedicated to ISDN-2B1Q systems. ***Measurements are invited !!!!***

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*
- *031t22, Sophia 2003 - Transmitter models for ISDN & HDSL-2B1Q modems - KPN/TNO*
- *041t05, Sophia 2004 - Measured ISDN.2B1Q transmitter PSD - Infineon*

SP 2-12. Implementation loss values for PAM, CAP and DMT

The SNR gap Γ, being used in various receiver performance models for xDSL modems, is a combination of various effects. This Γ parameter is usually split-up into the following three parts:

- Its theoretical value $\Gamma_{linecode}$, usually in the order of 9.8 dB, for the chosen line code (e.g. Γ_{PAM}, Γ_{CAP} or Γ_{DMT}).
- A theoretical coding gain Γ_{coding}, usually in the order of 3-5 dB, to indicate how much additional improvement is achieved by the chosen coding mechanism.
- The empirical implementation losses Γ_{impl}, usually 1.6 dB or more), indicating how much overall deterioration is caused by implementation dependent imperfections in echo cancellation, equalization, etc.

For SDSL this can be expressed as:

SNR gap (linear): $\Gamma_{SDSL} = \Gamma_{PAM} \;/\; \Gamma_{coding} \times \Gamma_{impl}$

SNR gap (in dB): $\Gamma_{SDSL\_dB} = \Gamma_{PAM\_dB} - \Gamma_{coding\_dB} + \Gamma_{impl\_dB}$

This study point is dedicated to split-up the SNR gap into the above mentioned components for all relevant xDSL modems (HDSL, ADSL, SDSL, VDSL, etc) by deriving the first two theoretical values, and by reconstructing the third empirical values. The resulting SNR gap shall be such that the receiver performance model can predict the performance values required by ETSI, under ETSI test conditions.

- *024t37, Darmstadt 2002 - Parameters for SDSL performance model - Conexant / Adtran*

SP 2-13. Method/model for crosstalk cumulative distribution, etc

To extend current performance evaluation methods (based on scenarios with a fixed set of disturbers) to statistical network modelling (based on scenarios with likelihood of occurrence), various additional parametric models are to be developed. These models are *generic* models only, because the inclusion of empirical values for these parameters and/or the inclusion of other statistical data is beyond the scope op SpM-2.
This study point defines the measurement methods, procedures and calculations required to determine (a) the crosstalk cumulative distribution, (b) the likelihood of occurrence (LOO) and (c) severity levels for *crosstalk*.
Related Contributions

- *023t56, Praha 2002 - Suggested starting point for NMC Crosstalk Models - Paradyne*
- *024t39, Darmstadt 2002 - Calculating the probability of interferers … - Paradyne*

SP 2-14 Methods for Impairment Combinations for multiple disturbers

The objective of this study point is the same as described for SP 2-13, but this one is focussed on how to determine the Impairment Combinations (IC) for multiple types of crosstalk.

SP 2-15 Methods for determining Loop Cumulative Distribution

To extend the interpretation of straight-forward reach calculation to the consequences of how many customers are enabled to demand for some service, various additional parametric models are to be developed that account for what percentage of customers live within a certain range. These models are country/region/cable specific, and therefore the models being studied are *generic* models only. This is because the inclusion of empirical values for these parameters and/or the inclusion of other statistical data is beyond the scope op SpM-2.
This study point is focussed on how to determine (a) the cumulative distribution, (b) the likelihood of occurrence (LOO) and (c) severity levels for *Loops*.

- *024t40, Darmstadt 2002 - A simple method of ETSImating the LOO of loop lengths - Paradyne*
- *031t40, Sophia 2003 - Updated European crosstalk CDFs & example procedure - Paradyne*
- *031t41, Sophia 2003 - Example for approximating European loop distribution - Paradyne*

A proposed generic model for how many customers are located within distance L is based on (a) the knowledge of the distance that encloses 63% of the customers, (b) the knowledge on the slope of this customer count, around this 63% distance, and (c) the assumption that this curve follows a Weibull distribution at all other distances. This model for loop length L, has therefore 2 scenario dependent constants (L_0 and q_0), and equals:

Cumulative distribution function: $$F(L; L_0, q_0) = \left(1 - \exp\left(-\left(\frac{L}{L_0}\right)^{q_0}\right)\right)$$

Probability density function: $$f(L; L_0, q_0) = \left(\frac{q_0}{L_0}\right) \times \left(\left(\frac{L}{L_0}\right)^{q_0} \times \exp\left(-\left(\frac{L}{L_0}\right)^{q_0}\right)\right) = \frac{\partial F}{\partial L}$$

Constant L_0 represent the length covering 63% of all subscribers: $F(L_0)=(1-1/e)$. Constant q_0 represents the slope of $F(L)$ at that length and equals $q_0 = e \cdot L \cdot (dF/dL)$ at $L=L_0$.

SP 2-16 Methods for Determining Network Model Coverage (NMC) Score based on IC LOO and Loop LOO

The study point defines the measurement methods, procedures and calculations required to determine the Network model coverage score(NMC-score) based on IC LOO and Loop LOO

SP 2-17. Transmitter/Disturber models for ISDN-MMS43 (4B3T)

Similar to SP 2-11, but dedicated to ISDN-MMS43 systems. These systems are widely deployed in Germany. The current proposal addresses in-band frequencies. Out of band values, above 400 kHz are left for further study. Measurements are invited.

- *014t13, Sophia 2001 - Proposal for same pair ISDN template (4B3T) - DTAG*
- *033t17, Sophia 2003 - Proposal for an ISDN-MMS43 (4B3T) in-band template - T-Systems*
- *041t24, Sophia 2004 - ISDN-4B3T PSD Measurements - T-Systems*
- *044t33, Sophia 2004 – ISDN PSD Template MMS43 - T-Systems*

SP 2-18. Generic Detection model for DMT.

Part 2 of SpM requires a range of calculation blocks, including one (or more) detection model(s) dedicated to DMT in general. This study point explores possible improvements of the proposed model.

Related Contributions:

- *032t09, Reykjavik 2003 - Generic DMT detection model - KPN*
- *034t23, Sophia 2003 - Generic detection model for DMT based modems - FTW*

SP 2-19. Performance models for ETSI compliant ADSL (EC-variant).

Part 2 of SpM requires a range of calculation blocks, including performance models that are specific for the EC variants of ADSL, including "ADSL over POTS" and "ADSL over ISDN". These specific models are based on generic models for DMT detection and the receiver input. This study point explores possible improvements of the proposed models.

Related Contributions:

- *032t10, Reykjavik 2003 - Receiver performance model for "ADSL over POTS" (EC) - KPN*
- *032t11, Reykjavik 2003 - Receiver performance model for "ADSL over ISDN" (EC) - KPN*

SP 2-20 Disturber model for line shared ISDN noise

A model is required that enhance ADSL performance simulations by accounting for the additional noise generated by the ISDN system that share the same line. A simple approach may be a PSD description of line shared ISDN noise, but more advanced models (including splitter models) are not excluded from being studied.

Related Contributions:

- *014t13, Sophia 2001 - Proposal for same pair ISDN template (4B3T) - DTAG*
- *033t18, Sophia 2003 - Disturber model for the line shared ISDN.4B3T noise - T-Systems*
- *044t34, Sophia 2004 – ISDN Same Pair Noise Templates - T-Systems*
- *051w22, Sophia, feb 2005 – ISDN Same Pair Noise (update) - T-Systems*

SP 2-21 Data collection of PSD measurements

Various contributions have provided PSD measurements on signals transmitted by modems. They indicate how good the various transmitter model can represent these modems. This study point is to collect this data in a computer readable format and to store this data on the ETSI server at some TM6 subdirectory (*ftp://docbase.etsi.org/tm/tm6/Inbox/PSD_data*). This is to enable all delegates to compare this data with possibly improved models.

The format shall be some tabular ascii format, and easily loadable by programs such as Matlab. The format is:

filename.psd **à** an **ascii data file** with numbers only, and without additional text
each line contains two numbers, separated by one ore more <tabs>
the first number is the frequency in [**Hz**] (so no [kHz] or [MHz] !!!)
the second number is the PSD value in [**dBm/Hz**]
the frequency increases with the line number,
each frequecny vallue occurs only once

filename.txt **à** an **ascii text file** describing all relevant details about the data file

SP 2-22 Improving the validity of receiver performance models

The validity of the current generic models for receivers is too limited to be usable for scenarios with high SNR. This limitation is highly relevant when simulating FDD modems (some ADSL variants or VDSL) because FDD modems are designed to maximize the SNR values due to the lack of spectral overlap. The high SNR aspect requires to model the imperfection of the equalization (causing inter symbol/carrier interference).

Another aspect of improvement is to add the need for a guard band between upstream and downstream by modelling the imperfections of the case echo cancellation (if any). A guard band of 7 DMT tones is quite common for the FDD variants of ADSL, and spectral management studies will become too optimistic when the model (incorrectly) predicts an improvement of the performance when DMT tones in the guard band are activated.

This guard-band aspect may be too implementation-dependent and therefore undesirable to model. A possible way forward is leaving all echo cancellation out of the modelling, to accept a restricted validity of the ADSL model, and to make the tones in the guard band unavailable by explicit warning in the SpM standard

Related Contributions:

- *033t13, Sophia 2003 - Extending the validity of receiver performance models - KPN*
- *034t40, Sophia 2003 - Discussion of generic receiver model in SpM2 - Alcatel*
- *034t39, Sophia 2003 - Discussion of enhanced ADSL receiver model - Alcatel*

SP 2-23 Performance model for ETSI compliant ADSL.FDD over POTS

Same as SP-2-19, but dedicated to the FDD variant of ADSL over POTS. The model should predict the performance that can be benchmarked against the performance requirements in the ADSL standard.

Related Contributions:

- *033t14, Sophia 2003 - Receiver performance model for "ADSL.FDD over POTS" - KPN*
- *034t40, Sophia 2003 - Discussion of enhanced ADSL receiver model - Alcatel*
- *041t27, Sophia 2004 - Revised modelling of "ADSL.FDD over POTS" (EC) - TNO/KPN*
- *SEE study point SP2-36*

SP 2-24 Performance model for ETSI compliant ADSL.FDD over ISDN

Same as SP-2-19, but dedicated to the FDD variant of ADSL over ISDN. The model should predict the performance that can be benchmarked against the performance requirements in the ADSL standard.

Related Contributions:

- *033t15, Sophia 2003 - Receiver performance model for "ADSL.FDD over ISDN" - KPN*
- *034t40, Sophia 2003 - Discussion of enhanced ADSL receiver model - Alcatel*
- *041t28, Sophia 2004 - Revised modelling of "ADS.FDDL over ISDN" (EC) - TNO/KPN*
- *SEE study point SP2-36*

SP 2-25 Performance model for ADSL2 and ADSL2+

New flavours of ADSL have been introduced in the ITU, and dedicated performance models are desired for SpM studies. A useful performance benchmark for ADSL2+ is unfortunately lacking, since there are currently no reach requirements in a standard that pushes these modem with extend spectrum to their true performance limits. Therefore this study point has also to address the way of preventing the inclusion of models in the SpM-2 standard that are predicting overoptimistic results

Related Contributions:

- *034t33, Sophia 2003 - Receiver models for G.992.3@A and G.992.5@A - TI*

SP 2-26 Modelling sidelobe pick-up in DMT Receivers

In order to improve the validity of performance models for DMT receivers, the impact of sidelobe pick-up in DMT receivers may be a useful addition to the model, including a model for input filtering

that reduces the impact of sidelobe pick-up. The main issues are detailed in 041t22, and this study point is to develop the text that should be added to the description of the DMT performance model.
Related Contributions:

- *991t30, Villach 1999 - Adopting HDSL2 components in SDSL (Fig 1 & table 1)*
- *034w13, Sophia 2003 - Sidelobe pick-up in DMT receivers - Alcatel, Conexant*
- *041t22, Sophia 2004 - Sidelobe pick-up in ADSL DMT receivers - Alcatel*
- *041t23, Sophia 2004 - Modeling filtering in ADSL receivers - Alcatel*

SP 2-27 Additions to the scope of SpM-2

Text that clarifies that SpM-2 is not intended to set requirements to DSL equipment. The text proposed in 034w16 is probably adequate for the job.
Related Contributions:

- *034t37, Sophia 2003 - Clarification of the scope - Alcatel, Ericsson, Texas Instruments*
- *034w16, Sophia 2003 - Text proposal for scope of SpM-2 - ad hoc meeting*

SP 2-28 Text for how to simulate power back-off

Power back-off is an essential aspect of modeling the behavior of transmitters, and practical implementations will cut-back this power in discrete steps (as specified in the relevant standards). Contribution 033w11 proposes to use for simulation purposes a smooth PCB function rather than the staircase PCB function described in the standard. Rational behind this proposal is to smoothen the bit-rate plots at low distances and enable so more accurate estimations of impact and deployment reaches. Contribution 041w23 shows that this approach leads indeed to smoother performance plots.
It was a common view within TM6 that the analysis of SpM-studies will deteriorate when implementation details like the staircase steps of PCB functions are incorporated as well. A simplified analysis with smooth function improves the analysis, even when this is less realistic.
This study point is dedicated to the precise wording and definition of the power back-of mechanism for SpM studies.
Related Contributions:

- *041w11, Sophia 2004 - Simulation Guide for ADSL and SDSL Power Back-Off - FTW*
- *041w23, Sophia 2004 - Comparison between smooth and staircase PCB - Ericsson*
- *042w08, Gent 2004 - Text, for power back-off in SDSL and ADSL transmitter - TNO*

SP 2-29. Transmitter/Disturber models for ADSL2 annex J&M

Similar to SP 2-5, but dedicated to ADSL2 annex J&M systems
Related Contributions:

- *041t34, Sophia 2004 - Problems with current templates in ADSL2 J/M evaluations - Ericsson*
- *041w12, Sophia 2004 - Proposed ADSL templates for Annex J/M - Ericsson*

SP 2-30. Text for preventing invalid bit-loading combinations

The current draft on SpM-2 has a note in clause 5.2.4, to warn against an invalid combination of loaded bits. This note is relevant, but not very helpful for those who are not highly skilled in the art of DMT simulations. This study point is to provide a more descriptive text.

