ELECTRICAL & COMPUTER ENGINEERING DEPARTMENT

UNIVERSITY OF UTAH

ABSTRACTS OF STUDENT PRESENTATIONS

March 26, 2009

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SESSION 1 **L-3 COMMUNICATIONS CLINIC (AOA)**
2:45-4:25 p.m. **Officer's Club South**

Brandt Hammer
Chinh Dam
Eliza Crandall
Yi Xu
Brian Matthews

SESSION 2 **L-3 COMMUNICATIONS CLINIC (TOOLS)**
12:45-2:25 p.m. **Officer's Club West**

Jacob Tateoka
Rohit Pathak
Beau Lund
Eric Seabury
Brian Rolfe

SESSION 3 **MICRON TECHNOLOGY, INC. CLINIC**
12:45-2:25 p.m. **Officer's Club North**

Raheem Alhamdani
Bryson Kent
Jordan Kemp
M. Lucas Loero
Ben Meakin

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2:45-4:25 p.m. **Officer's Club Sout**

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Beau Lund
Eric Seabury
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12:45-2:25 p.m. **Officer's Club Nort**

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Jordan Kemp
M. Lucas Loero
Ben Meakin

SESSION 4 **ROCKY MOUNTAIN POWER CLINIC**
12:25-2:05 p.m. **Officer's Club South**

Stephen Manrique
Calvin Yan
Lance Wayment
Jack Dam
Jason Wayment

SESSION 5 **SANDIA NATIONAL LABORATORIES CLINIC**
3:05-4:45 p.m. **Officer's Club North**

Rashin Bolkameh
Chris Chadwick
Michael B. Stevens
Daniel Rolfe
Eric Hsu

SESSION 6 **ON SEMICONDUCTOR CLINIC**
2:45-3:45 p.m. **Officer's Club West**

Mike Bombardier
Nikhil Handa
Jay Walston

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SESSION 7 — **RICHARD W. GROW PROJECT**
4:05-5:25 p.m. — **Officer's Club West**

Seaver W. Cauch
Paul Beard
Doug A. Tucker
Stephen Pendrey

SESSION 8 — **ELECTRICAL ENGINEERING PROJECTS**
12:25-4:45 p.m. — **Guest House Meeting Room B**

David Chick
Bryce Gardiner
Jacob Mattson
Michael J. Beck
Jason R. Saberin
Fernando Nelson
Brian M. Wynn
Quinn Tate
Bindu Dudipala
Beena Dudipala
Jason Weaver

SESSION 9 — **ELECTRICAL ENGINEERING PROJECTS**
3:05-5:45 p.m. — **Guest House Meeting Room A**

Chase Thompson
Jordan Nicholls
Chad Mann
Justin Ferguson
Arash Farhang

Daryl L. Wasden
William Peter Blackham

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4:05-5:25 p.m. — **Officer's Club Wes**

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SESSION 8 — **ELECTRICAL ENGINEERING PROJECT**
12:25-4:45 p.m. — **Guest House Meeting Room**

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3:05-5:45 p.m. — **Guest House Meeting Room**

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12:05-2:05 p.m. COMPUTER ENGINEERING PROJECTS
Guest House Meeting Room A

Glenn Barton
Stephen Sieb
Matthew M. Maddex
Gregg Durrant
Isaac D. Jensen
Shahene A. Pezeshki

SESSION 10 **ELECTRICAL ENGINEERING AND**
12:05-2:05 p.m. **COMPUTER ENGINEERING PROJECTS**
Guest House Meeting Room A

Glenn Barton
Stephen Sieb
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SESSION 1: L-3 Communications Clinic #1
AOA-Enabled Active Localization and Tracking in Buildings

Officer's Club South
Session Chairman: Brandt Hammer

2:45 **Brandt Hammer**
"Localization without GPS: Hardware Development"

3:05 **Chinh Dam**
"Introduction to Data Collection"

3:25 **Eliza Crandall**
"Data Analysis and Further Design Requirements"

3:45 **Yi Xu**
"Fourier Transform Algorithm and Angle Error Calculation"

4:05 **Brian Matthews**
"Localization Algorithm"

Industrial Liaison: Osama Haddadin

Faculty Advisor: Neal Patwari

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SESSION 1 2:45 p.m. Officer's Club South

LOCALIZATION WITHOUT GPS: HARDWARE DEVELOPMENT

Brandt Hammer, Chinh Dam, Eliza Crandall, Yi Xu, Brian Matthews (Neal Patwari), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

In order to improve upon a non-GPS localization system, angles from a known position are incorporated into a received signal strength-based node network that estimates position. Motes, the nodes of the network, calculate their angle from a known position. The round-robin turn based network then sends all of the received signal strength measurements from each network link back to the computer for position analysis.

