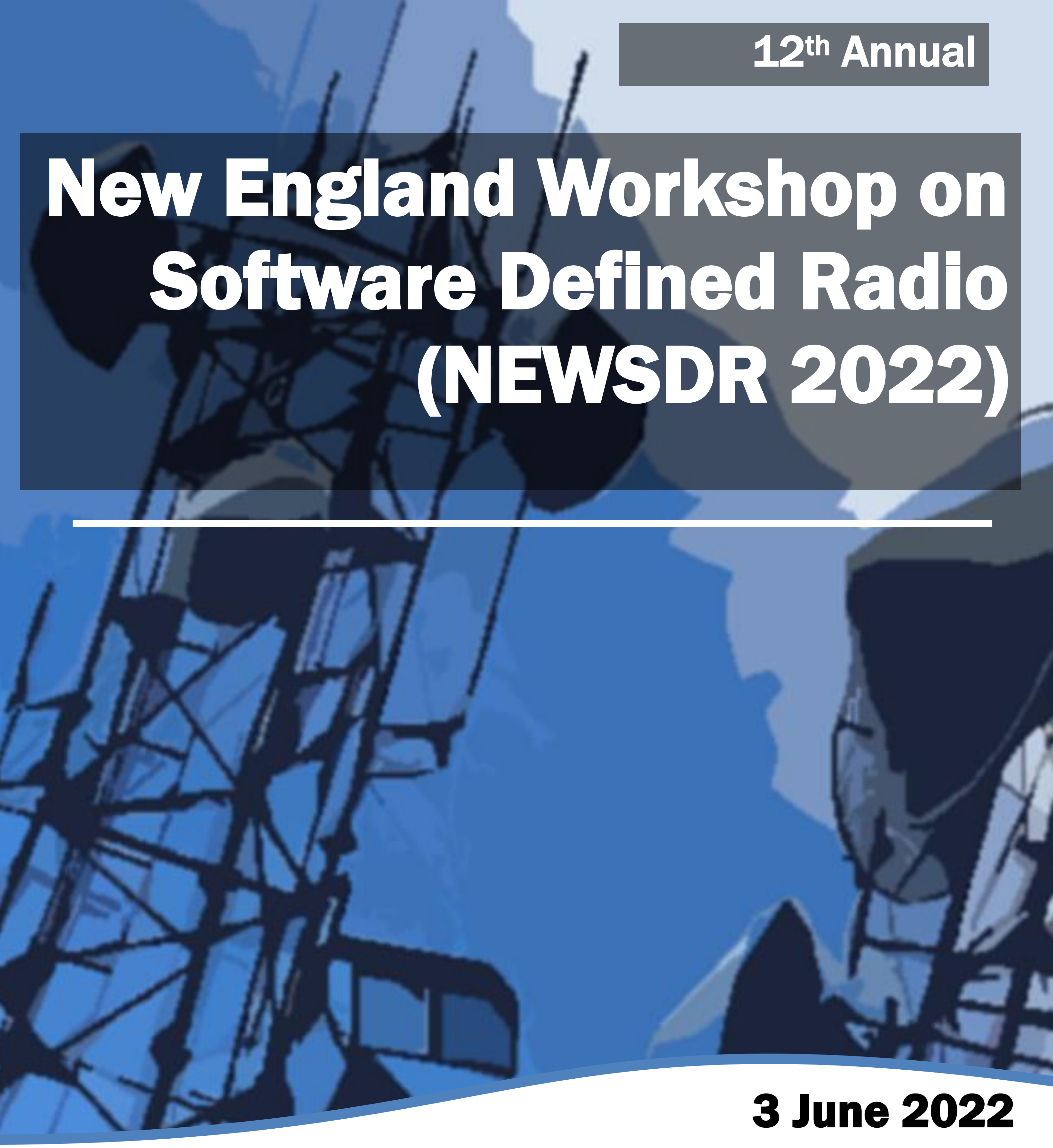


12th Annual

New England Workshop on Software Defined Radio (NEWSDR 2022)

3 June 2022

Virtual Event

Sponsored By:

MathWorks · NI · Ettus Research (A National Instruments Company) · MediaTek · Analog Devices · Lynk · SDR-Boston (Boston SDR User Group)

#NEWSDR

Greetings!

