DREXEL UNIVERSITY
Electrical and Computer Engineering
College of Engineering

A MATLAB Platform for Characterizing MIMO-OFDM Communications with Software-Defined Radios

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Motivation

USS Thomas S Gates (CG 51)

Source: http://commons.wikimedia.org/wiki/File:USS_Thomas_S._Gates_CG-51.jpg

Motivation

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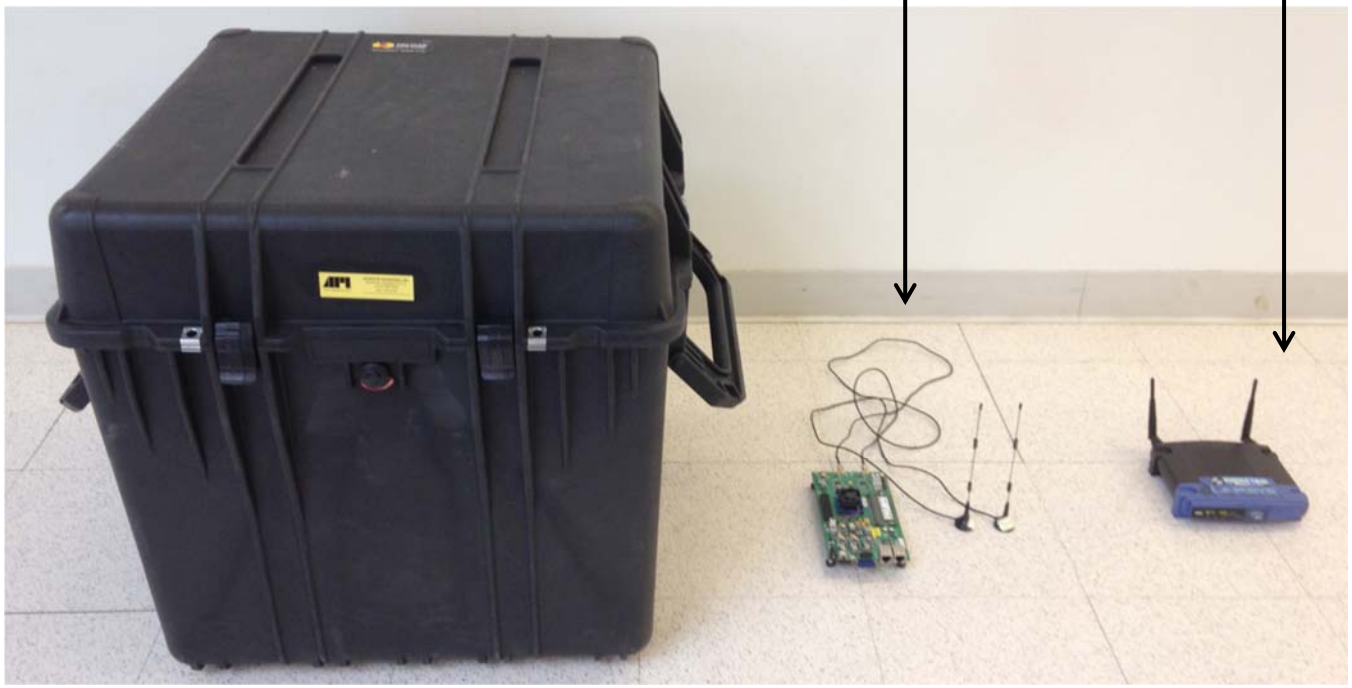
Agilent Signal Analyzer
Agilent Signal Generator
~$100,000

WARPv3[1] SDR Kit
~$4,900

Linksys Router
~$50

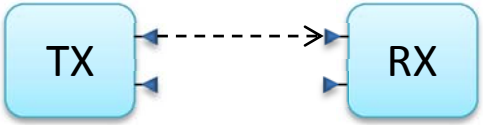


[1] http://warp.rice.edu

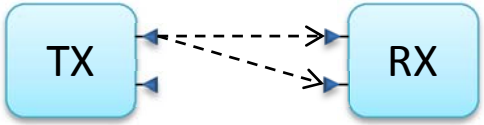
System Overview

- WARP[1] Software Defined Radio
- IEEE 802.11g OFDM Communications
- Physical layer transmission schemes[2]:

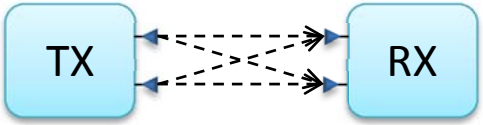
SISO 1x1, Rate 1



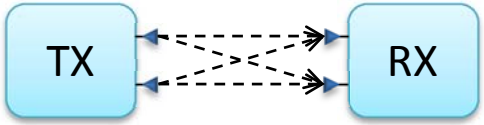
Maximal-Ratio Combining 1x2, Rate 1



Alamouti STBC 2x2, Rate 1

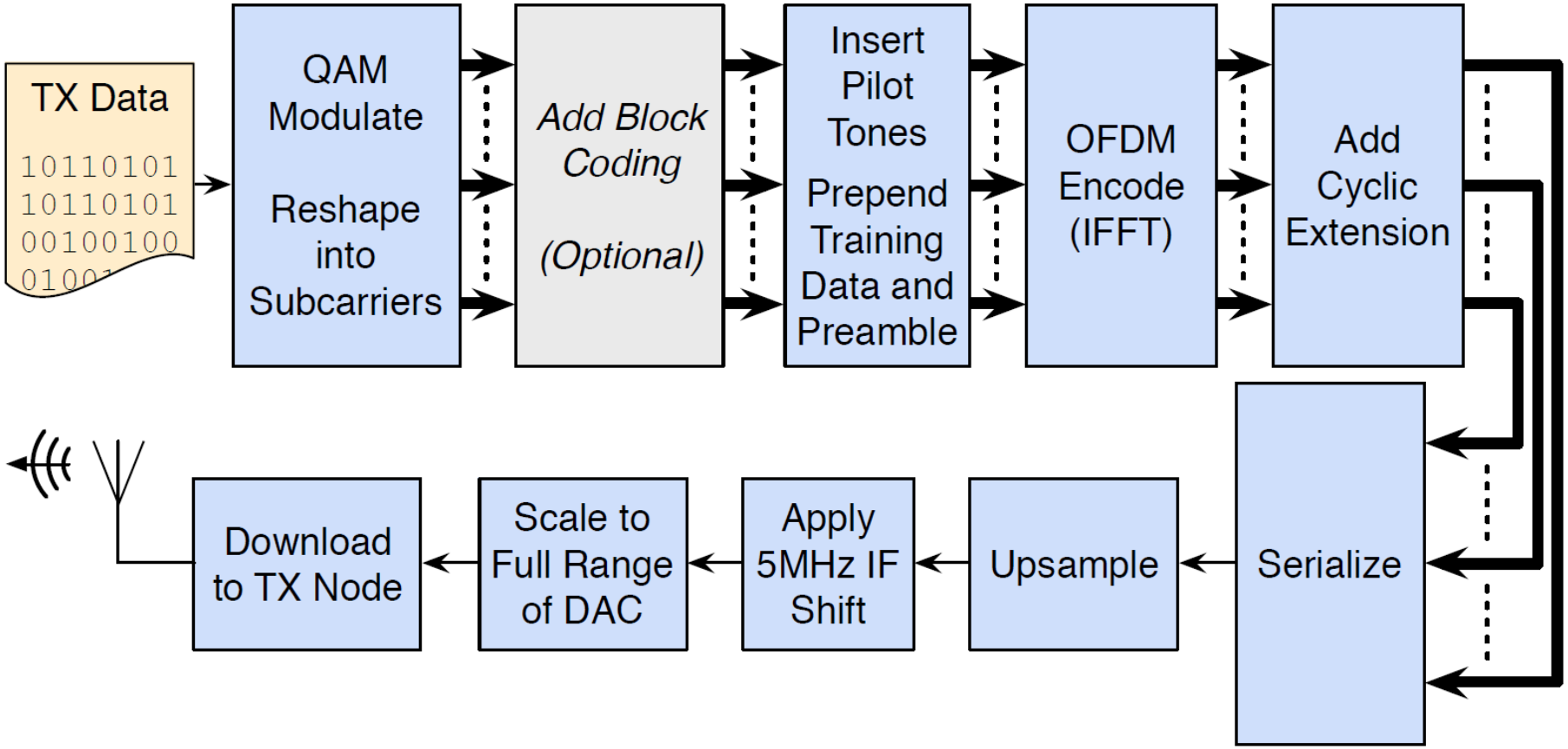


Spatial Multiplexing 2x2, Rate 2

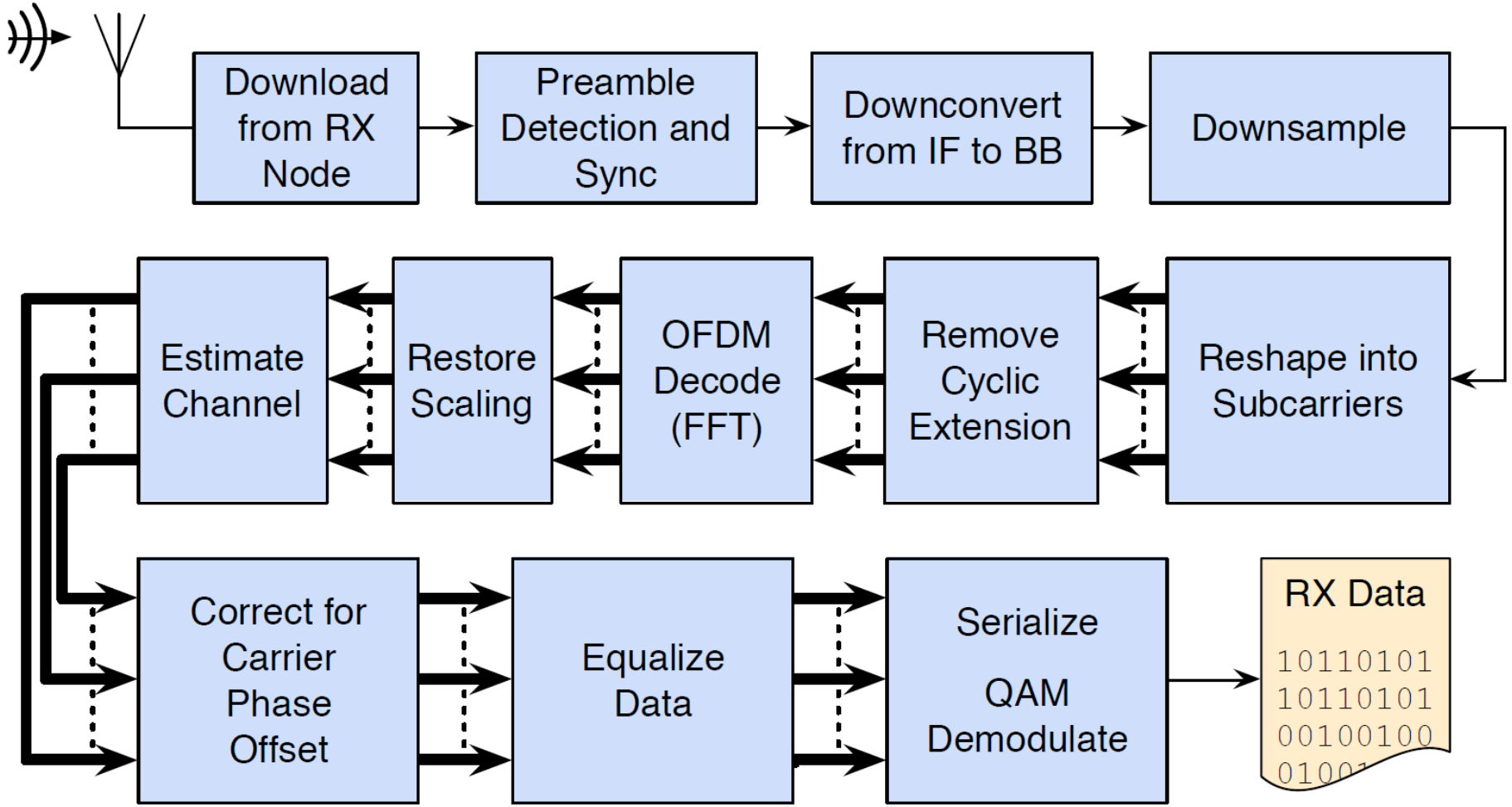


[2] Andreas Molisch. *Wireless Communications*. Wiley-IEEE Press, 2005.