The iterative design process to create the stated system contains three different stages: hardware design, data collection, and data analysis. The hardware design determines the bound of accuracy obtainable by any position algorithm. The final product consisted of a servo controlled rotating parabolic antenna which was chosen over a three element phased array.

SESSION 1 2:45 p.m. Officer's Club Soutl

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Brandt Hammer, Chinh Dam, Eliza Crandall, Yi Xu, Brian Matthew (Neal Patwari), Department of Electrical and Computer Engineerin University of Utah, Salt Lake City, UT 84112

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SESSION 1 3:05 p.m. Officer's Club South

INTRODUCTION TO DATA COLLECTION

Chinh Dam, Eliza Crandall, Yi Xu, Brian Matthews, Brandt Hammer (Neal Patwari), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

The importance of data collection and how can data be analyzed will be discussed. The purpose of collecting received signal strength (RSS) is to understand the characteristic of the directional antenna's radiation pattern. It is important since the antenna system can automate a mass of data collection to design an angle algorithm. The result from the algorithm using the collected data will let us know if the antenna is perfect or the antenna system needs to be redesigned for the better result.

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INTRODUCTION TO DATA COLLECTION

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SESSION 1 3:25 p.m. Officer's Club South

DATA ANALYSIS AND FURTHER DESIGN REQUIREMENTS

Eliza Crandall, Yi Xu, Brian Matthews, Brandt Hammer, Chinh Dam (Neal Patwari), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

This clinic project is advancing wireless sensor networks by improving localization estimation algorithms for in-building environments. Estimation of sensor location is important in applications in which a large number of sensors are deployed across a large area for monitoring applications. For a sensor network to function efficiently, the sensors must be able to accurately locate themselves relative to other sensors in the network. The goal of this clinic is to provide accurate localization and real-time tracking in 3-D using a phased array software radio. In order to develop an accurate angle of arrival (AOA) algorithm, test data is gathered to model the received signal strength (RSS) of a receiver at varying angles relative to a transmitter in an in-building environment.

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SESSION 1 3:45 p.m. Officer's Club South

FOURIER TRANSFORM ALGORITHM AND ANGLE ERROR CALCULATION

Yi Xu, Brian Matthews, Brandt Hammer, Chinh Dam, Eliza Crandall (Neal Patwari), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

There are varying tracking systems used right now. The most famous and commonly used one is the GPS (global positioning system), which localizes objects by using satellites. The GPS system is very precise but it cannot be used in special areas isolated from general satellite signals. In this case, an antenna array is the best solution. Right now, many tracking systems use received signal strength (RSS) to measure the distance and position of the objects. The shortcoming of RSS is it will not be precise when there is interference and big reflections. However, the angle of arrival (AOA) can avoid the reflections so that we can get an accurate localization.

We propose a tracking and localization system that can determine the location of the object by using the RSS and AOA between the object and the antenna. An algorithm which was based on Fourier series was created and is used to analyze the RSS during measurement. The plot of RSS values should match the plot of the first harmonic of the Discrete Fourier series. AOA is calculated based on the Fourier Transform, and the angle error between calculated and actual AOA will be calculated and shown.

SESSION 1 3:45 p.m. Officer's Club Sout

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SESSION 1 **4:05 p.m.** **Officer's Club South**

LOCALIZATION ALGORITHM

Brian Matthews, Brandt Hammer, Chinh Dam, Eliza Crandall, Yi Xu (Neal Patwari), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

Algorithms were developed that were heavily based on hill climbing, a minimization procedure. The localization part of the system took the received signal strength (RSS) to and from every mote, and the angle from every mote to the directed antenna, to extrapolate a position for motes with unknown positions. The presentation will be concluded with a summary of concepts and a team demo of the entire system in real time to locate motes.

