

LOW COMPLEXITY ALGORITHMS FOR VECTORED VDSL

by

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Certificate

This is to certify that the thesis titled “**LOW COMPLEXITY ALGORITHMS FOR VECTORED VDSL**” being submitted by **PRAVESH BIYANI** to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a record of bona-fide research work carried out by him under my guidance and supervision. In our opinion, the thesis has reached the standards fulfilling the requirements of the regulations relating to the degree. The results contained in this thesis have not been submitted to any other university or institute for the award of any degree or diploma.

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Abstract

Digital subscriber lines (DSL) are an important part of the broadband communications infrastructure. To cater to applications demanding high speed, DSL technologies have evolved to very high-speed-DSL (VDSL), which promises data rates in the excess of 100 Mbps by minimizing the impact of far-end-crosstalk (FEXT). Signal co-operation at the central office (CO) along with the synchronized reception and transmission and use of sophisticated multiple-input-multiple-output (MIMO) signal processing techniques are major features of the vectored VDSL systems. Although the solutions to FEXT and related issues in the VDSL are well known, innovative solutions are needed for many practical problems for making implementation of these systems feasible. In this thesis, we attempt to bridge this gap.

The questions addressed here are : what makes a solution practically implementable? And how to provide it with minimal compromise on performance? Adaptability, low complexity and backward compatibility are the major themes of this thesis. The focus in this thesis is on looking for such solutions. For self-FEXT mitigation, we introduce a unified framework in the upstream (US) and downstream

(DS) at the CO via the development of off-diagonal MIMO linear (ODML) operators. This framework leverages the detection errors for both US and DS self-FEXT mitigation, in compliance with developments in the VDSL standard. The off-diagonal operator leads to an LMS like adaptive solution that achieves near self-FEXT free performance in both directions. For the US alien FEXT mitigation, we again use a simple receiver that uses a linear combination of the detection errors after FEXT cancellation.

Unavailability of sufficient computational resource at the CO makes its efficient allocation very important. In this thesis, we suggest a way to perform such an allocation. Motivated by the discrete nature of the resource allocation problem, we develop a dynamic programming based technique to achieve an optimal solution. Such a strategy can be easily generalized to tackle other resource allocation issues (like power) with various objective functions. We also provide another perspective on the run time use of these resources by introducing the concept of instantaneous partial cancellation, and demonstrating its usefulness.

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