- *042w10, Gent 2004 - Additional note for the generic DMT model on bit loading - TNO*

SP 2-31 Out of band values of ISDN.2B1Q template

The out of band values that are currently available for modeling purposes, are based on values derived from the PSD masks, as specified in the standard (see also SP2-11). This study point is to improve these numbers, on the basis of measurements

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*

- *044t26, Sophia 2004 - PSD floor noise level for spectral simulations – Czech Telecom*

SP 2-32 Out of band values for SDSL template

The out of band values that are currently available for modeling purposes, are based on values derived from the PSD masks, as specified in the standard. This study point is to improve these numbers, on the basis of measurements

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*
- *044t30, Sophia, nov 2004 - SDSL PSD Measurements - Infineon*
- *051w25, Sophia, feb 2005 – Results of Ad Hoc on SDSL out-of-band spectrum - Rapporteur*

SP 2-33 VDSL templates based on ETSI standards

Description of the VDSL templates, as specified in part 1 of the ETSI VDSL standard, in a format that is suitable for the SpM-2 document.

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*
- *044t31, Sophia 2004 – Proposed text for section on VDSL - Alcatel*

SP 2-34 Out of band values for ADSL templates

The out of band values that are currently available for modeling purposes, are based on values derived from the PSD masks, as specified in the standard. This study point is to improve these numbers, on the basis of measurements

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*

SP 2-35 Out of band values for HDSL.CAP/2 template

The out of band values that are currently available for modeling purposes, are based on values derived from the PSD masks, as specified in the standard. This study point is to improve these numbers, on the basis of measurements

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*
- *044w23, Sophia 2004 – PSD measurements on HDSL.CAP modems – Schmid Telecom*

SP 2-36 ADSL.FDD performance model (over POTS & ISDN)

The performance models, that are currently created for ADSL.FDD (see SP 2-23 and 2-24) are benchmarked against the performance numbers specified in the ETSI ADSL standard. These are seen as minimum requirements, while ADSL is expected to perform significantly better than these ETSI numbers (DSL forum numbers were derived from higher performance demands). This study point is to provide a suitable model.

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*
- *043w16*
- *044t15*
- *044t16R1*

SP 2-37 Performance model for HDSL.2B1Q

This study point is to create a description of the HDSL.2B1Q receiver. Within TM6, performance studies have been carried out for e-SDSL and ADL-64 under the working title of NESP, and this could serve as a source for these HDSL.2B1Q models.

- *033t04R1, Sophia Antipolis, September 2004*
- *034w11, Sophia Antipolis, November 2004*
- *043t32, Zürich, September 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*
- *051t17R1, Sophia, Feb 2005 – Text proposal for Receiver Model for HDSL.2B1Q - SwissCom*

SP 2-38 Collecting public available cable models

Cable models are commonly used within TM6, but not always available for publication. The models collected in the "cable reference document" (970p02r3, R.F.M. van den Brink) are based on contributions from various operators that were intended for usage only *within* TM6. The quality models used in the VDSL testloops have been discosed to enable publication, so they can be copied into section 7 of SpM-2. The models used in the testloops for ADSL and SDSL have been extrapolated in frequency on the basis of an "edjucated guess" because measured data was unavailable. These models are therefore not suitable for inclusion of SpM-2

This study point is to collect all models with proven accuracy, that are disclosed for publication and are seen as relevant for SpM-2 (suggestion from the Rapporteur: copy the models of the VDSL loops in section 7 of SpM-2, and add public references to other loops if identified as suitable)

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*

2-39 Restructuring Clause 5

The structure in clause 5 on receiver performance models is seen by the Rapporteur as mature, but the Champion of this study point believes that it can be improved. This study point is to provide *literal* text, for introductory matters and overall structure, so that TM6 can see this improvement

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*

2-40 Text for sub-clauses 8.1 to 8.3

Introductory text explaining different network topologies and the validity of crosstalk modeling is seen as highly relevant but is currently lacking. This study point is to provide TM6 with a literal text proposal.

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*

2-41 Compiling available text for sub-clauses on multi node crosstalk

A two-node crosstalk model is computational convenient, but with limited validity. Especially when the loops are short. For VDSL scenarios this model is not usable since multiple customer modems are distributed along the line. This needs a multinode approach, a node for each point where modems are virtually collocated. Serving 10 customers (all at different locations) with VDSL from the cabinet requires an 11-node crosstalk model.

These models have been used in various VDSL studies, but a ***punctual*** description of that approach is lacking. This study point is to provide literal text that describes how to implement a multi-node crosstalk model.

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*
- *033w07, Sophia 2003 – Method on Xtalk Calculations in a Distributed Environment*

2-42 Describing the scenarios (without calculation results) identified within ESP (2004)

Within TM6, performance studies have been carried out for enhanced SDSL and new flavors of ADSL. The rationale behind the scenarios in these studies is generally accepted by TM6, however a precise description of these scenarios is lacking. The TM6 document describing these scenarios is still filled with all kinds of revision markers. This study point is to create a very ***punctual*** description of relevant material from these contributions that is adequate for inclusion into SpM-2.

- *033t04r2, Sophia 2003 – Framework for spectral management studies – TM6 Operators*
- *034t32, 2003 – Area Limits for the European Simulation Platform Network Model – Infineon*
- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*
- *044t28r1, Sophia 2004 – NESP: An Example of Use for SpM-2 – Swisscom*

- *051t32R1, Sophia, feb 2005 – Description of example scenarios on ESP/2004 in SpM2 - TNO*

2-43 Revising scope, or inclusion of chapter dedicated to measurements

The current SpM-2 draft is dedicated only to computational methods, while measurements may provide an alternative. The word “measurement” has been removed from the draft (revision 9) due to the lack of any contribution on this alternative method.
This study point is to identify if such a measurement approach should be added to SpM-2, or to decide that TM6 leaves this issue absent in SpM-2.

- *043t32, Zürich 2004 – Resolving the comments from AbC – Rapporteur SpM2, TNO*

2-44 Calculation methods for distributed cable tree topologies

A commonly used simplification of modeling crosstalk coupling in a loop assume a two-node topology, as if all disturbers are co-located at the NT side as well as the LT side. In some cases, more advanced models for crosstalk coupling are required, accounting for the fact that NT modems are not co-located but “scattered” along the loop, and connected with branches. This studypoint is to develop a literal text proposal on a mathematical description to specify such a multi-node crosstalk model.

- *051t21, Sophia, feb 2005 – Distributed cable tree installation scenario – Czech Telecom*

Text proposals, being candidate for inclusion into the Draft .

The text fragments below have been proposed for inclusion in the draft version of SpM part 2, but are still in the "under study" status. If agreement is achieved, they will be moved into the Draft

[1] ETSI TS 101 388 (v1.3.1): "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Asymmetric Digital Subscriber Line (ADSL) - European specific requirements".

[2] ETSI TS 101 135 (v1.5.3): "Transmission and Multiplexing (TM); High bit-rate Digital Subscriber Line (HDSL) transmission systems on metallic local lines; HDSL core specification and applications for combined ISDN-BA and 2 048 kbit/s transmission".

[3] ITU-T Recommendation G.992.1: "Asymmetric digital subscriber line (ADSL) transceivers".

[4] ETSI TS 101 270 1 (v1.3.1): "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL) – Part 1: Functional requirements".

ED. NOTE. Spelling conventions: "crosstalk" and "bitrate" without a space in-between

Text portion proposed for inclusion into clause 4

4.2 Cluster 2 Transmitter signal models

~~4.2 Transmitter signal model for "ISDN.2B1Q"~~

~~ED. NOTE. Contribution 044t26 proposed to apply an out-of-band value of –100dBm/Hz, additionally to the current value of –120dBm/Hz. This was left for further study~~

4.X Transmitter signal model for "ISDN.2B1Q/filtered"

When ISDN signals have to pass a low-pass filter (such as in an ADSL splitter) before they reach the line, the disturbance caused by these ISDN systems to other wire pairs will change, as well as their performance. SpM studies should therefore make a distinction between crosstalk generated from ISDN systems connected directly to the line and filtered ISDN systems.
The PSD template for modeling a "ISDN.2B1Q/filtered" transmitter signal that has passed a low-pass splitter/filter, is defined in table 1 in terms of break frequencies. It has been constructed from the transmitter PSD template, filtered by the low-pass transfer function representing the splitter/filter.
The values are based on measurements on these modems, and based on filter assumptions according to splitter specifications in [5] and [6]. The associated values are constructed with straight lines between these break frequencies, when plotted against a *logarithmic* frequency scale and a *linear* dBm scale.

ED NOTE <to be moved to the list of references>

[5] ETSI TS 101 952-1-3 (about splitters).

[6] ETSI TS 101 952-1-4 (about splitters).

ISDN.2B1Q/Filtered	(135W)
f [Hz]	P [dBm/Hz]
1 k	-32,1
10 k	-32,3
20 k	-33,1
30 k	-34,5
40 k	-36,6
50 k	-39,8
60 k	-44,5
65 k	-47,8
70 k	-52,2
75 k	-59,3
80 k	-126,5
85 k	-61,9
90 k	-57,4
100 k	-55,2
110 k	-57,9
115 k	-62,9
120 k	-68,2
125 k	-79,3
130 k	-90,8
135 k	-104,1
140 k	-117,9
145 k	-132,8
150 k	-136,9
160 k	-140,0
170 k	-140,0
180 k	-136,2
190 k	-135,2
200 k	-135,8
210 k	-137,8
220 k	-140,0
30 M	-140,0

Table 1: PSD template for modeling "ISDN.2B1Q/filtered" signals.

4.Y Transmitter signal model for "ISDN.MMS43/filtered"

When ISDN signals have to pass a low-pass filter (such as in an ADSL splitter) before they reach the line, the disturbance caused by these ISDN systems to other wire pairs will change, as well as their performance. SpM studies should therefore make a distinction between crosstalk generated from ISDN systems connected directly to the line and filtered ISDN systems.

The PSD template for modeling a "ISDN.MMS43/filtered" transmitter signal that has passed a low-pass splitter/filter, is defined in table 2 in terms of break frequencies. It has been constructed from the transmitter PSD template, filtered by the low-pass transfer function representing the splitter/filter.

The values are based on measurements on these modems, and based on filter assumptions according to splitter specifications in [5] and [6]. The associated values are constructed with straight lines between these break frequencies, when plotted against a *logarithmic* frequency scale and a *linear* dBm scale.

ISDN.MMS.43/filtered	**(150 W)**
f [Hz]	**P [dBm/Hz]**
1 k	-34,5
10 k	-34,6
20 k	-35,0
30 k	-35,7
40 k	-36,7
50 k	-38,2
60 k	-40,2
70 k	-42,8
80 k	-46,2
90 k	-50,8
100 k	-56,8
110 k	-66,8
115 k	-80,3
120 k	-93,6
125 k	-106,9
130 k	-112,4
135 k	-122,5
140 k	-131,4
150 k	-130,4
170 k	-129,8
190 k	-132,7
200 k	-134,8
210 k	-137,6
216 k	-140,0
30 M	-140,0

Table 2: PSD template for modeling "ISDN.MMS.43/filtered" signals.

