Project: VDSL

Title: The reach simulation results for VDSL Part 1

Source: FTW

Authors: Tomas Nordström

Contact: Tomas Nordström
Forschungszentrum Telekommunikation Wien (FTW),
Donau-City-Strasse 1/3
AT-1220 Wien, Austria
Telephone: +43 1 5052830-22
Fax: +43 1 5052830-99
Email: Tomas.Nordstrom@ftw.at

Abstract:

This contribution gives additional information on the theoretical reach simulation results produced by FTW currently in Appendix F of ETSI VDSL Part 1.

Distribution: ETSI STC TM6 working group members

Status: For information

Introduction

These are the results from FTW's effort to simulate the performance requirements for ETSI VDSL. All our results have been generated using the FTW xDSL simulator [2].

In our contribution 031w09r1 at the last ETSI meeting [7] we proposed reaches (performance numbers), for annex F in VDSL Part 1. After the meeting we ran a set of checks and found some minor problems in the numbers. With an e-mail dated 2003-04-22 to our e-mail list we proposed new performance numbers. Those numbers were accepted and are now in our current standard.

The reaches was first verified with the help of Sigurd Schelstraete, Alcatel, and our simulation results are very close to each other (most of the time within 10 m from each other, and are never more than 23 m away). A second confirmation of our results comes from Andreas Thöny, Swisscom, in his contribution TD08 to this meeting [8]. Thus we believe these numbers are now simulated correctly.

In this contribution we restate these reach numbers with the original accuracy of 1 m. Even if this is a too high precision it might be helpful for others trying to reproduce the numbers. Furthermore, we have included the reaches for the PSD template variant A (see Appendix A).

Again, we also want to point out that there is no TPS-TC (e.g. ATM) overhead included in these numbers. That is, the time domain overhead (12%) is only covering things like voc, eoc, framing, and cyclic extension overhead. As there are at least two TPS-TC variations it was decided (at some meeting long time ago) that the payload bit-rates in these simulations are not including any additional overhead for a TPS-TC (like 9.5% of ATM overhead).

The changes from the number in 031w09r1:

* We corrected the sign for the loss when calculating the kl parameter in the UPBO calculation.
* In the simulations performed at the meeting (e.g. those reported in 031w09r1) we unintentionally removed all the out-of-band energies in non-active frequencies. This had the same effect as removing VDSL-NEXT. The out-of-band energies are now restored.
* To speed up simulations we simulated previously only frequencies up to 14MHz. This led unfortunately to incorrect interpolation for some PSD definitions (especially noise C and F). By adding some frequency points up to 30MHz this effect is now removed.

In the standard we also rounded down all reaches to an accuracy of 10 m, as we think that it is not appropriate to state the reaches with higher accuracy in the standard.

Appendix B provides the assumptions used (in addition to [1]) when generating the simulation performance numbers. These assumptions are based on recommendations from TD33r1 in Torino [3] and WD14 Praha [4].

Mask M3 is mask M1 but without notches.

Proposed reaches (m) (FTTCab uses Variant B)

Without PBO

Frequency plan: 997

PSD and Noise	S1	S2	S3	S4	A3	A4
ETSI_E1_PcabB_M1_NA =	994	893	660	97	701	97
ETSI_E1_PcabB_M2_NA =	1105	963	732	137	879	137
ETSI_E1_PcabB_M3_NA =	1064	939	721	135	847	135
ETSI_E1_PcabB_M1_NB =	993	893	659	121	787	121
ETSI_E1_PcabB_M2_NB =	1104	963	732	165	940	165
ETSI_E1_PcabB_M3_NB =	1064	939	721	165	908	165
ETSI_E1_PcabB_M1_NC =	781	722	375	53	375	53
ETSI_E1_PcabB_M2_NC =	861	793	573	100	573	100
ETSI_E1_PcabB_M3_NC =	803	748	443	76	443	76
ETSI_E1_Pex_P2_M1_ND =	902	813	612	194	887	194
ETSI_E1_Pex_P2_M2_ND =	1010	886	675	247	1001	247
ETSI_E1_Pex_P2_M3_ND =	953	853	660	243	952	243
ETSI_E1_Pex_P2_M1_NE =	956	860	641	210	1124	334
ETSI_E1_Pex_P2_M2_NE =	1065	932	709	264	1221	392
ETSI_E1_Pex_P2_M3_NE =	1014	903	696	264	1194	418
ETSI_E1_Pex_P2_M1_NF =	724	673	532	206	701	268
ETSI_E1_Pex_P2_M2_NF =	802	739	597	262	815	343
ETSI_E1_Pex_P2_M3_NF =	744	692	565	257	725	319

