11th Annual

New England Workshop on Software Defined Radio (NEWSDR 2021)

20 August 2021

Virtual Event

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Greetings!

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We are very excited to welcome all of you to the *11th New England Workshop on Software Defined Radio* (NEWSDR 2021), 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 2021 experience will include the following activities, features, and resources:

- Spotlight talk by Professor Monisha Ghosh (University of Chicago)
- Plenary talk by Dr. Ashley Zauderer VanderLey (NSF)
- Opening talk by Mr. Ira Keltz (FCC)
- Technical presentations by our NEWSDR 2021 sponsors
- Poster presentations from members of the SDR-Boston community
- 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 2021 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 2021 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 20 August 2021

9:00 AM – 9:05 AM	Welcome Address
9:05 AM – 9:20 AM	Opening Speaker Mr. Ira Keltz, FCC
9:20 AM – 9:50 AM	Plenary Speaker Dr. Ashley Zauderer VanderLey, NSF
9:50 AM – 11:15 AM	Sponsor Talks NI/Ettus, MathWorks, ADI, MediaTek, Lynk
11:15 AM – 12:00 PM	Poster Preview Session
12:00 AM – 12:15 PM	Gather Interactive Session
12:15 PM – 2:00 PM	Networking Session Poster Presentations Sponsor/Exhibitor Tables Sponsor Breakouts
2:00 PM – 3:00 PM	Spotlight Presentation “The Spectrum Sharing Future: Technology and Policy Challenges” Dr. Monisha Ghosh, University of Chicago
3:00 PM – 3:15 PM	Networking Break
3:15 PM – 4:15 PM	Technical Breakouts – Session I
4:15 PM – 4:30 PM	Networking Break
4:30 PM – 5:30 PM	Technical Breakouts – Session II
5:30 PM – 5:45 PM	Closing Comments, Adjournment

Spotlight Talk: Professor Monisha Ghosh

The Spectrum Sharing Future: Technology and Policy Challenges

Spectrum sharing technologies, including cognitive radio, are unique in that research in this area needs to consider both technology development and policy implications. The TV White Spaces rule-making more than a decade ago spurred a flurry of activity in the academic community on cognitive radio. However, true shared spectrum remains more the exception than the norm, with protection methods still mostly divided into the RF sensing and database camps. In this talk, I will describe some of the challenges that need to be overcome in making spectrum sharing a reality, the research opportunities, spanning receiver front-ends to machine learning based approaches and some of our recent work in addressing coexistence between Wi-Fi and cellular technologies in the unlicensed bands.

Monisha Ghosh completed a term as the Chief Technology Officer at the Federal Communications Commission (FCC) on June 14, 2021. In this role she reported to the Chairman of the FCC and was closely involved with setting national strategy and technology specifications related to the explosive growth of broadband wireless communications technologies. These have included crafting rules and technology implementation for the 6 GHz unlicensed bands, developing national protocols for the standardized measurement of broadband signals, and open RAN. Prior to that she served in the NSF as a rotating Program Director (IPA) between 2017-2019, within the Directorate of Computer & Information Science and Engineering (CISE) where she managed wireless networking research. She was concurrently a Research Professor at the University of Chicago (since 2015) where she conducts research on wireless technologies for the 5G cellular, next generation Wi-Fi systems, IoT, coexistence and spectrum sharing. Prior to joining the University of Chicago in September 2015, she worked extensively in industrial research and development at Interdigital, Philips Research and Bell Laboratories, on various wireless systems such as the HDTV broadcast standard, cable standardization and cognitive radio for the TV White Spaces. She has made active technical contributions to many industry standards, including IEEE 802.22 and 802.11. She received her Ph.D. in Electrical Engineering from the University of Southern California in 1991, and her B. Tech from the Indian Institute of Technology, Kharagpur in 1986. She is a Fellow of the IEEE.

Plenary Talk: Dr. Ashley Zauderer VanderLey

Dr. Ashley (Zauderer) VanderLey is Senior Advisor for Facilities in the Division of Astronomical Sciences in the Directorate for Mathematical and Physical Sciences at the National Science Foundation. Dr. VanderLey joined the Division of Astronomical Sciences in 2017 as a Program Director. Since 2018, she has served as the lead Program Officer for the Arecibo Observatory, working closely with GEO/AGS who co-fund the Observatory. In this role, she liaised with NASA partners, oversaw cleanup activities from Hurricane Maria, and has helped navigate the critical structural challenges leading to the platform collapse and the related ongoing cleanup activities. Dr. VanderLey's other responsibilities have been in the Electromagnetic Spectrum Management Unit where she has worked to represent the scientific interests for protection and use of the electromagnetic spectrum both within the United States and internationally. In this role, she represents NSF on NTIA's Interagency Radio Advisory Committee and its subcommittees, coordinating frequency usage in the National Radio Quiet Zone, and serves as U.S. Head of Delegation on behalf of the State Department to the Radio Astronomy Working Party (7D) of the International Telecommunication Union. Additionally, she served as a spokesperson and subject matter expert on the U.S. delegation for several agenda items at the 2019 World Radio Conference in Egypt. She is a member of the NSF-wide ESM Coordination group and has helped lead NSF efforts to establish the cross-Directorate Spectrum Innovation Initiative (SII), serving on the SII Steering Committee and recently establishing a formal partnership with NTIA and FCC via an MOA. Dr. VanderLey's research specialization is observational radio astronomy applied to some of the most explosive astrophysical transients in the Universe including supernovae, gamma-ray bursts, and tidal disruption events of stars around supermassive black holes. She has also studied colliding wind binary star systems, the interstellar medium, merging galaxies, and an atmospheric correction technique for radio telescopes analogous to laser guide star adaptive optics. Dr. VanderLey is a member of the American Astronomical Society, the International Astronomical Union, and represents NSF as the government liaison to the U.S. National Committee for the International Union of Radio Science. Additionally, she is a Sophie and Tycho Visiting Professor of Astronomy at the Neils Bohr Institute DARK Cosmology Center, University of Copenhagen and serves as an executive mentor in the Brooke Owens Fellowship program for women and gender-minority students. Prior to joining the National Science Foundation in 2017, Dr. VanderLey served as Assistant Director of the Mathematical & Physical Sciences Department for the John Templeton Foundation from 2014 – 2017, where she developed and oversaw a portfolio of research grants focused on foundational questions in mathematics, physics, cosmology, and astronomy. Dr. VanderLey completed her masters and Ph.D. in Astronomy from the University of Maryland, College Park and her bachelor's degree in Astrophysics from Agnes Scott College. She conducted research before and during graduate school working for NRAO, the California Institute of Technology and Cornell University. Upon completion of her Ph.D., she was a Research Fellow and an NSF Astronomy & Astrophysics Postdoctoral Fellow in the Berger Time Domain Group at Harvard University.

Opening Talk: Mt. Ira Keltz

Ira Keltz is Deputy Chief of the FCC's Office of Engineering and Technology. OET is the Commission's primary resource for engineering expertise and provides technical support to the Chairperson, Commissioners and FCC Bureaus and Offices. Mr. Keltz is responsible for developing national spectrum policies for the United States telecommunications industry. This includes allocating spectrum for licensed services, setting technical rules for unlicensed devices, and implementing procedures for equipment certification. Mr. Keltz has totaled over 25 years at the FCC spanning two separate stints. In addition to positions in OET, he has held various positions in the Commission's Wireless Telecommunications Bureau. Mr. Keltz has also worked for the law firm DLA Piper as well as Loral Advanced Projects and LSA, Inc. He earned a Master's Degree in Electrical Engineering from the George Washington University and a Bachelor's Degree in Electrical Engineering from the University of Michigan.

Sponsor Breakout Session

Spectrum Sensing with Deep Learning To Identify 5G and LTE Signals

Presenter: Ethem Sozer (MathWorks)
Location: Breakout Room I
Abstract: Computer vision uses the semantic segmentation technique to identify objects and their locations in an image or a video. In wireless signal processing, the objects of interest are wireless signals, and the locations of the objects are the frequency and time occupied by the signals. In this talk, we apply the semantic segmentation technique to wireless signals to identify spectral content in a wideband spectrogram. Highlights of the talk are: (1) Generate training signals; (2) Apply transfer learning to a semantic segmentation network to identify 5G NR and LTE signals in time and frequency; (3) Test the trained network with synthetic signals; and (4) Use an SDR to test the network with over the air (OTA) signals.

Ettus Research SDR Engineering Technical Q&A

Presenters: Neel Pandeya, Haydn Nelson, Michael West, and Michael Dickens (NI / Ettus)
Location: Breakout Room G
Abstract: Join us for an open technical discussion. Bring your technical questions and challenges specifically related to engineering with the USRP. If you want to learn about leveraging the FPGA for your SDR application you're invited to pre-watch the Ettus Research USRP RFNoC Technical Workshop Video. You can also download the content from this video. We'll have Ettus Research Applications Engineering and R&D ready to discuss… Come ready to ask us anything.

Solving the Problems for Massive Phase Arrays

Presenters: Robin Getz, Travis Collins, and Mike Jones (Analog Devices)
Location: Breakout Room F
Abstract: The digitization of transmit and receive signals at the element level opens the door to new processing and beamforming schemes and promises to deliver maximum flexibility and unprecedented dynamic range in large systems. However, it is not without inherent risks and practical challenges associated with the amount of data to process and the use of less sophisticated transceivers. Depending on your application (required tuning range and instantaneous bandwidth), Analog Devices has solutions that can scale from single-digit narrow bandwidth channels to thousands of 500 MHz or wider bandwidth channels; all of which may be pure digital or use a mix of all analog or hybrid analog/digital beamforming techniques. This open technical discussion will provide broad overviews of several interrelated aspects of the resulting systems. A survey will be taken at the start of the discussion to ensure we are hitting the points that attendees are most interested in.

Changing the World with Ubiquitous Cellular Coverage

Presenter: Tyghe Speidel (Lynk)
Location: Breakout Room H
Abstract: We're building a network of small satellites to provide affordable cellular coverage everywhere on the planet. Our constellation of low-earth-orbit satellites will provide universal geographic coverage for existing mobile phones and cellular IoT devices. Users will have connectivity whenever they roam outside of terrestrial mobile tower coverage with no hardware or software changes needed to their mobile phone. When life-shattering events occur, the ability to call for help is critical. Whether it is a farm machine accident, a shipwreck, a hurricane, a flood or some other disastrous event, the ability of people in remote locations to call for help in an emergency is critical. Our satellites will provide the missing "link" to connectivity for everyone, everywhere, thereby our technology will literally save lives.

Technical Breakout – Session I

Remote Radio Operation with POWDER and GNU Radio

Tutorial Presenters: Kirk Webb, Gary Wong (University of Utah)
Location: Breakout Room B

Abstract: POWDER is a wireless testbed offering researchers around the world the opportunity to run remote wireless experiments in a large scale, real world laboratory. It offers deep end-to-end programmability, permitting researchers low-level control over a variety of radio transceivers, compute hardware, and wired network switches. POWDER is one of the initial NSF-funded PAWR platforms, and includes dozens of software-defined radios across many fixed and mobile locations, linked to thousands of CPU cores of computational resources connected by a 100 Gbps network backhaul. The tutorial we propose will introduce attendees to POWDER facilities. We will provide hands-on exploration of remote control of GNU Radio software on POWDER hardware. The tutorial will primarily consist of guided hands-on experimentation exploring how to use GNU Radio with POWDER resources. Users must sign up for POWDER accounts via: "https://www.powderwireless.net/signup.php?pid=newsdr21" before the tutorial begins. During the session, attendees will learn about POWDER policies and usage guidelines, log in to their accounts, and instantiate a testbed profile (which will automatically allocate either a pair of USRP B210 radios and corresponding Intel NUC compute hosts for them, or a generic compute host in case of resource shortage). The instantiation process will automatically provision the compute host with a pre-selected disk image (in this case, a base OS image plus UHD plus GNU Radio). Credentials will be established automatically, and attendees will learn how to follow the status of the experiment provisioning and then access their allocated compute host and radio. Each participant will construct and operate a simple GNU Radio Companion flowgraph to implement the functionality required to establish a digital link between two (physical or simulated) POWDER stations. For advanced users, or those interested in further investigation of POWDER after the tutorial concludes, we will also provide instructions on how users can create and modify their own profiles, to customize the resources they request and allocate, and to share results with other researchers.