4.7 Transmitter signal model for "HDSL.CAP"

The PSD templates for modelling signals generated by HDSL.CAP transmitters are different for single-pair and two-pair HDSL systems. The PSD templates for modelling the "HDSL.CAP/1" transmit spectra for one-pair systems and "HDSL.CAP/2" transmit spectra for two-pair systems are defined in terms of break frequencies, as summarised in table 35. These templates are taken from the nominal shape of the transmit signal spectra, as specified in the ETSI HDSL standard [24]. The associated values are constructed with straight lines between these break frequencies, when plotted against a *logarithmic* frequency scale and a *linear* dBm scale. The source impedance equals R_s=135Ω.

HDSL.CAP/1	1-pair 135 Ω		**HDSL.CAP/2**	2-pair 135 Ω
[Hz]	[dBm/Hz]		[Hz]	[dBm/Hz]
1	–57		1	–57
4.0 k	–57		3,98 k	–57
33 k	–43		21,5 k	–43
62 k	–40		39,02 k	–40
390.67 k	–40		237,58 k	–40
419.67 k	–43		255,10 k	–43
448.67 k	–60		272,62 k	–60
489.02 k	–70		297,00 k	–70
1956,08 k	–120		1,188 M	–120
30 M	–120		30 M	–120

Table 35. PSD template values at break frequencies for modelling "HDSL.CAP/2".

Note The out-of-band values may be lower than specified in these models

[74] ETSI TS 101 135 (v1.5.3): "Transmission and Multiplexing (TM); High bit-rate Digital Subscriber Line (HDSL) transmission systems on metallic local lines; HDSL core specification and applications for combined ISDN-BA and 2 048 kbit/s transmission".

4.8 Transmitter signal model for "SDSL"

ED. NOTE. It was provisionally agreed to change (and simplify) the SDSL PSD template into:

$P_{SDSL} = P_{sinc} + P_{floor}$

P_{sinc} = the current filtered sinc function, as described in the SpM2-draft

P_{floor_dBm} = –120 dBm/Hz

4.9 Transmitter signal model for "ADSL over POTS" (EC)

ED. NOTE. The definition of a value fx, representing the steepness of the downstream slope near 1.1 MHz, has been left for further study. The numbers below are the result from an ad-hoc meeting on this topic (see 051w21)

"Below" (down tlo lowest usable tone)	–40 dBm/Hz
1104 kHz	–40 dBm/Hz
1250 kHz	–45 dBm/Hz
1500 kHz	–70 dBm/Hz
2100 kHz	–90 dBm/Hz
"Above" (up to 3.093 MHz)	–90 dBm/Hz

4.10 Transmitter signal model for "ADSL.FDD over POTS"

ED. NOTE. The definition of a value f_x, representing the steepness of the downstream slope near 1.1 MHz, has been left for further study. See the editorial note in section 4.4.1 for further details The numbers below are the result from an ad-hoc meeting on this topic (see 051w21).

"Below" (down tto lowest usable tone)	–40 dBm/Hz
1104 kHz	–40 dBm/Hz
1250 kHz	–45 dBm/Hz
1500 kHz	–70 dBm/Hz
2100 kHz	–90 dBm/Hz
"Above" (up to 3.093 MHz)	–90 dBm/Hz

4.11 Transmitter signal model for "ADSL over ISDN" (EC)

ED. NOTE. The definition of a value f_x, representing the steepness of the downstream slope near 1.1 MHz, has been left for further study. See the editorial note in section 4.4.1 for further details. The numbers below are the result from an ad-hoc meeting on this topic (see 051w21).

"Below" (down tto lowest usable tone)	–40 dBm/Hz
1104 kHz	–40 dBm/Hz
1250 kHz	–45 dBm/Hz
1500 kHz	–70 dBm/Hz
2100 kHz	–90 dBm/Hz
"Above" (up to 3.093 MHz)	–90 dBm/Hz

4.12 Transmitter signal model for "ADSL.FDD over ISDN"

ED. NOTE. The definition of a value f_x, representing the steepness of the downstream slope near 1.1 MHz, has been left for further study. See the editorial note in section 4.4.1 for further details. The numbers below are the result from an ad-hoc meeting on this topic (see 051w21).

"Below" (down tto lowest usable tone)	–40 dBm/Hz
1104 kHz	–40 dBm/Hz
1250 kHz	–45 dBm/Hz
1500 kHz	–70 dBm/Hz
2100 kHz	–90 dBm/Hz
"Above" (up to 3.093 MHz)	–90 dBm/Hz

4.15 Transmitter signal model for "VDSL"

The PSD template for modeling the "VDSL" transmit spectrum, is defined in terms of break frequencies, as summarized in table 41 to 74 and in table 85 to 118. The associated values are constructed with straight lines between these break frequencies, when plotted against a ***logarithmic*** frequency scale and a ***linear*** dBm scale. The source impedance is equal to the selected design impedance, and can be R_V=135Ω or R_V=100Ω.

VDSL is defined for a range of scenarios, each with its own template PSD. The ETSI VDSL standard [1] has foreseen the following pairs of templates for upstream and downstream transceivers:

Note The templates below do not take into account that additional PSD reduction mechanisms like pre-defined downstream PSD limitation or automatic upstream power back-off can be applied in a practical situation. For the downstream signals of FTTEx-VDSL, and for the downstream signals of FTTCab-VDSL M2 (variant A and B), the transmitter is not allowed to fill the complete PSD mask, because it violates the maximum transmit power allowed. The transmitter has then to reduce the PSD, until the power constraint is fulfilled. This reduction mechanism is not specified in the VDSL standard. The templates below are based on a specific modem power reduction method using the ceiling power cutback. The actual transmit PSD could therefore differ from one modem to the other.

ED NOTE: By adding this note, the templates that were left for further study can be copied from the ones specified in ETSI VDSL1

VDSL/Cab - ETSI main bandplan (akalso known as 997)

	up	down	comment
1	E1::P.M1.withoutUS0	E1::Pcab.M1.A	*Main plan, non-boosted, DS above 1104 kHz*
2	E1::P.M1.withoutUS0	E1::Pcab.M1.B	*Main plan, non-boosted, DS above 958 kHz*
3	E1::P.M1.withUS0	E1::Pcab.M1.A	*Main plan, non-boosted, DS above 1104 kHz*
4	E1::P.M1.withUS0	E1::Pcab.M1.B	*Main plan, non-boosted, DS above 958 kHz*
5	E1::P.M2.withoutUS0	E1::Pcab.M2.A	*Main plan, boosted, DS above 1104 kHz*
6	E1::P.M2.withoutUS0	E1::Pcab.M2.B	*Main plan, boosted, DS above 958 kHz*
7	E1::P.M2.withUS0	E1::Pcab.M2.A	*Main plan, boosted, DS above 1104 kHz*
8	E1::P.M2.withUS0	E1::Pcab.M2.B	*Main plan, boosted, DS above 958 kHz*

VDSL/Ex - ETSI main bandplan (akalso known as 997)

	up	DS	comment
1	E1::P.M1.withoutUS0	E1::Pex.P1.M1	*Main plan, non-boosted, DS above 251 kHz*
2	E1::P.M1.withoutUS0	E1::Pex.P2.M1	*Main plan, non-boosted, DS above 138 kHz*
3	E1::P.M1.withUS0	E1::Pex.P1.M1	*Main plan, non-boosted, DS above 251 kHz*
4	E1::P.M1.withUS0	E1::Pex.P2.M1	*Main plan, non-boosted, DS above 138 kHz*
5	E1::P.M2.withoutUS0	E1::Pex.P1.M2	*Main plan, boosted, DS above 251 kHz*
6	E1::P.M2.withoutUS0	E1::Pex.P2.M2	*Main plan, boosted, DS above 138 kHz*
7	E1::P.M2.withUS0	E1::Pex.P1.M2	*Main plan, boosted, DS above 251 kHz*
8	E1::P.M2.withUS0	E1::Pex.P2.M2	*Main plan, boosted, DS above 138 kHz*

VDSL/Cab - ETSI optional bandplan (~~ak~~a<u>lso known as</u> 998)

	up	DS	comment
1	E2::P.M1.withoutUS0	E2::Pcab.M1.A	*Optional plan, non-boosted, DS above 1104 kHz*
2	E2::P.M1.withoutUS0	E2::Pcab.M1.B	*Optional plan, non-boosted, DS above 958 kHz*
3	E2::P.M1.withUS0	E2::Pcab.M1.A	*Optional plan, non-boosted, DS above 1104 kHz*
4	E2::P.M1.withUS0	E2::Pcab.M1.B	*Optional plan, non-boosted, DS above 958 kHz*
5	E2::P.M2.withoutUS0	E2::Pcab.M2.A	*Optional plan, boosted, DS above 1104 kHz*
6	E2::P.M2.withoutUS0	E2::Pcab.M2.B	*Optional plan, boosted, DS above 958 kHz*
7	E2::P.M2.withUS0	E2::Pcab.M2.A	*Optional plan, boosted, DS above 1104 kHz*
8	E2::P.M2.withUS0	E2::Pcab.M2.B	*Optional plan, boosted, DS above 958 kHz*

VDSL/Ex - ETSI optional bandplan (~~ak~~a<u>lso known as</u> 998)

	up	DS	comment
1	E2::P.M1.withoutUS0	E2::Pex.P1.M1	*Optional plan, non-boosted, DS above 251 kHz*
2	E2::P.M1.withoutUS0	E2::Pex.P2.M1	*Optional plan, non-boosted, DS above 138 kHz*
3	E2::P.M1.withUS0	E2::Pex.P1.M1	*Optional plan, non-boosted, DS above 251 kHz*
4	E2::P.M1.withUS0	E2::Pex.P2.M1	*Optional plan, non-boosted, DS above 138 kHz*
5	E2::P.M2.withoutUS0	E2::Pex.P1.M2	*Optional plan, boosted, DS above 251 kHz*
6	E2::P.M2.withoutUS0	E2::Pex.P2.M2	*Optional plan, boosted, DS above 138 kHz*
7	E2::P.M2.withUS0	E2::Pex.P1.M2	*Optional plan, boosted, DS above 251 kHz*
8	E2::P.M2.withUS0	E2::Pex.P2.M2	*Optional plan, boosted, DS above 138 kHz*

Power back-off

<FOR FURTHER STUDY>

4.15.1 Templates compliant with the ETSI main band plan

E1::P.M1		E1::P.M2	
Frequency (kHz)	Template (dBm/Hz)	Frequency (kHz)	Template (dBm/Hz)
With optional band			
0	-110	0	-110
4	-110	4	-110
25	-40	25	-40
138	-40	138	-40
307	-90	307	-90
482	-100	482	-100
Without optional band			
0	-110	0	-110
225	-110	225	-110
226	-100	226	-100
Common PSD			
2 825	-100	2 825	-100
3 000	-80	3 000	-80
3 001	-61	3 001	-54,8
5 099	-61	5 099	-57,1
5 100	-82	5 100	-82
5 274	-102	5 274	-102
5 275	-112	5 275	-112
6 875	-112	6 875	-112
6 876	-102	6 876	-102
7 050	-82	7 050	-82
7 051	-61	7 051	-58,5
11 999	-61	10 000	-60
12 000	-82	11 999	-60
12 175	-102	12 000	-82
12 176	-112	12 175	-102
30 000	-112	12 176	-112
		30 000	-112

Table 41: Default US PSD templates

E1::Pcab.M1		**E1::Pcab.M2**	
Frequency (kHz)	**Template (dBm/Hz)**	**Frequency (kHz)**	**Template (dBm/Hz)**
Variant A			
0	-110	0	-110
225	-110	225	-110
226	-100	226	-100
929	-100	929	-100
1 104	-80	1 104	-80
Variant B			
0	-110	0	-110
225	-110	225	-110
226	-100	226	-100
770	-100	770	-100
945	-80	945	-80
946	-78,3	946	-77,3
947,2	-74,8	947,2	-73,8
949	-72	949	-71
958	-67,1	958	-66,1
1 104	-61	1 104	-60
Common			
1 105	-61	1 105	-60
2 999	-61	1 394	-51,4
3 000	-82	2 999	-54,8
3 174	-102	3 000	-82
3 175	-110	3 174	-102
4 925	-110	3 175	-110
4 926	-102	4 925	-110
5 100	-82	4 926	-102
5 101	-61	5 100	-82
7 049	-61	5 101	-57,1
7 050	-82	7 049	-58,5
7 224	-102	7 050	-82
7 225	-112	7 224	-102
30 000	-112	7 225	-112
		30 000	-112

Table 52: Default DS FTTCab PSD templates

E1::Pex.P1.M1		E1::Pex.P1.M2	
Frequency (kHz)	Template (dBm/Hz)	Frequency (kHz)	Template (dBm/Hz)
FFS	FFS	FFS	FFS