Frequency plan: 998

PSD and Noise	S1	S2	S3	S4	A3	A4
ETSI_E2_PcabB_M1_NA =	823	721	275	55	1033	427
ETSI_E2_PcabB_M2_NA =	840	737	282	58	1161	579
ETSI_E2_PcabB_M3_NA =	825	725	282	58	1103	573
ETSI_E2_PcabB_M1_NB =	823	722	275	55	1055	480
ETSI_E2_PcabB_M2_NB =	840	737	283	58	1181	632
ETSI_E2_PcabB_M3_NB =	825	725	283	58	1123	627
ETSI_E2_PcabB_M1_NC =	695	621	272	55	654	288
ETSI_E2_PcabB_M2_NC =	726	647	281	57	796	443
ETSI_E2_PcabB_M3_NC =	697	624	279	58	694	372
ETSI_E2_Pex_P2_M1_ND =	752	659	275	55	1040	577
ETSI_E2_Pex_P2_M2_ND =	769	675	282	58	1120	697
ETSI_E2_Pex_P2_M3_ND =	754	662	282	58	1040	698
ETSI_E2_Pex_P2_M1_NE =	794	695	275	55	1093	793
ETSI_E2_Pex_P2_M2_NE =	811	711	282	58	1170	880
ETSI_E2_Pex_P2_M3_NE =	795	699	282	57	1093	887
ETSI_E2_Pex_P2_M1_NF =	646	577	269	55	766	543
ETSI_E2_Pex_P2_M2_NF =	678	605	280	58	823	649
ETSI_E2_Pex_P2_M3_NF =	648	580	276	57	766	589

With PBO

Frequency plan: 997

PSD and Noise	S1	S2	S3	S4	A3	A4
ETSI_E1_PcabB_M1_NA_UPBO =	969	785	269	56	704	97
ETSI_E1_PcabB_M2_NA_UPBO =	1061	936	356	72	885	137
ETSI_E1_PcabB_M3_NA_UPBO =	1037	915	355	72	855	135
ETSI_E1_PcabB_M1_NB_UPBO =	969	785	269	55	793	121
ETSI_E1_PcabB_M2_NB_UPBO =	1061	935	356	72	947	165
ETSI_E1_PcabB_M3_NB_UPBO =	1037	915	356	72	916	165
ETSI_E1_PcabB_M1_NC_UPBO =	780	620	169	35	375	53
ETSI_E1_PcabB_M2_NC_UPBO =	843	724	239	44	573	100
ETSI_E1_PcabB_M3_NC_UPBO =	803	724	238	45	443	76
ETSI_E1_Pex_P2_M1_ND_UPBO =	868	710	220	42	891	194
ETSI_E1_Pex_P2_M2_ND_UPBO =	939	832	287	53	1004	247
ETSI_E1_Pex_P2_M3_ND_UPBO =	916	812	287	53	957	243
ETSI_E1_Pex_P2_M1_NE_UPBO =	925	795	277	54	1133	334
ETSI_E1_Pex_P2_M2_NE_UPBO =	1006	890	355	68	1228	392
ETSI_E1_Pex_P2_M3_NE_UPBO =	982	870	355	68	1205	418
ETSI_E1_Pex_P2_M1_NF_UPBO =	723	510	92	25	701	268
ETSI_E1_Pex_P2_M2_NF_UPBO =	790	611	141	33	815	343
ETSI_E1_Pex_P2_M3_NF_UPBO =	744	610	141	32	725	319

