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SOURCE[1]: ST Microelectronics

TITLE: Spectral friendliness: ADSL++ compared to VDSL

ABSTRACT

Comparison between ADSL++ and VDSL is represented. It is shown that at the same rate VDSL transmission will cause much less interference on short loops. This leads to the conclusion that ADSL++ should be power limited to allow more users to get high data rates over short loops

1 Introduction:

New line codes meant for short loops and high bit rates should foresee the last mile bandwidth bottlenecks emerging in the near future. High bit rates transmitted over short loops should use the spectral resource in a way that will minimize interference to other transmissions on the same binder. A useful way to achieve this goal is to use high frequencies where the FEXT noise generated is relatively low (or more precisely where FEXT coupling is low due to loop attenuation).

We show here the benefits of using VDSL line code instead of an ADSL++ for providing the *same* service. In other words when 20 ADSL++ provide the same service as 20 VDSL the former create much higher interference than the latter. We conclude that an ADSL++ standard if exists should at least limit itself to an aggregate transmitted power not exceeding the VDSL limit (14.5dbm).

We present here an example using a 1Km loop, of a bundle of 20 ADSL++ transmitting at full power with a rate of 24Mpbs. Since the FEXT coupling is high at the used bandwidth, a relatively high noise is generated. When a VDSL is used for the same service (e.g. 24Mbps over 1Km), it uses a larger bandwidth thus to achieve the same rate the VDSL needs to backoff. Thus VDSL transmits at much lower power on wider bandwidth and thus with much less FEXT coupling. The resulting cross talk is much closer to the -140dBm/Hz floor thus causing little damage.

To demonstrate we check the bit rate of another VDSL link which tries to achieve maximum bit rate in the given cross talk scenario (from either 20 ADSL++ or 20 VDSL++ serving the same 24Mbps). The results are surprising: for ADSL++ interference the bandwidth demanding VDSL link achieves only 36Mbps while for VDSL interference the bandwidth demanding VDSL link achieves 62Mbps. Thus offering the *same service* ADSL++ generates much more interference than VDSL.

The results are presented in the following graphs:

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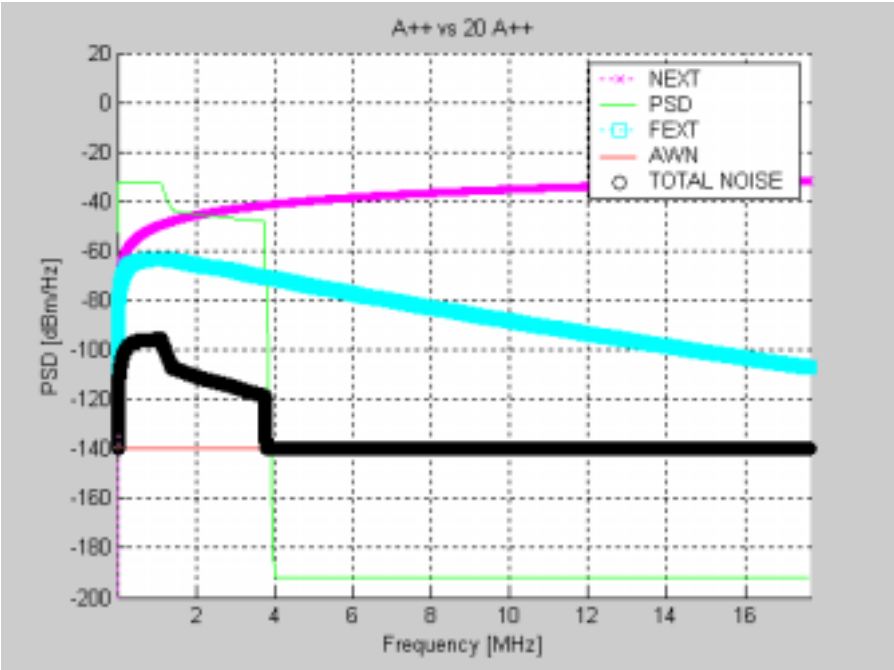
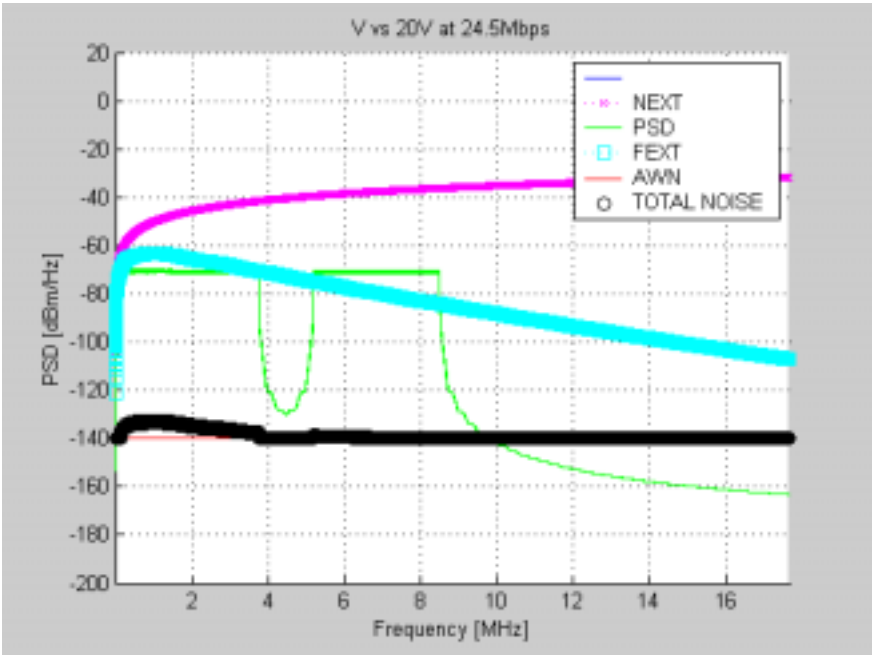
This figure shows 20 ADSL++ disturbers transmitting over 1km loop at full power (20.5dbm) at 24Mbps.