E1::Pex.P1.M1		E1::Pex.P1.M2	
Frequency (kHZ)	Template (dBm/Hz)	Frequency (kHZ)	Template (dBm/Hz)
0	-97,5	0	-97,5
3,99	-97,5	3,99	-97,5
4	-90	4	-90
138	-90	138	-90
139	-61	139	-61
217	-61	217	-61
256	-46,4	251	-48,2
1 254	-46,4	1 303	-48,2
1 677	-61	1 394	-51,4
2 999	-61	2 999	-54,8
3 000	-82	3 000	-82
3 174	-102	3 174	-102
3 175	-110	3 175	-110
4 925	-110	4 925	-110
4 926	-102	4 926	-102
5 100	-82	5 100	-82
5 101	-61	5 101	-57,1
7 049	-61	7 049	-58,5
7 050	-82	7 050	-82
7 224	-102	7 224	-102
7 225	-112	7 225	-112
30 000	-112	30 000	-112

Table 63: Default DS FTTEx P1 PSD templates

~~E1::Pex.P2.M1~~		~~E1::Pex.P2.M2~~	
~~Frequency (kHz)~~	~~Template (dBm/Hz)~~	~~Frequency (kHz)~~	~~Template (dBm/Hz)~~
~~FFS~~	~~FFS~~	~~FFS~~	~~FFS~~

E1::Pex.P2.M1		E1::Pex.P2.M2	
Frequency (kHZ)	Template (dBm/Hz)	Frequency (kHZ)	Template (dBm/Hz)
0	-97,5	0	-97,5
3,99	-97,5	3,99	-97,5
4	-90	4	-90
138	-90	138	-90
139	-46,9	139	-48,5
1 265	-46,9	1 314	-48,5
1 677	-61	1 394	-51.4
2 999	-61	2 999	-54.8
3 000	-82	3 000	-82
3 174	-102	3 174	-102
3 175	-110	3 175	-110
4 925	-110	4 925	-110
4 926	-102	4 926	-102
5 100	-82	5 100	-82
5 101	-61	5 101	-57,1
7 049	-61	7 049	-58,5
7 050	-82	7 050	-82
7 224	-102	7 224	-102
7 225	-112	7 225	-112
30 000	-112	30 000	-112

Table 74: Default DS FTTEx P2 PSD templates

4.15.2 Templates compliant with the ETSI optional band plan

E2::P.M1		**E2::P.M2**	
Frequency (kHz)	**Template (dBm/Hz)**	**Frequency (kHz)**	**Template (dBm/Hz)**
With optional band			
0	-110	0	-110
4	-110	4	-110
25	-40	25	-40
138	-40	138	-40
307	-90	307	-90
Without optional band			
0	-110	0	-110
225	-110	225	-110
226	-100	226	-100
Common PSD			
482	-100	482	-100
3 575	-100	3 575	-100
3 750	-80	3 750	-80
3 751	-61	3 751	-55,7
5 199	-61	5 199	-57,2
5 200	-82	5 200	-82
5 374	-102	5 374	-102
5 375	-112	5 375	-112
8 325	-112	8 325	-112
8 326	-102	8 326	-102
8 500	-82	8 500	-82
8 501	-61	8 501	-59,3
11 999	-61	10 000	-60
12 000	-82	11 999	-60
12 175	-102	12 000	-82
12 176	-112	12 175	-102
30 000	-112	12 176	-112
		30 000	-112

Table 85: Optional US PSD templates

E2::Pcab.M1		E2::Pcab.M2	
Frequency (kHz)	Template (dBm/Hz)	Frequency (kHz)	Template (dBm/Hz)
Variant A			
0	-110		
225	-110		
226	-100		
929	-100		
1 104	-80		
Variant B			
0	-110		
225	-110		
226	-100		
770	-100		
945	-80		
946	-78,3		
947,2	-74,8	FFS	FFS
949	-72		
958	-67,1		
1 104	-61		
Common			
1 105	-61		
3 749	-61		
3 750	-82		
3 924	-102		
3 925	-110		
5 025	-110		
5 026	-102		
5 200	-82		
5 201	-61		
8 499	-61		
8 500	-82		
8 674	-102		
8 675	-112		
30 000	-112		

E2::Pcab.M1		E2::Pcab.M2	
Frequency (kHZ)	Template (dBm/Hz)	Frequency (kHZ)	Template (dBm/Hz)
Variant A			
0	-110	0	-110
225	-110	225	-110
226	-100	226	-100
929	-100	929	-100
1 104	-80	1 104	-80
Variant B			
0	-110	0	-110
225	-110	225	-110
226	-100	226	-100
770	-100	770	-100
945	-80	945	-80
946	-78,3	946	-77,3
947,2	-74,8	947,2	-73,8
949	-72	949	-71
958	-67,1	958	-66,1
1 104	-61	1 104	-60
Common			
1 105	-61	1 105	-60
3 749	-61	1 295	-54,1
3 750	-82	2 603	-54,1
3 924	-102	3 749	-55,7
3 925	-110	3 750	-82
5 025	-110	3 924	-102
5 026	-102	3 925	-110
5 200	-82	5 025	-110

5 201	-61	5 026	-102
8 499	-61	5 200	-82
8 500	-82	5 201	-57,2
8 674	-102	8 499	-59,3
8 675	-112	8 500	-82
30 000	-112	8 674	-102
		8 675	-112
		30 000	-112

Table 96: Optional DS FTTCab PSD templates

E2::Pex.P1.M1		E2::Pex.P1.M2	
Frequency (kHz)	Template (dBm/Hz)	Frequency (kHz)	Template (dBm/Hz)
FFS	FFS	FFS	FFS

E2::Pex.P1.M1		E2::Pex.P1.M2	
Frequency (kHZ)	Template (dBm/Hz)	Frequency (kHZ)	Template (dBm/Hz)
0	-97,5	0	-97,5
3,99	-97,5	3,99	-97,5
4	-90	4	-90
138	-90	138	-90
139	-61	139	-61
217	-61	217	-61
255	-46,8	248	-49,4
1 262	-46,8	1 336	-49,4
1 677	-61	1 394	-51,4
3 749	-61	3 749	-55,7
3 750	-82	3 750	-82
3 924	-102	3 924	-102
3 925	-110	3 925	-110
5 025	-110	5 025	-110
5 026	-102	5 026	-102
5 200	-82	5 200	-82
5 201	-61	5 201	-57,2
8 499	-61	8 499	-59,3
8 500	-82	8 500	-82
8 674	-102	8 674	-102
8 675	-112	8 675	-112
30 000	-112	30 000	-112

Table 107: Optional DS FTTEx P1 PSD templates

~~E2::Pex.P2.M1~~		~~E2::Pex.P2.M2~~	
~~Frequency (kHz)~~	~~Template (dBm/Hz)~~	~~Frequency (kHz)~~	~~Template (dBm/Hz)~~
~~FFS~~	~~FFS~~	~~FFS~~	~~FFS~~

E2::Pex.P2.M1		E2::Pex.P2.M2	
Frequency (kHZ)	Template (dBm/Hz)	Frequency (kHZ)	Template (dBm/Hz)
0	-97,5	0	-97,5
3,99	-97,5	3,99	-97,5
4	-90	4	-90
138	-90	138	-90
139	-47,2	139	-49,7
1 273	-47,2	1 346	-49,7
1 677	-61	1 394	-51.4
3 749	-61	3 749	-55.7
3 750	-82	3 750	-82
3 924	-102	3 924	-102
3 925	-110	3 925	-110
5 025	-110	5 025	-110
5 026	-102	5 026	-102
5 200	-82	5 200	-82
5 201	-61	5 201	-57,2
8 499	-61	8 499	-59,3
8 500	-82	8 500	-82
8 674	-102	8 674	-102
8 675	-112	8 675	-112
30 000	-112	30 000	-112

Table 118: Optional DS FTTEx P2 PSD templates

Text portions proposed for inclusion into clause 5

5 Generic receiver performance models for xDSL

5.1. Generic input models for effective SNR

5.1.2 Second order input model (with residual distortion)

This input model assumes that two effects internally modify the SNR of the input signal:

- an equivalent *receiver noise power* P_{RN0} that indicates how much noise is added by the receiver electronics.
- a *distortion suppression factor* h_d that indicates how effective equalization has been implemented. It represents the difference between transmitted signal and equalized received signal, and any non-zero difference behaves like noise.

Figure 1 shows the flow diagram of this model.

The relevance of including distortion suppression in this input model is mainly to extend the validity of the model to scenarios with relatively high SNR values. This is of particular interest when studying scenarios for FDD modems.

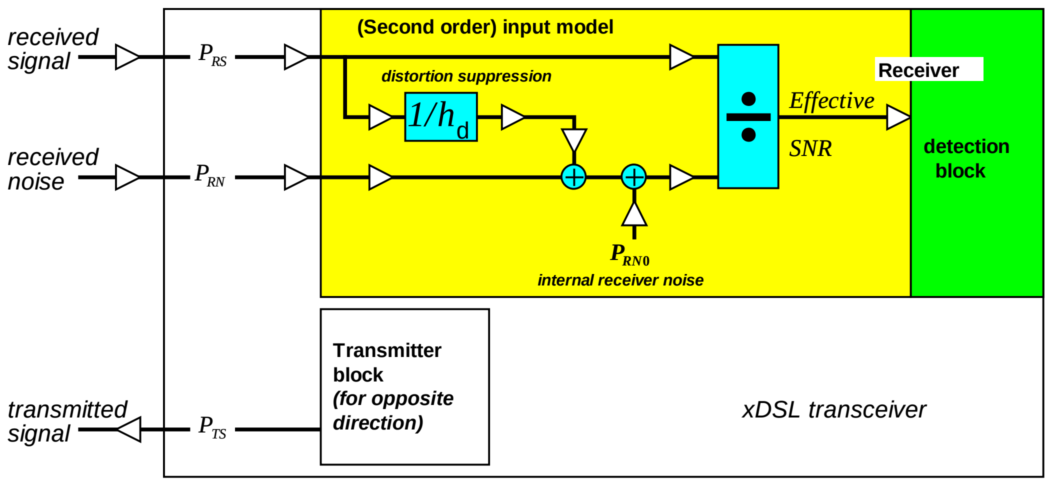

Figure 1: Flow diagram of a transceiver model that incorporates a linear second order input model for the determination of the effective SNR.

Expression 1 summarizes how to evaluate the effective SNR for this model, and it has been specified in plain and offset formats. Table 129 summarizes the involved parameters.

Plain format:	$SNR(f)$	=	$\frac{P_{RS}}{P_{RN} + P_{RN0} + P_{RS} / h_d^2}$
Noise offset format:	$SNR_{ofs,N}(m, f)$	=	$\frac{P_{RS}}{P_{RN} \times m + P_{RN0} + P_{RS} / h_d^2}$
Signal offset format:	$SNR_{ofs,S}(m, f)$	=	$\frac{P_{RS} / m}{P_{RN} + P_{RN0} + P_{RS} / (h_d^2 \times m)}$

Expression 1: Effective SNR, in various formats for a second order input model accounting for residual distortion

INPUT QUANTITIES	linear	In dB	remarks
Received signal power	P_{RS}	$10\times\log_{10}(P_{RS})$	*Frequency dependent*
Received crosstalk noise	P_{RN}	$10\times\log_{10}(P_{RN})$	*External noise*
Received reflected power	P_{RE}	$10\times\log_{10}(P_{RE})$	*External noise*
Model Parameters			
Receiver noise power	P_{RN0}	$10\times\log_{10}(P_{RN0})$	*Internal noise*
Distortion suppression	h_d	$20\times\log_{10}(h_d)$	*Quality of equalizer*
Output quantities			
Signal to noise ratio (effective)	*SNR*	$10\times\log_{10}(SNR)$	*Frequency dependent*

Table ~~9~~12: Involved parameters and quantities for a second order input model, accounting for residual distortion.

5.1.3. Second order input model (with residual echo)

ED NOTE The need for inclusion of the entire clause 5.1.3 is subject for further study, and the text below may be kept out of the draft if discussions within ETSI-TM6 on this topic have resulted in a conclusion

This input model assumes that two effects internally modify the SNR of the input signal:

- an equivalent *receiver noise power* P_{RN0} that indicates how much noise is added by the receiver electronics.
- an *echo suppression factor* h_e that indicates how effective echo cancellation is implemented.

Therefore this input model is enhanced with a simple but effective model of echo coupling as specified in clause 5.3. It models the echo coupling caused by the analogue hybrid used for “isolating” received and transmitted signal in a transceiver. When echo cancelation is on board, the echo can be suppressed additionally by a parameter h_e. Figure 2 shows the flow diagram of this model.