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SESSION 2: L-3 Communications Clinic #2
Dielectric Measurement Tools

Officer's Club West
Session Chairman: Beau Lund

12:45 **Jacob Tateoka**
"Introduction, and Theory of the Split Post Cavity"

1:05 **Rohit Pathak**
"Split Post Measurements and Results"

1:25 **Beau Lund**
"Resonant Cavity Redesign and Theory"

1:45 **Eric Seabury**
"Resonant Cavity Testing Procedure and Measurement Results"

2:05 **Brian Rolfe**
"Resonant Cavity Design and Analysis Software"

Industrial Liaison: Trevis Anderson

Faculty Advisor: J. Mark Baird

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SESSION 2 **12:45 p.m.** **Officer's Club West**

INTRODUCTION, AND THEORY OF THE SPLIT POST CAVITY

Jacob Tateoka, Rohit Pathak, Beau Lund, Eric Seabury, Brian Rolfe (J. Mark Baird), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

Cavities and resonators offer high accuracy measurements for dielectric materials because the resonant frequency changes when the dielectric material is introduced into the cavity. A commercial cavity called a "Split Post Resonator" has been established as a reliable method for measuring thin sheets of material. Two such cavities operating at 10 GHz and 13.5 GHz were used to measure materials with a range of relative permittivities from 2.1 to 9.5, and these data are compared to those taken with cavities operating in the circular TE (0,1,3) mode. In this presentation, the Split Post Resonator theory will be reviewed and covered.

SESSION 2 **12:45 p.m.** **Officer's Club Wes**

INTRODUCTION, AND THEORY OF THE SPLIT POS
CAVITY

Jacob Tateoka, Rohit Pathak, Beau Lund, Eric Seabury, Brian Rolf (J. Mark Baird), Department of Electrical and Computer Engineerin University of Utah, Salt Lake City, UT 84112

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SESSION 2 1:05 p.m. Officer's Club West

SPLIT POST MEASUREMENTS AND RESULTS

Rohit Pathak, Beau Lund, Eric Seabury, Brian Rolfe, Jacob Tateoka (J. Mark Baird), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

The purpose of our portion of this clinic is to measure the permittivity of different dielectric samples using Split Post cavities. Split-post are primarily chosen for this project because they are faster, accurate, and have the ability to measure low loss materials. We will measure several dielectric samples repeatedly to obtain consistent and reliable measurements. These measurements are compared with the dielectric constants measured by the TE mode cavities. The main purpose behind the comparison is to verify the accuracy of the dielectric constants and provide easy accessibility of accurate dielectric constants for the engineers at L-3 Communications.

SESSION 2 1:05 p.m. Officer's Club Wes

SPLIT POST MEASUREMENTS AND RESULTS

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SESSION 2 **1:25 p.m.** **Officer's Club West**

RESONANT CAVITY REDESIGN AND THEORY

Beau Lund, Eric Seabury, Brian Rolfe, Jacob Tateoka, Rohit Pathak (J. Mark Baird), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

The dielectric constant is essential in predicting and designing circuit boards and radomes that are used in RF applications. With values that are different than expected they will not perform as predicted. The TE_{01} mode was used because it has low loss and is high Q, which helps make measurements more accurate. The original clinic designed the cavity around Maxwell's Equations and explanations of circular cavities in *Microwave Equations* (David Pozar) and *Advanced Engineering Electromagnetics* (Constantine Balanis). We made slight design modifications that allow better control of the TE_{01} mode coupling that were discussed in an article in *IEEE Transactions on Microwave Theory and Techniques*. The RF signal was coupled into the cavity and the transmission coefficient S21 data was measured. The dielectric constant was calculated by comparing the S21 data from the cavity when it was empty to the S21 data when the cavity was loaded.

SESSION 2 **1:25 p.m.** **Officer's Club Wes**

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SESSION 2 **1:45 p.m.** **Officer's Club West**

RESONANT CAVITY TESTING PROCEDURE AND MEASUREMENT RESULTS

Eric Seabury, Brian Rolfe, Jacob Tateoka, Rohit Pathak, Beau Lund (J. Mark Baird), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

Since the redesign of the TE_{01} resonant cavities, two methods of measuring the dielectric constant were available. The first is a method that was used by previous clinics and was recreated by our clinic to verify that the redesign operated as effectively as the original cavity. It is done by fixing the length of the cavities and locating the TE_{01} mode at a desired frequency. Then a sample is inserted, relocating the TE_{01} mode by shifting the frequency. The second method is done by fixing the frequency and adjusting the length of the cavities and locating the TE_{01} mode. A MATLAB™ simulation was used to predict the behavior of the cavities and to aid in isolating the TE_{01} mode. Samples of common dielectrics used for RF circuit board fabrication were acquired and tested in the resonant cavities. The values obtained from this analysis were then compared against the known dielectric values and the obtained values from the Split-Post Cavities to verify the validity of the resonant cavities.