The next figure shows 20 VDSL disturbers with power back-off (-9dbm) transmitting 24.5Mbps over 1km loop



Simulation is based on the ETSI VDSL standard for exchange (ETSI VDSL standard from May 2003, part 1).
The used masks are based on the ETSI 998 boosted mask without Ham band notching.

The initial power for VDSL (before backoff) is based on ETSI/ANSI Exchange side power limitation of 14.5dBm

The loop used is ETSI loop 4 with 1Km length.
Background noise is -140dBm/Hz.

Assumed: net coding gain is 3.8dB, 2dB implementation loss and 6dB margin.

Clearly, the VDSL is much friendlier to other users. The ADSL++ should use power back-off of at least 20dB to be as friendly to its neighbors as VDSL.

This example is not artificial since in the coming years bottlenecks on the binder may occur, and we do not want the many 24Mbps users hurting the fewer users willing to pay more for even higher bandwidth.

In addition the ADSL++ is also much more harmful to VDSL than other line codes. For example we will compare it to ADSL+. In the following all bit rates include overheads:

With 1.0Km loop, -140dBm/Hz noise floor, and 20 FEXT only interferers:
A+ reduces VDSL down bitrate to 45696Kb
A++ reduces VDSL down bitrate to 35912Kb

With 1.5Km loop, -140dBm/Hz noise, and 20 FEXT only interferers:
A+ reduces VDSL down bitrate to 22356Kb
A++ reduces VDSL down bitrate to 18036Kb

To solve these issues we need on one hand to limit ADSL++ power to 11.5dBm or 14.5dBm. As an example VDSL is also limited to 14.5dBm from exchange and 11.5dBm from cabinet. Moreover in T1E1 Spectral management standard the device class transmitting above 1.1MHz is limited to 14.5dBm (class 6). On the other hand it would also be smart to define a down stream backoff algorithm that would limit transmittion power according to loop length (similar to VDSL upstream backoff algorithm).

2 Summary

In long term view, installations of medium bit rate modems with relatively narrow bandwidth would limit the number of high bit rate users on the same binder. In particular, VDSL can achieve the same rates of ADSL++ (and much higher) with much less “spectral pollution”. If ADSL++ is to be allowed, we recommend limiting its aggregate transmitted power to less than 14.5dbm.