

# Complexity Reduced Near Maximum-Likelihood Detection Techniques for MIMO Systems

## Introduction

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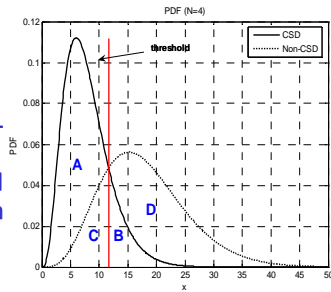
## Optimum Threshold Analysis

In MIMO systems, optimal detection involves a tree search whose complexity increases exponentially with the number of antennas and symbol alphabet, which is soon prohibitively high for practical implementation. The sphere decoder (SD) and its variant fixed-complexity SD (FSD) are simpler alternatives, however, the complexity of those algorithm will still be very high when many antennas are involved or/and higher-order constellations are utilised. In this work, we aim to seek novel detection algorithms which offer a good trade-off between complexity and performance in real scenarios.

Through analysis the distribution of correct and wrong estimates, we found that the intersection point of the PDF curves of the CSD and Non-CSD is the optimum threshold.

$$\rho = \frac{\|\mathbf{r} - \mathbf{H}\hat{\mathbf{s}}\|^2}{\sigma^2} = \frac{\|\mathbf{n}\|^2}{\sigma^2}$$

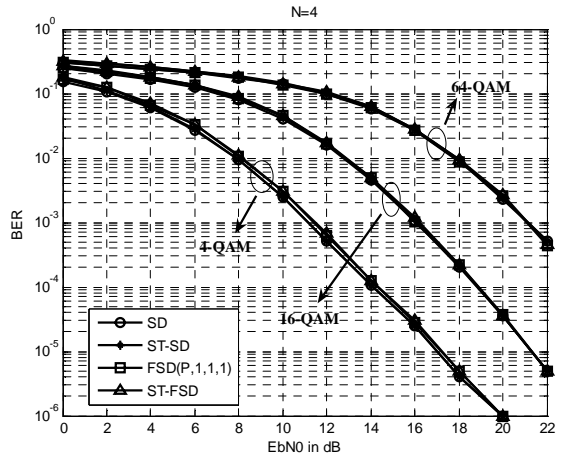
If correct estimate, chi-square distribution (CSD) otherwise, non-central chi square distribution (Non-CSD).



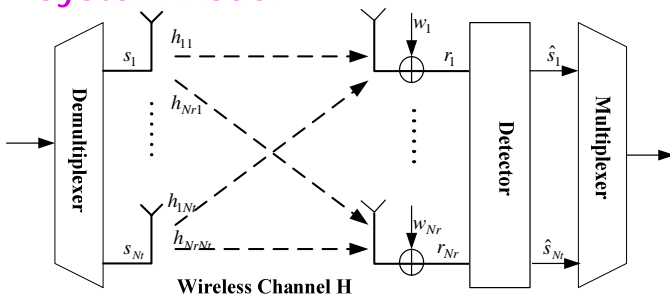
## Objectives

1. to design novel near-ML performance detection algorithms with much reduced complexity for MIMO systems;
2. to provide a scalable MIMO simulation test-bed and investigate various detection algorithms;
3. to produce efficient hardware implementations of demanding signal processing applications.

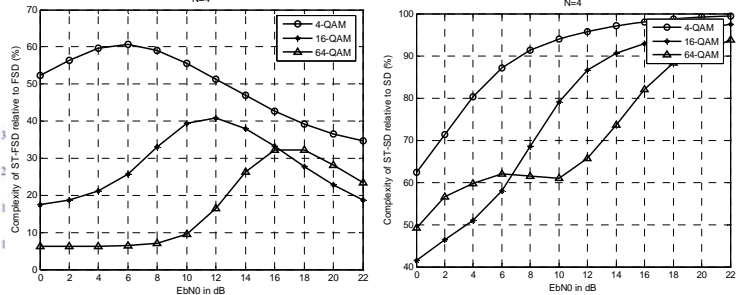
## Bit Error Ratio Results



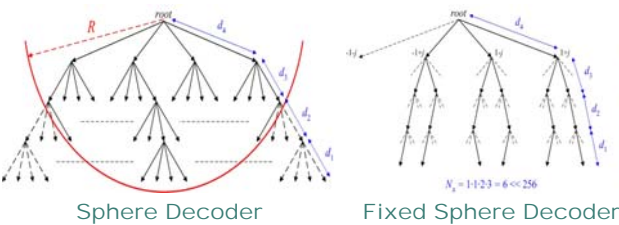
## System Model



## Complexity Results



## Sphere Decoder Tree Search



## Motivation

The basic idea is to design a metric-first SD/FSD scheme which employs an optimum threshold for measuring the "goodness" of estimates from different search paths traversed by the SD/FSD. We discard unnecessary search paths that do not match the true solution. Schnorr-Euchner ordering is employed to expedite the tree search.

## Conclusions and Future Work

1. Conventional SD and FSD algorithms have been restructured by use of proposed threshold. Significant reduction in complexity while almost no loss in performance.
2. Future work will include the analysis of the proposed scheme in larger MIMO systems and real-time hardware implementation.