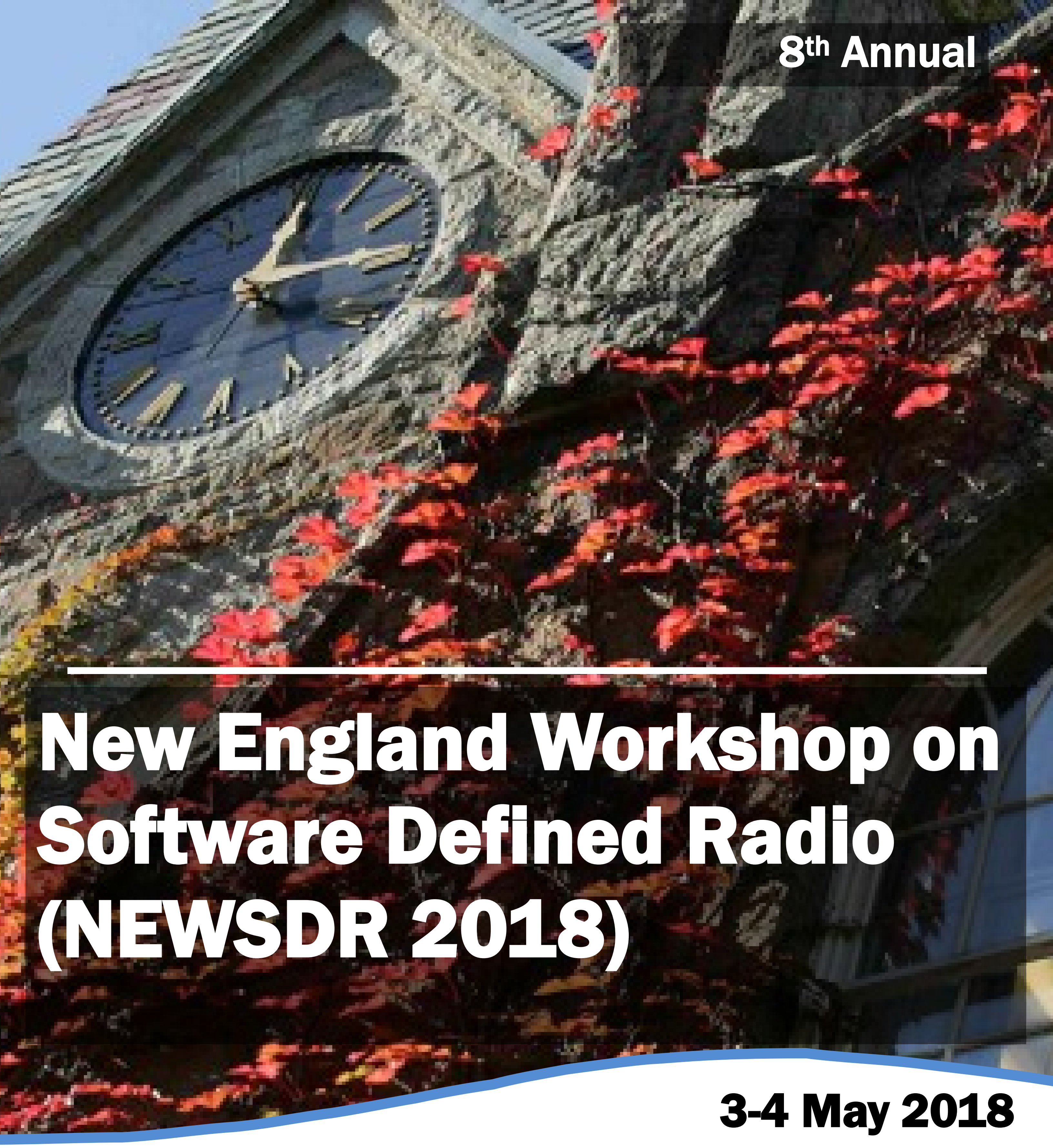

8th Annual

New England Workshop on Software Defined Radio (NEWSDR 2018)

3-4 May 2018

Worcester Polytechnic Institute | Worcester, Mass

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Welcome

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Alex Wyglinski
Worcester Polytechnic Institute

The 2018 New England Workshop on Software Defined Radio (NEWSDR) is the eighth installment of an annual series of workshops organized by the Boston SDR User Group (SDR-Boston). This year, we are very excited about having Worcester Polytechnic Institute (WPI) generously serve as the host institution for NEWSDR 2018 in the historic Atwater Kent Laboratories Building!

The goal of this series of workshops is to provide a forum through which individuals working on SDR-related projects in the New England area can get together in order to collaborate and introduce SDR concepts to those interested in furthering their knowledge of SDR capabilities and available resources.

Following on the success of these workshops, this year's NEWSDR event offers a chance for presenting the latest developments in SDR and Cognitive Radio research by individuals from academia, industry, and government in the New England area, as well as from across the Nation. In addition to providing an opportunity for researchers in this area to network and interact on issues relating to SDR and Cognitive Radios, NEWSDR 2018 will include:

- Keynote Presentations on the latest in SDR
- Poster Presentations with Short "Elevator-Pitch" Oral Presentations
- Technology demonstrations
- Hands-On Tutorials
- Breakfast / coffee / lunch included with advanced registration

During 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 2018 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 – Thursday 3 May 2018

4:00PM-5:00PM	Pizza/Soda & Attendee Networking
5:00PM-6:00PM	Early Session for Setup
6:00PM-9:00PM	Short Course 1: "Real Time Over-the-Air Communications Links with MATLAB/Simulink" by Mike McLernon (Mathworks)
6:00PM-9:00PM	Short Course 2: "FPGA Programming on the USRP with the RFNoC Framework" by Neel Pandeya (Ettus Research)

Agenda – Friday 4 May 2018

8:00AM-8:15AM	Welcome and Introduction
8:15AM-9:45AM	Sponsor Overview Presentations (20 minutes each, 5 sponsors)
9:45AM-10:15AM	Poster Presenter Elevator Pitches/Oral Presentations (2 minutes each)
10:15AM-11:00AM	Coffee, Attendee Networking, Poster Sessions, Sponsor Exhibits and Demos
11:00AM-11:45AM	Invited Presentation 1: "Remote Sensing of the Space Environment Using Software Defined Radio" by Dr. Frank Lind, MIT Haystack Observatory
11:45AM-12:45PM	Lunch, Attendee Networking, Poster Sessions, Sponsor Exhibits/Demos
12:45PM-1:30PM	Invited Presentation 2: "Multi-objective SDR Optimization for Wireless Access, Actuation and Attacks" by Professor Kaushik Chowdhury, Northeastern University
1:30PM-2:15PM	Technical Presentation 1: "Personal Wireless Testbeds for SDR" by Nandini Venkatraman and Andrew McGarry (octoScope)
2:15PM-2:45PM	Coffee, Attendee Networking, Poster Sessions, Sponsor Exhibits and Demos
2:45PM-3:30PM	Invited Presentation 3: "Reinventing Wireless with Deep Learning" by Nathan West, DeepSIG
3:30PM-4:15PM	Technical Presentation 2: "The Software Side of a Hardware Company" by Travis Collins and Robin Getz (Analog Devices)
4:15PM-4:30PM	Closing Remarks

Invited Presentations

Remote Sensing of the Space Environment Using Software Defined Radio

Dr. Frank Lind (MIT Haystack Observatory)

From studies of the ionosphere to astronomical measurements with arrays of radio telescopes the manipulation and analysis of RF signals has been key to new instrumentation and many resulting discoveries. Software radio technology has been a core component of remote sensing of the space environment for several decades now. The flexibility of combining computing and radio was adopted very early on in scientific applications. This enabled new classes of scientific experiments which would otherwise have been impossible. The capability and adaptability of software radio instrumentation and systems has been growing consistently with the exponential increase in available computing power. The recent surge of low cost software radio hardware technology has enabled a new generation of instrumentation. These instruments are increasingly blurring the line between traditionally separate scientific disciplines as well as practical applications. I will discuss the science and the instrumentation enabled by software radio with highlights from studies of the ionosphere and radio astronomy. My overview will focus on the relationship to work underway at MIT Haystack Observatory. I will highlight the core architectural patterns of scientific software radio and discuss the evolution of our systems over several decades of rapid technological change. I will also look forward to the possibilities for discovery offered by the next generation of software radio and radar instrumentation.

Biography: Dr. Frank D. Lind is a Research Engineer at MIT Haystack Observatory where he works to develop and use radio science instrumentation. At the Observatory he leads many technical efforts involving software radio instrumentation cutting across Geospace, Astronomy, and Space science. These instruments are used to make detailed physical measurements and have been part of many NSF, NASA, and DoD supported investigations. Key instrumentation includes the National Science Foundation's Millstone Hill Geospace Radar Facility, the new RAPID (Radio Array of Portable Interferometric Detectors) system, low cost array radars, software defined radio architectures for radio telescopes, and efforts to develop an electromagnetic vector sensor for the upcoming NASA AERO (Aurora Emissions Radio Observer) cubesat mission. Dr. Lind studied at the University of Washington where he received a Bachelor of Science degree in Physics and a Bachelor of Science degree in Computer Science in 1994. He then joined the UW Geophysics Program and pursued studies leading to the Doctor of Philosophy in Geophysics in 1999. His work there focused on Passive Radar observations of the Aurora Borealis. He is a prior chair of USNC URSI Commission G (United States National Committee of the International Union of Radio Science), a member of the American Geophysical Union (AGU), and a member of the IEEE.

Multi-objective SDR Optimization for Wireless Access, Actuation and Attacks

Professor Kaushik Chowdhury (Northeastern University)

Software defined radios (SDRs) have become the foundational block of agile wireless communications. The first part of the talk presents an overview of how the same SDR can alternate between multiple different and non-traditional actuation functions, such as aerial distributed beamforming and wireless energy transfer. Furthermore, as SDR technology becomes more pervasive assuming roles beyond communication, there is a growing risk of security concerns of ID spoofing and malicious hardware attacks. The second part of this talk describes our efforts of fingerprinting individual SDRs using machine learning, where we only analyze the I/Q samples collected at the receiver. We demonstrate the feasibility of achieving 90-95% classification accuracy through experiments conducted with 12 radios, at separation distances of beyond 50 feet. The talk concludes with a summary of the challenges ahead and identifies other emerging application areas of SDRs that will impact the next decade.

Biography: Prof. Kaushik R. Chowdhury received the PhD degree from the Georgia Institute of Technology, Atlanta, in 2009. He is currently Associate Professor and Faculty Fellow in the Electrical and Computer Engineering Department at Northeastern University, Boston, MA. He was awarded the Presidential Early Career Award for Scientists and Engineers (PECASE) in Jan. 2017, the DARPA Young Faculty Award in 2017, the Office of Naval Research Director of Research Early Career Award in 2016, and the NSF CAREER award in 2015. He received multiple best paper awards, including the IEEE ICC conference, in 2009, '12 and '13, and ICNC conference in 2013. He is presently a co-director of the Platforms for Advanced Wireless Research project office, a joint $100 million public-private investment partnership between the US NSF and wireless industry consortium to create city-scale testing platforms. His current research interests span software defined and cognitive radios, intra body implant communications, wireless energy transfer, and unmanned aerial systems.

Reinventing Wireless with Deep Learning

Nathan West (DeepSIG)

While wireless communications technology has advanced considerably since its invention in the 1890s, the fundamental design methodology has remained unchanged throughout its history – expert engineers hand-designing radio systems for specific applications. Deep learning enables a new, radically different approach, where systems are learned from wireless channel data. This talk will provide a high-level overview of deep learning applied to wireless communications, discuss the current state of the technology and research, and present a vision for the future of wireless engineering using a data-centric approach.

Biography: Nathan West is the Principal Engineer at DeepSig Inc., which is commercializing the fundamental research behind deep learning applied to wireless communications and signal processing. He also contributes to GNU Radio, maintaining a component called VOLK which provides highly optimized signal processing routines. He is currently pursuing a Ph.D. in Electrical Engineering at Oklahoma State University focused on machine learning sensing systems for RF signals and lives in Washington, D.C.

Short Courses & Technical Presentations

Real Time Over-the-Air Communications Links with MATLAB/Simulink

Mike McLernon (Mathworks)

In this talk we show how you can transmit and receive over-the-air signals with MATLAB and a variety of hardware, such as RTL-SDR, ADALM-PLUTO (PlutoSDR), and USRP. We will work with applications like broadcast FM, ADS-B (aircraft tracking), and QPSK. We show how you can build up your own wireless communications link, learning practical receiver design in the process. After the talk, we will conduct a workshop for up to 50 attendees to download the RTL-SDR driver on your personal laptops. We will give you an RTL-SDR radio to keep, walk you through the install process, and launch several applications to ensure proper installation. To participate in this workshop, you must have MATLAB R2017b or later loaded on your laptop, and you must also have Communications System Toolbox loaded in your MATLAB install. If need be, you can install the required products through the Home Version or the Student Version. A Communications System Toolbox install must include DSP System Toolbox, Signal Processing Toolbox, and MATLAB. Simulink is optional.

FPGA Programming on the USRP with the RFNoC Framework

Neel Pandeya (Ettus Research)

Ettus Research's RFNoC (RF Network-on-Chip) software is meant to decrease the development time for experienced FPGA engineers seeking to integrate IP into the USRP signal processing chain. RFNoC is the architecture for USRP devices that use Xilinx 7-series FPGAs (E310, E312, X300, X310). RFNoC is built around a packetized network infrastructure in the FPGA that handles the transport of control and sample data between the host CPU and the radio. Users target their custom algorithms to the FPGA in the form of Computation Engines (CE), which are processing blocks that attach to this network. CEs act as independent nodes on the network that can receive and transmit data to any other node (e.g., another CE, the radio block, or the host CPU). Users can create modular, FPGA-accelerated SDR applications by chaining CEs into a flow graph. RFNoC is supported in UHD and GNU Radio. In this workshop, we will present an interactive hands-on tutorial on RFNoC, including a discussion on its design and capabilities, demonstrations of several existing examples, and a walk-through on implementing a user-defined CE and integrating the CE into GNU Radio.

Personal Wireless Testbeds for SDR

Nandini Venkatraman and Andrew McGarry (octoScope)

octoScope designs and produces wireless personal testbeds that guarantee a stable, repeatable RF environment. Our testbeds are the de facto standard for performance testing, with many applications for the SDR community. We provide testbeds complete with partner devices, attenuators, and multipath emulators, allowing engineers to emulate real-world scenarios in a controlled RF environment. In addition, all the devices in our testbeds are remotely controllable. We include with each of our testbeds an octoBox Server, which controls octoBox testbed devices and automates standard wireless performance tests. SDR allows for rapid cycle time changes to the radios themselves, and, with its ease of use and highly reproducible environment, the octoBox solution allows for rapid verification of those changes. At NSDR 2018, we will introduce one of our standard testbed configurations as well as an advanced Wi-Fi sniffer solution.

The Software Side of a Hardware Company

Travis Collins and Robin Getz (Analog Devices)

Analog Devices Inc (ADI) is the leader in converter technology and complete analog and digital signal chain hardware solutions. However, software integration with hardware is the key driving force behind high-speed software-defined devices of the future, and as a result ADI's software ecosystem has become more important. The focus of this talk will be on ADI's software ecosystem which enables software-defined radios to be more flexible, agile, and performant. An ecosystem even other SDR manufacturers have adopted. Specially, we will discuss the recently introduced the PackRF complete system reference design based on the ADI RF SOM. Including the complete full stack modem design with a completely open codebase from simulation to HDL.

Poster Presentations

Synthesizing Robust Training Data for Machine Learning

Kyle McClintick (WPI), Alexander Wyglinski

Developing machine learning-based signal classifiers that generalize well requires training data that capture the underlying probability distribution of real signals. To synthesize a set of training data that can capture the large variance in signal characteristics, a robust framework that can support arbitrary baseband signals and channel conditions is required. Furthermore, a classifier trained on a probability distribution that reflects the expected range of channel conditions is better able to detect anomalies (e.g., poisoning attacks).

V2V SIMULATION USING MATHWORKS TOOLS

Renato Iida (WPI), Le Wang, Alexander M. Wyglinski

Vehicular network simulator based on the MATLAB Discrete Event System (DES), which supports the full stack of vehicular network, the DSRC communication and the connected autonomous vehicle (CAV).It supports different traffic profiles with specific priority and evaluates the performance in the network. The simulation can be create using simulink or matlab. The scenarios are single direction, multi direction road or a crossing with traffic lights.

Using Deep Learning for Simultaneous Classification and Demodulation of Wireless Communications Signals

Sarunas Kalade (University of Strathclyde), Robert W. Stewart, Louise Crockett

In the last few years Machine Learning (ML) has seen explosive growth in a wide range of research fields and industries. With the advancements in Software Defined Radio (SDR), which allows more intelligent, adaptive radio systems to be built, the wireless communications field has a number of opportunities to apply ML techniques. In this work, a novel approach to demodulation using a Sequence to Sequence (Seq2Seq) model is proposed. This type of model is shown to work effectively with baseband PSK modulated data and also has a number of useful properties that are not present in other machine learning algorithms. It is capable of Automatic Modulation Classification (AMC) and de-mapping of arbitrary length sequences of pulse shaped symbols, with no matched filtering. Smarter and more functionality-packed radio systems will be a must for future 5G networks, and using Deep Learning (DL) for radio PHY layer improvements is an exciting new avenue of research.

A Dynamic Spectrum Access Case Study: Secondary User Coexistence in the FM Band

Kenny Barlee (University of Strathclyde), Robert Stewart, Louise Crockett

The explosion of wireless everything in recent years has placed a strain on the radio spectrum, and has led to the so-called 'spectrum crunch', where the spectrum is described as being nearly at capacity. It is widely accepted that in reality this is not the case, as great numbers of 'allocated' bands are underutilized or not in use at all. Commonly, bands (containing many channels) are classified by spectrum regulators for a particular type of use, such as those for FM Radio, Digital TV and cellular services. If there are not enough Primary Users (PUs) to use all of the channels in these bands, they simply lie empty. Using new spectrum access techniques, these channels can be targeted for 5G and IoT applications.

This poster introduces an SDR based radio transmitter which leverages Dynamic Spectrum Access (DSA) techniques to permit Secondary User (SU) access to the traditional FM Radio spectrum (88-108 MHz). The radio automatically builds a channel mask based on ambient FM broadcasts, and uses this in conjunction with a PHYDYAS FilterBank Multicarrier (FBMC) scheme to create communication channels in the empty FM channels.

Wireless RF Front End Algorithm Implementation using ZC706 and FMCOMMS-3 SDR Platform

Suranga Handagala (Northeastern University), Mohamed Mohamed, Miriam Leeser

State of the art SDR technologies are used for rapid prototyping of radio systems using reconfigurable hardware, which offer significant advantages over conventional non-configurable implementations. Recently developed SDR platforms include modules such as programmable front end filters, gain correction modules and other configurable hardware to improve the received signal quality for wideband signals. Further front end processing include frequency offset compensation, phase correction, and channel estimation, all of which are required for better OFDM demodulation.Interfacing an FPGA to these platforms to perform time critical tasks such as packet detection and channel estimation can significantly improve the overall receiver performance. However, hardware implementation of front end algorithms require that the design meets power, area and timing constraints. Since these devices have limited word-length and memory footprint, it is important to limit resource utilization to the required level. We use ADI FMComms3 SDR front end along with Xilinx ZC706 evaluation board which has a Zynq SoC, to implement fast and efficient front end receiver algorithms. We use ADI's LibIIO API for controlling configuration parameters of the FMComms-3, and MATLAB and Simulink to translate high level designs into synthesizable HDL which can be directly mapped to the FPGA on the Zynq SoC.

FPGA Implementation and Optimization of An LTE Encoder

Jieming Xu (Northeastern University), Miriam Leeser

SDR brings great flexibility and speed to the implementation of fast changing LTE protocols. To ensure both flexibility and real-time processing speed, we prototype our designs on the Xilinx Zynq System-on-Chip, which is comprised of both FPGA hardware and an embedded ARM processor. Focusing on resource usage, speed and power consumption, we optimize rate matching in the Downlink Shared Channel to achieve high throughput and low power consumption. From the results, we find that, with cross component design optimization of the whole channel's encoding, memory resources can be reduced to 75% of the original requirement by sharing memory resources between different components. We also defined an interface for communication and reconfiguration among components. The whole system is implemented on FPGA fabric and the embedded ARM processor, running Linux, is used to communicate with the FPGA hardware via an AXI interface.

Dynamic generation and deployment of communication modes to different hardware platforms using ontological representations

Mehmet Gungor (Northeastern University), Miriam Leeser, Mieczyslaw M. Kokar, Shweta Singh, Alexey Tazin, Yanji Chen, Kai Huang

We consider the problem of mapping communication modes to different hardware platforms dynamically based on available hardware, latency and processing requirements. Our approach uses an ontology to specify different communications modes and designs. Making use of the ontology and rules, we automatically generate implementations of different communications modes for FPGA hardware, software, or a hybrid design that mixes the two. Designs are specified as tasks for the processing elements and conduits for data transfer between tasks. Implementations use a library based approach where components are predesigned for different platforms. This style of specification supports the easy migration between target hardware platforms. We present a method that uses ontological definitions and code generation that allows a user to dynamically deploy the modes to different hardware. Our method improves the flexibility of communication mode deployment. We demonstrate this approach on a converged mode that does spectrum sensing and decides what frequency to transmit on depending on the available spectrum.