ORGANIZING COMMITTEE

Neel Pandeya
Ettus Research

Michael Rahaim
UMass Boston

John Swoboda
MIT Haystack Observatory

Alex Wyglinski
Worcester Polytechnic Institute

We are very excited to welcome all of you to the *12th New England Workshop on Software Defined Radio* (NEWSDR 2022), an annual event organized by the Boston SDR User Group (SDR-Boston). Due to the global health crisis of the COVID-19 pandemic, this year's NEWSDR event is being conducted entirely online to ensure everyone's safety while the community comes together to share the latest developments in SDR and Cognitive Radio research conducted by individuals from academia, industry, and government in the New England area, as well as from across the Nation.

The NEWSDR 2022 experience will include the following activities, features, and resources:

- Opening talk by Dr. Joseph Evans (STR)
- Four rising stars presentations
- Technical presentations by our NEWSDR 2022 sponsors
- Poster presentations from members of the SDR-Boston community
- Presentations of upcoming SDR events
- Four fully interactive technical breakout sessions
- Numerous networking sessions
- Full attendee interaction via Gather virtual conference environment
- Real-time live streaming of presentations via YouTube Live

We would like to sincerely thank the generous support of the NEWSDR 2022 sponsors: MathWorks, NI/Ettus Research, Analog Devices, MediaTek, and Lynk.

Throughout this event, we would like to encourage all of you to engage in conversation with your fellow attendees, exchange ideas, and talk about your latest findings with respect to SDR. We hope that you will find NEWSDR 2022 a productive event to expand your knowledge and horizons regarding SDR technology, and we would like to wish you a very positive and rewarding workshop!

Agenda – Friday 3 June 2022

9:00 AM – 9:30 AM	Welcome Address and Event Overview
9:30 AM – 9:50 AM	Opening Talk: Dr. Joseph Evans, STR
9:50 AM – 11:30 AM	Sponsor Talks: NI/Ettus, MathWorks, Analog Devices, Lynk, MediaTek
11:30 AM – 12:15 PM	Poster Preview Session
12:15 PM – 1:30 PM	Networking Session Sponsor/Exhibitor Tables Poster Presentations
1:30 PM – 1:45 PM	Upcoming SDR Events: GNURadio Conference, AFRL Beyond 5G SDR Challenge
1:45 PM – 3:00 PM	Rising Stars Presentations: Dr. Mariya Zheleva (University of Albany), Dr. Ryan Volz (MIT Haystack Observatory), Dr. Nathaniel Frissell (The University of Scranton), Dr. Bashima Islam (Worcester Polytechnic Institute)
3:00 PM – 3:15 PM	Networking Break
3:15 PM – 4:15 PM	Breakouts Session I: Using SDR in Education, SDR Roundtable Discussions
4:15 PM – 4:30 PM	Networking Break
4:30 PM – 5:30 PM	Breakouts Session II: Future Opportunities in SDR Innovation, “Spectrum Painting” Competition
5:30 PM – 5:45 PM	Closing Comments, Adjournment

Opening Talk: Dr. Joseph Evans

Joseph B. Evans is Vice President of STR and was the former Principal Director for 5G in the Office of the Director of Defense Research and Engineering (Modernization) within the office of the Under Secretary of Defense for Research and Engineering. While serving as the Principal Director for 5G, Dr. Evans was responsible for coordinating 5G efforts across the Department of Defense, oversaw and directed the Department's "5G to Next G" research and development portfolio, and advised the Under Secretary of Defense for Research and Engineering on 5G-related topics. Dr. Evans served as a Program Manager in the DARPA Strategic Technology Office from 2015 to 2019. While there, he started the SHARE (Secure Handhelds on Assured Resilient networks at the tactical Edge) and GCA (Geospatial Cloud Analytics) programs, and managed the Mobile Hotspots, RadioMap, SSPARC (Shared Spectrum Access for Radar and Communications), CommEx (Communications Under Extreme RF Spectrum Conditions), WND (Wireless Network Defense), and DyNAMO (Dynamic Network Adaptation for Mission Optimization) programs. From 1989 to 2019, Dr. Evans was a professor at the University of Kansas (KU) in Lawrence, Kansas, where his ultimate position was the Deane E. Ackers Distinguished Professor of Electrical Engineering & Computer Science. At KU, he also served in various administrative posts and led funded research programs in the areas of adaptive networking and communications systems, high speed network testbeds, rapidly deployable broadband wireless systems, and spectrum sharing technologies. Dr. Evans served as a Program Director in the Division of Computer and Network Systems, Directorate of Computer & Information Science & Engineering (CISE) at the National Science Foundation (NSF) from 2003 to 2005. At NSF, he was responsible for multi-organizational networking research efforts in wireless networking, cybersecurity, optical networking, and scientific applications. Dr. Evans was a co-founder and member of the Board of Directors of NetGames USA, Inc., a network gaming company acquired by Microsoft in 2000. Dr. Evans was a partner and Chief Scientist at Ascend Intelligence, LLC, which developed the Tactical Ground Reporting System (TIGR) for DARPA and the US Army, with large deployments in the Iraq and Afghanistan theatres of operation. Ascend Intelligence was acquired by General Dynamics in 2010. Among other service activities, Dr. Evans served as a Council member for the Computing Community Consortium Council from 2012 to 2015, and as a Member-at-Large on the IEEE Communications Society Board of Governors from 2009 to 2011. Dr. Evans received the B.S.E.E. degree from Lafayette College in 1983, and the M.S.E., M.A., and Ph.D. degrees from Princeton University in 1984, 1986, and 1989, respectively. He is an IEEE Fellow.

Rising Stars Presentations

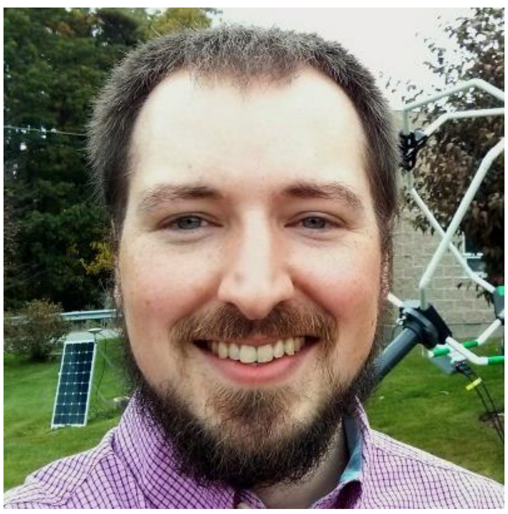
Automating the measurement and management of the radio spectrum for future spectrum-sharing applications

The radio spectrum is a precious, finite and instantly renewable natural resource upon which we all depend in more ways than we realize. While our personal and professional lives thrive on mobile broadband communications, a plethora of other applications, such as weather forecasting, climate science, astronomy, space exploration, and civil/military navigation also critically depend on the radio spectrum. Although these technologies are vastly different in terms of sensitivity levels, interference tolerance, space, time, and frequency usage patterns, they increasingly converge towards the same frequency bands. We currently lack in both technological and policy frameworks to enable harmonious coexistence of such vastly different spectrum stakeholders. A corner stone towards spectrum coexistence is the measurement and characterization of the radio spectrum over wide frequency ranges, across a variety of technologies and with as little supervision as possible. In this talk, I will introduce my work on automating the measurement and management of the radio spectrum for future spectrum-sharing applications. I will talk about spectrum analytics from low-cost and imperfect data and its implications on algorithm design. Finally, I will discuss the importance of spectrum coexistence to bridge the digital divide while allowing critical sciences to thrive.

Dr. **Mariya Zheleva** is an Assistant Professor in Computer Science at University at Albany – SUNY. She graduated with her PhD in Computer Science from University of California Santa Barbara in 2014. She holds a M.Eng. and B.Eng. in radio communications from the Technical University, Sofia, Bulgaria. She leads the UbiNET Lab, which conducts research at the intersection of wireless communications and Information and Communication Technology for Development. Mariya is the recipient of the NSF CAREER award, the Dynamic Spectrum Alliance 2019 Award for University Research on New Opportunities for Dynamic Spectrum Access, and the University at Albany 2019 President's Award for Exemplary Public Engagement. She is the co-lead for the NSF-supported National Radio Dynamic Zones Partnership and Workshop Series; and a founding member of SpectrumX.

Measuring Winds at the Edge of Space with the Zephyr Meteor Radar Network

Most people know meteors by seeing them as “shooting stars” in the night sky. Radio enthusiasts might also be aware that meteors are much more common than just the visible ones, and that it is possible to reflect radio signals off of meteor trails. But even beyond that, meteors are an important dynamic component of the upper atmosphere, and they provide a unique tool for remote sensing of winds. In this talk, I will describe the Zephyr project which is building a next-generation meteor radar network that relies on software-defined radios (SDR). Compared to traditional meteor radars, such networks increase the density of meteor observations and provide diversity in sensing Doppler-derived wind projections. The resulting datasets contain enough information to estimate the three-dimensional wind field within the observation volume. The eventual goal is to expand to a large-scale network based in part on participation by SDR enthusiasts. Such a network would revolutionize our ability to observe winds in the upper atmosphere.



Dr. **Ryan Volz** is a Research Scientist at MIT Haystack Observatory with interests in signal processing, statistical estimation, and novel instrumentation applied particularly to radio science. He earned a BS degree in Aerospace Engineering from the Pennsylvania State University in 2007, an M.Phil degree in Engineering (Control Systems) from the University of Cambridge in 2008, and MS and PhD degrees in Aeronautics and Astronautics from Stanford University in 2009 and 2015, respectively. He and colleagues at CU Boulder are currently developing the Zephyr meteor radar network, a novel MIMO system designed to estimate the 3-D wind field in the upper atmosphere by way of meteor trail scattering. He also contributes to software and signal processing for the AERO and VISTA cubesats, which launch in 2023 with the goal of locating and characterizing auroral emissions using an electromagnetic vector sensor.

HamSCI Research with Software Defined Radios

The Ham Radio Science Citizen Investigation (HamSCI) is a platform to foster collaborations between the amateur (ham) radio and professional space science and space weather communities. Recent advances in software defined radios (SDRs), computers, and the internet have made it possible for citizens to come together to make global-scale ionospheric measurements in ways never seen before the SDR revolution. In this presentation, we highlight the power of the global high frequency (HF) KiwiSDR network and show how amateur radio observation networks such as the Reverse Beacon Network (RBN), Weak Signal Propagation Reporter Network (WSPRNet), and PSKReporter/FT8 can be used to study ionospheric effects of solar flares and traveling ionospheric disturbances (TIDs). Finally, we talk about upcoming technologies being developed as part of the HamSCI Personal Space Weather Station project.

Dr. **Nathaniel Frissell**, W2NAF, is an Assistant Professor of Physics and Engineering at The University of Scranton. Nathaniel's passion for radio and radio science began in middle school when he was introduced to the amateur radio hobby through scouting. He eventually went on to earn his B.S. in Music Education and Physics from Montclair State University, and M.S. and Ph.D. in Electrical Engineering from Virginia Tech working in the Virginia Tech Super Dual Auroral Radar Network (SuperDARN) laboratory. Nathaniel founded and now leads the Ham Radio Science Citizen Investigation (HamSCI) citizen science collective. He is the lead Principal Investigator for the NSF-funded HamSCI Personal Space Weather Station project and a recipient of an NSF CAREER award to study traveling ionospheric disturbances. Nathaniel is the advisor for the W3USR University of Scranton Amateur Club, is a winner of the 2017 Yasme Foundation Excellence award, the 2019 Dayton Amateur Radio Association Amateur of the Year Award, and is a 2021 inductee of the CQ Amateur Radio Hall of Fame.

Sustainable Intelligent Everyday Objects are the Future

With the miniaturization of microcontrollers, our everyday objects are equipped with computational capabilities and augmented intelligence. We expect to have a trillion Internet of Things (IoT) devices by 2035. But how will we power them without generating battery wastage or imposing high maintenance costs? Computing on battery-free IoT devices and passive communication focuses on addressing this question and is a stepping stone for the vision of sustainable and intelligent everyday objects. We can envision that the future of sustainable computing will reshape how everyday objects behave and influence our life by continuously learning our behavior, our actions, and the environment around us. To achieve this, we need a joint effort of experts from different domains, e.g., machine learning, embedded systems, and wireless communication. My talk will focus on introducing reliable intelligence to these tiny battery-free computers. I will furthermore discuss the challenges and opportunities of this emerging field of sustainable and intelligent everyday objects.

Dr. **Bashima Islam** will be joining the Department of Electrical and Computer Engineering at Worcester Polytechnic Institute as an Assistant Professor from Fall 2022. She will direct the Bringing Awareness through Systems for Humans Lab (BASH Lab), which focuses on understanding and enhancing the usability, intelligence, and processing capabilities of tiny low-power edge devices to realize their full potential in our daily lives. She aims to develop a new set of intelligent edge computers that provide sustainable and scalable sensing solutions in various application domains ranging from health wearable to precision agriculture. The interdisciplinary nature of her research involves diverse domains, including Machine Learning, Mobile Computing, Embedded Systems, and Ubiquitous Computing. Her work has been published in top conferences, including IMWUT/UBICOMP, IPSN, RTAS, and MobiSys. In recognition of her work on time-aware intermittent systems, she received an honorable mention for the Gaetano Borriello Outstanding Student Award at UbiComp 2020. She was one of the Rising Stars in EECS, 2020, and received the N2Women Young Researcher Fellowship in 2017. Forbes named her as one of the 30 most influential scientists under the age of 30 in 2021. Bashima received her Ph.D. in Computer Science from the University of North Carolina at Chapel Hill (UNC) in 2021 and is currently a Visiting Postdoctoral Research Associate at the University of Illinois at Urbana Champaign (UIUC).

Breakout Session I

Using SDR for Education

Dr. David Starobinski (Boston University)
Dr. John Swoboda (MIT Haystack Observatory)

Abstract: Software Defined Radio has become a popular topic for workshops, hands-on projects, and courses within an academic environment. This panel will discuss a range of SDR education-based use cases from the perspective of an academic course as well as a NSF-sponsored workshop. The panelists will share their lessons learned and insights, as well as discuss various aspects of these SDR educational experiences.

SDR Roundtable Discussions

Dr. Alexander Wyglinski (Worcester Polytechnic Institute)
Mr. Neel Pandeya (NI/Ettus Research)
Dr. Michael Rahaim (University of Massachusetts Boston)
Dr. Ruolin Zhou (University of Massachusetts Dartmouth)

Abstract: Four concurrent, dynamic, interactive discussions will involve interested NEWSDR attendees in the Gather virtual conference environment. Each table will consist of a moderator and will focus on one of the four possible topics: (1) SDR and the Future of Work; (2) Software Defined "Radio" Beyond Radio Communications: Sensing, Radar, and Optical Wireless; (3) Practical Limitations and the Future of COTS SDR Equipment; (4) Spectrum Coexistence and the Application of ML/AI for SDR.

Breakout Session II

Future Opportunities for SDR Innovation

Dr. Alexander Wyglinski (Worcester Polytechnic Institute)
Dr. John Chapin (National Science Foundation)
Dr. Frank Robey (DARPA)
Mr. Joseph Downing (Massachusetts Technology Collaborative)

Abstract: SDR technology is a game changer in today's information society given its ability to enable complex and innovative approaches for wireless connectivity. As a result, numerous government agencies are interested in funding research and development activities that rely on SDR due to its flexibility and transmission performance. In this session, panelists from NSF, DARPA, and the Commonwealth of Massachusetts will discuss topics of interest and funding avenues for individuals pursuing activities involving SDR technology.

"Spectrum Painting" Competition

Dr. John Swoboda (MIT Haystack Observatory)
Mr. Mike Mclernon (Mathworks)

Abstract: Interested in generating wireless transmissions that form artwork embedded in spectrograms? Keen on drawing your alma mater's logo across frequency and time? Want to produce some cool image using SDR technology? If so, check out this session where you and other individuals will compete to "paint" images across frequency and time that is saved in a PNG file containing the corresponding spectrogram.

Poster Presentations

The Small Radio Telescope Python Package (srt-py) [Poster 1]

John Swoboda, Blaine Huey, Ryan Volz, and Alan Rogers
MIT Haystack Observatory
The Small Radio Telescope (SRT) is a education-oriented radio telescope developed by Haystack Observatory, which, since its inception in 1998, has progressed through many upgrades taking advantage of the new technologies that have matured in recent years. Since the code for operating the SRT was first written, there have been many advancements and changes in methodology in the world of software development. While the original had custom implementations of every aspect of communicating with motors, tracking celestial objects, signal processing, and displaying those results to the user, incorporating modern libraries could serve to vastly simplify the code and improve the extensibility of SRT. Herein we describe the design process, features and operations, and validating experiments on a complete rewrite of the SRT control code in Python, aimed at making its usage by wide audiences easier in a way not previously possible. Future improvements to the code and SRT system will also be discussed.

RF Environment Monitoring Using RFSoC 2×2 Board [Poster 2]

John Swoboda, Yana Galina, Jaime Mohedano Aragon, Kakit Wong, Isaac Yamnitsky, Sharanya Srinvas, and Joshua Semeter
MIT Haystack Observatory
The RF Spectrum is becoming increasingly congested with interference (RFI), making it difficult to achieve high-fidelity measurements of physical processes especially in radio astronomy and the Geospace communities. As such numerous easy to use tools for RF environment monitoring will be needed. These tools cannot only aide in operations but if properly designed can aide in RFI mitigation research that use advanced signal processing techniques to eliminate unwanted signals while preserving the capability of high fidelity sensors to make sensitive physical measurements. Recently the Xilinx Radio Frequency System on a Chip (RFSoC) has become available. This system promises high bandwidth and low power RF measurements within a single chip. A 2×2 development board has been made available to academic institutions which also leverages the PYNQ framework to reduce the barrier to entry of developing applications. We will present the RF spectrum monitoring software stack that was developed at Boston University in collaboration with MIT Haystack. This software stack performs real time spectrum measurements using the RFSoC hardware and uses open source tools, such as REDIS and Dash, to exfiltrate, distribute and display data to numerous users. There is also capability to record band limited snippets of raw RF data that will be delivered through a browser interface. There is also the capability to expand to other SDR systems.

Intelligent Sample Selection for Low Latency Training of Neural Networks for Digital Predistortion [Poster 3]

Yiyue Jiang, John Dooley, and Miriam Leeser
Northeastern University
Over the last decade, Neural Networks (NNs) have become increasingly used in Digital Predistortion (DPD) and DPD models due to their promising capability for nonlinear mapping. While different Neural Network structures have been proposed for tackling the improvement of DPD performance, the size of the training data set is rarely discussed. This project presents an innovative way to select the training signal samples based on a biased probability density function (pdf) so that the training phase of the DPD will be shortened. This subsampling method has been experimented with using a Real-Valued Time-Delay Neural Network (RVTDNN) and an Augmented Real-Valued Time-Delay Neural Network (ARVTDNN) and validated in hardware using a Xilinx RFSoC ZUC111 board.

Real-Time DPD System on RFSoC [Poster 4]

Zhaoyang Han, John Dooley, and Miriam Leeser
Northeastern University
Power amplifier(PA) is an important device in modern wireless communication systems. Digital predistortion (DPD) is widely used to ameliorate the non-linearities exhibited by PA behavior. DPD needs to be performed in real time, and close to the RF Front End (RFFE). Our work aims to develop a DPD system on a System-on-Chip (SoC) platform, the AMD/Xilinx's RFSoC (ZCU216). The RFSoC integrates an embedded ARM processor and FPGA

fabric along with the RFFE. We partition the DPD algorithm among these components and explore design options for optimization. Specifically, the computationally heavy pre-distorter model with high throughput requirements is placed on the FPGA fabric. The control logic and coefficient extraction algorithm reside on the embedded ARM processor. In order to close the processing speed gap between the two parts and make them work collectively, data transfer models are explored. Our work builds on MathWork's SoC Blockset which provides an easy but complete flow for building both the processor and FPGA fabric on the AMD/Xilinx's RFSoC from a Simulink description.

Multi-node SDR Testbed with Tetherless Mobile Nodes and Centralized Control [Poster 5]

Myles Toole, Humza Ali, Davidson Andrade, Dhimitri Foto, Nasser Alshamari, and Michael Rahaim
University of Massachusetts, Boston

With each new generation of wireless communications, new devices are invented and distributed to the public. These devices introduce new internet-based capabilities that demand more wireless capacity. Eventually, this trend starts over again in a constant cycle where new devices and applications drive the demand for capacity and more capacity enables the development of new devices and applications. In this work, we have developed a testbed that emulates an ultra-dense environment which will be used as a research tool to provide experimental analysis and evaluation of future wireless systems. The testbed utilizes distributed nodes that are built from Raspberry Pi microcontrollers and B200 mini USRPs. Nodes are centrally controlled by our Testbed Controller which can configure the test environment, initialize GNURadio flowgraphs at each node, and aggregate stored data files at the central computer. Tetherless operation is also enabled with a wireless control network and battery powered nodes, allowing the nodes to be placed on an optional rover that can also be controlled from the Testbed Controller.

Software Defined Visual Light Communications with Wavelength Division Multiple Access [Poster 6]

Evan Urban, Sharareh Rezaeiboroujerdi, Hussam Aboutahoun, Ilyas Saheb, Victor Chu, and Michael Rahaim
University of Massachusetts, Boston

Wavelength Division Multiple Access (WDMA) is a method in which multiple signals are transmitted via an optical channel and are received individually on multiple receivers. Using WDMA introduces the possibility of transmitting numerous signals by having a single LED or light. Our Optical Wireless Communications (OWC) testbed provides a low-cost alternative to research experimentations that will implement Wavelength Division Multiplexing or WDMA for researchers to investigate different methods and protocols for resource allocations across multiple optical color channels. A demo of our testbed is the generation of a signal by GNURadio which is then transmitted via the blue light channel by our Optical Transmitter. Using a Photo-Receiver with a blue light filter, we can transmit and receive this signal. We introduce another blue light optical signal which is considered interference. GNURadio is then used by changing the optical channel of submission for the transmitter and receiver. This means that the transmitted channel is switched to red light, and the received signal is utilized by a Photo-Receiver with a red-light filter. This eliminates the introduced blue-light interference signal while being able to receive the desired optical signal. By using SDR, we can implement WDMA in our OWC testbed.

Minimally Constrained Neural Architecture Search in CNNs using Genetic Algorithm for Modulation Classification [Poster 7]

Charles Montes, Todd Morehouse, and Dr. Ruolin Zhou
University of Massachusetts, Dartmouth

Neural architecture search (NAS) is an optimization problem for neural networks, such as convolutional neural networks (CNNs), to find the optimal architecture for an objective function. With much research going into neural networks many researchers use manually created networks instead of optimal networks. Choosing the optimal architecture can be done by applying genetic algorithm (GA) to perform the NAS. Much work has gone into NAS as the architecture greatly affects the network's performance and enables automated machine learning. Most existing research for NAS uses highly constrained network building operations but not much research has gone into minimally constrained network building operations. Unconstrained operations such as considering the network layers and layer hyperparameters simultaneously and allowing layers or skip connections to appear anywhere within the network. We have implemented a GA framework for NAS in CNNs with minimal constraints and apply it to baseband modulation classification. The GA network building process can add any number of layers anywhere within the network, skip connections between any layers, and simultaneously decides layer hyperparameters. Performance metrics considered are network accuracy, and NAS runtime. Performance metrics are evaluated on automatic modulation classification datasets such as DeepSig RadioML2018 and DeepSig RadioML2016.

Spectrum Sensing in a Cluttered RF Environment through Faster Region Based CNNs [Poster 8]

Todd Morehouse, Charles Montes, and Dr. Ruolin Zhou
University of Massachusetts, Dartmouth

Intelligent radio must contend for spectrum resources in an increasingly complex and dynamic environment. These radio systems continue to become more mobile, sustain higher data rates, and support complex behaviors, such as the ability to learn and adapt in dynamic environments. Therefore, to operate in this field, radios must sense the spectrum and respond accordingly. The dynamic nature of the wireless environment makes this a particularly challenging task. Traditional methods detected transmissions by statistical analysis of the channel, and are not reliable, lacking the ability to handle complex and dynamic scenarios. Convolutional neural networks (CNNs) were found to greatly exceed traditional systems without prior statistical information, but fail to detect multiple signals. Our research focuses on extending the ability of CNNs to multi-signal cases. Region based CNNs allow bounding box detection of objects within an image. This can be used to detect the frequency location of multiple signals within a channel. We modified the baseline FRCNN to process 1-D signals, greatly reducing computation time. We tested our system over-the-air using software defined radio (SDR), allowing us to model complex transmitter behavior, to show the effectiveness of our system.

AI-Based RF Fingerprinting Framework Design and Implementation Using Software-Defined Radios [Poster 9]

Elizabeth Batz, Eduardo Garcia, Selena Vega, Sanjana Velma, Michel Kulhandjian, and Hovannes Kulhandjian
California State University, Fresno

In recent years, radio frequency (RF) fingerprinting has gained a lot of attention from the research community. RF fingerprinting is a technique that identifies a radio transmitter based on the unique characteristics of its signal transmission, referred to as its electronic fingerprint, which is difficult to duplicate. This is due to the inherent variations embedded in the hardware during manufacturing. Cellular providers routinely utilize RF fingerprinting to prevent cell phone cloning; a cloned device will have the same numeric equipment identity but a distinct radio fingerprint. Research on this topic is still in its infancy as more needs to be done to further improve its detection capabilities. In this project, we propose utilizing software-defined radio (SDR) tools and concepts in conjunction with machine learning techniques to demonstrate the capability of RF fingerprinting by identifying transmit radios that are in a preselected whitelist (authorized users) and rejecting all other transmit radios.

Multi-User Visible Light Communications using Software Defined Radios [Poster 10]

Jordan DiViccaro, Vahae Ohanian, HaoYuan (James) Wu, Michael Rahaim, Michel Kulhandjian, and Hovannes Kulhandjian
California State University, Fresno

The goal of this project is to develop a Visible Light Communication (VLC) framework that utilizes Software Defined Radios (SDRs) in a multi-user environment. This will allow multiple photodiode receivers (users) to capture their desired information from a single light emitting diode (LED) transmitter. The system will be implemented through novel modulation techniques and schemes that we are currently developing for SDRs. The source code of the project will be solely implemented through GNU Radio functions and files. The outcome will include a multi-user system that can eventually be married to a multi-cell system, thus providing a testbed that can be used as an open-source, baseline tool for other researchers to use as a resource when studying and developing future VLC technology. Such a modular system that utilizes SDR will increase accessibility, and further advance the state-of-the-art research in Visible Light Communications.

Deep Learning-based Adaptive Detection and Classification of Modulation Schemes using Software Defined Radios [Poster 11]

Elizabeth Batz, Michel Kulhandjian, and Hovannes Kulhandjian
California State University, Fresno

Deep learning (DL) is a branch of machine learning (ML) that uses numerous successive layers of nonlinear processing units to model high-level abstractions in data. In recent years, this technique has gained a great popularity due to its state-of-the-art capability for the big data analysis. As one of the most powerful identification classification tools, it has been applied in various application fields, such as computer vision, natural language processing, economics. and bioinformatics [2].Although the DL is widely investigated in many application domains, its usage in communications systems has not been well explored. Specifically, there is very little work done on modulation classification using DL. So, we proposed developing a convolutional neural network-based architecture that can automatically detect and identify the different modulation schemes received over the air from a software-defined radios (SDRs). The process involved building a synthetic data set from scratch, using different modulation including BPSK, 8-PSK, 16-PSK, QAM, 16-QAM, and 64-QAM.

Millimeter Wave Backhaul Architecture for Rural Broadband Access [Poster 12]

Yael Rogoszinski, Joseph Murphy, Shamsnaz Virani Bhada, Alexander M. Wyglinski
Worcester Polytechnic Institute
Approximately 10% of Americans lack the minimal level of broadband connectivity access defined by the FCC of 25 Mbps. Many of these individuals live in rural regions of this country where broadband connectivity options are limited due to the absence of the necessary infrastructure needed to reliably support sufficient data rates across sparsely populated areas in a cost effective manner. One solution to the issue of insufficient broadband connectivity infrastructure is millimeter wave backhaul networks, where large amounts of data is communicated via fixed bidirectional line-of-sight links such that this data can then be disseminated across a region using last mile technology such as 5G and WiFi. This poster presents work done as part of an ongoing effort to implement a mesh network architecture consisting of millimeter wave backhaul links to assist with the reliable routing of information across different regions of a large geographical area. Given the susceptibility of millimeter wave transmissions to various phenomena such as rain fade, the mesh network architecture is designed to enable additional degrees of freedom to ensure data makes it from point A to point B even in the event of a meteorological phenomena such as a rain storm.

Intelligent Routing for Rural Broadband Access using Custom Wireless Networks [Poster 13]

Joseph Murphy, Yael Rogoszinski, Shamsnaz Virani Bhada, Alexander M. Wyglinski
Worcester Polytechnic Institute
Given the limited amount of broadband connectivity infrastructure available in rural parts of the US, new technologies such as millimeter wave transmission techniques and unlicensed 4G and 5G systems are being used to bridge the “Digital Divide” that separates approximately 10% of Americans who are unable to obtain the minimum 25 Mbps of connectivity defined by the FCC to be considered broadband access. Even with new technologies being rolled out into these broadband deserts, it will take some time before all households will achieve reliable access to data connectivity, especially during peak usage times, due to limited backhaul connections to the service area. Given the limited infrastructure currently available in rural regions of this country, intelligent networking techniques are needed to efficiently allocate bandwidth resources to different households in an adaptive and fair manner. This poster presents current research into the development of an intelligent router framework designed to allocate bandwidth to different rural households within a service area based on their need and priority rather than employing a static uniform approach that inefficiently makes use of the broadband connectivity infrastructure. Results are currently being obtained via CORE-EMANE and efforts are underway to implement this framework using a prototype hardware testbed.

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Lynk (Lynk Global, Inc.), is a mobile network technology company focused on providing universal connectivity for the mobile phone. Lynk's patented and proven technology allows standard mobile phones, without any changes in hardware or software, to be connected virtually anywhere on the globe using our low-earth-orbit nanosatellites. The growing Lynk network represents the best way forward to broadband connectivity everywhere, including the most isolated areas. We are the world's safety net.

SDR-Boston

Boston SDR User Group

A community within the New England area that possesses members from academia, industry, and government who are involved in the design and implementation of software-defined radio (SDR) technology in order to advance the current state-of-the-art in wireless communication systems and networks. Find out more about SDR-Boston at our website: **http://www.sdr-boston.org**