The relevance of including echo cancellation in this input model is mainly to cover the case that *lacks* echo cancellation, such as for FDD systems like ADSL and VDSL. Residual frequency overlap in the guard bands between up and downstream spectra may cause some deterioration of performance. By tweaking the value for echo suppression h_e, the amount of additional echo cancellation can be controlled.

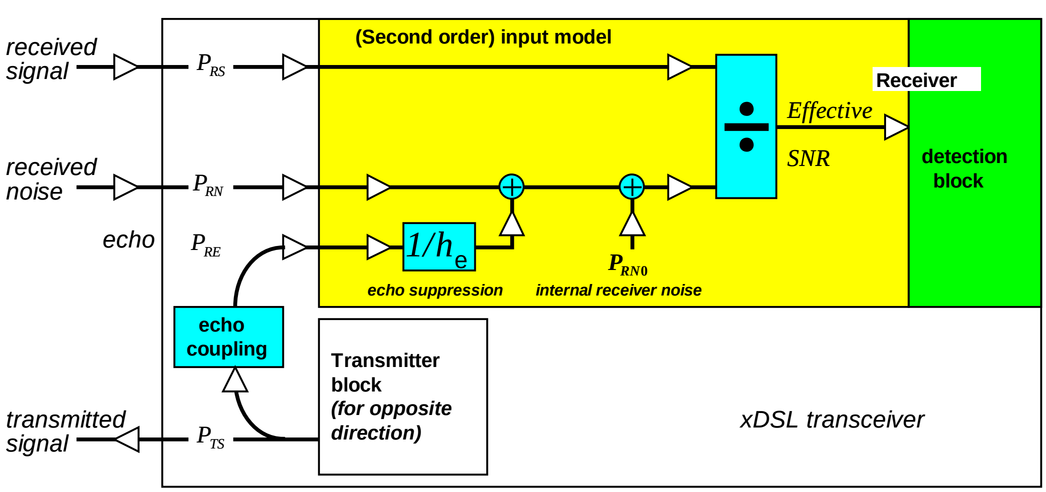

Figure 2: Flow diagram of a transceiver model that incorporates a linear second order input model for the determination of the effective SNR.

Expression 2 summarizes how to evaluate the effective SNR for this model, and it has been specified in plain and offset formats. Table 1310 summarizes the involved parameters.

Plain format:	$SNR(f)$	=	$\dfrac{P_{RS}}{P_{RN} + P_{RN0} + P_{RE}/h_e^2}$
Noise offset format:	$SNR_{ofs,N}(m, f)$	=	$\dfrac{P_{RS}}{P_{RN} \times m + P_{RN0} + P_{RE}/h_e^2}$
Signal offset format:	$SNR_{ofs,S}(m, f)$	=	$\dfrac{P_{RS}/m}{P_{RN} + P_{RN0} + P_{RE}/h_e^2}$

Expression 2: Effective SNR, in various formats, for a second order input model accounting for residual echo

INPUT QUANTITIES	*linear*	*In dB*	*remarks*
Received signal power	P_{RS}	$10\times\log_{10}(P_{RS})$	*Frequency dependent*
Received crosstalk noise	P_{RN}	$10\times\log_{10}(P_{RN})$	*External noise*
Received reflected power	P_{RE}	$10\times\log_{10}(P_{RE})$	*External noise*
Model Parameters			
Receiver noise power	P_{RN0}	$10\times\log_{10}(P_{RN0})$	*Internal noise*
Echo suppression	h_e	$20\times\log_{10}(h_e)$	*Quality of echo canceller*
Output quantities			
Signal to noise ratio (effective)	*SNR*	$10\times\log_{10}(SNR)$	*Frequency dependent*

Table 1310: Involved parameters and quantities for a second order input model accounting for residual echo

5.1.4. Third order input model (with residual distortion and echo)

ED NOTE The need for inclusion of the entire clause 5.1.4 is subject for further study, and the text below may be kept out of the draft if discussions within ETSI-TM6 on this topic have resulted in a conclusion

This input model assumes that three effects internally modify the SNR of the input signal:

§ an equivalent *receiver noise power* P_{RN0} that indicates how much noise is added by the receiver electronics.

§ an *echo suppression factor* h_e that indicates how effective echo cancellation is implemented.

§ a *distortion suppression factor* h_d that indicates how effective equalization has been implemented. It represents the difference between transmitted signal and equalized received signal, and any non-zero difference behaves like noise.

This model is essentially the combination of the two previous (second order) models, and is shown in figure 3.

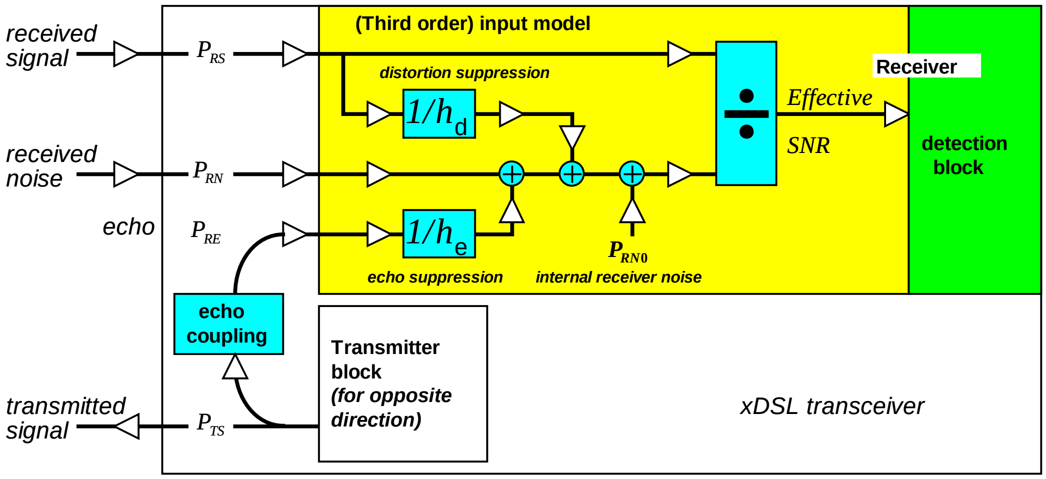

Figure 3: Flow diagram of a transceiver model that incorporates a linear third order input model for the determination of the effective SNR.

Expression 3 summarizes how to evaluate the effective SNR for this model, and it has been specified in plain and offset formats. Table ~~11~~14 summarizes the involved parameters.

Plain format: $SNR(f) = \dfrac{P_{RS}}{P_{RN} + P_{RN0} + P_{RE}/h_e^2 + P_{RS}/h_d^2}$

Noise offset format: $SNR_{\text{ofs,N}}(m, f) = \dfrac{P_{RS}}{P_{RN} \times m + P_{RN0} + P_{RE}/h_e^2 + P_{RS}/h_d^2}$

Signal offset format: $SNR_{\text{ofs,S}}(m, f) = \dfrac{P_{RS}/m}{P_{RN} + P_{RN0} + P_{RE}/h_e^2 + P_{RS}/(h_d^2 \times m)}$

Expression 3: Effective SNR, in various formats for a third order input model

INPUT QUANTITIES	***linear***	***In dB***	***remarks***
Received signal power	P_{RS}	$10\times\log_{10}(P_{RS})$	*Frequency dependent*
Received crosstalk noise	P_{RN}	$10\times\log_{10}(P_{RN})$	*External noise*
Received reflected power	P_{RE}	$10\times\log_{10}(P_{RE})$	*External noise*
Model Parameters			
Receiver noise power	P_{RN0}	$10\times\log_{10}(P_{RN0})$	*Internal noise*
Echo suppression	h_e	$20\times\log_{10}(h_e)$	*Quality of echo canceller*
Distortion suppression	h_d	$20\times\log_{10}(h_d)$	*Quality of equalizer*
Output quantities			
Signal to noise ratio (effective)	*SNR*	$10\times\log_{10}(SNR)$	*Frequency dependent*

Table ~~11~~14: Involved parameters and quantities for a third order input model.

5.2. Generic detection models

EDITORIAL NOTE: remove the "data rate" from all the four generic detectio`n models, since they only use the "line rate" in their formulas

Text portions proposed for inclusion into clause 6

6 Specific receiver performance models for xDSL

6.1 Receiver performance model for "HDSL.2B1Q"

The reach predicted by this calculation model, under the stress conditions (loss, noise) of the associated ETSI HDSL specification [72], is close to the reach required by ETSI specification [72]. The receiver performance model for ETSI compliant HDSL.2B1Q is built-up from the following building blocks:

- A first order (linear) input model for the input block, specified in clause 5.1.1, that combines all imperfections (front-end noise, residual echo, equalization errors), in one virtual noise source.
- The generic PAM detection model, specified in clause 5.2.2.
- The parameter values specified in table 1512.

The parameter values, used in the receiver performance model for ETSI compliant two-pair HDSL.2B1Q/2, are summarised in table 1512. Parts of them are directly based on HDSL specifications. The remaining values are based on theory and assumptions.

Model Parameter		HDSL.2B1Q/2
SNR-Gap (effective)	G_{dB}	12.25 dB
SNR-Gap in parts	G_{PAM_dB} G_{coding_dB} G_{impl_dB}	9.75 dB 0 dB 2.5 dB
Receiver noise	P_{RN0_dB}	–140 dBm/Hz
Data rate	f_d	2×1024 kb/s
Line rate	f_b	1168 kb/s
bits per symbol	b	2
Summation bounds in the PAM model	N_H N_L	+1 -2
Derived Parameter		
Required SNR	SNR_{req}	$G \times (2^{2b}-1)$
	SNR_{req_dB}	≈ 24.0 dB
Symbol rate	f_s	f_b / b = 584 kbaud

Table 1512. Values for the parameters used in the performance model, obtained from ETSI requirements for HDSL.2B1Q/2 [72].

Note: The receiver noise in this model has an unrealistic low level, but this is irrelevant for SpM studies in a mixed noise environment. As a result, this model will give too optimistic estimates of reachable distance in scenarios without any self crosstalk or any equivalent noise with similar bandwidth.

6.5 Receiver performance model for "FDD ADSL over POTS"

NOTE The text below is proposed as a FULL replacement of the associated text in the current draft

The receiver performance models for ETSI compliant "FDD ADSL over POTS" are build-up from the following building blocks:

- A first order (linear) input model for the input block specified in clause 5.1.1, that combines all kinds of imperfections (front-end noise, residual echo and equalization errors), in one virtual noise source (P_{RN0}).
- The generic DMT detection model, specified in clause 5.2.4.

This model is capable of evaluating the data rate (f_d), and uses the evaluation of the line rate (f_b) as intermediate step. In addition, the data rates (f_d) predicted by the model shall is to be limited to the maximum data rates (f_{d_max}) specified in table 1613.

The parameter values, used in the receiver performance model for ETSI compliant "FDD ADSL over POTS" modems, are summarised in table 1613. Some of these are directly based on ADSL specifications. The remaining values are extracted from ADSL performance requirements or based on theory.

Model parameter		DMT	model	
		Upstream	Downstream	Remarks
SNR-Gap (effective)	G_{dB}	9.0 dB	8.0 dB	
SNR-Gap in parts	G_{DMT_dB} G_{coding_dB} G_{impl_dB}	9.75 dB 4.25 dB 3.5 dB	9.75 dB 4.25 dB 2.5 dB	
Receiver noise	P_{RN0_dB}	–120 dBm/Hz	–140 dBm/Hz	
Symbol rate	f_s f_{sd}	69/68 × 4000baud 4000 baud	69/68 × 4000 baud 4000 baud	*See clause 5.2.4*
Data rate	f_d	32 kb/s … f_{d_max}	32 kb/s … f_{d_max}	
	f_{d_max}	800 kb/s (*640 kb/s, see note 2*)	8192 kb/s (*6144 kb/s, see note 2*)	*Limit data rate to these maxima, if model predicts higher rates*
Line rate	 f_{bd} f_b	$f_{bl} = f_d + 16 \times f_{sd}$ $f_{bh} = (f_d + 8 \times f_{sd}) \times 1.13$ $f_{bd} = \max(f_{bl}, f_{bh})$ $f_b = 69/68 \times f_{db}$	$f_{bl} = f_d + 16 \times f_{sd}$ $f_{bh} = (f_d + 8 \times f_{sd}) \times 1.13$ $f_{bd} = \max(f_{bl}, f_{bh})$ $f_b = 69/68 \times f_{db}$	*See clause 5.2.4, and note 3*
Bits per symbol	b	f_{bd} / f_{sd}	f_{bd} / f_{sd}	
Default set of sub carriers, for use with "adjacent transmitter model"	{*k*}	$k \in [7:31]$	$k \in [33:63, 65:255]$	*DMT tone k = 64 does not convey any bits because it is reserved as pilot tone*
Alternative set of sub carriers, for use with "guard-band transmitter model"	{*k*}	$k \in [7:31]$	$k \in [38:63, 65:255]$	*DMT tone k = 64 does not convey any bits because it is reserved as pilot tone*
~~Available set of tones~~	~~{*k*}~~	~~$k \in [7:31]$~~	~~$k \in [33:63, 65:255]$~~	~~*DMT tone k = 64 does not convey any bits because it is reserved as pilot tone*~~
Centre frequency location of tone k; k ∈ tones	f_k	$f_k = k \times \Delta f$ $\Delta f = 4.3125$ kHz	$f_k = k \times \Delta f$ $\Delta f = 4.3125$ kHz	
Bit-loading algorithm		FBL	FBL	*See clause 5.3.4*
Minimum bit-loading	b_{min}	1 (*see note 1*)	1 (*see note 1*)	*Bits per tone per symbol*
Maximum bit-loading	b_{max}	15 (*see note 1, note 2, and max data rate* f_{d_max})	15 (*see note 1, note 2 and max data rate* f_{d_max})	*Data rate shall be limited to* f_{d_max} *if model predicts higher rates*

Table 1613: Values for the performance parameters of the ADSL receiver model.

