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Project: VDSL

Title: Expected performance reduction when mixing frequency plans for VDSL

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Contact: Tomas Nordström
Forschungszentrum Telekommunikation Wien (FTW),
Maderstrasse 1/9
AT-1040 Wien, Austria
Telephone: +43 1 5052830-22
Fax: +43 1 5052830-99
Email: Tomas.Nordstrom@ftw.at

Abstract:

This paper describes our findings regarding mixing the suggested four-band plans up to 12 MHz for VDSL. Our conclusion is that mixing two different plans (e.g. “997” and “998”) in the same binder should always be avoided. The NEXT that occurs in the overlapping frequency bands essentially reduces the capacity offered by these bands to zero.

Distribution: ETSI STC TM6 working group members

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1. Introduction

At the last couple of ETSI meetings there have been two main frequency plans (a.k.a. 997 and 998) together with a third plan (a.k.a. the Fx-plan). In this paper we try to see what happens if one, by mistake or deliberately, mixes 997 with 998 or mixes two Fx plans that would correspond to the 997 and 998 plans.

The analysis of the mixing of frequency plans considered here is based on the simulation basics described in ETSI TM6 Edinburgh WD29 [4]. For all simulations, the FSAN xDSL-simulation tool [3] has been used. For all of the simulations, we have used 5% guard band.

At the FSAN meeting 7-9th February 2000 a large number of other plans were suggested. The US operators expressed a strong preference for the 22/3 (approximately A3) service. The fallout of these discussions was that the US operators preferred:

```
Plan   998 = [0.138        3.75         5.2          8.5          12],
```

which since has been known as the “998 plan”. Meanwhile, the European operators (with a few exceptions) put forward a compromise plan, balancing asymmetric and symmetric services:

```
Plan   997 = [0.138           3          5.1         7.05          12]
```

The “997” is much more balanced (by design) in its support of many different services (without loosing badly even on 22/3) and was thus considered better suited for the unbundled case. At the Helsinki-meeting, a flexible plan, the Fx-plan, was suggested [5]:

```
Plan Fx  = [0.138        2.5        3.75        X          12]
```

In the Fx-plan, the crossover frequency X is chosen from a given set of values, and communicated to the modem at start-up. The actual value to be used in a country or region is typically determined by the regulator having jurisdiction over that region.

In this study we were interested to see what would happen if we mixed 997 with 998, or Fx=6 with Fx=10.125.

The experiment was set up so that we always use 20 disturbing modems. First, we determine the reach when a single plan is used. Secondly, we test the reaches when we mix two kinds of frequency plans (with 10 modems using each plan). We selected to only run the experiments for Noise A (from the cabinet) and Noise E (from the Exchange) as these two quite well represent what will happen for the other noise models.

2. Simulation Results

In the tables below, we show the reaches for all services, a certain noise, and modems using the specified frequency plans. The first and second columns (labelled with single plans) show the reach when a single plan is used for the whole bundle. While in the last two columns, we see what will happen with the reaches for these frequency plans when we mix the plans.

In the tables below we have marked (in red and italic) the services for which the reach are severely reduced.

Noise A

	Single plans		Mixed Plans	
Service	**997**	**998**	**997**	**998**
S1	1300	1060	*1110*	1060
S2	1180	930	*1000*	930
S3	950	460	*690*	460
S4	330	110	290	100
S5	140	0	130	0
A1	1710	1550	*1560*	1550
A2	1710	1550	*1560*	1550
A3	1230	1390	1230	*1280*
A4	330	950	330	*560*

Table 1. This table shows the difference in reach if we mix two different frequency plans (997 & 998), compared to the case where all modems use the same frequency plan.

Noise A

	Single plans		Mixed Plans	
Service	**Fx=6**	**Fx=10.125**	**Fx=6**	**Fx=10.125**
S1	1280	910	*970*	910
S2	1180	700	*820*	700
S3	960	150	*390*	140
S4	310	0	200	0
S5	120	0	120	0
A1	1840	1830	1830	1830
A2	1660	1660	1660	1660
A3	1260	1350	1260	1300
A4	310	1050	300	*470*

Table 2. This table shows the difference in reach if we to mix two different frequency plans (Fx=6 and Fx=10.125), compared to the case where all modems use the same frequency plan.

Noise E

	Single plans		Mixed Plans	
Service	**997**	**998**	**997**	**998**
S1	1200	1000	*1040*	1000
S2	1090	870	*940*	880
S3	870	460	*660*	460
S4	440	100	290	100
S5	190	0	170	0
A1	1540	1470	1470	1470
A2	1540	1470	1470	1470
A3	1330	1340	1330	1350
A4	480	1040	480	*690*

Table 3. This table shows the difference in reach if we mix two different frequency plans (997 & 998), compared to the case where all modems use the same frequency plan.

Noise E

	Single plans		Mixed Plans	
Service	**Fx=6**	**Fx=10.125**	**Fx=6**	**Fx=10.125**
S1	1160	820	*880*	820
S2	1080	640	*740*	640
S3	890	130	*380*	130
S4	440	0	200	0
S5	180	0	130	0
A1	1430	1370	1370	1370
A2	1430	1370	1370	1370
A3	1340	1210	1210	1210
A4	440	1040	440	*580*

Table 4. This table shows the difference in reach if we mix two different frequency plans (Fx=6 and Fx=10.125), compared to the case where all modems use the same frequency plan.

3. Observations and Conclusions

From the results and figures we can make some observations.

For services optimised for asymmetrical services (997 and Fx=10.125), we find the high-end asymmetrical services are the worst hit. While for the more symmetrical services (997 and Fx=6) the high-end symmetrical services are the ones worst hit. That is, if a plan is optimised for a certain service, this service will be the "bottle neck" and are the most susceptible for "cross talk" from other frequency plans. This is clearly shown for the service S3 (for 997 and Fx=6) and for the service A4 (for 998 and Fx=10.125)

We also note that the Fx plans are in no way more protected from degradation than the 997 and 998 plans. The 997 and 998 plans have 2.3 MHz overlap while the two Fx plans have 4.125MHz, and in both cases very little capacity remains in the overlapping bands because of NEXT.

The moral from this study is "Thou shalt not mix frequency plans in the same bundle".

References

[1] ETSI Document *TS-101-270-1, Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional Requirements*, June 1999

[2] ETSI Document *TS-101-270-2, Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 2: Transceiver specification*, V1.0.2, May 2000

[3] Nordström T., D. Bengtsson, FSAN xDSL simulation tool, Version 2.0, 2000. Version 2.0 is available at <http://www.xdsl.ftw.at/xdslsimu/ >.

[4] Rapporteur *"On optimization of the VDSL band allocation*, ETSI TM6 Edinburgh WD29, 1999.

[5] Isaksson M., P. Ödling, A. Uvliden, T. Stefansson, "Proposal for a third VDSL spectrum plan" ETSI TM6 002t44R0, Helsinki May 2000.

Appendix A, Plans under study

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Plan     997       = [0.138        3.0       5.1        7.05         12]
Plan     998       = [0.138        3.75      5.2        8.5          12]
Plan     Fx=6      = [0.138        2.5       3.75       6.0          12]
Plan     Fx=10.125 = [0.138        2.5       3.75      10.125        12]
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