Bumblebee-Inspired Channel Selection in an Ad-hoc Network

Kuldeep Gill (WPI), Alexander M. Wyglinski

In this poster, we design a test-bed for a bumblebee inspired channel selection algorithm employed on a wireless ad-hoc network. Vehicles in connected ad-hoc networks are routinely challenged with the complex decision-making problem of either staying with the same channel or moving to a different channel under highly time-varying channel quality conditions. In order to enable vehicles to adapt to these time-varying channel conditions, we designed a bumblebee-inspired decision-making algorithm. The proposed algorithm uses temporal channel quality information for optimal channel selection. Channel energy values are used for making switching decisions by taking switching costs into consideration. We implemented a test-bed inside a controlled laboratory environment using ADALM-Pluto Software-defined radios (SDRs) to evaluate the proposed approach. The test-bed can be configured to emulate a vehicular network environment. Furthermore, in this work we show the novelty of our bumblebee algorithm for optimal channel selection in a steady environment. We compared the performance of our Bumblebee algorithm with a random channel selection algorithm, and noticed an increase of 158.33\% in the throughput of the network with our algorithm.

Detection of Rouge Transmitter in RFML System for Vehicular Networks using SDRs

Tathagata Mukherjee (Intelligent Robotics Inc.), Debashri Roy, Mainak Chatterjee

Understanding and analyzing the RF environment has become indispensable for wireless deployments of different automated domains. Various learning mechanisms can be used to characterize RF signals which in turn is used to characterize and identify RF transmitters and model their behavior. Machine learning methods, that include recurrent structures, have been shown to be applicable to Radio Frequency Machine Learning (RFML) systems for autonomous control, such as in self-driving vehicles. The signals received from other vehicles and/or road side units play a crucial role in the decision making process of any autonomous vehicle. However, the signal can be modified with ill intentions by malicious entities. The objective of this work is to learn, characterize, and determine such rouge transmitters by proposing and implementing a Generative Adversarial Networks (GAN) based learning technique for RFML systems. We use our implementation for real data synthesis by sensing radio signals using Universal Software Radio Peripherals (USRPs) or other Software Defined Radios.

Deep Learning Convolutional Neural Networks for Radio Identification

Shamnaz Mohammed Riyaz (Northeastern University), Kunal Sankhe, Stratis Ioannidis, Kaushik Chowdhury

Advances in software defined radio (SDR) technology allow unprecedented control on the entire processing chain, allowing modification of each functional block as well as sampling the changes in the input waveform. This poster describes a method for uniquely identifying a specific radio among nominally similar devices using a combination of SDR sensing capability, and machine learning (ML) techniques. The key benefit of this approach is that ML operates on raw I/Q samples and distinguishes devices using only the transmitter hardware-induced signal modifications that serve as a unique signature for a particular device. No higher level decoding, feature engineering, or protocol knowledge is needed; further mitigating challenges of ID spoofing and coexistence of multiple protocols in a shared spectrum. Our main contributions include: (i) Using an over-the-air dataset compiled from an experimental testbed of SDRs, an optimized deep convolutional neural network (CNN) architecture is proposed, and results are quantitatively compared with alternate techniques such as support vector machines and logistic regression. (ii) Research challenges for increasing the robustness of the approach, as well as the parallel processing needs for efficient training, are described. Our work demonstrates 90% to 99% experimental accuracy at transmitter-receiver distances varying between 2-50 feet over a noisy, multi-path wireless channel

DYNAMIC subarray scheduling for mmWave Massive MIMO-enabled 5G applications

Carlos Bocanegra (Northeastern university), Santiago Rodrigo, Zhengnan Li, Kaushik Chowdhury

We present a novel scheduler for real-time applications framed within the 5G requirements (higher throughput and lower latency than its predecessors) in the edge of the network (communication between the Base Station or BS, and the Mobile Station or MS) employing Multi-User Multiple-Input Multiple-Output scenario (MU-MIMO) capabilities. That is, being able to effectively allocate antennas to users and configure them with the right amplitude and phase so that (1) we serve users concurrently within the same time slot and (2) we don't generate interference to each other. Thus, increasing the network throughput substantially.