Note 1 The ADSL standard [3] specifies the bit-loading as integer values between 2 and 15, however the use of a model with "Fractional" bit-loading enables the use of non-integer values to account for other receiver

properties as well. This enables the modelling of other receiver characteristics, as if the bit-loading caused them. Using a minimum bit-loading value of 1 instead of 2 is partially to account for absence of rounding in the FBL bit-loading and partially to account for increased bit-loading flexibility when modems operate with excess margin.
In some cases it may be appropriate to use maximum upstream bit-loading lower then 15 in the models to account for imperfections commonly observed in real ADSL implementations.

Note 2 The maximum data rate assumed for the first generation ADSL are 800 kb/s upstream and 8192 kb/s downstream. In some cases these maximum values are limited to 640 kb/s upstream and 6144 kb/s downstream. These limitations need to be considered when evaluating ADSL performance.

Note 3 The correction factor 1.13 represents the Reed Solomon coding overhead, and is connected with the coding gain of 4.25 dB

6.X Receiver performance model for "legacy FDD ADSL over POTS"

NOTE The text below is proposed as an additional model, BUT WILL BE REMOVED FROM THE LL

The receiver performance models for ETSI compliant "legacy FDD ADSL over POTS" are build-up from the following building blocks:

- A second order input model (with residual distortion) for the input block, specified in clause 5.1.2, that combines all kinds of imperfections (front-end noise, residual echo and equalization errors).
- The generic DMT detection model, specified in clause 5.2.4.

In addition, the data rates (f_d) predicted by the model shall be limited to the maximum data rates (f_{d_max}) specified in table 17~~14~~.

The parameter values, used in the receiver performance model for ETSI compliant "legacy FDD ADSL over POTS" modems, are summarised in table 17~~14~~. Some of these are directly based on ADSL specifications. The remaining values are extracted from ADSL performance requirements or based on theory.
This model is intended to be representative of legacy equipment and has a higher noise floor than the corresponding model for "FDD ADSL over POTS" in clause [*].This higher noise floor makes the model more pessimistic under low noise conditions.

ED NOTE What is the rational behind a "legacy" model that has a better effective SNR-gap for the upsteam than the "state-of-the-art" model in clause 6.5?????
The same applies for minimum bitloading in both directions: this legacy model seems to squeeze more capacity out of the copper line then "state-of-the-art" can achieve when SNR is low.?????

Model parameter		DMT	model	
		Upstream	Downstream	Remarks
SNR-Gap (effective)	G_{dB}	8.7 dB 9.0 dB ???	8.7 dB	
SNR-Gap in parts	G_{DMT_dB} G_{coding_dB} G_{impl_dB}	9.75 dB 4.25 dB 3.2 dB (3.5 dB ???)	9.75 dB 4.25 dB 3.2 dB	
Receiver noise	P_{RN0_dB}	–115 dBm/Hz	–140 dBm/Hz	
Symbol rate	f_s f_{sd}	69/68 × 4000baud 4000 baud	69/68 × 4000 baud 4000 baud	*See clause 5.2.4*
Data rate	f_d	32 kb/s … f_{d_max}	32 kb/s … f_{d_max}	
	f_{d_max}	800 kb/s (*640 kb/s, see note 2*)	8192 kb/s (*6144 kb/s, see note 2*)	*Limit data rate to these maxima, if model predicts higher rates*
Line rate	 f_{bd} f_b	$f_{bl} = f_d + 16 \times f_{sd}$ $f_{bh} = (f_d + 8 \times f_{sd}) \times 1.13$ $f_{bd} = \max(f_{bl}, f_{bh})$ $f_b = 69/68 \times f_{db}$	$f_{bl} = f_d + 16 \times f_{sd}$ $f_{bh} = (f_d + 8 \times f_{sd}) \times 1.13$ $f_{bd} = \max(f_{bl}, f_{bh})$ $f_b = 69/68 \times f_{db}$	*See clause 5.2.4*
Bits per symbol	b	f_{bd} / f_{sd}	f_{bd} / f_{sd}	
Available set of tones	$\{k\}$	$k \in$ [7:31]	$k \in$ [33:63 , 65:255]	*DMT tone k = 64 does not convey any bits because it is reserved as pilot tone*
Centre frequency location of tone k; k ∈ tones	f_k	$f_k = k \times \Delta f$ Δf = 4.3125 kHz	$f_k = k \times \Delta f$ Δf = 4.3125 kHz	
Bit-loading algorithm		FBL	FBL	*See clause 5.3.4*
Minimum bit-loading	b_{min}	0 (*see note 1*) 1 ???	0 (*see note 1*) 1 ???	*Bits per tone per symbol*
Maximum bit-loading	b_{max}	15 (*see note 1, note 2, and max data rate* f_{d_max})	15 (*see note 1, note 2 and max data rate* f_{d_max})	*Data rate shall be limited to* f_{d_max} *if model predicts higher rates*
Distortion suppression	h_d	40 dB	∞	

Table 1714: Values for the performance parameters of the ADSL receiver model.

Note 1 The ADSL standard [3] specifies the bit-loading as integer values between 2 and 15, however the use of a model with "Fractional" bit-loading enables the use of non-integer values to account for other receiver properties as well. This enables the modelling of other receiver characteristics, as if the bit-loading caused them. Using a minimum bit-loading value of 0 (1??) instead of 2 is partially to account for absence of rounding in the FBL bit-loading and partially to account for increased bit-loading flexibility when modems operate with excess margin.
In some cases it may be appropriate to use maximum upstream bit-loading lower then 15 in the models to account for imperfections commonly observed in real ADSL implementations.

Note 2 The maximum data rate assumed for the first generation ADSL are 800 kb/s upstream and 8192 kb/s downstream. In some cases these maximum values are limited to 640 kb/s upstream and 6144 kb/s downstream. These limitations need to be considered when evaluating ADSL performance.

6.7 Receiver performance model for “FDD ADSL over ISDN"

The downstream receiver performance model for ETSI compliant “FDD ADSL over ISDN” is build-up from the following building blocks:

- A first order (linear) input model for the input block specified in clause 5.1.1, that combines all kinds of imperfections (front-end noise, residual echo and equalization errors), in one virtual noise source (P_{RN0}).
- The generic DMT detection model, specified in clause 5.2.4.

This model is capable of evaluating the data rate (f_d), and uses the evaluation of the line rate (f_b) as intermediate step. In addition, the data rates (f_d) predicted by the model shall is to be limited to the maximum data rates (f_{d_max}) specified in table 1815.

The parameter values, used in the receiver performance model for ETSI compliant "FDD ADSL over ISDN" modems, are summarised in table 1815. Some of these are directly based on ADSL specifications. The remaining values are extracted from the ADSL performance requirements or based on theory.

Model parameter		DMT	model	
		Upstream	Downstream	Remarks
SNR-Gap (effective)	G_{dB}	8.0 dB	7.0 dB	
SNR-Gap in parts	G_{DMT_dB} G_{coding_dB} G_{impl_dB}	9.75 dB 4.25 dB 2.5 dB	9.75 dB 4.25 dB 1.5 dB	
Receiver noise	P_{RN0_dB}	–120 dBm/Hz	–140 dBm/Hz	
Symbol rate	f_s f_{sd}	69/68 × 4000 baud 4000 baud	69/68 × 4000 baud 4000 baud	*See clause 5.2.4*
Data rate	f_d	32 kb/s … f_{d_max}	32 kb/s … f_{d_max}	
	f_{d_max}	800 kb/s (*640 kb/s, see note 2*)	8192 kb/s (*6144 kb/s, see note 2*)	*Limit data rate to these maxima, if model predicts higher rates*
Line rate	f_{bd}	$f_{bl} = f_d + 16 \times f_{sd}$ $f_{bh} = (f_d + 8 \times f_{sd}) \times 1.13$ $f_{bd} = \max(f_{bl}, f_{bh})$	$f_{bl} = f_d + 16 \times f_{sd}$ $f_{bh} = (f_d + 8 \times f_{sd}) \times 1.13$ $f_{bd} = \max(f_{bl}, f_{bh})$	*See clause 5.2.4 and note 3*
	f_b	$f_b = 69/68 \times f_{db}$	$f_b = 69/68 \times f_{db}$	
Bits per symbol	b	f_{bd} / f_{sd}	f_{bd} / f_{sd}	
Default set of sub carriers, for use with "adjacent transmitter model"	{*k*}	$k \in$ [33:63] see Note 4	$k \in$ [64:95 , 97:255] see note 4	*DMT tone k = 96 does not convey any bits because it is reserved as pilot tone*
Alternative set of sub cariers, for use with "guard band transmitter model"	{*k*}	$k \in$ [33:56] see Note 4	$k \in$ [64:95 , 97:255] see note 4	*DMT tone k = 96 does not convey any bits because it is reserved as pilot tone*
~~Available set of tones~~	~~{*k*}~~	~~$k \in$ [33:59]~~	~~$k \in$ [60:95 , 97:255]~~	~~*DMT tone k = 96 does not convey any bits because it is reserved as pilot tone*~~
Centre frequency location of tone k; k ∈ tones	f_k	$f_k = k \times \Delta f$ Δf = 4.3125 kHz	$f_k = k \times \Delta f$ Δf = 4.3125 kHz	
Bit-loading algorithm		FBL	FBL	*See clause 5.2.4*
Minimum bit-loading	b_{min}	1 (*see note 1*)	1 (see note 1)	*Bits per tone per symbol*
Maximum bit-loading	b_{max}	15 (*see note 1, note 2, and max data rate f_{d_max}*)	15 (*see note 1, note 2 and max data rate f_{d_max}*)	*Data rate shall be limited to f_{d_max} if model predicts higher rates*

Table 1815: Values for the performance parameters of the ADSL receiver model.

Note 1 The ADSL standard [3] specifies the bit-loading as integer values between 2 and 15, however the use of a model with "Fractional" bit-loading enables the use of non-integer values to account for other receiver properties as well. This enables the modelling of other receiver characteristics, as if the bit-loading caused them. Using a minimum bit-loading value of 1 instead of 2 is partially to account for absence of rounding in the FBL bit-loading and partially to account for increased bit-loading flexibility when modems operate with excess margin.
In some cases it may be appropriate to use maximum upstream bit-loading lower then 15 in the models to account for imperfections commonly observed in real ADSL implementations.

Note 2 The maximum data rate assumed for the first generation ADSL are 800 kb/s upstream and 8192 kb/s downstream. In some cases these maximum values are limited to 640 kb/s upstream and 6144 kb/s downstream. These limitations need to be considered when evaluating ADSL performance.

Note 3 The correction factor 1.13 represents the Reed Solomon coding overhead, and is connected with the coding gain of 4.25 dB

Note 4 The available set of tones, according to the standard, is somewhat wider and ranges for upstream $k \in$ [33:64], and for downstream $k \in$ [60:95 , 97:255]. However this was not intended to be used in overlap.

6.Y Receiver performance model for “legacy FDD ADSL over ISDN"

NOTE The text below is proposed as an additional model, BUT WILL B E REMOVED

The downstream receiver performance model for ETSI compliant “legacy FDD ADSL over ISDN” is build-up from the following building blocks:

- A first order (linear) input model for the input block specified in clause 5.1.1, that combines all kinds of imperfections (front-end noise, residual echo and equalization errors), in one virtual noise source (P_{RN0}).
- The generic DMT detection model, specified in clause 5.2.4.

