

# Channel Detection and Synchronization in Ultra-Wideband Communication Systems

Student Researcher: Stephen Matz

Advisor: Dr. Moncef Tayahi

# Presentation Agenda

- Abstract
- Introduction and Background
- Project Objectives
- Methodology
- Results and Discussion
- References

# Abstract

- Analyze characteristics of optimal ultra-wideband (UWB) communication system
- Evaluate MATLAB Model to overcome technical challenges
  - Signal Detection, Estimation, Synchronization
  - Use Bit-Error-Ratio, timing offsets as metrics

# Introduction and Background

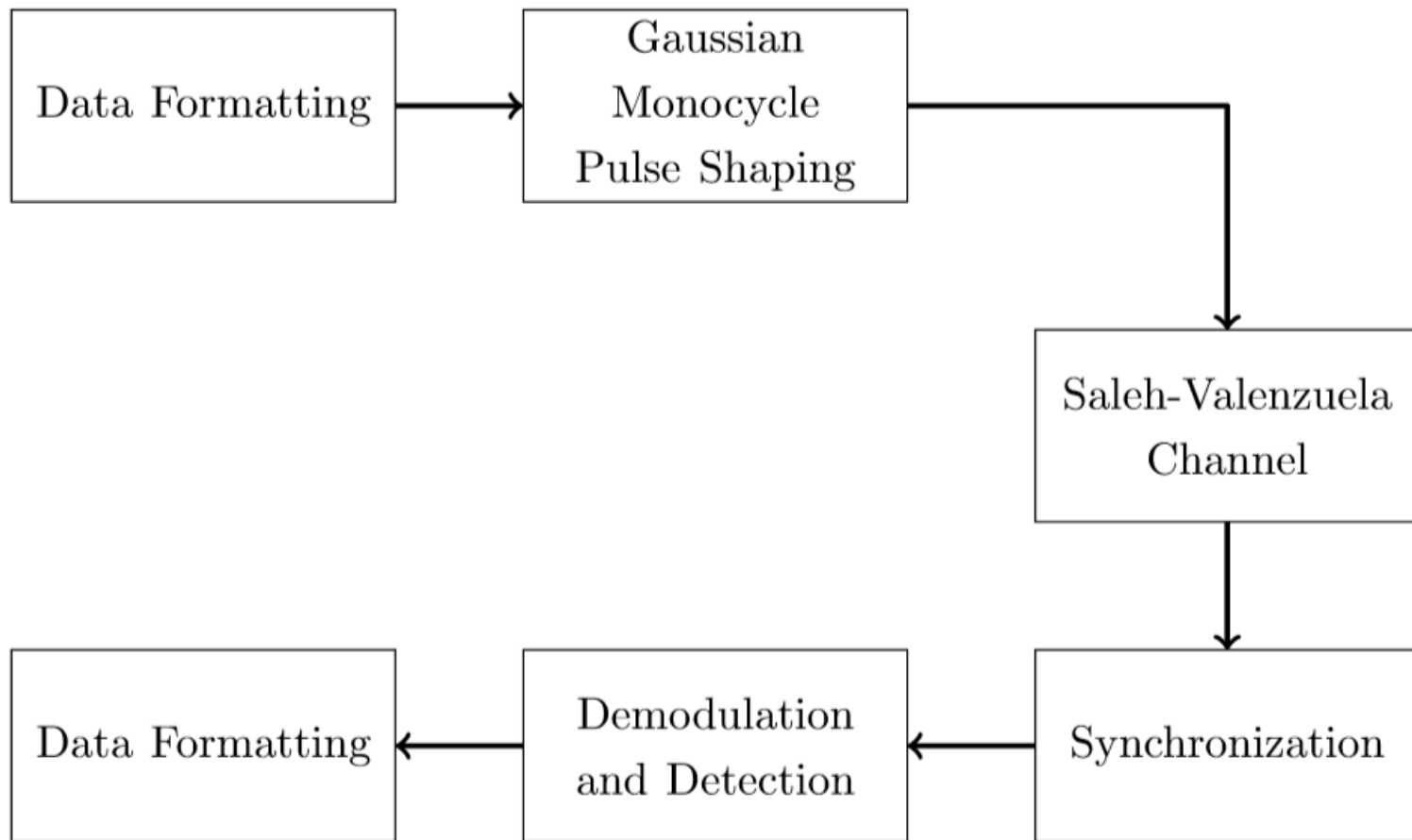
- Narrowband channel models do not hold in UWB environments
- Multi-path channel models required
  - Account for frequency dependency
  - Account for random amplitude attenuation, phase shift, and group delay