SESSION 2 **1:45 p.m.** **Officer's Club Wes**

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SESSION 2 2:05 p.m. Officer's Club West

RESONANT CAVITY DESIGN AND ANALYSIS SOFTWARE

Brian Rolfe, Jacob Tateoka, Rohit Pathak, Beau Lund, Eric Seabury (J. Mark Baird), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

In order to assist in the design and perform the data analysis of the TE_{01} resonant cavities, three MATLAB™ simulation codes were written or modified from previous clinics. The first of the codes models the cavity without loss to assist in the design of the cavity and ensure that there are three wavelengths of the specified frequency present in the cavity, thus allowing the desired $TE0_{13}$ analysis to be performed. The second simulation code that was written was a modification of the previous clinics' analysis software. The purpose of the code is to model the cavity with loss and optimize the data input of an empty and a loaded cavity with respect to several parameters and produce a value for the _r and tan_ material parameters. It was modified to remove many clerical errors of embedded measurements in subroutines that were not consistent with a similar measurement in another, and also to have a single script file that will call all of the necessary components to perform the optimizations. The third simulation code creates a map of the TE and TM modes and how they respond to different _r values with respect to frequency or micrometer settings to assist the end user in ensuring the proper data are being captured.

SESSION 2 2:05 p.m. Officer's Club Wes

RESONANT CAVITY DESIGN AND ANALYSIS SOFTWARE

Brian Rolfe, Jacob Tateoka, Rohit Pathak, Beau Lund, Eri Seabury (J. Mark Baird), Department of Electrical and Compute Engineering, University of Utah, Salt Lake City, UT 84112

In order to assist in the design and perform the data analysis c the TE_{01} resonant cavities, three MATLAB™ simulation codes wer written or modified from previous clinics. The first of the code models the cavity without loss to assist in the design of the cavit and ensure that there are three wavelengths of the specified frequenc present in the cavity, thus allowing the desired $TE0_{13}$ analysis to b performed. The second simulation code that was written was modification of the previous clinics' analysis software. The purpos of the code is to model the cavity with loss and optimize the dat input of an empty and a loaded cavity with respect to severa parameters and produce a value for the _r and tan_ materia parameters. It was modified to remove many clerical errors o embedded measurements in subroutines that were not consistent wit a similar measurement in another, and also to have a single script fil that will call all of the necessary components to perform th optimizations. The third simulation code creates a map of the TE an TM modes and how they respond to different _r values with respec to frequency or micrometer settings to assist the end user in ensurin the proper data are being captured.

SESSION 3: **Micron Technology, Inc. Clinic**
Analysis and Optimization of Multi Gb/s Chip-to-Chip Communication

Officer's Club North
Session Chairman: Ben Meakin

12:45 **Raheem Alhamdani**
"Introduction and Motivation for Modeling and Verification of Interconnects"

1:05 **Bryson Kent**
"Worst Case Verification of High Speed Interconnects"

1:25 **Jordan Kemp**
"Statistical Analysis of Electrical Signaling"

1:45 **M. Lucas Loero**
"Modeling Jitter in Chip-to-Chip Communication"

2:05 **Ben Meakin**
"Project Software Engineering, Development, and Results"

Industrial Liaison: Tim Hollis

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SESSION 3 **12:45 p.m.** **Officer's Club North**

INTRODUCTION AND MOTIVATION FOR MODELING AND VERIFICATION OF INTERCONNECTS

Raheem Alhamdani, Bryson Kent, Jordan Kemp, M. Lucas Loero, Ben Meakin (Ken Stevens), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

As the semiconductor technology continues the aggressively scaling of transistors, and as on-chip processing speeds go into the multigiga hertz range, off-chip (I/O) bandwidth, however, has not scaled as aggressively, which in turn limits the performance of high-speed chip-to-chip based communication by the limit of the I/O bandwidth. Increasing data rates through transmission lines introduces signal degradation and limits the maximum achievable data-rates. Some of the issues encountered are jitter, signal noise, and reference voltage noise. We propose a cost-effective and accurate statistical analysis of a high-speed chip-to-chip communication link tool. This tool, implemented in graphical user interface, will read data from an outside source and output the resulting performance diagram, pass/fail, and bit error rate on a user-defined simulation data.