In addition, the data rates (f_d) predicted by the model shall be limited to the maximum data rates (f_{d_max}) specified in table 1916.

The parameter values, used in the receiver performance model for ETSI compliant “legacy FDD ADSL over ISDN” modems, are summarised in table 1916. Some of these are directly based on ADSL specifications. The remaining values are extracted from the ADSL performance requirements or based on theory.

Model parameter		DMT	model	
		Upstream	Downstream	Remarks
SNR-Gap (effective)	G_{dB}	8.7 dB	7.2 dB	
SNR-Gap in parts	G_{DMT_dB} G_{coding_dB} G_{impl_dB}	9.75 dB 4.25 dB 3.2 dB	9.75 dB 4.25 dB 1.7 dB	
Receiver noise	P_{RN0_dB}	–108 dBm/Hz	–140 dBm/Hz	
Symbol rate	f_s f_{sd}	69/68 × 4000 baud 4000 baud	69/68 × 4000 baud 4000 baud	*See clause 5.2.4*
Data rate	f_d	32 kb/s … f_{d_max}	32 kb/s … f_{d_max}	
	f_{d_max}	800 kb/s (*640 kb/s, see note 2*)	8192 kb/s (*6144 kb/s, see note 2*)	*Limit data rate to these maxima, if model predicts higher rates*
Line rate	f_{bd}	$f_{bl} = f_d + 16 \times f_{sd}$ $f_{bh} = (f_d + 8 \times f_{sd}) \times 1.13$ $f_{bd} = \max(f_{bl}, f_{bh})$	$f_{bl} = f_d + 16 \times f_{sd}$ $f_{bh} = (f_d + 8 \times f_{sd}) \times 1.13$ $f_{bd} = \max(f_{bl}, f_{bh})$	*See clause 5.2.4*
	f_b	$f_b = 69/68 \times f_{db}$	$f_b = 69/68 \times f_{db}$	
Bits per symbol	b	f_{bd} / f_{sd}	f_{bd} / f_{sd}	
Available set of tones	$\{k\}$	$k \in$ [33:59]	$k \in$ [60:95 , 97:255]	*DMT tone k = 96 does not convey any bits because it is reserved as pilot tone*
Centre frequency location of tone k; k ∈ tones	f_k	$f_k = k \times \Delta f$ Δf = 4.3125 kHz	$f_k = k \times \Delta f$ Δf = 4.3125 kHz	
Bit-loading algorithm		FBL	FBL	*See clause 5.2.4*
Minimum bit-loading	b_{min}	2 (*see note 1*)	2 (see note 1)	*Bits per tone per symbol*
Maximum bit-loading	b_{max}	15 (*see note 1, note 2, and max data rate* f_{d_max})	15 (*see note 1, note 2, and max data rate* f_{d_max})	*Data rate shall be limited to* f_{d_max} *if model predicts higher rates*

Table 1916: Values for the performance parameters of the ADSL receiver model.

Note 1 The ADSL standard [3] specifies the bit-loading as integer values between 2 and 15, however the use of a model with "Fractional" bit-loading enables the use of non-integer values to account for other receiver properties as well. This enables the modelling of other receiver characteristics, as if the bit-loading caused them.
In some cases it may be appropriate to use maximum upstream bit-loading lower then 15 in the models to account for imperfections commonly observed in real ADSL implementations.

Note 2 The maximum data rate assumed for the first generation ADSL are 800 kb/s upstream and 8192 kb/s downstream. In some cases these maximum values are limited to 640 kb/s upstream and 6144 kb/s downstream. These limitations need to be considered when evaluating ADSL performance.

Text portions proposed for inclusion into clause 7

7 Transmission and reflection models

7.1. Summary of test loop models

Over the years, a variety of two-port models have been extracted from cable measurements up to 30MHz, and published in several documents. These models are so numerous due to the wide range of cables being used in different countries.

An example of a two-port models of a 100Ω cable and of a 150Ω cable can be found in the VDSL specification ETSI TS 101 270-1, Annex A [4].

Note Other examples of two-port cable models can be found in [SDSL,ADSL], however they are not defined up to the full 30 MHz band

ED NOTE <to be moved to the list of references>

[8] ETSI TS 101 270-1 (V1.3.1): "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements".

Text portions proposed for inclusion into clause 9

9 Examples of how to evaluate various scenarios

This chapter summarizes examples to show how the models in this document can be used to perform spectral management studies.

9.1 European Spectral Platform 2004 (ESP/2004)

In 2004 several European operators created a simulation platform to support spectral management studies on e-SDSL and ADL-64. This platform comprises of several (theoretical) scenarios to cover a wide range of situations being identified in European access networks. Each scenario is a compromise between computational convenience and computational complexity of real access networks. Nevertheless, the calculated performances of xDSL systems operating under these theoretical scenarios are assumed to be indicative for the minimum performance of these systems in various European situations.
The scenarios are a combination of a technology mix (to create a noise environment), system models, topology models and loop models.

9.1.1 Technology mixtures within ESP/2004

A distinct number of technology mixtures have been identified to enable a reasonable representation of scenarios that are being deployed in various European Networks. Their names are specified in table 2017.

Name	Description of the mix
	High penetration mixtures
HP/M	Mix includes both ADSL FDD flavors, SDSL, VDSL, HDSL CAP/2 and HDSL 2B1Q/2
HP/R	Mix includes all four ADSL (FDD and EC) flavors, SDSL, VDSL and HDSL CAP/2
	Medium penetration mixtures
MP/M	Mix includes both ADSL FDD flavors, SDSL, VDSL and HDSL 2B1Q/2
MP/P	Mix includes ADSL over POTS FDD, SDSL, VDSL and HDSL 2B1Q/2
MP/I	Mix includes ADSL over ISDN FDD, SDSL, VDSL and HDSL 2B1Q/2

Table 2017: Naming convention of used mixtures

The number of systems of each technology to be considered in each scenario is specified in table 2118.

- For each *reference* scenario, the associated reference mix is specified in the columns labelled as “ref”.
- For each *modified* scenario, the associated modified mix is specified in the columns labelled as “mod”. The number of wire pairs occupied by the broadband systems remains the same as for the reference scenario.

By comparing the change in performance between both scenarios, the impact of replacing some “legacy” systems by systems of the new technology can be visualized. This concept is referred to as the “reference method”.

Note: The victim system shall not be considered among the disturbers, i.e. it shall be subtracted from the total number of disturbing systems. For two-pairs HDSL systems, only one pair shall be considered as victim, whereas the other one shall be kept among the disturbers.

System \ Mix	HP/M		HP/R		MP/M		MP/P		MP/I	
	Ref.	Mod.	Ref.	Mod.	Ref.	Mod.	Ref.	Mod.	Ref.	Mod.
SDSL 1024 kb/s	5	5	16	16	4	4	4	4	4	4
SDSL 2048 kb/s	10	10	16	16	5	5	5	5	5	5
HDSL 2B1Q/2	3×2	2×2	-	-	1×2	0×2	1×2	1×2	1×2	1×2
HDSL CAP/2	2×2	2×2	3×2	3×2	-	-	-	-	-	-
ADSL over POTS FDD	75	68	63	55	18	16	25	20	-	-
ADSL over ISDN FDD	25	22	96	84	7	6	-	-	25	20
ADSL over POTS EC	-	-	21	19	-	-	-	-	-	-
ADSL over ISDN EC	-	-	32	29	-	-	-	-	-	-
VDSL (FTTEx)	12[1)]	12[1)]	25[2)]	25[2)]	5[1)]	5[1)]	5[1)]	5[1)]	5[3)]	5[3)]
New system under study	0	12	0	25	0	5	0	5	0	5
ISDN.~~/~~2B1Q (alone)	50	53	97	103	14	15	14	14	0	0
ISDN.~~/~~2B1Q/filtered (~~same pair~~) [6)]	25[4)]	22	53[4)]	48[4)]	7[4)]	6[4)]	0	0	0	0
ISDN.~~/~~4B3T (alone)	0	0	0	0	0	0	0	0	14	19
ISDN.~~/~~4B3T/filtered (same pair) [6)]	0	0	0	0	0	0	0	0	30[5)]	30[5)]
Pairs in total for BB	137	137	275	275	41	41	41	41	41	41
Pairs in total for BB and ISDN	187	190	372	378	55	56	55	55	55	60

1) VDSL (FTTEx) P2 M2 with US0, ETSI main plan (997) or optional regional band plan (998)
2) VDSL (FTTEx) P2 M2 with US0, ETSI main plan (997) only
3) VDSL (FTTEx) P1 M1 without US0, ETSI main plan (998) only
4) These ISDN/2B1Q systems share the same pair with ADSL over ISDN systems
5) These ISDN/4B3T systems share the same pair with ADSL or VDSL over ISDN systems
6) In case the victim modem shares the line with ISDN, reduce the number of filtered ISDN disturbers by one, and add a "Line shared ISDN" model to the line of that victim modem.

Table 21~~18~~ : Reference mixtures and modified mixtures with the new technology for the five scenarios

Note 1: When VDSL is considered as disturbing system for the other systems it is not necessary to specify its band plan. When making simulations on VDSL performance instead, a homogeneous VDSL environment and the band plan indicated in the explanations of Table 21~~18~~ should be considered.

Note 2: The modified mixtures depend on the type of system under study. In this example the modified mixtures where determined for studies of ADL-64 and E-SDSL.

9.1.2 System models within ESP/2004

Table 22~~19~~ specifies transmitter signal models for each system being part of the mix. Power back-off or power cut-back shall be taken into account for all the systems for which it is mandatory in the relevant specification. Concerning VDSL UPBO, use the reference PSD for Noise D (see VDSL [8~~4~~]) in high penetration scenarios (using HP/M and HP/R) and the one for Noise E in medium penetration scenarios (using MP/P, MP/I and MP/M).
Table 23~~20~~ specifies receiver performance models for each system being part of the mix.

Name	*Transmitter signal model*
SDSL 1024 kb/s	SDSL transmitter model, as specified in clause 4.6 for 1024 kb/s
SDSL 2048 kb/s	SDSL transmitter model, as specified in clause 4.6 for 2048 kb/s
HDSL 2B1Q/2	HDSL transmitter model, as specified in clause 4.4 (use" default" model)
HDSL CAP/2	HDSL transmitter model, as specified in clause 4.5
ADSL over POTS FDD	ADSL transmitter model, as specified in clause 4.8 (*see NOTE 1*)
ADSL over ISDN FDD	ADSL transmitter model, as specified in clause 4.10 (*see NOTE 1*)
ADSL over POTS EC	ADSL transmitter model, as specified in clause 4.7
ADSL over ISDN EC	ADSL transmitter model, as specified in clause 4.9
VDSL (FTTEx)	(*see NOTE 2*)
ISDN/2B1Q	ISDN transmitter model, as specified in clause 4.2
ISDN/4B3T	ISDN transmitter model, as specified in clause 4.3
NOTE 1:	*Use the ADSL adjacent FDD template when ADSL is considered a disturber (in the noise), but use the ADSL guardband FDD template when ADSL is considered a victim*
NOTE 2:	*PSD Templates are defined in the VDSL standard [84]*

Table 2219 Transmitter signal models

Name	*Receiver performance model*
SDSL	SDSL receiver model, as specified in clause 6.3
HDSL 2B1Q/2	HDSL receiver model, as specified in clause 6.1
HDSL CAP/2	HDSL receiver model, as specified in clause 6.2
ADSL over POTS FDD	ADSL receiver model, as specified in clause 6.5
ADSL over ISDN FDD	ADSL receiver model, as specified in clause 6.7
ADSL over POTS EC	ADSL receiver model, as specified in clause 6.4
ADSL over ISDN EC	ADSL receiver model, as specified in clause 6.6
VDSL (FTTEx)	*See NOTE 1*
ISDN/2B1Q	*See NOTE 1*
ISDN/4B3T	*See NOTE 1*
NOTE 1:	*The evaluation of the performance of this victim system is no part of ESP/2004*

Table 2320 Receiver performance models

9.1.3 Topology models within ESP/2004

The scenario assumes that an uninterrupted homogeneous cable, without branches, interconnects the victim system under study. In addition, it assumes that the network topology can be represented by a simple (point-to-point) two-node topology model (see clause 8.3.1).
This is of course an over-simplification of real access networks, and therefore the way systems are disturbing each other is refined (a) according to the way NT systems are distributed along the cable, and (b) to what distance NT systems are separated from their LT counterpart.