# Project Objectives

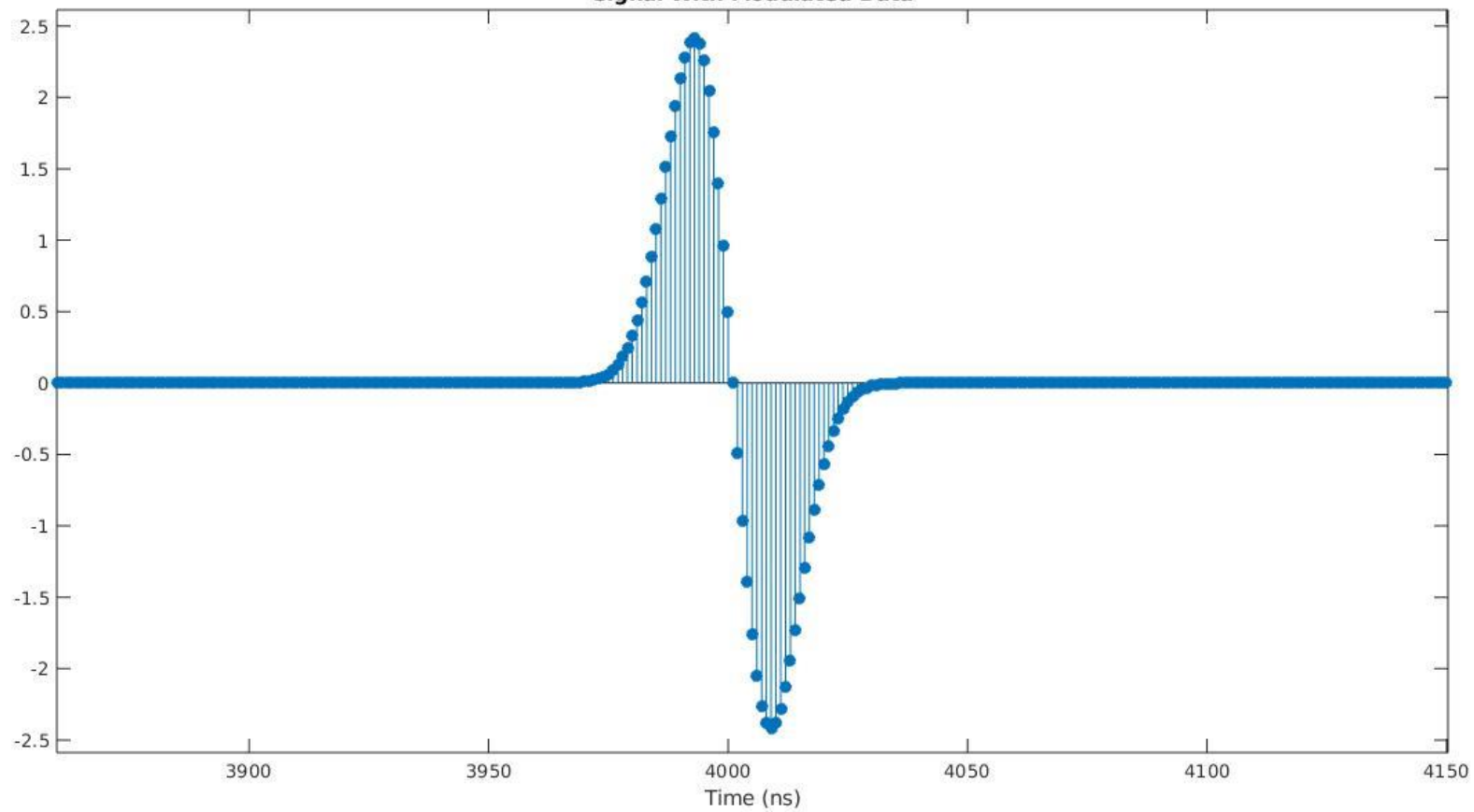
- The project objectives are:
  1. Develop UWB system model in MATLAB
  2. Simulate parameters for detection, estimation, and synchronization
  3. Improve system model based on results for better performance

# Project Methodology

- Direct modulation with Gaussian monocycle  
Pulse Shaping
- Saleh-Valenzuela channel model
- Modified matched-filter demodulator