Frequency plan: 998

PSD and Noise	S1	S2	S3	S4	A3	A4
ETSI_E2_PcabB_M1_NA_UPBO =	503	266	54	2	1041	427
ETSI_E2_PcabB_M2_NA_UPBO =	508	271	56	3	1086	580
ETSI_E2_PcabB_M3_NA_UPBO =	508	271	56	3	1074	573
ETSI_E2_PcabB_M1_NB_UPBO =	503	266	54	2	1063	480
ETSI_E2_PcabB_M2_NB_UPBO =	509	272	56	3	1086	633
ETSI_E2_PcabB_M3_NB_UPBO =	509	272	56	3	1074	630
ETSI_E2_PcabB_M1_NC_UPBO =	459	237	44	6	654	288
ETSI_E2_PcabB_M2_NC_UPBO =	466	244	45	7	796	443
ETSI_E2_PcabB_M3_NC_UPBO =	465	244	46	7	694	372
ETSI_E2_Pex_P2_M1_ND_UPBO =	493	257	47	5	1006	578
ETSI_E2_Pex_P2_M2_ND_UPBO =	499	263	48	6	1016	698
ETSI_E2_Pex_P2_M3_ND_UPBO =	498	262	48	6	1006	700
ETSI_E2_Pex_P2_M1_NE_UPBO =	547	303	57	6	1052	798
ETSI_E2_Pex_P2_M2_NE_UPBO =	553	310	59	6	1063	883
ETSI_E2_Pex_P2_M3_NE_UPBO =	553	309	59	6	1052	891
ETSI_E2_Pex_P2_M1_NF_UPBO =	368	148	33	5	766	543
ETSI_E2_Pex_P2_M2_NF_UPBO =	373	155	34	5	822	649
ETSI_E2_Pex_P2_M3_NF_UPBO =	374	155	34	5	766	589

References

[1] ETSI RTS/TM-06026 (Draft), “Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements”, ETSI Draft TS 101 270-1, Version 2.0.8, March 2003.

[2] Nordström T., D. Bengtsson, *FTW xDSL simulation tool*, Version 3.0alpha3, 2003. Version 2.3 is available at <http://www.xdsl.ftw.at/xdslsimu/ >.

[3] Nordström T., “Second Proposal for VDSL Simulation Parameters”, ETSI TD33r1 Torino (021t33r1), 2002.

[4] Rapporteur, “Report on break-out session to discuss simulation parameters for VDSL”, ETSI WD14 Praha (023w14), 2002.

[5] van den Heuvel B., R. Persico, “PSD masks for VDSL, and corresponding templates”, ETSI TD03r1 Darmstadt (024t03r1), 2002.

[6] Nordström T., “Proposal for VDSL Performance Requirements”, ETSI TD15 Darmstadt (024t15), 2002.

[7] Nordström T., “VDSL Reaches”, ETSI WD09R1, Sophia Antipolis (031w09r1), France, 2003.

[8] Thöny A. and F. Pythoud “VDSL performance numbers”, ETSI TD08, Raykjavik (032t08), Iceland, 2003.

Appendix A: Reaches (m) when FTTCab uses Variant A

The numbers that are repeated from Variant B are written in gray.

