USRP Update
Low Cost High Performance SDR

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Introduction

- **Who am I?**
  - Core GNU Radio contributor since 2001
  - Designed the Universal Software Radio Peripheral (USRP) in 2003
  - Founded Ettus Research in 2004

- **Ettus Research**
  - Formed to support and commercialize the USRP
  - Acquired by National Instruments in 2010
  - Committed to our Vision of building low-cost, easy to use software radios
  - Committed to Open Source and the GNU Radio Community
The USRP story
Outline

1. Introduction
2. Third Generation
3. RFNoC
4. New product announcements
5. Roadmap
6. Thanks
Third Generation of USRP

- Easy integration of multiple processing paradigms, especially large FPGA fabric
- Very large bandwidth (56 to 160 MHz), very wide frequency coverage
- Massive MIMO scalability
- RF Network on Chip Architecture
  - Common FPGA design allows for portable IP development
  - UHD exposes FPGA capabilities to the user
  - Enables easy FPGA programming without hand written Verilog
  - Accessible from GNU Radio
X300 and X310

- 160 MHz RF Bandwidth
- 200 MS/s 14-bit ADCs, 800 MS/s 16-bit DACs
  - Flexible clock rates
- Dual 10GbE with SFP+ ports
  - SFP+ ports will also do 1 GbE and CPRI
- PCIe x4 (over cable)
- Large Kintex 7 FPGA
  - 840/1540 DSP units (X300/X310)
- 1 GB onboard DDR3
- Built-in GPS Disciplined OCXO, or use with external references
- 2x2 MIMO w/beamforming out of the box
  - Expandable to arbitrary width MIMO
- Uses standard Ettus Research high dynamic range RF boards covering DC to 6 GHz
Stream 300+ MHz of RF BW each way in 10 GbE mode, 200 MHz in PCIe mode

Very low latency
  - Should be good enough for 802.11ac

Auxiliary digital IO for control of external amps, switches, etc.

Half-width single rack unit enclosure
  - 4x4 MIMO in 1 RU
E300

- Xilinx Zynq FPGA/Processor
  - Dual Core ARM Cortex A9 at 800 MHz
  - Large Programmable Logic Area
  - 1 GB DDR3 DRAM for processor, separate 512 MB for Logic

- Integrated RF
  - 70 MHz to 6 GHz integrated RF
  - 2x2 MIMO, Full Duplex
  - 56 MHz RF BW
  - Full coverage RF Filterbanks

- Gigabit Ethernet, USB 2.0 Host
- GPS Synchronization
- Stereo audio in/out
- 10-axis IMU (Accelerometers, gyros, magnetometers, altimeter)
E300 Features

- Small handheld enclosure, 60mm by 120mm by 27mm
  - Cellphone sized, but thicker
- Runs a full Linux distribution maintained by key members of embedded Linux community
- Strong SW Ecosystem
  - UHD Device
  - GNU Radio support
  - LabVIEW and LabVIEW FPGA support
  - Develop on desktop, deploy on embedded device
- Expandable via USB
  - Flash drives, WiFi, Bluetooth, LTE modems, display, keyboard, etc.
- Battery and battery-less configurations
E300 Applications

- Mobile Network research
- Network testbeds
- Small, portable, low cost spectrum monitor
- Small UAVs
- Handheld universal communicator
- Wireless sensor nodes
- Portable signal analysis and test equipment
- Indoor positioning development system
Full duplex Transceiver daughterboard

- 10 MHz to 6 GHz
- 40 and 160 MHz BW options
- RX: 2-7dB NF, 4-13dB IIP3
- TX: 10-20+ dBm output power
- Fully shielded
- Full characterization data on line
RFNoC

- Complete system for developing SDR applications in FPGAs
  - Transparently move between CPU and FPGA domains
  - Distribute processing across many FPGAs
- Fully accessible from GRC
  - NOCScript reduces or eliminates support code on host
- E300-series and X300-series support
- Growing library of blocks
- Xilinx Vivado-based tool flow
- Vivado HLS-enabled
  - Use C/C++ and never write Verilog or VHDL again!
RFNoC sessions

- Wed 10:00AM – RFNoC Overview and Introduction
- Wed 11:00AM to 3:00PM – Half-Day Hands-on RFNoC tutorial
- Thur 9:30AM – RFNoC fosphor
- Thur 12:00AM – OFDM in RFNoC
B200-Mini

- Small, Low cost all-in-one solution
- 70 MHz to 6 GHz integrated RF
- Spartan 6 LX75 FPGA
- USB 3.0 interface, bus-powered
- 56 MHz of RF BW
  - 61.44 MS/s, with flexible clock rates
- Full Duplex operation
- 20-50mW output power
- JTAG and GPIO connectors for FPGA development
- Extended temperature and bigger FPGA versions available
E312

- E310 + Battery
- 3200 mAh Li Ion
- Full safety certifications
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TwinRX

- 10 MHz to 6 GHz Dual Receiver daughterboard
  - 4 receivers in an X300
  - 8 receivers in a single rack unit
- 80 MHz Bandwidth per channel
- Better than 8dB Noise Figure
- Greater than 5 dBm IIP3
- RF preselector filter bank
- Phased Array and direction-finding capable (true shared LO)
  - ~1 us switching between independent and phased-array modes
- Very fast frequency hopping (~1us)
The Future...

- Wider bandwidth
- Higher density
- Higher frequencies
- Embedded processing
- RFNoC everywhere
- Complete reference applications for OFDM, spectrum monitoring, etc.
Thanks!

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