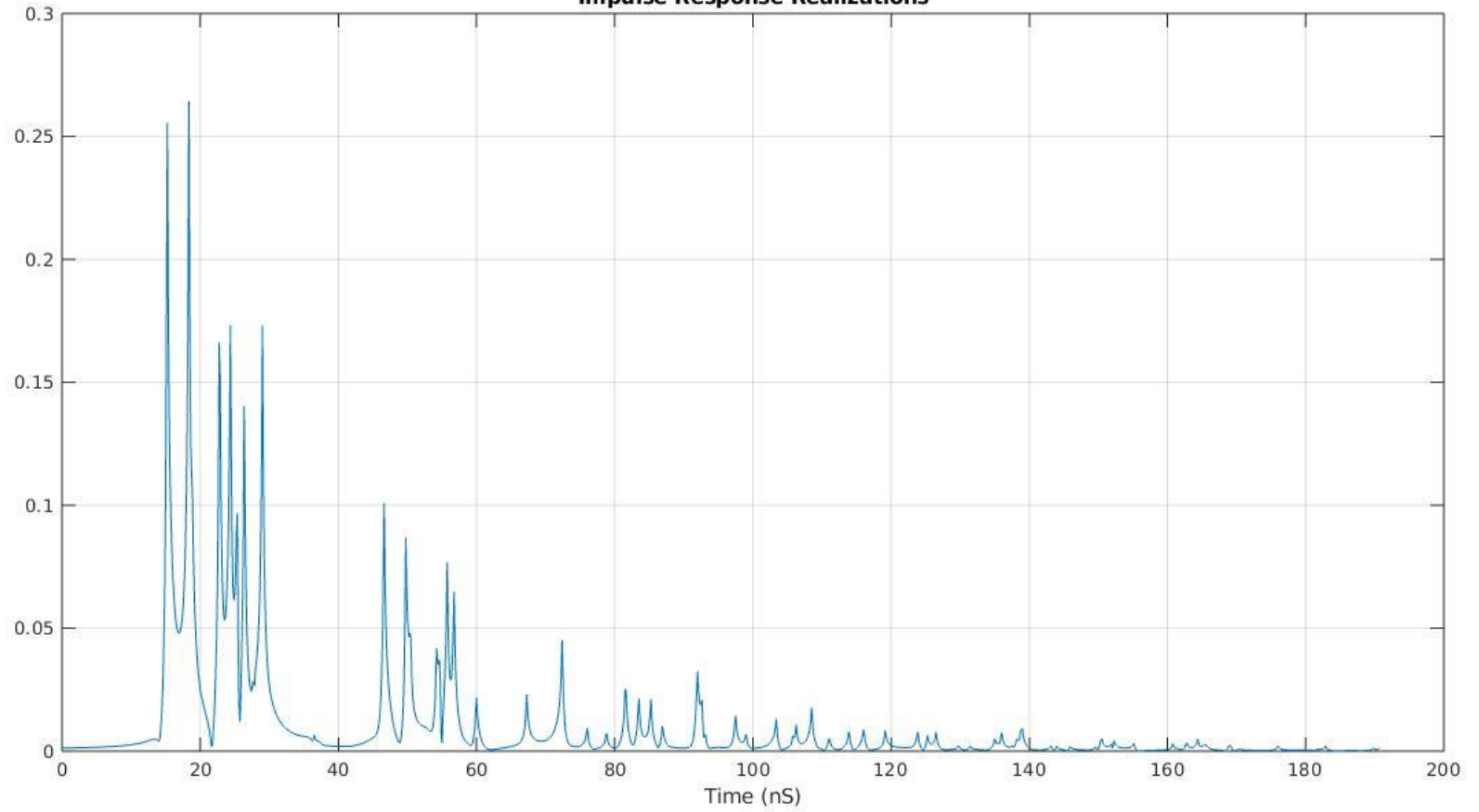


Signal With Modulated Data





### Impulse Response Realizations



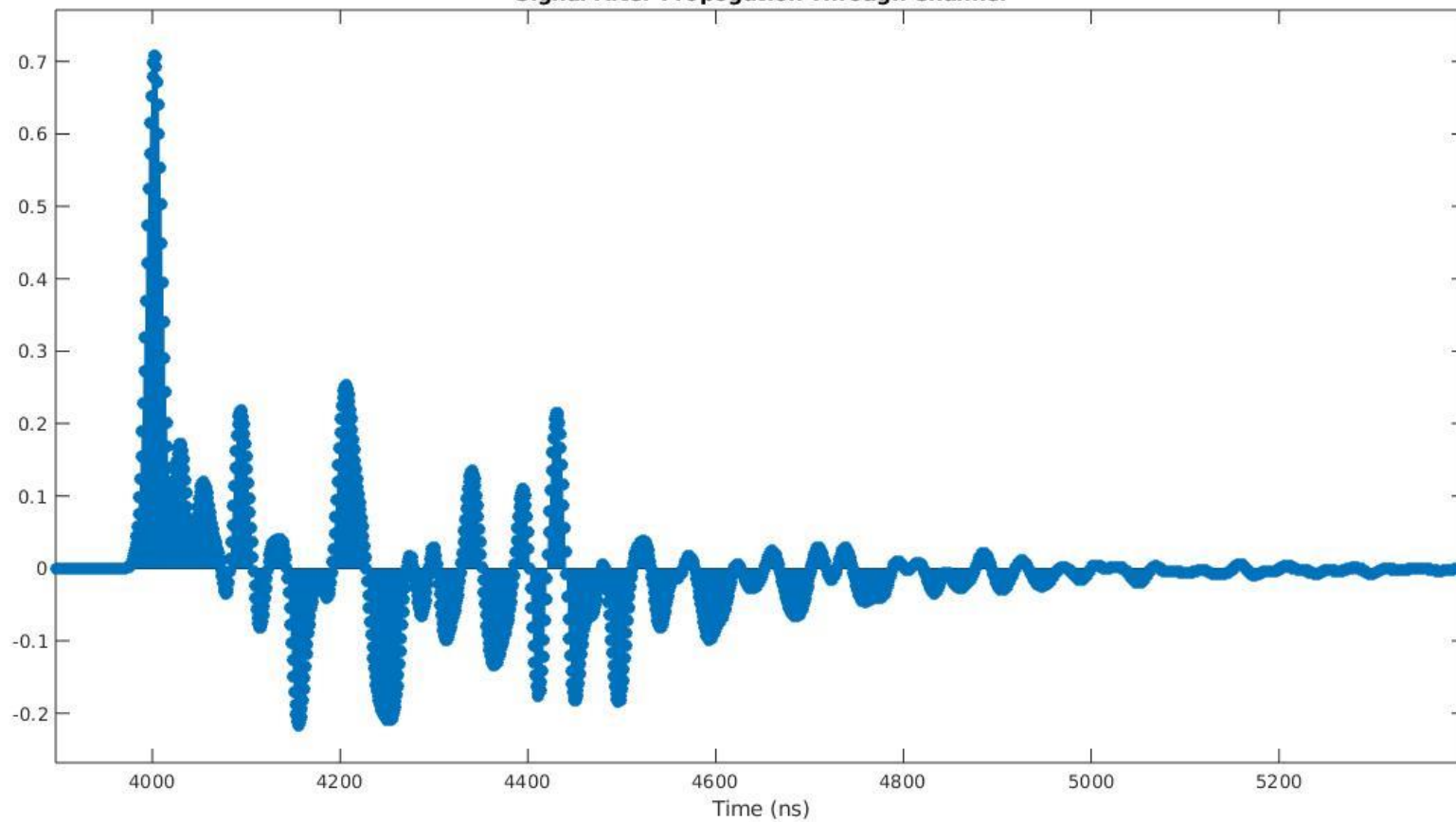
# Results and Discussion

- Gaussian monocycle is effective for UWB
- BER remained zero for 1, 100, and 500 multipath channel impulse responses
- BER remained zero using two different residential models

# Results and Discussion

- Originally designed matched filter inadequate
  - Required modified reference signal
  - Possibly implemented in future with training sequence
- Synchronization based on number of samples in symbol period
  - Possibly implemented in future based on calculated symbol spacing in a training sequence

Signal After Propagation Through Channel



# References

- [1] B. Sklar, *Digital Communications: Fundamentals and Applications*, 2<sup>nd</sup> ed. Prentice Hall PTR, 2001.
- [2] M.-G. D. Benedetto, T. Kaiser *et al.*, Eds., *UWB Communication Systems A Comprehensive Overview*. Hindawi Publishing Corporation, 2006.
- [3] A.F. Molisch, K. Balakrishnan *et al.*, “IEEE 802.15.4a Channel Model – Final Report,” IEEE 802.15 WPAN Low Rate Alternative PHY Task Group 4a (TG4a), Tech. Rep., Nov. 2004.
- [4] A. Meijerink and A.F. Molisch, “On the Physical Interpretation of the Saleh-Valenzuela Model and the Definition of Its Power Delay Profiles,” *IEEE Trans. On Antennas and Propagation*, vol. 62, Sep. 2014.