Without PBO

Frequency plan: 997

PSD and Noise	S1	S2	S3	S4	A3	A4
ETSI_E1_PcabA_M1_NA =	994	893	570	73	570	73
ETSI_E1_PcabA_M2_NA =	1104	964	732	104	740	104
ETSI_E1_PcabA_M3_NA =	1063	939	721	104	727	104
ETSI_E1_PcabA_M1_NB =	993	893	658	97	658	97
ETSI_E1_PcabA_M2_NB =	1104	964	732	134	814	134
ETSI_E1_PcabA_M3_NB =	1063	939	721	134	798	134
ETSI_E1_PcabA_M1_NC =	781	709	340	43	340	43
ETSI_E1_PcabA_M2_NC =	861	792	537	82	537	82
ETSI_E1_PcabA_M3_NC =	803	740	412	63	412	63
ETSI_E1_Pex_P2_M1_ND =	902	813	612	194	887	194
ETSI_E1_Pex_P2_M2_ND =	1010	886	675	247	1001	247
ETSI_E1_Pex_P2_M3_ND =	953	853	660	243	952	243
ETSI_E1_Pex_P2_M1_NE =	956	860	641	210	1124	334
ETSI_E1_Pex_P2_M2_NE =	1065	932	709	264	1221	392
ETSI_E1_Pex_P2_M3_NE =	1014	903	696	264	1194	418
ETSI_E1_Pex_P2_M1_NF =	724	673	532	206	701	268
ETSI_E1_Pex_P2_M2_NF =	802	739	597	262	815	343
ETSI_E1_Pex_P2_M3_NF =	744	692	565	257	725	319

Frequency plan: 998

PSD and Noise	S1	S2	S3	S4	A3	A4
ETSI_E2_PcabA_M1_NA =	823	722	275	55	995	366
ETSI_E2_PcabA_M2_NA =	840	736	282	58	1117	503
ETSI_E2_PcabA_M3_NA =	825	725	282	58	1065	501
ETSI_E2_PcabA_M1_NB =	823	721	275	56	1011	417
ETSI_E2_PcabA_M2_NB =	840	737	283	58	1130	556
ETSI_E2_PcabA_M3_NB =	825	725	282	58	1079	554
ETSI_E2_PcabA_M1_NC =	695	621	272	55	643	265
ETSI_E2_PcabA_M2_NC =	726	647	281	58	788	416
ETSI_E2_PcabA_M3_NC =	697	623	279	57	685	350
ETSI_E2_Pex_P2_M1_ND =	752	659	275	55	1040	577
ETSI_E2_Pex_P2_M2_ND =	769	675	282	58	1120	697
ETSI_E2_Pex_P2_M3_ND =	754	662	282	58	1040	698
ETSI_E2_Pex_P2_M1_NE =	794	695	275	55	1093	793
ETSI_E2_Pex_P2_M2_NE =	811	711	282	58	1170	880
ETSI_E2_Pex_P2_M3_NE =	795	699	282	57	1093	887
ETSI_E2_Pex_P2_M1_NF =	646	577	269	55	766	543
ETSI_E2_Pex_P2_M2_NF =	678	605	280	58	823	649
ETSI_E2_Pex_P2_M3_NF =	648	580	276	57	766	589

With PBO

Frequency plan: 997

PSD and Noise	S1	S2	S3	S4	A3	A4
ETSI_E1_PcabA_M1_NA_UPBO =	969	785	269	56	571	73
ETSI_E1_PcabA_M2_NA_UPBO =	1061	936	355	72	743	104
ETSI_E1_PcabA_M3_NA_UPBO =	1037	915	356	72	731	104
ETSI_E1_PcabA_M1_NB_UPBO =	969	785	269	56	660	97
ETSI_E1_PcabA_M2_NB_UPBO =	1061	935	355	72	818	134
ETSI_E1_PcabA_M3_NB_UPBO =	1037	915	356	72	804	134
ETSI_E1_PcabA_M1_NC_UPBO =	780	620	169	35	340	43
ETSI_E1_PcabA_M2_NC_UPBO =	842	724	239	44	537	82
ETSI_E1_PcabA_M3_NC_UPBO =	803	724	238	44	412	63
ETSI_E1_Pex_P2_M1_ND_UPBO =	868	710	220	42	891	194
ETSI_E1_Pex_P2_M2_ND_UPBO =	939	832	287	53	1004	247
ETSI_E1_Pex_P2_M3_ND_UPBO =	916	812	287	53	957	243
ETSI_E1_Pex_P2_M1_NE_UPBO =	925	795	277	54	1133	334
ETSI_E1_Pex_P2_M2_NE_UPBO =	1006	890	355	68	1228	392
ETSI_E1_Pex_P2_M3_NE_UPBO =	982	870	355	68	1205	418
ETSI_E1_Pex_P2_M1_NF_UPBO =	723	510	92	25	701	268
ETSI_E1_Pex_P2_M2_NF_UPBO =	790	611	141	33	815	343
ETSI_E1_Pex_P2_M3_NF_UPBO =	744	610	141	32	725	319

Frequency plan: 998

PSD and Noise	S1	S2	S3	S4	A3	A4
ETSI_E2_PcabA_M1_NA_UPBO =	503	266	55	2	1001	366
ETSI_E2_PcabA_M2_NA_UPBO =	509	272	56	3	1086	504
ETSI_E2_PcabA_M3_NA_UPBO =	508	272	56	3	1074	501
ETSI_E2_PcabA_M1_NB_UPBO =	503	266	55	2	1017	417
ETSI_E2_PcabA_M2_NB_UPBO =	508	272	56	3	1086	556
ETSI_E2_PcabA_M3_NB_UPBO =	509	271	56	3	1074	555
ETSI_E2_PcabA_M1_NC_UPBO =	460	237	44	7	643	265
ETSI_E2_PcabA_M2_NC_UPBO =	466	244	46	7	788	416
ETSI_E2_PcabA_M3_NC_UPBO =	465	244	45	7	685	350
ETSI_E2_Pex_P2_M1_ND_UPBO =	493	257	47	5	1006	578
ETSI_E2_Pex_P2_M2_ND_UPBO =	499	263	48	6	1016	698
ETSI_E2_Pex_P2_M3_ND_UPBO =	498	262	48	6	1006	700
ETSI_E2_Pex_P2_M1_NE_UPBO =	547	303	57	6	1052	798
ETSI_E2_Pex_P2_M2_NE_UPBO =	553	310	59	6	1063	883
ETSI_E2_Pex_P2_M3_NE_UPBO =	553	309	59	6	1052	891
ETSI_E2_Pex_P2_M1_NF_UPBO =	368	148	33	5	766	543
ETSI_E2_Pex_P2_M2_NF_UPBO =	373	155	34	5	822	649
ETSI_E2_Pex_P2_M3_NF_UPBO =	374	155	34	5	766	589

Appendix B: Simulation assumptions

The simulations to generate the performance numbers are based on the following assumptions:

Shannon gap	9.8 dB
SNR cross-talk margin	6.0 dB
Coding gain	3.8 dB
Implementations losses	2 dB
Time-domain overhead	12%
Maximum useful SNR	57 dB (15 bits)
Power back-off	Assuming equal length scenario for the disturbing systems. Use UPBO parameters according to ETSI VDSL specification Part 1.
Maximum transmit power	+14.5dBm for FTTEx downstream else +11.5 dBm.
FEXT coupling	–45 dB at 1MHz growing as f^2
NEXT coupling	–50 dB at 1MHz growing as f^1.5 Crosstalk combination use the FSAN rule
Self FEXT and NEXT from	20 VDSL (of the same kind, i.e., same PSD) (This corresponds to an increase of 7.806 dB)
AWGN	–140 dBm/Hz
Noise model	VDSL Noise A-F
Loops	Loop #2, (cable TP150)
Frequency plans	E1 (997), E2 (998)

Use 125 kHz guard band from each side, except 138 kHz and 12 Mhz.
The optional low frequency band is not to be used.
No transmission (i.e., at –80 dBm/Hz) is assumed in the HAM bands.

Nominal PSD masks specified	Pcab, Pex-P2
Mask variations:	M1 with notching, M2 without notching, and M1 without notching (called M3 here) Variant A and B of FFTCab

Templete masks as defined in Part 1 [1] have been used.

Out of band PSD levels as specified in ETSI VDSL specification Part 2.