Refinements of disturbance

For the first refinement, two different topologies are defined:

- **Distributed topology**. Here it is assumed that the NT ports of a cable (or bundle or binder group) are distributed along the loop, and that a single cable is capable of providing access to customers at both near and far distances from the exchange.
- **Virtually co-located topology**. Here it is assumed that the NT ports of a cable (or bundle or binder group) are virtually co-located, and that a single cable can only provide access to near locations or to far locations. Different cables are then needed to connect customers at both locations.

In either case, the LT disturbers are co-located with the LT victim. To compensate for the fact that some NT disturbers are not always at the same location as the NT victim system, the crosstalk of these disturbers is attenuated first.
Attenuated crosstalk means within this context the following: Assume that no disturber resides beyond the victim NT. If L is the distance between an investigated NT victim and a group of co-

located NT disturbers, then calculate the crosstalk of these disturbers (NEXT & FEXT) at the location of these disturbers as if no other disturber does exist. In the following step, attenuate this noise level by the loss of a loop with length *L*. Repeat this for each group of co-located NT disturbers, and subsequently add the powers of all these crosstalk components to evaluate the crosstalk level at the location of the victims.

For the second refinement, the reach limits of the involved systems are accounting for the disturbance of such a system. This means that a system will not be deployed beyond its reach limits, and that the composition of the disturber mix changes when the loop length exceeds certain reach boundaries.
To simplify this refinement, only five reach boundaries are distinguished, and the involved systems are all classified according to these boundaries. This is summarized in table 2421, and illustrated in figure 4.

System class	System examples	Deployment practice
1	VDSL	*VDSL will not be deployed beyond area 1 limits*
2	SDSL, 2048 kb/s	*2048 kb/s SDSL will not be deployed beyond area 2 limits.*
3	HDSL/2	*Two-pair HDSL will not be deployed beyond area 3 limits, (except for "virtually co-located topologies" where the use of a regenerator is assumed to extent the reach).*
4	SDSL, 1024 kb/s	*1024 kb/s SDSL will not be deployed beyond area 4 limits. (except for "virtually co-located topologies" where the use of a regenerator is assumed to extent the reach).*
5	ADSL ISDN (SDSL, 512 kb/s)	*All these systems in the mix will be deployment up to area 5. (except for the "distributed topologies", that do not include 512 kb/s SDSL systems)*

Table 2421: System classification according to the boundaries in figure 4.

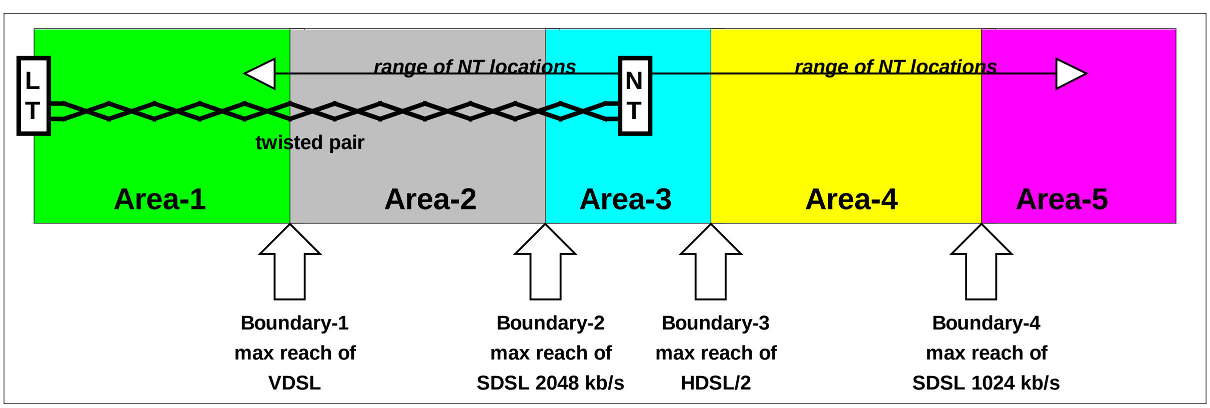

Figure 4: Concept of reach areas in ESP/2004, and associated boundaries

Boundary locations of the disturbers

The location of each boundary between two areas in figure 4 is scenario dependent, and is specified in table 25~~22~~. Not all combinations of system mixtures and topology models are required for the ESP/2004 scenarios, and therefore table 25~~22~~ is restricted to those combinations. An example of the boundary values are summarized in table 25.These boundary values are assumed to be a fair reach estimation of the associated victim system, under the stress conditions of that particular scenario. Due to minor changes in the models, a reproduction of this table may not result in exactly the same numbers~~.~~

> EDITORS NOTE: USE ONE ROUNDED TABLE AND CHECK IF THEY ARE EQUAL TO THOSE IN 041t25

Scenario \ Area bounds	Boundary 1 (Area 1–2)	Boundary 2 (Area 2-3)	Boundary 3 (Area 3–4)	Boundary 4 (Area 4–5)
HP/M (distributed)	1500 m	2405 m	2614 m	3459 m
HP/R (co-located)	1500 m	2113 m	2487 m	3154 m
MP/P (co-located)	1500 m	2794 m	2975 m	3995 m
MP/P (distributed)	1500 m	2794 m	2977 m	4112 m
MP/I (distributed)	1500 m	2861 m	3036 m	4267 m
MP/M (distributed)	1500 m	2802 m	2985 m	3957 m

Scenario \ Area bounds	Boundary 1 (Area 1–2)	Boundary 2 (Area 2-3)	Boundary 3 (Area 3–4)	Boundary 4 (Area 4–5)
HP/M (distributed)	1500 m	2400 m	2610 m	3460 m
HP/R (co-located)	1500 m	2110 m	2490 m	3150 m
MP/P (co-located)	1500 m	2790 m	2970 m	3990 m
MP/P (distributed)	1500 m	2790 m	2980 m	4110 m
MP/I (distributed)	1500 m	2860 m	3040 m	4270 m
MP/M (distributed)	1500 m	2800 m	2980 m	3960 m

Table 25~~22~~: Location of boundaries within the scenarios in ESP/2004

Note The estimations in table 25~~22~~ have been carried out in a certain order, and all these systems operated with at least 6 dB of noise margin. First a system was considered that has the shortest reach in the given scenario. Next the system was considered that has the second shortest range in the same scenario, and so on. In addition, the following simplifications have been applied:
(a) Boundary 1 is fixed to 1500m. (*This is the right-hand boundary of area 1, representing the maximum deployment distance of VDSL.*)
(b) In scenarios where both HDSL.2B1Q/2 and HDSL.CAP/2 systems are present, boundary 3 represents the shortest reach of the two.

Handling disturbers in “distributed” topologies

Table 26~~23~~ summarizes how to deal with the various disturbers in distributed topologies.

- ***Crosstalk from area 1 systems***: If a victim system is deployed beyond area 1, assume that VDSL is terminated at boundary 1 and disturbs the victim system by attenuated crosstalk.
- ***Crosstalk from area 2 systems***: If a victim system is deployed beyond area 2, assume that SDSL 2048 kb/s is terminated at boundary 2 and disturbs the victim system by attenuated crosstalk.
- ***Crosstalk from area 3 systems***: If a victim system is deployed beyond area 3, assume that HDSL is terminated at boundary 3 and disturbs the victim system by attenuated crosstalk.
- ***Crosstalk from area 4 systems***: If a victim system is deployed beyond area 4, assume that SDSL 1024 kb/s is regenerated and neglect the effect of the additional crosstalk by the repeaters somewhere between the LT and NT. However, the crosstalk that is generated by the SDSL 1024kb/s system at the end of the line should be taken into account.

Disturbers when victim NT is in				
Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
VDSL	X-1	X-1	X-1	X-1
SDSL-2048	SDSL-2048	X-2	X-2	X-2
HDSL	HDSL	HDSL	X-3	X-3
SDSL-1024	SDSL-1024	SDSL-1024	SDSL-1024	Reg. SDSL-1024
ADSL	ADSL	ADSL	ADSL	ADSL
ISDN	ISDN	ISDN	ISDN	ISDN
Reg-SDSL-1024 means regenerated SDSL 1024 kb/2 systems X-n means attenuated crosstalk from area-“n”				

Table 26~~23~~: Summary of the disturbers to be considered in a distributed topology

Handling disturbers in “virtually co-located” topologies

Table 27~~24~~ summarizes how to deal with the various disturbers in virtually co-located topologies.

- ***Crosstalk from area 1 systems***: If a victim system is deployed beyond area 1, assume that a disturbing VDSL is terminated at boundary 1 and disturbs the victim system by attenuated crosstalk. (NOTE The concept of “virtual co-location” conflicts with the concept of attenuated VDSL crosstalk up to area 5, but the impact of such crosstalk becomes ignorable beyond some distance.)
- ***Crosstalk from area 2 systems***: If a victim system is deployed beyond area 2, convert the disturbing SDSL 2048 kb/s into an SDSL system with lower bitrate. For victims deployed in area 3 or 4, this bitrate equals 1024 kb/s. For victims deployed in area 5, this bitrate equals 512 kb/s.
- ***Crosstalk from area 3 systems***: If a victim system is deployed beyond area 3, assume that HDSL is regenerated and neglect the effect of the additional crosstalk by the repeaters in the middle of the line. However, the crosstalk that is generated by the HDSL system at the end of the line should be taken into account.
- ***Crosstalk from area 4 systems***: If a victim system is deployed beyond area 4, assume that a disturbing SDSL 1024 kb/s is regenerated and neglect the effect of the additional crosstalk by the repeaters in the middle of the line. However, the crosstalk that is generated by the SDSL 1024kb/s systems at the end of the line should be taken into account.

Disturbers when victim NT is in				
Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
VDSL	X-1	X-1	X-1	X-1
SDSL-2048	SDSL-2048	SDSL-1024	SDSL-1024	SDSL-512
HDSL	HDSL	HDSL	Reg-HDSL	Reg-HDSL
SDSL-1024	SDSL-1024	SDSL-1024	SDSL-1024	SDSL-512
ADSL	ADSL	ADSL	ADSL	ADSL
ISDN	ISDN	ISDN	ISDN	ISDN
Reg-HDSL means regenerated-HDSL 2 pairs systems SDSL-512 means a 512 kb/s SDSL system (or lower if that rate will not work either) X-n means attenuated crosstalk from area-“n”				

Table 27~~24~~: Summary of the disturbers to be considered in a virtually co-located topology

9.1.4 Loop models within ESP/2004

The models for transmission and crosstalk are specified in table 28~~25~~. For the sake of simplicity, all effects related to the impedance for both the insertion loss and the crosstalk calculations are ignored. The impedance of 135 Ohm is selected for all the systems, even if this is not correct for such systems like e.g. those belonging to the ADSL family.

Transmission	Two-port model See VDSL [1]	TP100	The TP100 cable model described in Annex A of ETSI VDSL[1] is chosen. Bridge taps are assumed to be absent, and the characteristics of all cable sections in a cascade are assumed to be equal per unit length.
	Reference Impedance	R_N = 135Ω	The impact of the levels of signals, as a function of the termination impedance, is ignored for computational convenience. For calculating signal loss, assume that source and load impedance are R_N= 135Ω, for each xDSL system under study.
Crosstalk	Cumulation See clause 8.3.2		The FSAN sum for crosstalk cumulation, as specified in clause 8.3.2.1, applies for cumulating the power levels of M individual disturbers into the power level of an equivalent disturber.
	Coupling See clause 8.3.3.	K_{xn_dB} = –50 dB K_{xf_dB} = –45 dB f_0 = 1 MHz L_0 = 1 km	The basic models for equivalent NEXT and FEXT diagram for two-node topologies, as specified in clause 8.3.3.1, applies for modeling the equivalent crosstalk coupling.
	Injection See clause 8.3.4	$H_{xi} \equiv 1$	The impact on the levels of crosstalk noise, as a function of the termination impedance, is ignored for computational convenience (equivalent to $H_{xi} \equiv 1$)

Table 2825: The involved models and associated parameters to account for various cable characteristics.

9.1.5 Scenarios within ESP/2004

To carry out a spectral management study for a “new system” under ESP/2004, the six scenarios in table 2926 are to be evaluated according to the reference method. This means that the change in performance is to be evaluated for each broadband system in the mix of each scenario, when the mix changes from the “reference mix” to the “modified mix” (as specified before in table 2118).
In addition, the following applies

- All the systems shall have at least 6 dB of noise margin.
- The frequency resolution to be used in the simulations shall be 4.3125 kHz or smaller.
- A flat level of -140 dBm/Hz representative of background noise shall be added to the overall crosstalk noise.

Scenario	Mix	Topology
1	HP/M	distributed
2	HP/R	co-located
3	MP/P	co-located
4	MP/P	distributed
5	MP/I	distributed
6	MP/M	distributed

Table 2926: The combination of mixtures and topologies that form the scenarios of ESP/2004

End of literal text proposals

Hidden definitions: