Workshop Tutorial

There are three training workshops/tutorials offered by Ettus Research, which are listed below.

These training workshops/tutorials can be run as a lecture/seminar, or as a hands-on workshop. They can be run at the NI office in Austin, Texas, USA, or at the location of the customer. These workshops/tutorials are run ad hoc and upon request, and there is no regular schedule for when they are run.

For questions about these workshops/tutorials, please contact us at support@ettus.com.

- **USRP Open-Source Toolchain: UHD and GNU Radio** [NI P/N 910915-21]: This tutorial provides a thorough and practical introduction to the USRP hardware and the open-source software toolchain (UHD and GNU Radio). After exploring the hardware and the architecture of the USRP family of software-defined radios, we will discuss topics such as getting started using a new USRP device, using the UHD device driver, programming the USRP from C++ using the UHD API, using GNU Radio with the USRP, creating and running flowgraphs from both GRC and Python, managing FPGA images, viewing packetized I/Q data with Wireshark, and debugging and triaging common technical problems, such as with network configuration, flow-control errors, and RF issues. Several demos and examples will be shown, such as performing real-time spectrum monitoring, transmitting pre-recorded waveforms, implementing an FM transmitter and receiver, and running an OFDM transceiver. Several additional complementary open-source tools will also be discussed, such as GQRX, Fosphor, Inspectrum, and several GNU Radio Out-of-Tree (OOT) modules. We will explore several demonstrations of wireless systems running on the USRP, such as a record-and-playback system, a spectrum-painting tool, and an LTE network scanner tool. We will include several additional focused topics, such as high-rate 10 Gigabit Ethernet networking and I/Q data streaming, host system performance tuning, USRP device recovery, and various operational best-practices. Attendees should gain a solid foundation and practical understanding of how to configure, program, and operate the USRP to implement a wide range of wireless systems and applications.
    - Workshop_GnuRadio_Materials_20171212.tar.gz (TAR-GZ) (13 MB) (2017-12-12)
    - Workshop_GnuRadio_Slides_20190507.pdf (PDF) (45 MB) (2019-05-07)

- **USRP FPGA Processing Using the RFNoC Framework** [NI P/N 910916-21]: This tutorial provides an in-depth introduction to the RFNoC framework, including a discussion on its design and capabilities, several live demonstrations, and a walk-through of implementing a new user-defined RFNoC block and integrating it into both UHD and GNU Radio. The RFNoC (RF Network-on-Chip) framework is the FPGA architecture used in USRP devices. The RFNoC framework enables users to program the USRP FPGA, and facilitates the integration of custom FPGA-based algorithms into the signal processing chain of the USRP radio. Users can create modular, FPGA-accelerated SDR applications by chaining multiple RFNoC Blocks together and integrating them into both C++ and Python programs using the UHD API, and into GNU Radio flowgraphs. Attendees should gain a practical understanding of how to use the RFNoC framework to implement custom FPGA processing on the USRP radio platform.
    - Workshop_RFNoC_4_GRCon20_Part_1_Slides.pdf (PDF) (2.7 MB) (2020-09-14)
    - Workshop_RFNoC_4_GRCon20_Part_2_Slides.pdf (PDF) (2.7 MB) (2020-09-14)
    - Video Presentation (YouTube URL) (2020-09-14)
    - Application Note for Getting Started with RFNoC in UHD 4.0
    - RFNoC Specification Document

- **USRP Open-Source 5G/NR System Implementation** [NI P/N 910917-21]: This tutorial provides a detailed overview of how to implement a 3GPP-compliant 5G/NR testbed using the USRP radio with the open-source software stacks, srsRAN from Software Radio Systems (SRS), and OpenAirInterface (OAI) from Eurecom, for research, development, and prototyping. We examine both the base station (eNB and gNB) side, as well as the handset (UE) side. We examine three implementations for the UE: an emulated software UE; a commercial handset; and a stand-alone modem module. We discuss in detail how to install, configure, and operate the hardware and software for the base station side and the handset side, as well as for the core network, in order to create a fully functional network. We discuss various aspects of radio and network planning and implementation, discuss network operation monitoring, and discuss performance and throughput measurements. We show a video of a demonstration of the real-time operation of a 5G network. Attendees should gain a practical understanding of how to use USRP devices to implement 5G/NR wireless networks.
    - Application Note for 5G OAI USRP Reference Architecture & Testbed