Project: SDSL

Title: SDSL start-up instabilities

Source: FTW

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Abstract:

This paper discusses a potential instability problem during SDSL start-up. Through a “gedanken” experiment and simulations, we find that during start-up of SDSL modems we can get a ping-pong effect with multiple restarts. Furthermore, we see that for each restart we will be forced to reduce the bit-rates of earlier deployed modems.

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1. Introduction

For SDSL the start-up is done one modem at the time (that is, not all at once). Furthermore, SDSL has a very special set of PSD masks which shape depends on the bit-rate. Combined these two design characteristics can lead to instabilities during start-up.

2. Gedanken experiment

Let us assume that we have a cable that may have some DSL systems within. The noise in the cable before our experiment is not important but it can be assumed that, with little or no other systems in the cable already, the effect would be more apparent than if the cable contains many other systems.

Now install the first SDSL modem S1 into the cable at a distance where it precisely reaches 1536kbit/s.

Then we install a second SDSL modem S2 further out and with S1 in the cable it can achieve 512kbit/s.

But now S1 will experience more noise and must retrain and establish a new (lower) bit-rate. Let us say that S1 now only can support lower bit-rate than 1536kbit/s (with S2 at 512kbit/s) and starts transmitting at this rate.

At this point the modem S1 with its new lower bit-rate will disturb the modem S2 more than what it did with 1536kbit/s, S2 now experiences more noise and must retrain!

Thus S2 might need to reduce its bit-rate to a lower value and we can foresee a downward spiral of ever decreasing bit-rates as a result.

3. Simulation experiment

We can also show this phenomenon during simulation using our xDSL simulator [1]. Let us assume we have an empty 0.4mm cable with a flat BG noise at –120dBm/Hh. The bit-rate throughout all simulations was increased respectively decreased with steps of 64kbit/s.

STEP 1) Let us first deploy a SDSL modem S1 achieving 1536kbit/s at 5000m with extra margin 0.10dB on the LT (Line Termination) and NT (Network Termination) side before the modem S2 is turned on.

STEP 2) The second modem S2 which should support 512kbit/s could be deployed at a reach of 5800m with margin 0.08dB on the LT side an 4.41dB on NT side. Thus, we have a set-up as in figure 1.

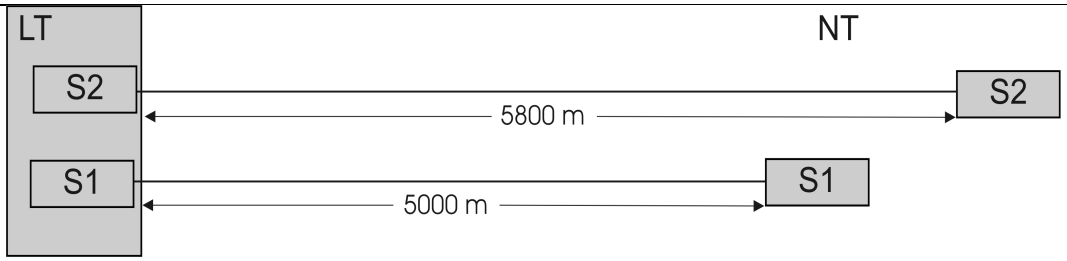

Figure 1. Simulation scenario

Now, as result of NEXT and FEXT noise from the modem S2 into the twisted pair of the modem S1, S1 will get negative margins namely –4.71dB at LT and –2.47dB at NT.

STEP 3) Then the modem S1 must be retrained to get positive margins again. As result the bit-rate is decreased to 832kbit/s and then the new margins are 0.01dB at LT and 4.11dB at NT.

We would now naively expect that both modems would get positive margins, as would have been the case if the PSD masks had not been a function of transmission bit-rate. However, this will not be the case because the maximum value of the SDSL PSD mask at 832kbit/s is higher in the frequency band that modem S2 uses than at 1536kbit/s. Thus, this will cause higher ingress noise into the S2 modem and it will get a negative margin of –1.67dB at the LT side and reduce the positive margin to 2.99dB at the NT side.

STEP 4) Now we decrease the bit-rate of the modem S2 until we get positive margins again, the resulting bit rate is 448kbit/s with margins 0.80dB at LT and 5.28dB at NT. After this the bit rate of the modem S1 was the same 832kbit/s with margins 1.27dB at LT and 4.75 at NT.

We can see that the margins of S1 are increased and we could actually try to increase the bit rate of this modem because it will not more disturb the modem S2 with its higher bit rate. This is a result of the lower PSD mask in the frequency band that is used by modem S2.

STEP 5) With such retraining of S1 we could get 960kbit/s, with both modems still having positive margins. We note however that it is not likely (or desired) that such retraining would take place. Thus, with this start-up we end up with bit-rates far from the optimum ones.

All results given above step by step for the aim of clarity are shown in table 1.

Table 1.

Step Nr.	Modem S1			Modem S2		
	Bit rate [kbit/s]	Margin LT [dB]	Margin NT [dB]	Bit rate [kbit/s]	Margin LT [dB]	Margin NT [dB]
1	1536	0.10	0.10	–	–	–
2	1536	– 4.71	– 2.47	512	0.08	4.41
3	832	0.01	4.11	512	– 1.67	2.99
4	832	1.27	4.75	448	0.80	5.02
5	*960*	*0.37*	*3.38*	*448*	*1.20*	*5.61*

4. Conclusions

In this contribution, we have shown that problems may arise during start-up of SDSL modems. This is result of ping-pong effect that comes from changes in transmission PSD masks with transmission bit-rate. It is our opinion that further studies should be conducted to understand how this ping-pong effect would influence the startup management and also how these cascading restarts will affect other xDSL modems deployed within the same cable bundle.

This ping pong effect could be mitigated by using excessive margins when installing modems, or installing modems under the assumption that they should work under the worst case scenario but then the reach and transmission bit-rate will be pessimistic and therefore reduce the usefulness of SDSL.

5. References

[1] Nordström T., D. Bengtsson, *FTW xDSL simulation tool*, Version 2.2, 2001. Version 2.2 is available at <http://www.xdsl.ftw.at/xdslsimu/ >.