Transmitter Subsystem



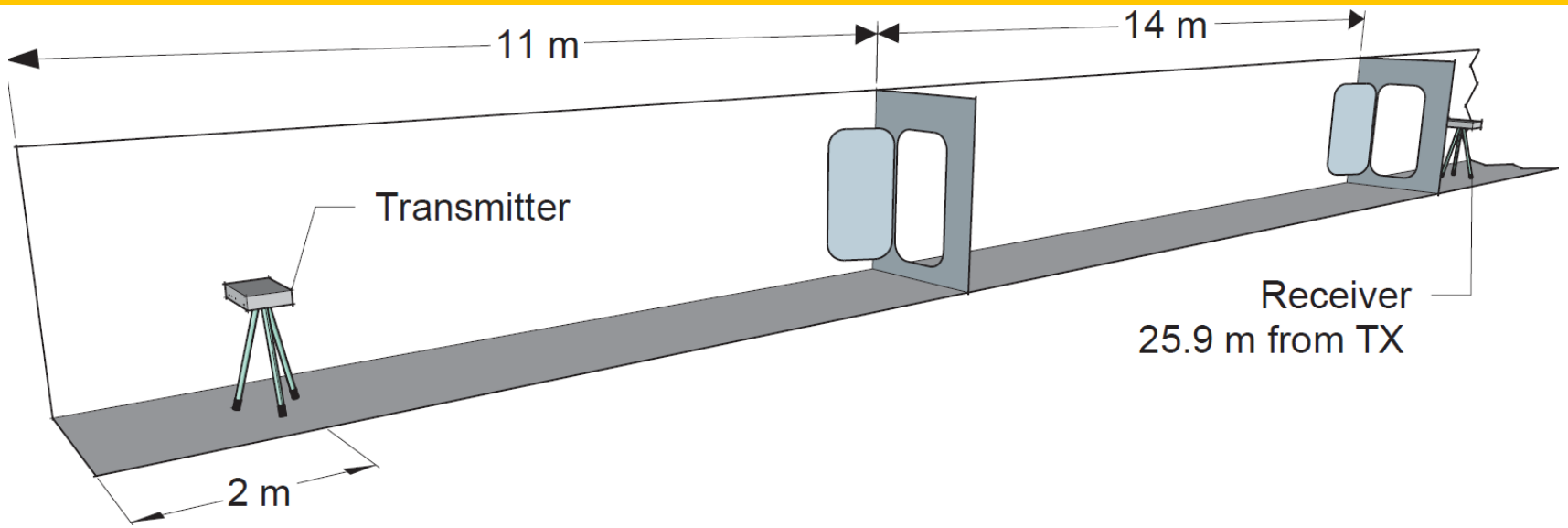
Receiver Subsystem



Performance Metrics

- **Error Vector Magnitude (EVM):** Euclidean distance between a transmitted and a received IQ symbol.
- **Post Processing Signal to Noise Ratio (PP-SNR):** Ratio of signal power to the root-mean squared EVM (dB).
- **Channel Capacity:** Upper bound on the rate of information that can be sent over a channel with an arbitrarily small level of error (bps/Hz).