Software Defined Radio with the RFSoC 2×2

Tutorial Presenters: Robert W. Stewart and David Northcote (University of Strathclyde), Patrick Lysaght (Xilinx, Inc.)
Location: Breakout Room C

Abstract: This tutorial will demonstrate SDR design leveraging the Xilinx Zynq Radio Frequency System on Chip (RFSoC), an FPGA-based platform that includes high speed (GHz) data converters. It will also feature PYNQ, a Python based software framework that makes SoC design more accessible, which we deploy on the RFSoC for SDR. Using PYNQ, we can interface directly with software running on the RFSoC chip via a web browser, and even build user-friendly graphical user interfaces ('dashboards'). As well as reviewing the architecture of the RFSoC, and providing an overview of PYNQ, a few key signal processing features will be highlighted. Finally, live SDR demonstrations of PYNQ-RFSoC will be presented, featuring in particular an entirely RFSoC-based spectrum analyser (interface pictured below) and inspection of 'off-the-air' signals. We will also outline the design flow, and explain how new users can access learning materials and get started with this technology.

Technical Breakout – Session II

Wireless Solutions for the Digital Divide: Need for a Systems Approach

Panelists: Filippo Malandra (University at Buffalo), Shams Bhada (Worcester Polytechnic Institute), Casey Canfield (Missouri University of Science & Technology), Jigyasa Sharma, (US Ignite)
Moderator: Alexander M. Wyglinski (Worcester Polytechnic Institute)
Location: Breakout Room D
Abstract: At least 17 million Americans lack adequate access to the internet, reducing their access to jobs, education, and healthcare. This panel highlights two wireless deployments in underserved communities as part of Project OVERCOME, which aims to test novel broadband technology solutions. To solve the digital divide, we need to approach this problem from a systems perspective to develop solutions that integrate tools from technology, community engagement, and policy.

Software Defined Radar

Panelists: Julio Urbina (Penn State University), Frank Robey (MIT Lincoln Laboratory), Michael Hirsch (Boston University)
Moderator: John Swoboda (MIT Haystack Observatory)
Location: Breakout Room E
Abstract: Radar has gone through drastic changes recently as software defined radio (SDR)technology becomes more prevalent. This panel will discuss this shift in various aspects of radar technology. This will include how does this new paradigm impacts the development cycle of new systems, discussion of techniques that are now that are more feasible to implement and what sort of features in future SDR systems would help speed up the development process.

Poster Presentations

1 – A Flexible Digital Radio Interface for CubeSat Communications using GNURadio

Timothy Lucas Briggs (MIT Haystack Observatory)

AERO and VISTA are twin 6U small satellite missions funded through NASA and are both being led by MIT Haystack Observatory. The main goal of the missions is to study the radio emissions from the aurora and will require the downlink of numerous types of data. As part of these missions a testable digital radio interface for CubeSat communications has been developed. This radio interface is designed for maximum flexibility and versatility using open-source software tools. The signal chains for both transmitter and receiver allow reliable "bursty" transmission of definite-length packets using GFSK modulation/demodulation between two USRP B210 SDRs using GNURadio. Packet input/output utilizes ZMQ message-passing blocks such that packets can be built/parsed using more straightforward Python class implementations. Radio and packet building parameters are fully configurable through YAML files. These parameters include center frequency, samples per symbol for GFSK, packet length, syncword, CRC, and whitening. A REDIS server is used to stream data to and from the radio communication interface to other portions of a larger satellite ground data pipeline. All software is designed with proper SOLID principles and object composition/inheritance patterns in mind to create a package that is as usable and extendable as possible.

2 – Adaptive Radio Science and the Challenge of Spectrum Coexistence

Frank Lind, Sharanya Srinivas, Phil Erickson, John Swoboda, Kazunori Akiyama, Chris Rackauckas, Theo Diamandis, Alan Edelman (MIT Haystack Observatory)

Spectrum coexistence is a major challenge facing radio science in the modern era. Scientific use of the radio spectrum aids in the study of Earth's atmosphere, near space environment, and the larger astronomical universe. To enable fundamental research, scientific instruments span wide bandwidths and have high sensitivity. Proliferation of radio frequency (RF) systems pose new interference challenges. Historically, commercial, military and science users have been operating in relative spectral isolation. This has resulted in sparse usage of frequency bands (i.e. often called "white space"). New-era applications propose to use dynamic allocation of these bands to alleviate spectral congestion problems. However, spectrum that is sparse from a transmit point of view is often being leveraged by scientific users, precisely because it is not occupied. Signals used for radio science are often extremely weak and susceptible to interference. This has driven new radio science instruments to very remote locations. Most recently, the launch of satellite communications constellations is creating a new generation of globally visible mobile sources that cannot be easily avoided. We will discuss the challenges of this new era and our efforts to develop novel and highly efficient interference cancellation techniques for radio science observatories.

3 – Analyzing Amazon Sidewalk FSK Protocol

Victor Cai, Stefan Gvozdenovic, Amit Krishnaiyer, Dr. David Starobinski (Boston University)

Amazon Sidewalk is a low-bandwidth mesh network primarily used for home automation. Among several other communication protocols, Sidewalk supports a new proprietary communication protocol dubbed FSK (frequency shift keying). This project demonstrates a programmable method of capturing, channelizing, and decoding FSK packets of Amazon Sidewalk through Software-Defined Radio (SDR) technology. Specific accomplishments include: (1) energy detection of packets; (2) filtering multiple channels in parallel; (3) detection of preamble and sync word; (4) decoding of the bit stream. This method can be used for traffic analysis and security and privacy evaluation of the Sidewalk IoT protocol.

4 – An Adaptive Intelligent Wireless Demodulator

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

In wireless communication systems, a received signal is corrupted by various means, such as noise, multi-path fading, and defects in hardware. Each of these defects must be corrected for at the receiver side to properly demodulate the signal and obtain the original data. In typical systems, this involves a series of filtering, phase and frequency corrections, timing recovery, and finally demodulation; with many of these stages being modulation specific. Deep learning (DL) has been used to replace these stages into a single system capable of blindly demodulating received signals. However, these systems can only handle scenarios that were accounted for in the training stage. If a new modulation type, channel condition, or pulse shaping is encountered, the DL system may be unable to demodulate the signal. We introduce adaptability into this system using incremental learning (IL). This allows a network to learn new information, after the initial training phase, while retaining previously learned information. When the system encounters a modulation type or scenario it is unable to recognize, it trains on new signals received over-the-air, so that it can demodulate them in the future. The system is tested using software defined radio, to show its feasibility in a real system.

5 – Cloud-based 5G Spectrum Observatory

Joseph Murphy, Ian Casciola, Sreeshti Chuke, Aneela Haider, Kevin Mbogo (Worcester Polytechnic Institute)
The goal of the Cloud-based 5G Spectrum Observatory was to build a low-cost, easily accessible spectrum analyzer capable of monitoring multiple 5G frequency bands in real-time. By creating a web-based system, the observatory was remotely accessible and enabled remote control over the radios to change operational parameters during runtime. The implementation granted access to a system that would typically be more expensive to deploy and much less accessible. Using GNU Radio, Python, JavaScript, and Node.js, as well as multiple USRP2901 software-defined radios, the observatory was implemented as a successful proof-of-concept that serves as a starting point for future works expanding upon the project and adding additional functionality.

6 – Dual Security System with Link Signature Keying (LSK) and Optical Wireless Communication (OWC) using Software Defined Radio (SDR)

John Carlo Laude, Arsalan Ahmed, Rosalind Agasti, Zachary Garnes, Myles Toole, KC Patel and Michael Rahaim (University of Massachusetts Boston)
The management and distribution of encryption keys are essential components of a secure wireless communication. However, the RF medium is susceptible to eavesdropping and interception of vital shared information that would provide unauthorized access to the encrypted keys. To counteract this, we introduce a dual security protocol that jointly uses link signature keying (LSK) and optical wireless communication (OWC). The proposed protocol takes advantage of the OWC link's locality and the location dependence and ability to derive symmetric encryption keys of LSK. LSK is first observed over the RF link to define an encryption key which will encrypt the OWC link, a secondary key is then distributed over the low-rate optical link which is also used to encrypt the primary RF link. The RF encryption key can be dynamically modified and redistributed over the secure OWC link We developed a proof-of-concept implementation of the proposed protocol using the GNU Radio software defined radio toolkit. The system is simulated using custom OWC channel modules and existing tools within the GNURadio core library. We also demonstrate a physical instantiation of the system using the Universal Software Radio Peripheral (USRP) hardware.

7 – gr-owc: An Open Source GNURadio-Based Toolkit for Optical Wireless Communications

Arsalan Ahmed and Michael Rahaim (University of Massachusetts Boston), Myles Toole and Tyree Spears (University of Lorraine)
In recent times, the growing demand for wireless capacity along with the advancement of laser and light emitting diode (LED) technology has accelerated Optical wireless communications (OWC) research. However, a huge hurdle for new researchers in this field is the lack of openly available toolkits that can provide real-time signal processing capabilities and allow performance evaluation at higher layers. Therefore, we extend the concept of software defined radio (SDR) to present gr-owc, an open source out-of-tree module for the widely used GNURadio signal processing toolkit. Within gr-owc, we have developed signal processing blocks for OWC channel simulation and common OWC modulation/demodulation techniques. Once integrated with GNURadio, gr-owc can be used to simulate a multi-cell/multi-user OWC network. In addition, gr-owc signal processing blocks can be deployed in a physical implementation using SDR hardware, namely the universal software radio peripheral (USRP). Furthermore, the project is designed for continued development internally and with the goal of engaging the broader OWC research community.

8 – Hyperparameter Optimization in Convolutional Neural Network using Genetic Algorithm with Stopping Criterion

Charles Montes (University of Massachusetts Dartmouth)
Hyperparameter optimization is the maximization of a neural network's accuracy using a set of input hyperparameters. With much research going into neural networks, in this case convolutional neural networks (CNNs), most research uses manually chosen hyperparameters instead of choosing optimal hyperparameters. Much work has gone into optimizing hyperparameters as they greatly effect the accuracy of CNNs and enable automated machine learning. Choosing the optimal hyperparameters requires applying an algorithm, in this

case the genetic algorithm, to search for them. Each search operation requires a full training using a set of hyperparameters which is computationally expensive. New research has shown advantages to applying a stopping criterion to improve the neural network accuracy while reducing the computational cost. The goal of this research project is to use the genetic algorithm with adapted stopping criterion to reduce the computational cost of optimizing hyperparameters in CNN sand to apply it on baseband modulation classification.

9 – Introduction to Deepwave Digital AIR-T

Jeff Zurita (Deepwave Digital)

This poster talk will introduce Deepwave Digital's product, the Artificial intelligence Radio Transceiver, or AIR-T. The AIR-T is the first-of-its-kind single-board software defined radio (SDR) featuring a fully integrated FPGA, CPU, and GPU. Tightly coupling these hardware components together enables high-speed access to RF signal data (IQ samples) by artificial intelligence and machine learning (AI/ML) applications. The AIR-T software defined radio can process up to a 100 MHz bandwidth and with its embedded compute capabilities has the ability to execute any number of software algorithms, including artificial intelligence and machine learning of RF signals. The AIR-T has already been deployed as an intelligent spectrum sensor and has the potential for many other applications. The AIR-T has a small form factor, having been designed as an edge-compute platform. It can be deployed outdoors in harsh environments and can easily be adapted to a vehicle or human-portable configuration.

