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Title:	MIMO-systems' Performance Potential	
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Abstract:	This paper discusses the potential performance of future MIMO-systems. It is shown that for one of the suggested applications for a MIMO-system, as a fibre replacement between the central office and the cabinets, the potential performance increase is below two times the non-MIMO system.	
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## 1. Introduction

For multi-channel DSL (MIMO) systems, that is, coordinated parallel DSL systems, there is a potential performance increase compared to non-coordinated DSL systems. This paper studies the upper bound on the performance increase possible with a MIMO-system.

One of the suggested applications for a MIMO-system would be as a fibre replacement between the central office (CO) and the cabinets. In this paper we set up our simulations to correspond to this scenario. That is, 0.4mm cable, a background noise level at -120 dBm/Hz, and we expect the average distance to be somewhere between 1000 m and 1500 m, 25 pair bundles.

## 2. **Results**

The following assumptions were used for simulating [1] the studied scenario (between a central office and a cabinet):

- background noise at -120 dBm/Hz,
- NEXT and FEXT couplings as used in ETSI,
- a 0.4 mm cable (ANSI\_TP1),
- a Shannon gap of 12 dB,
- the PSD mask is at -40 dBm/Hz in the ADSL band and then at -60 dBm/Hz above that,
- a SNR maximum of 58 dB (i.e., max 15-bit constellations)
- the active frequency band is between 2 kHz and 12 MHz,
- and a general efficiency loss of 10%.

It is not obvious what noise environment we should assign for the two cases, but for this study there is no added noise from alien systems in neighbouring bundles but instead an increased background noise is used (from the typical -140dBm/Hz to -120dBm/Hz).

The active frequencies are designed for a system without POTS or ISDN and for a system aiming at 1000-1500 m, thus having a useful upper frequency of around 12 MHz.

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**Figure 1**. The potential bitrates for MIMO and non-MIMO systems depending on distance between the CO and the Cabinet.

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Distance [m]	MIMO increase	
500	1.4	
1000	1.3	
2000	1.2	

Table 1. Potential increase in bit rate:

In Figure 1 and Table 1 it is shown that, for the scenario under study, the implementation of a MIMO-system would not give much.

Note that the performance numbers are the total possible bit rates and for a symmetrical system, this would be divided by two for each direction.

Because of the strong influence on the noise assumption, we can rerun the simulations using a -140 dBm/Hz background noise level. Then, the potential bit rates are as shown in Figure 2.

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**Figure 2**. The potential bitrates for MIMO and non-MIMO systems depending on distance between the CO and the Cabinet, if background noise is lowered to -140dBm/Hz.

Still for this much lower background noise, the performance increase for MIMO-systems is between 1.5 and 2.5 for the distances above 500 m.

# 3. Conclusions

In this contribution, we have calculated the performance potential for MIMO-systems. It is found that no more than a 1.5-2.5 times performance increase compared to a non-coordinated systems is possible for a MIMO-system, in a fibre replacement scenario from the CO to the cabinets. Only in scenarios with distances shorter than 800 m, a MIMO-system can potentially give more than twice the performance.

# 4. References

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