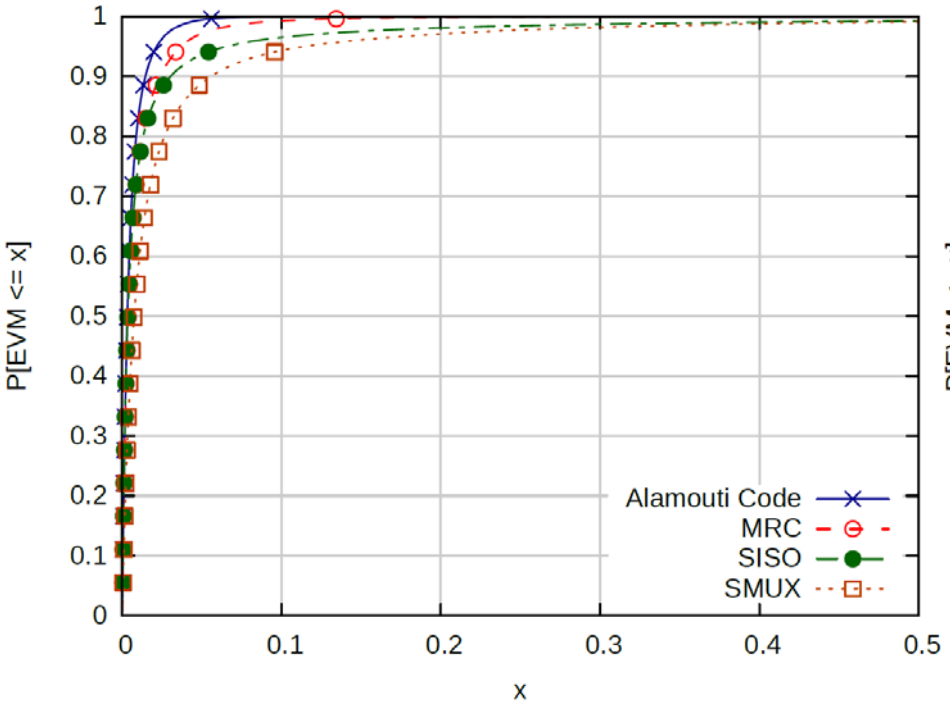
Measurement Validation Study



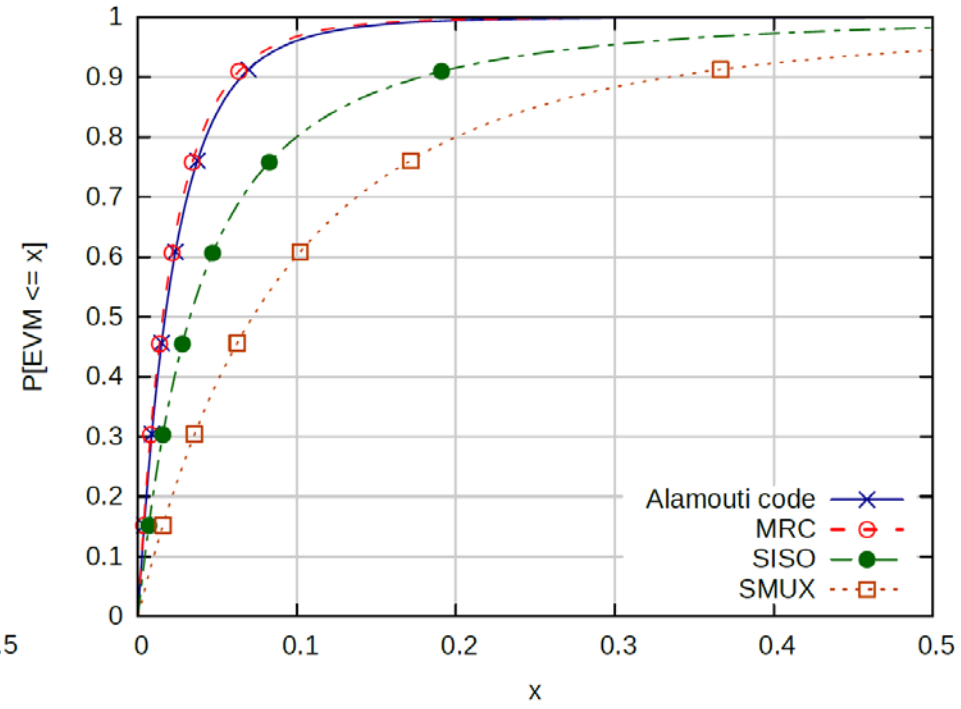
- **Location:** Corridor along the length of the vessel
- **Objective:** Characterize wireless communications in the below-deck environment and determine the feasibility of implementing a wireless network
- **Tests:**
  - Both doors open (500 trials)
  - Door 1 (11m) closed (500 trials)

