



## MIMO Detection: Theory and Practice

***Scheduled:***

Monday 15 September 2008, afternoon

***Presenter:***

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***Abstract:***

Multiple-input multiple-output (MIMO) techniques offer the promise of high spectral efficiency and robustness to fading. Key to their success is the MIMO detector at the receiver, whose job it is to recover the symbols that are transmitted simultaneously from multiple antennas. In practice the MIMO detector is often the bottleneck for performance, or the bottleneck for complexity. Or sometimes, the bottleneck for both!

This tutorial will present the basic principles of MIMO detection. We describe the fundamental problem, and present an overview of MIMO detectors that are used in practice. Our coverage ranges from simple linear detectors based on the zero-forcing and minimum-MSE criteria to the optimal maximum-likelihood sphere detector. In between, we will describe successive-cancellation or decision-feedback detectors, multistage detectors, and suboptimal tree-based detectors like the MMSE sphere detector, the Fano algorithm, the M-algorithm, the K-best algorithm, and list-based algorithms like the Chase algorithm. The role of lattice reduction preprocessing and column ordering will be described. Lastly we will quantify the performance-complexity tradeoff for a variety of detection strategies.

This tutorial will benefit practicing engineers and researchers who are interested in understanding and doing research in MIMO and related topics, particularly those who are engaged in the design of high-speed wireless data systems.

### **Planned Outline:**

- A. Motivation and Background
  - A.1. Why antenna arrays, why MIMO
  - A.2. The importance of MIMO detection
- B. Classical MIMO Detection Strategies
  - B.1. Joint ML Detection
  - B.2. Genie-Aided Receivers and the Matched-Filter Bound
  - B.3. Linear MIMO Detection
  - B.4. Decision-Feedback Detection for MIMO Channels
- C. State-of-the-Art Detection Strategies
  - C.1. Multistage Parallel-Interference Cancellation
  - C.2. Lattice-Aided Detection
  - C.3. The Sphere Detector and its Variants
  - C.4. The M and K-Best Algorithms
  - C.5. List-Based Detectors and the Chase algorithm
  - C.6. Soft-Output Detection
- D. Performance versus Complexity: A Case Study
  - D.1. A Time-Line of Existing Detection Strategies
  - D.2. The Slow Fading Scenario
  - D.3. The Fast-Fading Scenario
- E. Bibliography

### **Biographical Sketch:**

Dr. John R. Barry received the M.S. and Ph.D. degrees from the University of California at Berkeley in 1987 and 1992, respectively, both in electrical engineering. Since 1985 he has held engineering positions in the fields of communications and radar systems at Bell Communications Research, IBM T.J. Watson Research Center, Hughes Aircraft Company, and General Dynamics. He is a coauthor (with David G. Messerschmitt and Edward A. Lee) of *Digital Communication, Third Edition*, Kluwer/Springer, 2004, and the author of *Wireless Infrared Communications*, Kluwer/Springer, 1994. He received the 1992 David J. Griep Memorial Prize and the 1993 Eliahu Jury Award from U.C. Berkeley, a 1993 Research Initiation Award from NSF, and a 1993 IBM Faculty Development Award. He joined the Georgia Tech faculty in 1992, where he is a Professor with the School of Electrical and Computer Engineering. He is currently visiting the Georgia Tech Lorraine campus in Metz, France.