

Tutorial 6

Resilient Communication Systems

Prof. Dr.-Ing. Vahid Jamali

Tutor: Mohamadreza Delbari

Email: mohamadreza.delbari@rcs.tu-darmstadt.de



TECHNISCHE
UNIVERSITÄT
DARMSTADT

Released: November 17, 2025.

MIMO Detectors III

Problem 1

Non-linear MIMO Detectors: Consider a MIMO communication system with the following channel matrix

$$\mathbf{H} = \begin{bmatrix} 0.2 & -0.2 \\ 0.1 & 0.4 \\ 1 & 0.2 \end{bmatrix}.$$

- Sketch the block diagram of a non-linear MIMO detector and determine the corresponding filter matrices of ZF decision-feedback, and MMSE decision feedback, considering $P_x/\sigma_n^2 = 10$ dB. Calculate the total error variance of the mentioned detection schemes and compare them.
- With assuming $\mathbf{y} = [0.6, -0.1, 1.3]^T$, obtain estimation of $\mathbf{x}$ when $\mathcal{A} = \{-1, 1\}$ by using 2 different non-linear detectors.



Problem 2

Fig. 1 is generated with the MATLAB code in [GitHub Repository](#).

- Based on Fig. 1, determine which color is for which detector? Name them as ML, SIC-ZF, SIC-MMSE?
- Determine the number of receiver antennas (N) and the number of transmitter antenna is (M)?

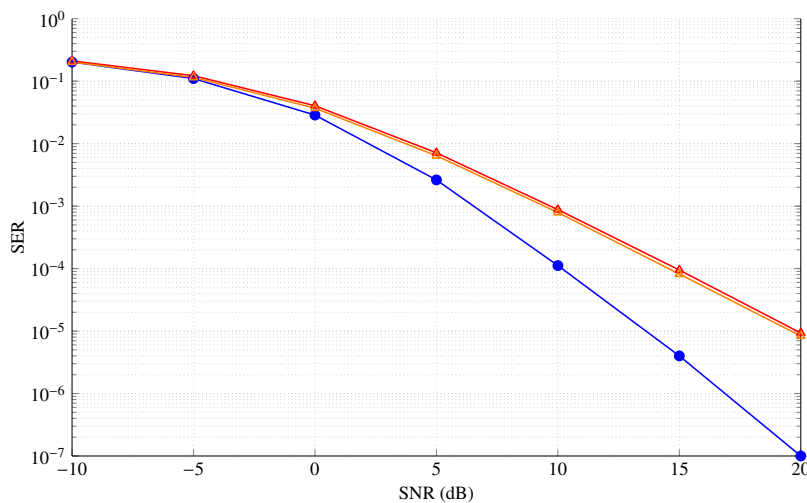
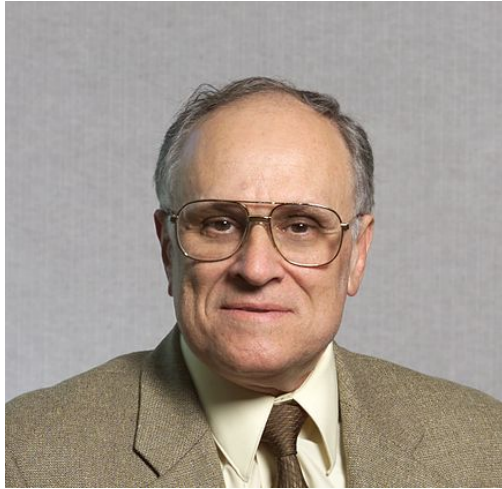


Figure 1: SER of three different linear MIMO detectors.

Gerard Joseph Foschini

Gerard Joseph Foschini was a distinguished American telecommunications engineer renowned for his groundbreaking contributions to wireless communications. Born in Jersey City, New Jersey, Foschini earned his B.S. in Electrical Engineering from the New Jersey Institute of Technology, followed by an M.E.E. from New York University, and a Ph.D. in Mathematics from Stevens Institute of Technology in 1967.

In 1961, Foschini began his illustrious career at Bell Laboratories, where he remained until his retirement in 2013. During his tenure, he made significant advancements in data communications, particularly in wireless and optical domains. His most notable achievement was the development of the Bell Laboratories Layered Space-Time (BLAST) architecture, a pioneering MIMO technology that utilizes multiple antennas at both the transmitter and receiver to significantly enhance data transmission rates.



Gerard Joseph Foschini
Born: February 28, 1940
Died: September 17, 2023

Foschini's work on BLAST laid the foundation for modern MIMO systems, which are integral to contemporary wireless communication standards, including Wi-Fi and LTE. He introduced these concepts in [1] and has been extensively cited in subsequent research.

Throughout his career, Foschini authored over 100 publications and held 14 patents related to communications technology. His contributions earned him numerous accolades, including the IEEE Eric E. Sumner Award in 2006 and the IEEE Alexander Graham Bell Medal in 2008. In 2009, he was elected to the National Academy of Engineering for his seminal work in wireless communications.

Beyond his technical achievements, Foschini was a dedicated mentor and educator, teaching at institutions such as Princeton University and Rutgers University. His legacy continues to influence the field of telecommunications, reflecting his profound impact on both the theoretical and practical aspects of wireless communication systems. Read more in [Wikipedia](#).

Reference: [1, 2].

References

- [1] G. J. Foschini, "Layered space-time architecture for wireless communication in a fading environment when using multi-element antennas," *Bell Labs Technical Journal*, vol. 1, no. 2, pp. 41–59, 1996.
- [2] G. D. Golden, C. Foschini, R. A. Valenzuela, and P. W. Wolniansky, "Detection algorithm and initial laboratory results using v-blast space-time communication architecture," *Electronics letters*, vol. 35, no. 1, pp. 14–16, 1999.