This presentation will cover the introduction of the project, the importance and the reason behind the motivation, and who the stake holders are. Roles and responsibilities as a member of this group will be outlined in the presentation and include documentation, graphical user interface design (GUI), and tool development.

SESSION 3 **12:45 p.m.** **Officer's Club Nortl**

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SESSION 3 **1:05 p.m.** **Officer's Club North**

WORST CASE VERIFICATION OF HIGH SPEED INTERCONNECTS

Bryson Kent, Jordan Kemp, M. Lucas Loero, Ben Meakin, Raheem Alhamdani (Ken Stevens), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

In modern high performance computing systems it is necessary to validate the link to off-chip memory. Current methods of validating a link require the simulation of a trillion bits to find the bit error rate per trillion. This presentation deals with the computation of link performance to validate error-free transmission. Using a pulsed based analysis it is possible to calculate and add the negative effects of inter symbol interference (isi), co-channel interference, and timing jitter. The project makes use of an intuitive graphical user interface design (GUI) that is able to output an eye diagram of the link performance and a pass/fail notification. This allows the user to validate link performance without extensive simulation.

SESSION 3 **1:05 p.m.** **Officer's Club Nortl**

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SESSION 3 1:25 p.m. Officer's Club North

STATISTICAL ANALYSIS OF ELECTRICAL SIGNALING

Jordan Kemp, M. Lucas Loero, Ben Meakin, Raheem Alhamdani, Bryson Kent (Ken Stevens), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

As the speed and capacity of chip-to-chip communication increase, the integrity of the signals being communicated decreases. This project presents an implementation of a graphical user interface (GUI) that shows worst-case and statistical analysis eye-diagrams of peak distortion and jitter in chip-to-chip signals. The worst-case eye-diagram shows the user a pass/fail mask for the bit-error rate, while the statistical analysis eye-diagram allows the user to determine whether or not the bit-error rate is within a user-defined specification. The statistical analysis eye-diagram is formed from the probability density function of a pulse convolved with the impulse response of the channel. This analysis allows the user to view the probabilistic eye-diagram from one single set of data without running millions of time-consuming and hardware-intensive simulations.

SESSION 3 1:25 p.m. Officer's Club Nortl

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SESSION 3 1:45 p.m. Officer's Club North

MODELING JITTER IN CHIP-TO-CHIP COMMUNICATION

M. Lucas Loero, Ben Meakin, Raheem Alhamdani, Bryson Kent, Jordan Kemp (Ken Stevens), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

High-frequency chip-to-chip communication introduces signal degradation and limits the maximum achievable data-rates. Some of the issues encountered are jitter, signal noise, and reference voltage noise. The problem is introduced from timing uncertainty in clocking, causing clock jitter, which makes sampling correct bit values more difficult. There are several methods used for modeling clock jitter. A method was used to analyze the signal degradation caused by transmitter jitter and receiver jitter autonomously from each other. This model allows the analysis of the clock jitter in an acceptable simulation time.

SESSION 3 1:45 p.m. Officer's Club Nortl

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Jordan Kemp (Ken Stevens), Department of Electrical and Compute
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SESSION 3 **2:05 p.m.** **Officer's Club North**

PROJECT SOFTWARE ENGINEERING, DEVELOPMENT, AND RESULTS

Ben Meakin, Raheem Alhamdani, Bryson Kent, Jordan Kemp, M. Lucas Loero (Ken Stevens), Department of Electrical and Computer Engineering, University of Utah, Salt Lake City, UT 84112

Developing medium- to large-scale software applications is a complicated task that requires extensive organization, collaboration, and problem solving. This work presents the development of a formal verification tool for high-speed electrical signaling called Open Eye. Using statistical and worst-case analysis methods as the core functional units, Open Eye adds the software infrastructure to provide a useful design verification platform. Object-oriented programming techniques are used to develop a platform for supporting statistical and worst-case analysis methods, as well as accurate modeling of timing jitter and co-channel interference. The functionality provided by this platform includes a graphical user interface (GUI), plotting of simulation data, file I/O, multi-threading, and a plethora of mathematical utility functions. It will be shown that this functionality was implemented with modularity and efficiency in mind. Results of an example simulation are provided and explained.

SESSION 3 **2:05 p.m.** **Officer's Club Nortl**

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