Results: EVM

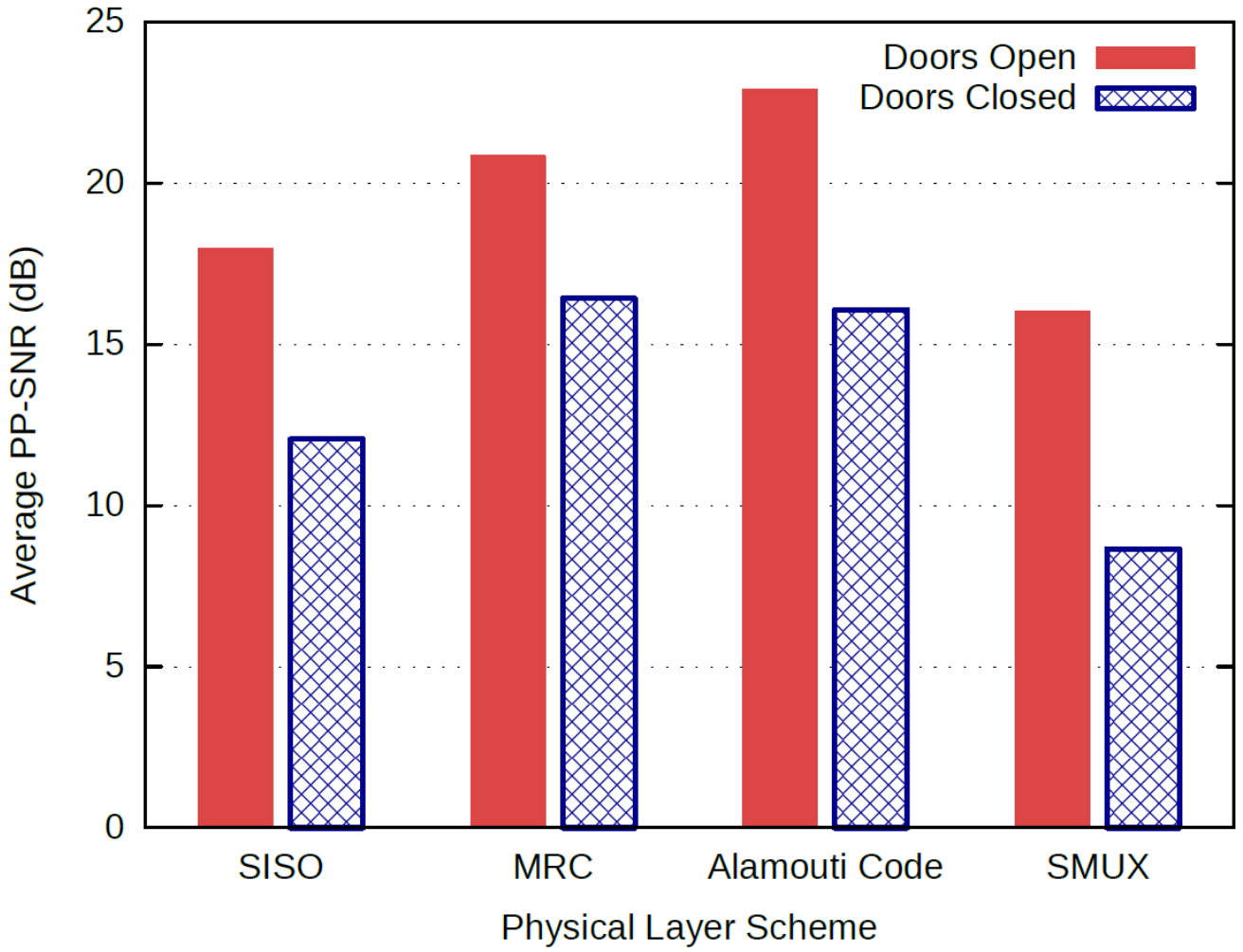
Both Doors Open



Door 1 Closed

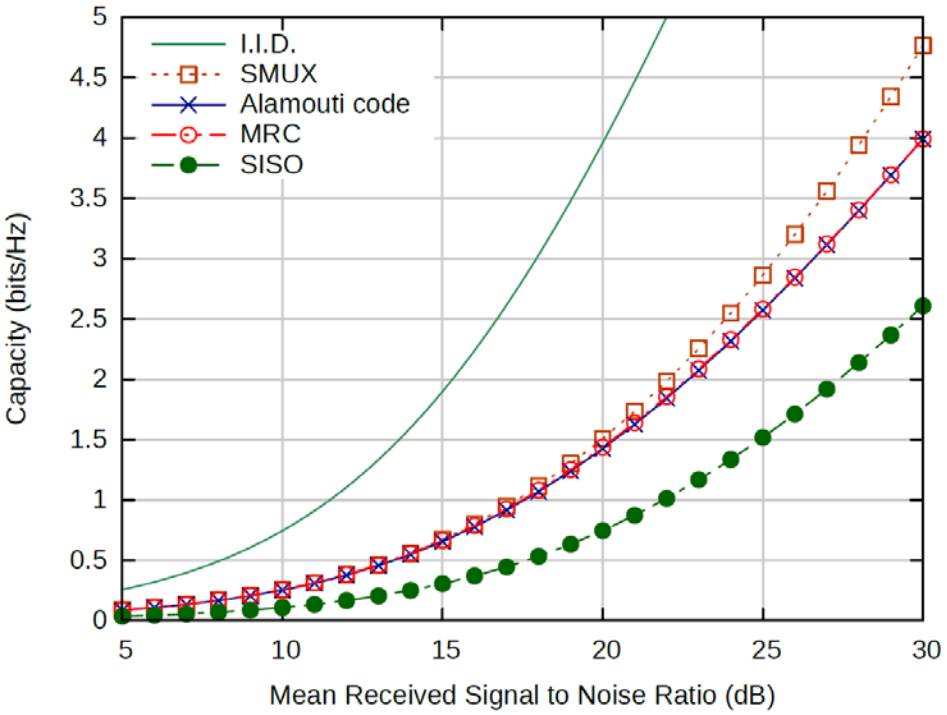


Results: PP-SNR

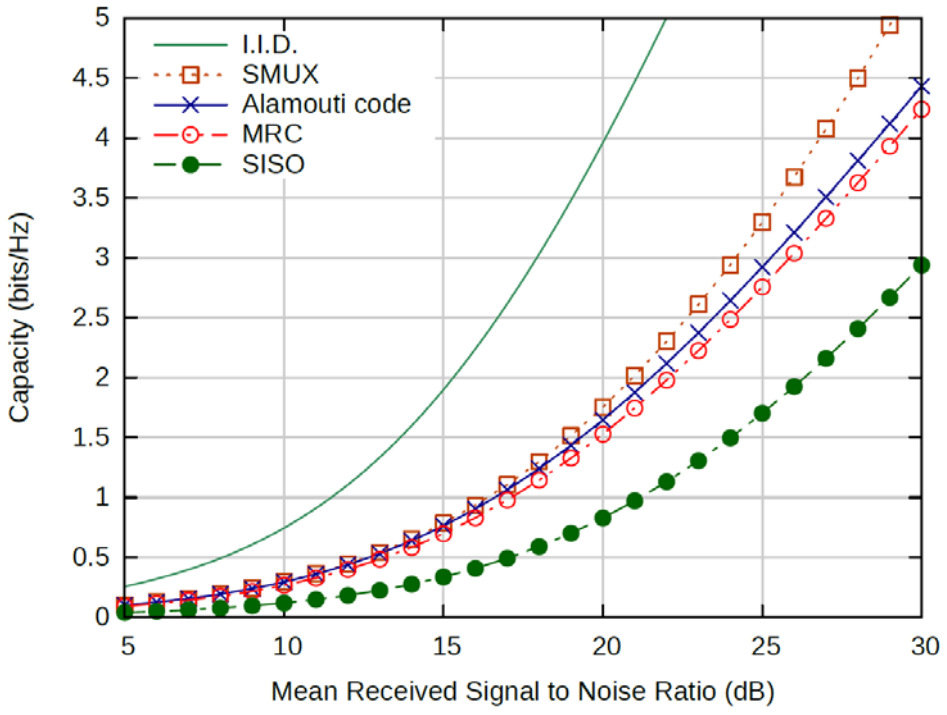


Results: Channel Capacity

Both Doors Open



Door 1 Closed



Conclusions

- A MATLAB-based SDR platform was presented as a cost-effective, lightweight solution for the field testing of wireless communications .
- The platform implements four MIMO-OFDM transmission schemes based on the IEEE 802.11g protocol and provides a variety of metrics for analyzing the performance.
- A measurement validation study aboard a decommissioned naval vessel was presented.
- The study demonstrated the platform's ability to characterize a challenging wireless environment.

Related References

[1] R. Measel, C. S. Lester, D. J. Bucci, K. Wanuga, R. Primerano, K. Dandekar, and M. Kam, "Reconfigurable Antennas in Highly Multipath Environments. In: IEEE International Symposium on Antennas and Propagation, Memphis, TN. Jun 2014. (In Press)

[2] C. S. Lester, R. Measel, D. J. Bucci, K. Wanuga, R. Primerano, M. Kam, and K. Dandekar, "Effects of reconfigurable antennas on wireless network performance within a Ticonderoga-class engine room," in Proc. ASNE Electric Machines Technology Symp., (Villanova, PA), May 2014. (In Press)

[3] K. Wanuga, R. Measel, C. S. Lester, D. J. Bucci, D. Gonzalez, R. Primerano, M. Kam, and K. R. Dandekar, "Performance evaluation of MIMO OFDM systems in on-ship below-deck enviornments," IEEE Antennas Wireless Propag. Lett., vol. 13, pp. 173–176, 2014.