10 – Radioware: Courseware and Lab Kit for Interference-Limited Communications and Electronic Defense

Nathan Jensen, John Morris, Xiwen Kang, Jonathan Chisum, Bertrand Hochwald, and J. Nicholas Laneman (University of Notre Dame)

The use of the radio frequency spectrum is exploding due to high demand from communications, sensing, positioning, public safety, and defense. This has led to an equally increasing demand for learners who have an understanding of practical radio systems that must operate in the presence of interference. This project aims to expose the issues involved in maintaining link quality when operating in congested and contested environments. Specifically, we are developing educational materials and a low-cost laboratory kit meant to increase interest in and prepare learners for tackling these modern challenges. With this new courseware, we hope to provide a solid foundation on the concepts, hardware and software implementation aspects, testing and debugging, and performance evaluation of radio systems. Due to the importance of hands-on learning in this setting, the laboratory kit is of particular interest. The ADALM-Pluto is an all-in-one fully integrated SDR which is used as a learning aid in many modern digital communication classes. Our goal is to create a novel and supplementary SDR learning aid which has a modular design in order to expose the various analog components involved in radio that can be particularly sensitive to interference. To do so, we utilize the ADALM-2000 and several evaluation boards from Analog Devices. These include fully differential amplifier drivers supporting I/Q operation, tunable phase locked-loops serving as the local oscillators, and active mixers for the modulators and demodulators. We have designed a custom interface board for the ADALM-2000 that provides differential Tx output, Rx filtering and amplification, and SPI communication. This latest setup allows us to support a homodyne, 16 QAM communication scheme at a streaming bit rate of 100 kbps, which we are steadily improving. The similar internal architectures between the ADALM-Pluto and ADALM2000 means that only minor changes are needed to support both devices on the software side, where various signal processing techniques are utilized to ensure a robust and high performing communication link.

11 – RFSoC-based SDR designs using GNU Radio and PYNQ

Marius Siauciulis (University of Strathclyde)

This work focuses on developing an open-source FPGA-accelerated SDR development methodology for Xilinx RFSoC (with collateral ZYNQ & MPSoC support) using GNU Radio and the PYNQ framework. The Xilinx RFSoC family is a new generation of highly integrated Software Defined Radio (SDR) devices that incorporate a Linux-capable, ARM-based Processing System (PS), high performance Programmable Logic (PL) and multi-Gsps RF Data Converters (RF-DCs) on a single chip. The ultimate objective of this work is the implementation of an RFSoC-based radio running GNU Radio on the PS, handling input data generation and output data visualization as well as some parts of the DSP chain. Custom GNU Radio blocks based on the Python PYNQ library are used to handle the FPGA bitstream, AXI4-Lite register access for control signals, AXI4-Stream for data transactions and RF-DC parameter control. Finally, the FPGA fabric contains the computationally expensive modulation/demodulation, interpolation/decimation, filtering stages, and interface to the high-speed RF-DCs. The poster will showcase the initial findings and a proof of concept design that efficiently utilizes the different available resources on the RFSoC platform.

12 – SMP – an SDR Middleware Platform

Johannes Becker and David Starobinski (Boston University)

The growing number of IoT protocols and the upcoming availability of new spectrum bands for wirelessly connected devices have made SDR technology increasingly useful to interact with radio-based communication. However, SDR-based tools are typically complex and technical, and inherently require a specialized skillset in digital signal processing (DSP) to operate. To address this problem, we present SMP, a Software-Defined Radio Middleware Platform that encapsulates and abstracts much of the current complexity in software-defined radio (SDR) toolchains. SMP allows network security professionals to interact with the physical layer of wireless devices across protocols and frequency bands, without requiring digital signal processing skills. SMP implements interfaces with common network analysis tools, such as Wireshark, to facilitate use cases such as traffic analysis or rogue device detection. To demonstrate SMP capabilities, we show how it can encapsulate GNU Radio flowgraphs, facilitate simultaneous multi-protocol scanning, and convert existing SDR-based protocol implementations into fully contained applications.

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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**