BAE Systems' Participation in DARPA Spectrum Collaboration Challenge

Scott Kuzdeba (BAE Systems)

Spectrum crowding is becoming a more pressing issue with the explosion of Internet of Things and the ever-increasing number of wireless devices for personal, industrial, public, and military use. Our method of licensing spectral bands and times for different networks / protocols / users has caused overcrowding in some parts of the spectrum, while leaving other parts relatively empty. DARPA launched the Spectrum Collaboration Challenge (SC2) in the beginning of 2017 to rethink spectral sharing in crowded bands, pulling together teams from the commercial industry, DoD contractors, academia, and individuals. The goal of the challenge is for each team to develop a collaborative and intelligent radio network, with SDRs, which can autonomously determine how to operate across scenarios, while collaborating with other networks to maximize the joint ensemble goals. BAE Systems with Eigen LLC, under the SHARE THE PIE banner, placed 2nd in the first of three challenge events. Our focus for the first challenge event was primarily on building an adaptive (cognitive) radio, with several key factors playing into our success, including an inherent spectral sharing radio mindset, being a predictable spectral occupant by bounding discrete changes to slow timescales (seconds), and letting both observations and collaboration drive decision-making.

Assessment of Positioning Errors on V2V Networks Employing Dual Beamforming

Nivetha Kanthasamy (WPI), Ruixiang Du, Alexander Wyglinski, Raghvendra Cowlagi

We present an analysis of Vehicle-to-Vehicle (V2V) Networks employing beamforming at both the transmitter and the receiver when positioning errors are present. Specifically, we will examine the performance of this system setup when the source of the positioning errors are from the Global Positioning System (GPS) measurements as well as from variations in the delays due to the overhead communication channels. To achieve adequate performance, beamforming requires precise location information of the transmitter and the receiver, and when accurate information is unavailable the system performance can potentially deteriorate. This is especially challenging in highly mobile vehicle networking environments where the operating conditions and location information varies rapidly in time. Simulation results are obtained showing Bit Error Rate (BER) values increasing by 99.9\% when the exact GPS locations are known by the vehicles when compared to a 6.6m error in GPS location.

NEWSDR 2018 was made possible by generous contributions from our sponsors.

MathWorks is the leading developer of mathematical computing software. Engineers and scientists worldwide rely on its products to accelerate the pace of discovery, innovation, and development.

Ettus Research™, a National Instruments (NI) company since 2010, is the world's leading supplier of software defined radio platforms, including the Universal Software Radio Peripheral (USRP™) family of products. With a low overall system price, expansive capabilities, and software availability, USRP products are used by thousands of engineers worldwide and remain the top choice in software defined radio hardware for algorithm development, exploration, and prototyping.

octoScope was founded in 2006 by Fanny Mlinarsky, former CTO and Founder of Azimuth Systems. The company manufactures octoBox™ wireless testbeds for R&D, QA and production testing of 2G/3G/4G and 802.11 devices and systems. octoScope builds products that enable repeatable RF environments in order to make wireless measurements easy to manage, as well as provide compact wireless personal testbeds that are cost-effective and high performance within repeatable MIMO OTA environments.

MediaTek is a pioneering fabless semiconductor company, and a market leader in cutting-edge systems on a chip for wireless communications, HDTV, DVD and Blu-ray. MediaTek created the world's first octa-core smartphone platform with LTE and our CorePilot technology released the full power of multi-core mobile processors. MediaTek [TSE:2454] is headquartered in Taiwan and has offices worldwide.

Analog Devices is a world leader in the design, manufacture, and marketing of a broad portfolio of high performance analog, mixed-signal, and digital signal processing (DSP) integrated circuits (ICs) used in virtually all types of electronic equipment. Used by over 60,000 customers worldwide, our signal processing products play a fundamental role in converting, conditioning, and processing real-world phenomena such as temperature, pressure, sound, light, speed, and motion into electrical signals to be used in a wide array of electronic devices.

WPI's Department of Electrical and Computer Engineering was formally established in 1896. Located in historic Atwater Kent Laboratories Building, WPI ECE is nationally ranked possessing an ABET-accredited BS program. Furthermore, WPI ECE possesses an extensive MS program (on-campus and online) as well as a large PhD program, with advanced research being pursued in areas such as wireless communications and software-defined radio, cyber security, embedded systems, biomedical devices, power systems and smart grid, and vehicular technology. External funding sources include the NSF, NIH, DARPA, and numerous corporate collaborators.

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.

NOTES: